

SOIL TAXONOMIC UNITS AND POTENTIAL PLANT COMMUNITY RELATIONSHIPS IN A PRISTINE RANGE AREA OF SOUTHERN IDAHO

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The use of soil survey data in range evaluation and management is receiving increasing attention (3, 4, 6, 7, 8, 9). Soil surveys on rangelands are currently included in the National Cooperative Soil Survey.

The interpretation of soil surveys on rangelands is based on the assumption that the nature of a plant community is affected by environmental factors such as soils and climate. This concept is translated into practice in terms of range sites which are defined as groups of soils that produce similar kinds and amounts of native vegetation.

There is a need for soil survey data that accurately indicate the kind of plants that grow on each kind of soil. There are, however, few undisturbed areas where plant-soil relationships can be observed with the assurance that they have not been influenced by domestic grazing, fire, or other factors. It is necessary, then, to study a small number of undisturbed relict areas and project the data to other similar soils (1, 10).

A pristine range area in southern Idaho afforded the opportunity to study the vegetation and soils where a minimum of disturbance has occurred.

STUDY AREA

The Soil Conservation Service conducted investigations in a 200-acre area known as the "Carey Kipuka," located on the Snake River Plain about 25 miles northeast of Carey, Idaho. The soils of the Carey Kipuka are isolated from surrounding land areas by extensive lava flows about 250 to 1,000 years old (11). There is

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no evidence of grazing but signs of rodents, bobcats, snakes, coyotes, sage grouse, and deer were noted.

The topography is hilly and elevations range from approximately 5,200 to 5,400 feet.

Big sagebrush, grasses, and forbs are growing on the area. Idaho fescue is the dominant grass but bluebunch wheatgrass and Nevada and Sandberg bluegrass contribute substantial amounts of herbage.

The continental climate of the area is characterized by variable precipitation, cold winters, and hot dry summers. Winds are common at all seasons. The average annual temperature is about 42° F. and the mean annual precipitation is about 14 inches. Snow covers the soil in the winter and melts slowly in the spring. There is usually a plentiful supply of soil moisture at the beginning of the growing season. Summer rains are usually of short duration and soil moisture is quickly lost through evaporation and transpiration.

The nearest source of weather information is at Craters of the Moon National Monument about 10 miles north and slightly east of the study area. Here, in 1959, precipitation for the period December 1 to April 4 was 5.03 inches. In April precipitation was 0.93 inch, in May it was 1.41 inches, and in June it was 1.21 inches. The average temperature for April was 41° F., for May it was 49° F., and for June it was 61° F. Weather data for the period July to November were not available.

Soils of the Carey Kipuka were formed mainly from loess, basaltic ash, and basaltic cinders. They are in the Chestnut great soil group. Studies were made on Tetonia silt loam, deep over basalt; Eagle Cone very stony silt loam, moderately deep over basalt; Carkip silt loam; Goodington silt loam; Gooding loam, deep over basalt; and Bancroft silt loam, deep over basalt cinders. Soil names are tentative.

Tetonia silt loam, deep over basalt (Fig. 1) is a nearly level soil on an eastern slope in the southeast part of the study area. It has formed in Snake River loess underlain by basalt. The surface soil, to a depth of 7 inches, is brown silt loam that is slightly to medium acid. Between 7 and 18 inches, the subsurface or B2t horizon is brown neutral heavy silt loam with subangular blocky and cylindrical blocky (5) structure. Between 18 and 36 inches, the Cca horizon is light gray, strongly calcareous silt loam with lenses of weakly cemented calcium carbonate and many calcium carbonate concretions.

