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REVEGETATION RESEARCH ON AMCHITKA ISLAND, A MARITIME TUNDRA LOCATION IN ALASKA

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University of Alaska
School of Agricultural and Land Resources Management
Agricultural Experiment Station

PREPARED FOR THE

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
NEVADA OPERATIONS OFFICE

Under Contract No AT(29-2)-20/Purchase Order DB-845A
With Holmes and Narver , Inc.

PRINTED IN THE UNITED STATES OF AMERICA
AVAILABLE FROM:
NATIONAL TECHNICAL INFORMATION SERVICES, NTIS
U. S. DEPARTMENT OF COMMERCE
5285 PORT ROYAL ROAD
SPRINGFIELD, VA. 22161

PRICE: PRINTED COPY: $4.50
MICROFICHE: $2.25

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REVEGETATION RESEARCH ON AMCHITKA ISLAND, A MARITIME TUNDRA LOCATION IN ALASKA

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Final Report

by

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CONTENTS

ABSTRACT

Revegetation studies commenced by the Alaskan Agricultural Experiment Station in 1970 on Amchitka Island culminated in 1973 with the seeding of disturbed areas associated with the nuclear testing program. Cool temperatures coupled with strong winds and a high incidence of fog and cloud cover impose a tundra aspect on Amchitka, one of Alaska's most southerly land areas. Natural revegetation is undependable for the near term.

Twenty-two perennial grasses, two clovers, and four annual grasses were tested on different soil types at low to medium-high (480 ft) elevation sites. At higher elevations severe winds and frost action maintain a barren-ground aspect. Relatively humic, acidic sites were the least favorable, a test site gravel pad the most favorable. Cultivars of red fescue--Boreal, Pennlawn, and Highlight chewings--and an experimental entry of Bering hairgrass, taxa conspecific with species found on the island, and Engmo timothy performed the best. Kentucky bluegrasses and reed canarygrass grew moderately well. Wheatgrasses, wildrye, bromegrass, creeping foxtail, grandis alkaligrass, redtop bentgrass, and white and alsike clover performed unsatisfactorily at some or all of the sites. The revegetation seeding mix included Boreal red fescue, Highlight chewings fescue, Bering hairgrass, and annual ryegrass.

Fertilization was necessary to establish plants on most sites. Plants responded erratically to added N on relatively humic, acidic soils, but more normally on gravelly and subsoil sites. Raising the P ration improved fertilizer response. Fertilization greatly enhanced growth on a disturbed site undergoing natural revegetation.

INTRODUCTION

The U.S. Atomic Energy Commission departed Amchitka Island in September 1973, thus terminating a nuclear testing program commenced by the Department of Defense in 1964. The completion of three underground tests during this period--Long Shot by the DOD in 1965, Milrow by the AEC in 1969, and Cannikin by the AEC in 1971--entailed considerable drilling, road building, and site construction. Seedings conducted on these disturbances by the AEC in 1973 culminated a revegetation research program initiated in 1967. This report concerns research conducted by the University of Alaska's Agricultural Experiment Station from 1970 to 1973.

Amchitka Island lies about 1500 miles southwest of Anchorage, Alaska's largest city (Fig. 1). Though it is one of the most southerly land areas in Alaska, Amchitka's maritime position limits its vegetative cover to tundra communities. Spruce trees, almost 30 years after being transplanted in a sheltered location on the island during World War II, are less than 1 meter tall (Fig. 2). When initiated, the success of the planting trials, the first such effort known for the Aleutian island chain, was very much in doubt.

Cool temperatures combined with severe winds and a high incidence of fog and cloud cover severely limit growth. The sky is partly or completely clouded over 90% of the time from May through July. Winds are frequent and often severe, averaging from 22 knots in January to 14 knots in June and July. They may achieve velocities over 100 knots (Armstrong, 1971; Kirkwood, 1971; Arctic Weather Central, 1950).