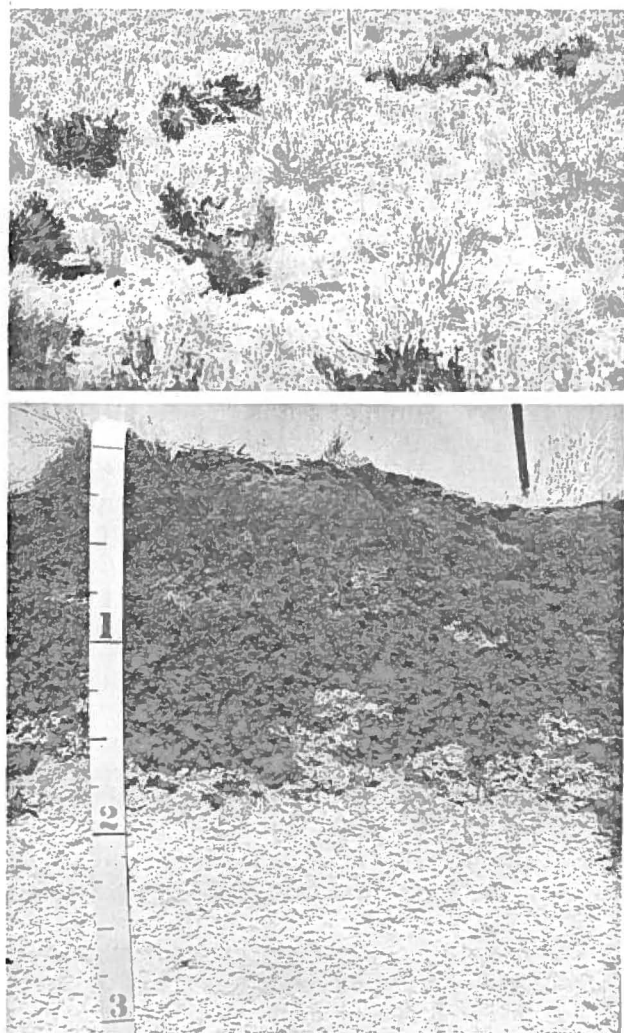


Fig. 1. Tetonia silt loam, deep over basalt: General view of vegetation (above) and soil profile (below).

Eagle Cone very stony silt loam, moderately deep over basalt (Fig. 2), is a nearly level soil on an east-facing ridge east of the Tetonia site. It has formed in loess, 12 to 24 inches deep over fractured basalt. The A horizon, 5 inches thick, is brown, neutral silt loam containing about 25%, by volume, of basalt stones.

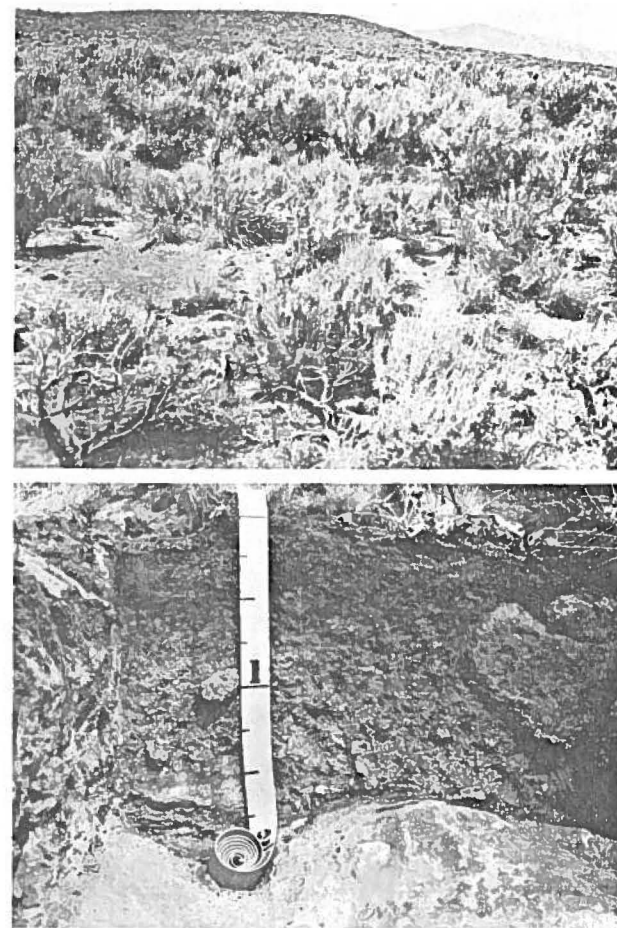


Fig. 2. Eagle Cone very stony silt loam, moderately deep over basalt: General view of vegetation and soil profile.

The B2 horizon, between 5 and 11 inches, is light brown, mildly alkaline, very stony silt loam. The Cca horizon, between 11 and 24 inches, is light brownish gray, strongly calcareous, very stony silt loam containing calcium carbonate concretions.

Carkip silt loam (Fig. 3) is a nearly level soil on a south-facing slope. It has formed in loess over basaltic ash and cinders. The surface soil, 15 inches deep, is dark grayish brown to dark

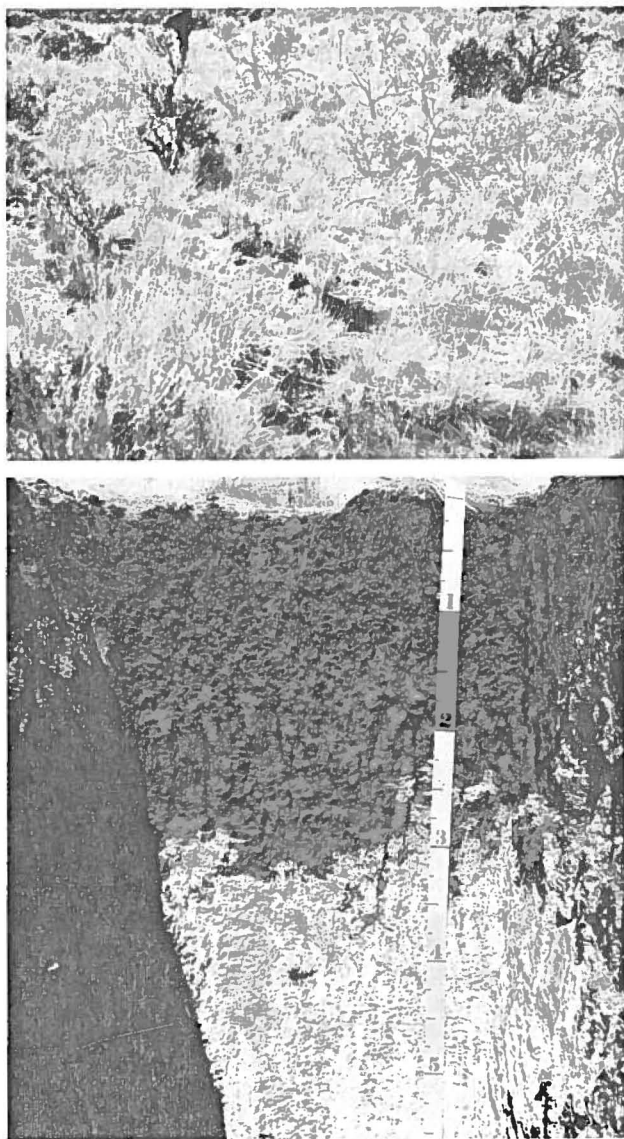


Fig. 3. Carkip silt loam: General view of vegetation and soil profile.

brown, slightly acid loam. At 15 to 23 inches is a brown transitional zone, B1 horizon, of brown slightly acid heavy loam. The boundary between the B1 and B2t horizons is abrupt. The B2t horizon, at 23 to 57 inches, is silty clay throughout. The upper part is brown and mildly alkaline. The lower part is pale brown and moderately alkaline clay. From 57 to 68 inches the soil is a pale brown, strongly calcareous silty clay containing coarse veins of calcium carbonate and many basalt pebbles.

Goodington silt loam (Fig. 4) is a nearly level soil on a south slope adjacent to the Carkip area. The A1 horizon is dark grayish brown to brown, slightly acid to neutral silt loam. The A2 horizon contains bleached sand and silt grains on the ped surfaces. The upper subsoil, at 15 to 34 inches, is brown to pale brown silty clay. It is mildly to moderately alkaline. The lower subsoil of pale brown, moderately alkaline silty clay contains veins of calcium carbonate and is strongly calcareous. The Cca horizon, 56 to 96 inches, is white, strongly calcareous silty clay in the upper part and very pale brown, strongly calcareous gravelly loam in the lower part. It is underlain by basalt at 96 inches.

Gooding loam (Fig. 5) is a gently sloping soil in the northwest part of the study area. The soil has formed in basaltic ash and cinders. The surface soil, 0 to 14 inches, is brown, slightly acid to neutral loam containing angular basalt pebbles. In the lower 4 inches, A2 horizon, the ped surfaces are coated with bleached sand and silt grains. The subsoil, at 14 to 30 inches, is brown, neutral to mildly alkaline clay with thin continuous clay films. From 30 to 35 inches, the soil is pale brown, strongly calcareous clay underlain by basalt.