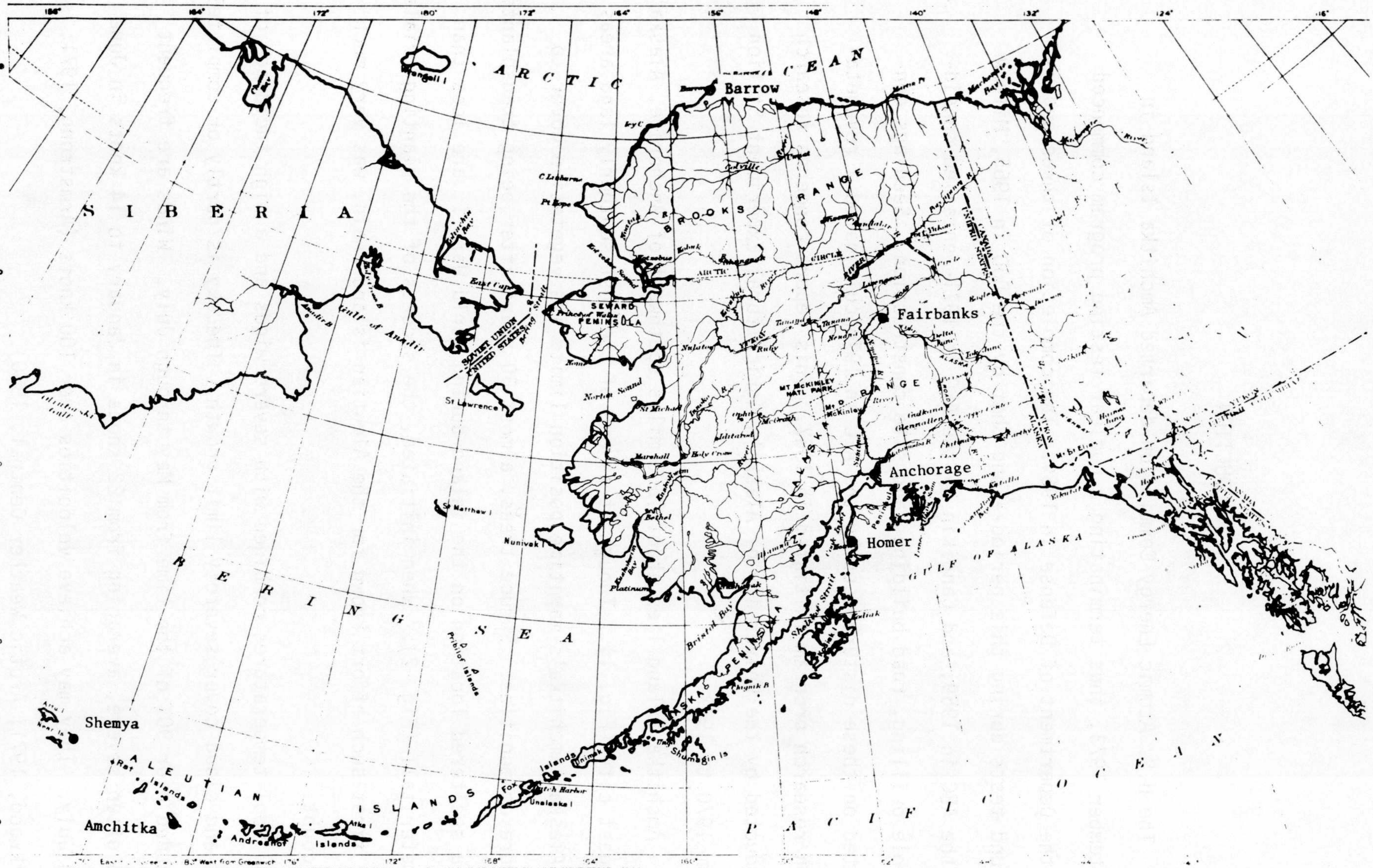


FIGURE 1. Location of Amchitka Island in relation to remainder of Alaska.

FIGURE 2. Spruce trees, species unknown, were transplanted on Amchitka Island during the island's occupation in World War II. The trees are less than a meter tall after almost 30 years' growth.

Temperature and precipitation records are more complete for Shemya, another western Aleutian island, than for Amchitka. Mean temperature in July at Shemya is about 46° F, compared with 52.6° F at Homer near the southcentral coast, 58° F in the inland southcentral Matanuska Valley, 60° F at Fairbanks in the central interior region, and 39° F at Barrow on the northern arctic coast (Fig. 3). Winter temperatures fluctuate near the freezing mark. Precipitation during the growing season is ample, particularly under the conditions of low evaporative stress that characterize this region. The growing season extends into the autumn longer at the tundra locations of the western Aleutians than on mainland Alaska.