Bancroft silt loam, deep over basalt cinders (Fig. 6) is a moderately steep soil on a north facing slope at the north end of the kipuka. The upper 10 inches is dark brown, neutral silt loam containing common basalt pebbles in the lower part. The subsoil, 10 to 38 inches, is brown, neutral clay loam with basalt pebbles and cobblestones. The lower 6 inches is brown, mildly alkaline silt loam. The Cca horizon, 38 to 55 inches, is very pale brown strongly calcareous silt loam. It is underlain by pale brown, moderately calcareous, gravelly silt loam.

METHODS

Methods and techniques used in this study have been discussed in detail by Passey and Hugie (6).

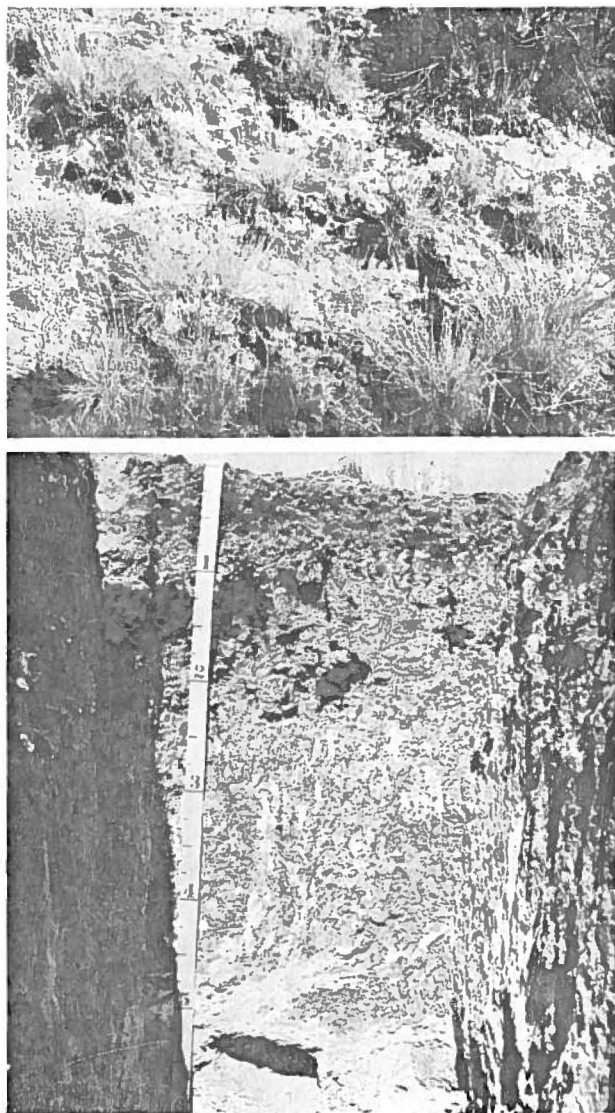


Fig. 4. Goodington silt loam: General view of vegetation and soil profile.

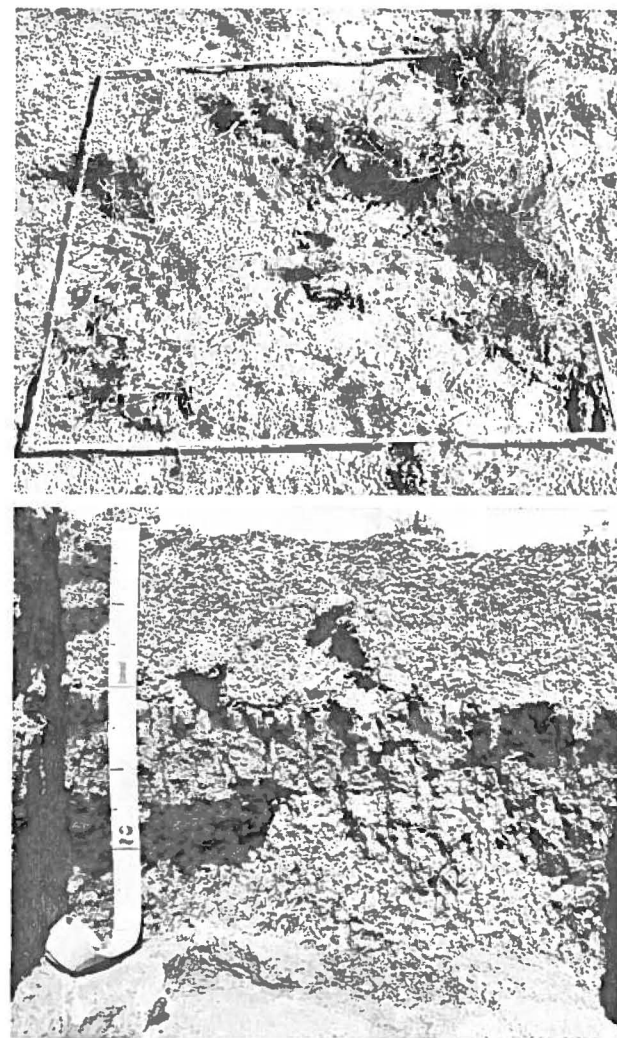


Fig. 5. Gooding loam, deep over basalt: Close-up of vegetation and soil profile.

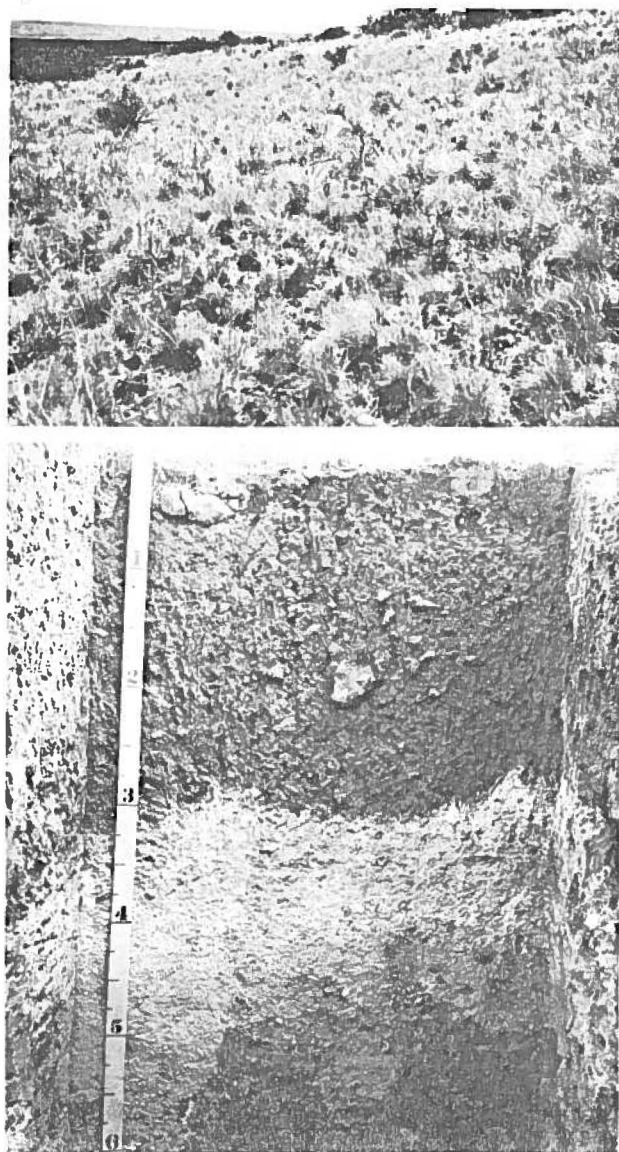


Fig. 6. Bancroft silt loam, deep over basalt cinders: General view of vegetation and soil profile.

RESULTS AND DISCUSSION

The total yield and species composition of the natural plant communities on the six soils are presented in Table 1. This table is incomplete. Only the species that contributed substantial amounts of herbage are included. Yields of Sandberg bluegrass and Nevada bluegrass are combined. Nevada bluegrass occurred in small amounts and was common over the area but difficult to separate at the time of clipping.

Table 1. Yield and species composition of natural plant communities on 6 soils, Carey Kipuka, Idaho, 1959.*