PRELIMINARY INVESTIGATIONS

Revegetation research on Amchitka Island was initiated by Kazmaier (1968) under a contract with Battelle Columbus Laboratories. Amchitka is within the Aleutian Islands National Wildlife Refuge, and the introduction of plants for test plantings was prohibited at this time. Sites and soil types requiring revegetation were investigated, and soils were obtained from the island for greenhouse trials in the Columbus Laboratories. Seeds of plants native to Amchitka and of certain commercially available plants were tested under conditions simulating growing conditions of the island.

The commercial grasses grew more vigorously than the native grasses in the greenhouse trials. Engmo timothy, Polar bromegrass, and alsike clover were recommended for possible use or further trials on the island. Procedures for the possible increase of native seeds were outlined.

The investigation was renewed by the Alaska Agricultural Experiment Station with an on-site survey in September 1970 (Mitchell, W.W. and

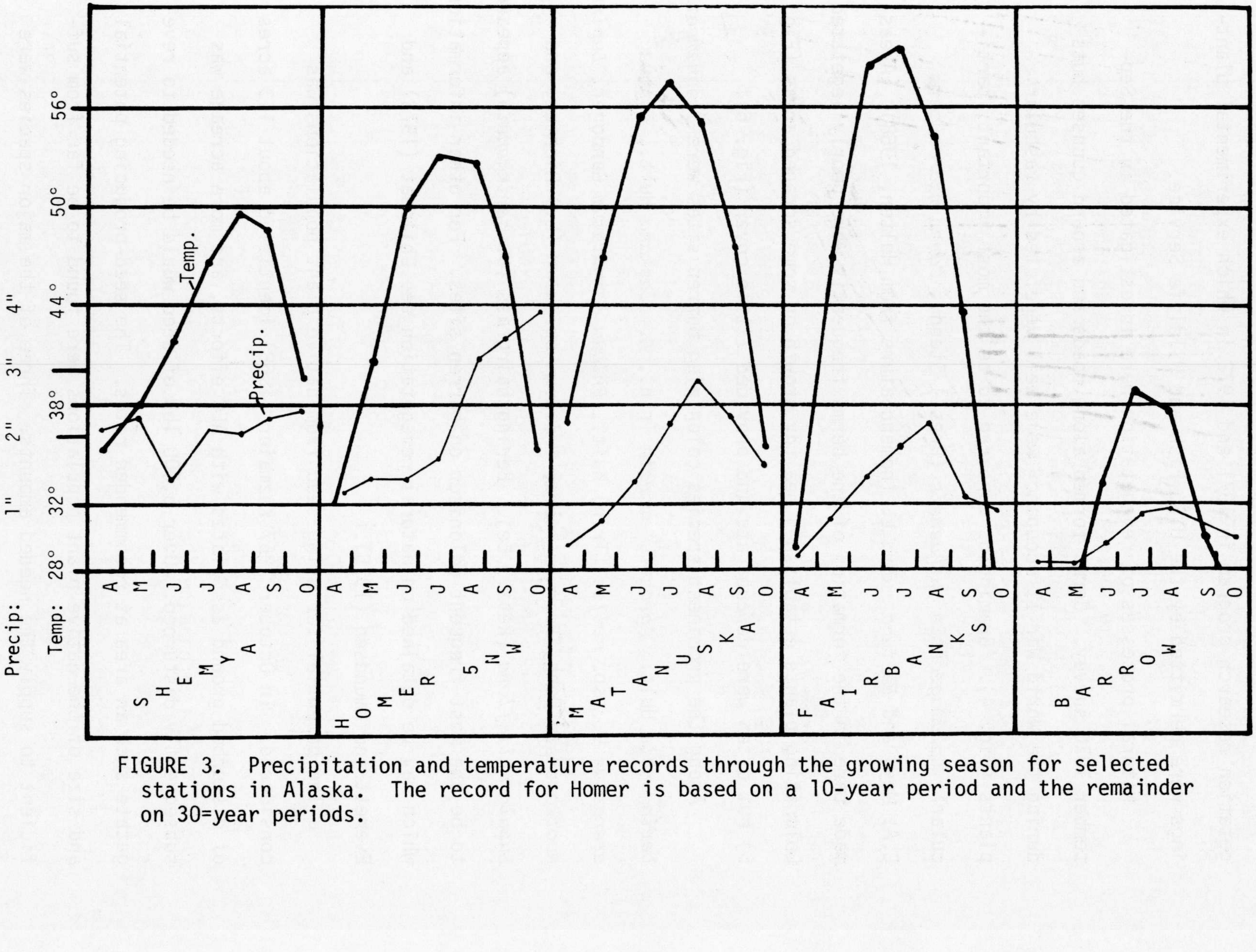


FIGURE 3. Precipitation and temperature records through the growing season for selected stations in Alaska. The record for Homer is based on a 10-year period and the remainder on 30=year periods.

C.I. Branton, 1970). The Atomic Energy Commission then funded a revegetation research program in 1971 and 1972 in which experimental plantings were permitted by the U.S. Fish and Wildlife Service.