Plant species	Tetonia		Eagle Cone		Carkip		Goodington		Gooding		Bancroft	
	lb. †	%†	lb.	%	lb.	%	lb.	%	lb.	%	lb.	%
Idaho fescue	295	37	164	20	394	51	130	25	38	8	297	46
Bluebunch wheatgrass	93	12	70	9	73	10	49	9	4	1	107	17
Sandberg bluegrass	46	6	72	9	54	7	58	11	44	10	92	14
Prairie junegrass	55	7	26	3	3	T†	7	1	4	1	28	4
Bottlebrush squirreltail	--	T	5	1	7	1	37	7	24	6	--	--
Thurber needlegrass	--	--	25	3	--	--	--	T	43	10	--	--
Total grasses	489	62	362	45	531	69	281	53	157	36	524	81
Tapertip hawksbeard	41	5	--	T	--	T	--	T	--	--	42	7
Arrowleaf balsamroot	34	4	101	13	--	T	--	T	--	--	--	T
Milkvetch	30	4	--	T	--	T	--	--	--	--	--	T
Velvet lupine	--	T	--	T	29	4	--	--	--	--	--	T
Longleaf and Hoods phlox	12	1	7	1	13	2	26	5	40	9	9	1
Andersons buttercup	--	--	--	--	--	--	--	T	14	3	--	--
Pussytoes	--	--	--	--	--	--	18	3	106	24	--	--
Mat eriogonum	--	--	--	T	--	--	--	T	33	8	--	--
Beckwith violet	--	--	--	--	--	--	--	T	--	T	--	--
Other forbs	37	5	61	8	82	10	119	23	28	6	34	5
Total forbs	154	19	169	22	124	16	163	31	221	50	85	13
Big sagebrush	--	T	133	17	75	10	33	6	--	--	--	T
Threetip sagebrush	135	17	--	T	12	2	22	4	--	--	18	3
Douglas rabbitbrush	5	1	10	1	14	1	19	4	--	--	18	3
Antelope bitterbrush	--	--	106	14	--	--	--	--	--	--	--	T
Alkali sagebrush	--	--	--	--	--	--	--	--	64	14	--	--
Total shrubs	140	18	249	32	101	13	74	14	64	14	36	6
Total annuals	7	1	7	1	16	2	12	2	--	T	3	T
Total yield	790	100	787	100	772	100	530	100	442	100	648	100

* Tetonia silt loam, deep over basalt; Eagle Cone very stony silt loam; Carkip silt loam; Goodington silt loam; Gooding loam; Bancroft silt loam, deep over basalt cinders.

† Pounds per acre and % composition. ‡ These species occur in minor amounts.

The approximate date that plant species reach full growth and the depth of their root system in deep soils with no restrictive layers are presented in Table 2. These data are based on field observations from 1958 to 1963. Full growth dates are recorded

Table 2. Growth habits of dominant plants in the Carey Kipuka.

Plant species	Approx. date full growth	Maximum root depth, in.	Plant species	Approx. date full growth	Maximum root depth, in.
Idaho fescue	6/20-6/30	48	Longleaf and Hoods phlox	5/25-6/5	36
Bluebunch wheatgrass	6/20-6/30	48	Pussytoes	4/30-5/10	36
Sandberg bluegrass	5/30-6/10	18	Mat eriogonum	6/20-6/30	42
Bottlebrush squirreltail	6/15-6/30	24	Big sagebrush	8/31-9/10	96+
Thurber needlegrass	6/15-6/30	24	Threetip sagebrush	8/31-9/10	54
Tapertip hawksbeard	6/25-7/5	50	Antelope bitterbrush	6/5-6/20	96+
Arrowleaf balsamroot	5/25-6/5	48	Alkali sagebrush	7/5-7/15	36+

in the table as 10-day intervals and are usually coincident with the full bloom stage. In general, the full growth dates in this table agree with the flower in bloom stage reported by Blaisdell (2) in his studies near Dubois, Idaho, at a similar elevation.

Root systems of forbs, such as pussytoes, phlox, and mat eriogonum are suited to soils with clay subsoils. The roots branch profusely under the crown, spread laterally, and penetrate the clay B horizon along vertical cleavage planes. The roots are flattened but unbroken by expansion and contraction of this horizon. Roots of alkali sagebrush penetrate the B horizon and extract moisture from underlying horizons.

The size of plant species varies with soils. In general, the dominant plants of the area appear thrifty, productive and normal in size on Tetonia silt loam, Carkip silt loam, and Bancroft silt loam. On Goodington silt loam and Gooding loam, these plants with the exception of Sandberg bluegrass are small, less vigorous and produce little herbage. Most plants on Eagle Cone very stony silt loam are normal in size. Big sagebrush and antelope bitterbrush are exceptionally large.

Natural plant communities were a mixture of plant species. Some species grew on all the soils. Others grew on one or two soils. Because of variations in their growth habits, dates of maturity and depths of rooting, a mixture of plants is able to draw soil moisture and nutrients from different depths in the soil and at different times in the growing season. Thus a mixture of species uses available moisture and fertility more efficiently than a single species would.

The plant community on Tetonia silt loam is characterized by an open stand of threetip sagebrush, with an understory of Idaho fescue, bluebunch wheatgrass and a wide variety of forbs. The presence of threetip sagebrush and the absence of big sagebrush indicate that this soil is too shallow for the deep-rooting plants. Cemented calcium carbonate lenses and nodules in the lower

part of the soil indicates the presence of excess water. This could also affect the survival of big sagebrush (Fig. 1).

The outstanding feature of the plant community on Eagle Cone very stony silt loam is the thrifty growth of big sagebrush and antelope bitterbrush (Fig. 2). The high content of coarse fragments in Eagle Cone very stony silt loam influences the available soil moisture by increasing the amount of water per unit volume of soil. Water penetrates deeply into the fissures and crevices of the underlying basalt and is used by deep-rooting plants.

The plant community on Carkip silt loam is an open, savanna-like, stand of big and threetip sagebrush with an understory of Idaho fescue, bluebunch wheatgrass, Sandberg bluegrass, and a wide variety of forbs. The mixture of shallow, moderately deep-, and deep-rooted plants on this soil indicates that there are no restrictions to root growth. The high yield of Idaho fescue may indicate that this soil is more suited to the production of moderately deep-rooted plants (Fig. 3).

The plant community on Goodington silt loam is a sparse stand of single-stemmed, scraggly big sagebrush and small Douglas rabbitbrush and threetip sagebrush, with an understory of grasses and mat forbs. Sandberg bluegrass and bottlebrush squirreltail, two shallow-rooted, early-maturing grasses, grow abundantly but the plants are small. Pussytoes and phlox, moderately deep-rooted, early-maturing mat forbs are productive. Andersons buttercup and Beckwith violet, although not abundant, generally grow on this soil (Fig. 4).

In early spring the top 15 inches of Goodington silt loam is usually saturated with water. The A2 horizon of this soil is evidence of this condition. The fine-textured B horizon of Goodington silt loam swells on wetting and shrinks and cracks widely upon drying. This shrinking and cracking breaks many small roots, especially those of grasses. The medium to large woody roots of mat forbs and shrubs withstand this soil movement and are able to penetrate the B horizon. In general, roots grow along vertical cleavage planes in the fine-textured B horizon and are unbranched and deformed in shape.

Andersons buttercup and Beckwith violet, two very early-maturing plants, grow on Goodington silt loam because of abundant early spring moisture. Shallow-rooted, early-growing grasses such as Sandberg bluegrass and bottlebrush squirreltail are well suited to this soil. Mat forbs such as pussytoes and phlox are prominent members of the plant community because they are early growing and their root systems penetrate the clay B horizon to secure moisture and nutrients from deeper horizons.

The 5% slope and depth to bedrock result in a drier moisture regimen in Gooding loam than in the Goodington silt loam. The well-developed A2 horizon of this soil suggests lateral movement of soil moisture down the slope above the clay B horizon. This is the only soil in the kipuka on which alkali sagebrush grows. A variety of grasses grow on this soil but plants are small, widely spaced, and produce little herbage. The abundant growth of phlox and pussytoes is due to plentiful early spring moisture and extensive root systems of the plants. In the early spring the saturated upper 14 inches of this soil is favorable to the growth of Anersons buttercup and Beckwith violet. Alkali sagebrush secures moisture from the clay B horizon and lower horizons to complete its growth later in the season (Fig. 5).

Bancroft silt loam, a deep moderately permeable soil, occupies a steep 19% northern exposure. The plant community on this soil is mainly grasses dominated by Idaho fescue. There are very few shrubs on this soil. Surrounding areas support an open stand of big sagebrush and threetip sagebrush, and a scattered stand of antelope bitterbrush.

A piece of charred wood in one of the clipped plots suggested the possibility that fire might be responsible for the absence of shrubs. The age of big sagebrush plants growing on an area adjacent to the Bancroft soil was 60 years or more. It is possible, but not probably, that the small area of Bancroft soil could have burned without spreading to the surrounding parts of the kipuka. Even if the area was burned, it would not account for the absence of shrubs. The evidence indicates that if there was a fire it occurred so long ago that there has been time for the shrubs to reestablish themselves. Since they have not done so, it is assumed that the absence of shrubs on this soil has been caused by the lack of deep soil moisture.