Natural processes of revegetation were investigated in the September 1970 survey. Berms formed along roads and around quonset huts during the World War II occupancy were well vegetated by vascular plants (Fig. 4). Graminoids appeared to be the most important, particularly *Calamagrostis nutkaensis* (Presl) Steud., *Carex macrochaeta* C.A. Mey, and *Festuca rubra* L. (nomenclature from Hulten, 1968). Areas made bare in the formation of the berms frequently were poorly vegetated. Colonizing plants established healthy growth on some scraped areas (Fig. 5) but often were depauperate and provided little cover (Fig. 6).

Among the prominent species colonizing barren sites were *Deschampsia beringensis* Hult., *Agrostis exarata* Trin., *A. alaskana* Hult., *Elymus arenarius* L. ssp. *mollis* (Trin) Hult., *Phleum commutatum* Gandoger, *Lupinus nootkatensis* Donn, *Festuca rubra, Trisetum spicatum* (L.) Richter, and *Luzula multiflora* (Retz.) Lej. Bering hairgrass (*D. beringensis*) appeared to be the most frequent colonizer on barren sites. For other information which may be obtained on natural revegetation see Chilcoat (1973) and Everett and Amundsen (1975).

The potential for using seed from native plant populations was considered. In October 1967 Kazmaier (1968) identified about 163 acres of disturbed ground associated with AEC efforts, and more acreage was subsequently disturbed. Over 5,000 lbs of seed would be needed to revegetate such an area at recommended rates. The seed-producing potential and size of the native plant populations were found to be far from sufficient to supply the needed amounts. Three of the major species were

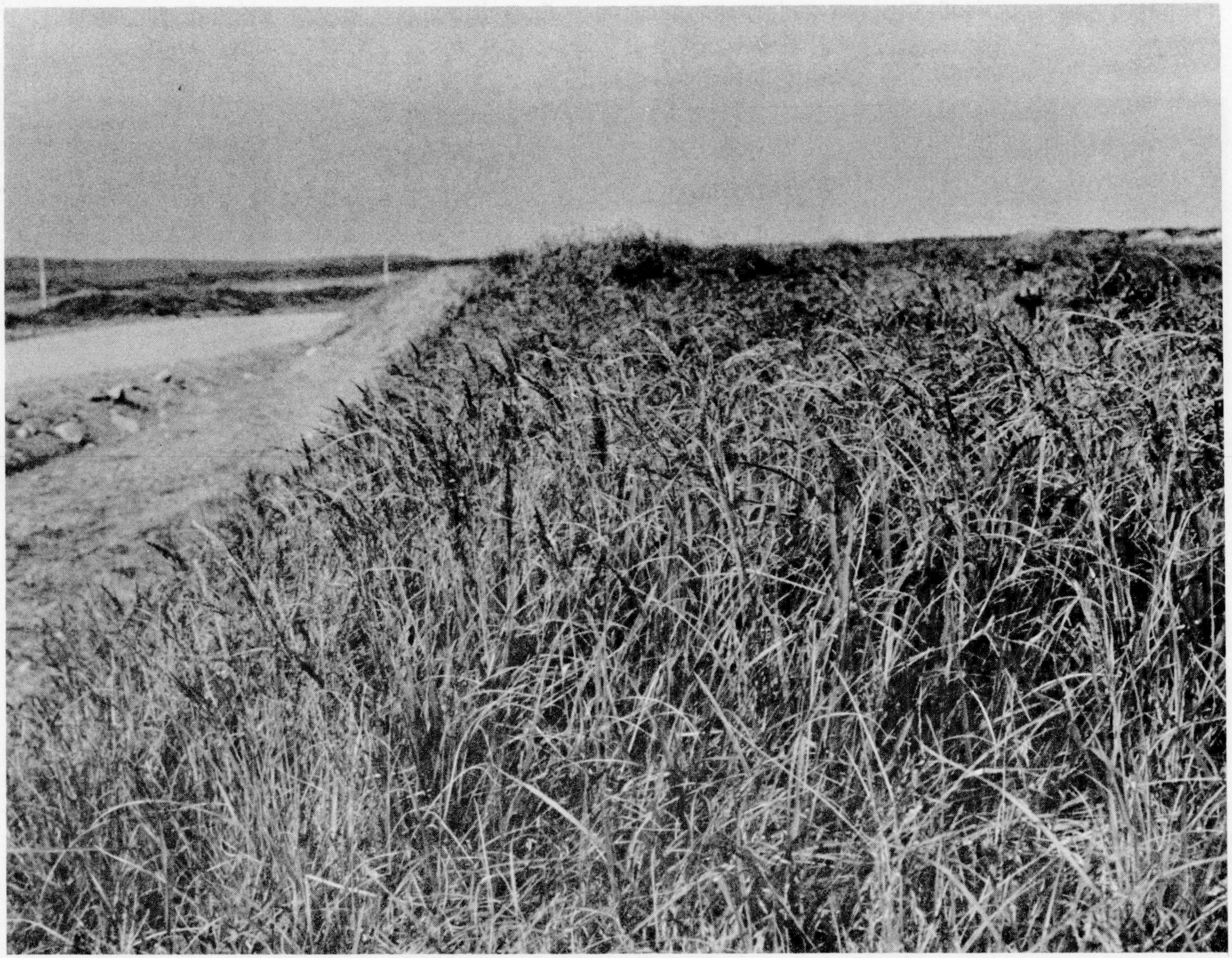


FIGURE 4. The crest and back side of berms bulldozed during World War II are generally lushly vegetated with such plants as *Carex macrochaeta*, *Calamagrostis nutkaensis*, and *Festuca rubra*.