Here Bancroft silt loam is leached of free carbonates to depths of 38 inches and yet has little soil development below a depth of 55 inches. This soil apparently receives and stores about the same amount of moisture each year.

The shallow depth of soil moisture in this soil may be due to its microclimate. There is evidence that the soil remains frozen later in the spring than adjacent soils. The late release of moisture appears to coincide closely with plant growth. Most of the moisture either runs off the frozen soil or is used by plants, leaving very little for deep percolation. Thus soil moisture seldom moves deeply into the soil.

SUMMARY

Six soil taxonomic units and their respective plant communities were studied in "Carey Kipuka", a pristine range area in southern Idaho. It is assumed that the nature of plant communities is the result of soil differences because the climate is about the same throughout the area and the natural vegetation is undisturbed. Differences in plant composition, size of plants, and total herbage production are apparently caused by physical characteristics of the soils.

Natural plant communities consist of a wide variety of plant species and indicate that a mixture of species is more efficient in using soil moisture and fertility than is a single plant species.

Soil characteristics such as depth to bedrock, nature of the bedrock, content of coarse fragments, depth to and presence of a clay B horizon, slope and exposure, influence the distribution and availability of soil moisture. These are important factors in determining the composition of plant communities in the Carey Kipuka.

Big sagebrush and antelope bitterbrush grow well on Eagle Cone very stony silt loam because roots use moisture stored in the deep cracks of the underlying fractured basalt.

Threetip sagebrush grows on all soils except Gooding loam. Alkali sagebrush grows only on Gooding loam.

Moderately deep-rooted forbs, such as tapertip hawksbeard, arrowleaf balsamroot, and velvet lupine grow well on all soils except Goodington and Gooding. Matlike, early-maturing forbs grow well on these two soils.

Moderately deep-rooted, later-maturing grass species, such as Idaho fescue, bluebunch wheatgrass, and prairie junegrass, are not well suited to soils with clay B horizons at depths less than 15 inches. Sandberg and Nevada bluegrass, shallow-rooted early-maturing grasses, made good growth on all soils studied.

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APPENDIX

COMMON AND BOTANICAL NAMES

OF

PLANT SPECIES

<u>Agropyron spicatum</u> (Pursh.) Scrib. & Smith	bluebunch wheatgrass
<u>Antennaria stenophylla</u> Gray	pussytoes
<u>Artemisia longiloba</u> (Osterhaut) Beetle	alkali sagebrush
<u>Artemisia tridentata</u> Nutt.	big sagebrush
<u>Artemisia tripartita</u> Rydb.	threetip sagebrush
<u>Astragalus stenophyllus</u> T. & G.	milkvetch
<u>Balsamorhiza sagittata</u> (Pursh.) Nutt.	arrowleaf balsamroot
<u>Bromus tectorum</u> L.	cheatgrass
<u>Chrysothamnus viscidiflorus</u> (Hook.) Nutt.	Douglas rabbitbrush
<u>Crepis acuminata</u> Nutt.	tapertip hawksbeard
<u>Elymus cinereus</u> Scrib. & Morr.	Great Basin wildrye
<u>Eriogonum caespitosum</u> Nutt.	mat eriogonum
<u>Festuca idahoensis</u> Elmer	Idaho fescue
<u>Koeleria cristata</u> (L.) Pers.	prairie junegrass
<u>Lupinus leucophyllus</u> Dougl.	velvet lupine
<u>Phlox hoodii</u> Richn.	Hoods phlox
<u>Phlox longifolia</u> Nutt.	longleaf phlox
<u>Poa nevadensis</u> Vasey	Nevada bluegrass
<u>Poa secunda</u> Presl.	Sandberg bluegrass
<u>Purshia tridentata</u> (Pursh.) D. C.	antelope bitterbrush
<u>Ranunculus andersonii</u> A. Gray	Andersons buttercup
<u>Senecio integerrimus</u>	lambs tongue groundsel
<u>Sitanion hystrix</u> (Nutt.) J. G. Smith	bottlebrush squirreltail
<u>Stipa thurberiana</u> Piper.	Thurber needlegrass
<u>Viola beckwithii</u> T. & G.	Beckwith violet