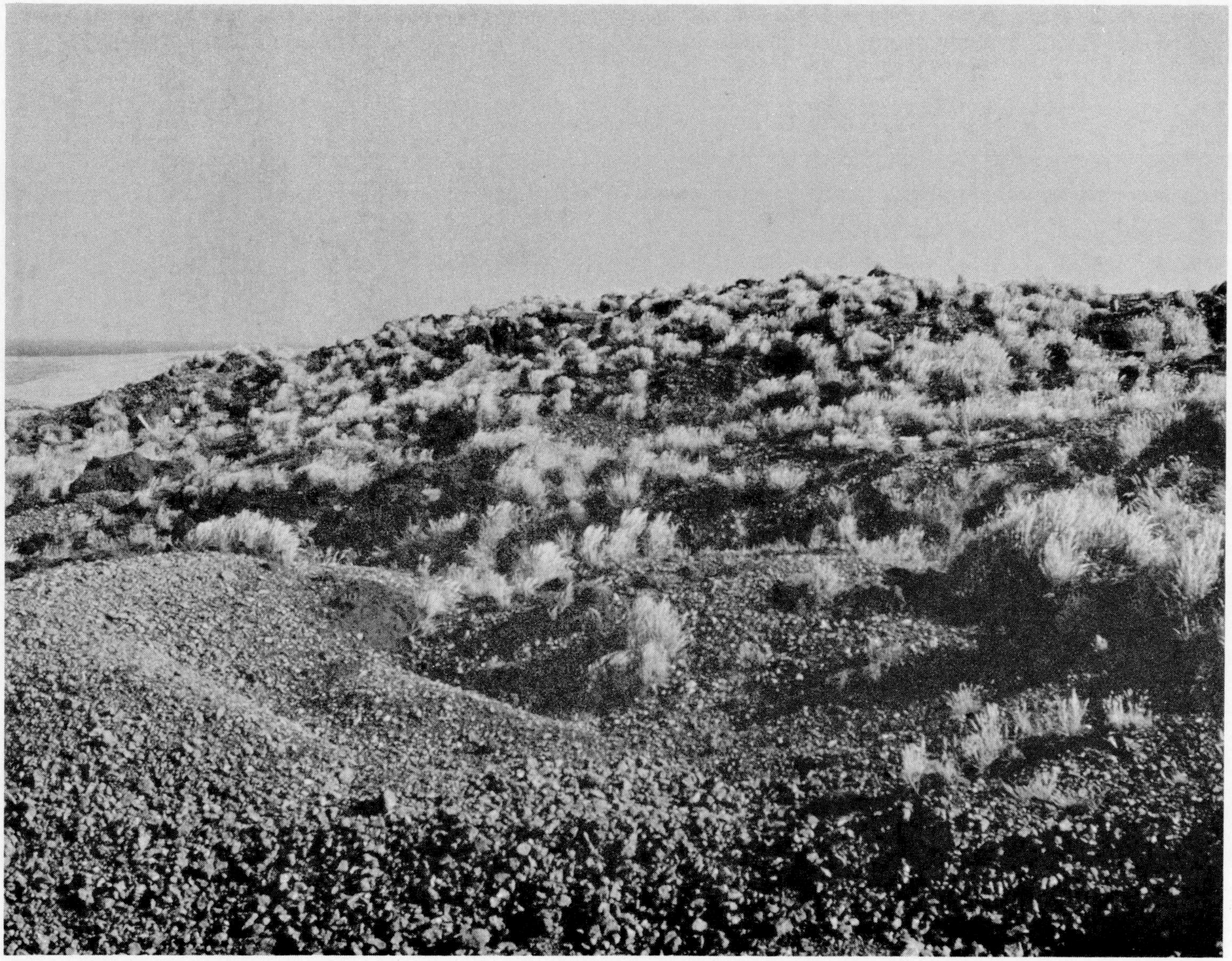


FIGURE 5. Colonizers at a rock quarry site have developed healthy growth. The invading plants at this site consist principally of *Deschampsia beringensis* and *Festuca rubra*.

FIGURE 6. Plants that have colonized this area that was bulldozed clear during World War II have remained depauperate and unhealthy. Growth on much of the area laid bare during World War II is of this nature.

noted to have unusual flowering habits. A wide range of maturity was evident in *F. rubra, D. beringensis,* and *C. nutkaensis*. Many plants had just reached the flowering stage (anthesis) in September while others were mature. Seed heads of some individuals ranged from the emergence to mature stages. Mature heads bore few seeds. *Lupinus nootkatensis* was one of the better seed producers. Some fairly dense stands of this lupine occur on small gravelly areas (Fig. 7). Dune wildrye (*Elymus arenarius* ssp. *mollis*) frequents coastal bluffs in dense stands but is an exceptionally poor seed producer.

Insufficient time was available to test these grasses under cultivation for seed production. Thus it was necessary to plan for the use of commercially available plant materials, concentrating in particular on cultivars that were conspecific or closely related to species native to the island. Experimental materials from native populations occurring on mainland Alaska also were included in the trials.

PROCEDURES AND SITE DESCRIPTIONS

Sites were chosen for trial plantings that would test soil-type and altitudinal differences. Amchitka Island is about 40 miles (65 km) long and .9 to 5 miles (1.5-8 km) wide aligned in a southeast to northwest direction. The southeastern portion consists of lowlands and the northwestern portion of highlands. The highest point on the island is about 1200 feet (366 m) in elevation. The highlands of the northwest portion are subject to extreme winds and severe frost action. These areas are sparsely vegetated with sub shrubs and grass stripes (Amundsen, 1971, 1972) interspersed with extensive barren ground (Fig. 8). Revegetation of disturbances under these harsh conditions was considered

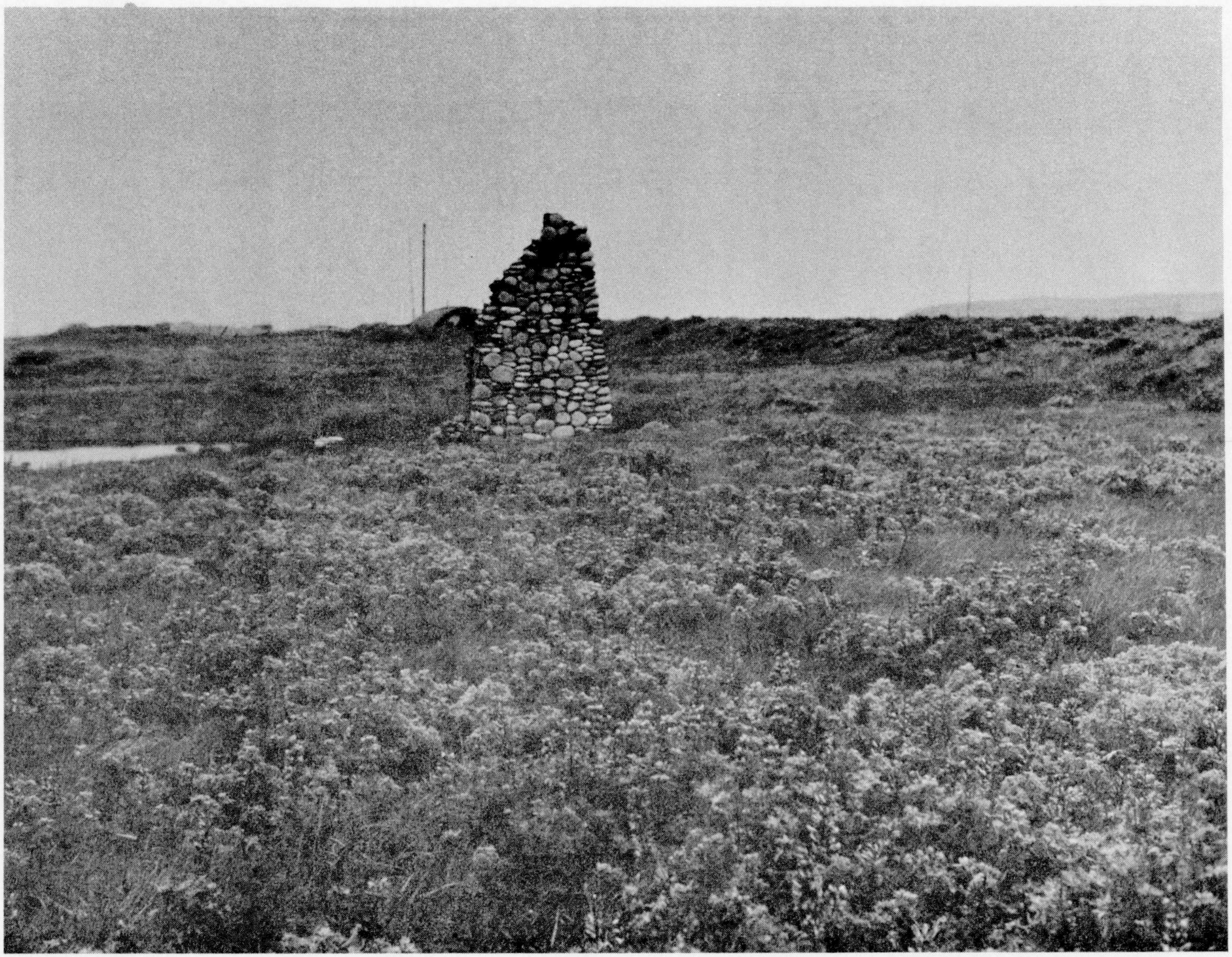


FIGURE 7. Lupine (*L. nootkatensis*) is one of the prominent, showy plants to occupy disturbances. A good stand developed on this well vegetated clearing near the remnants of a World War II building.

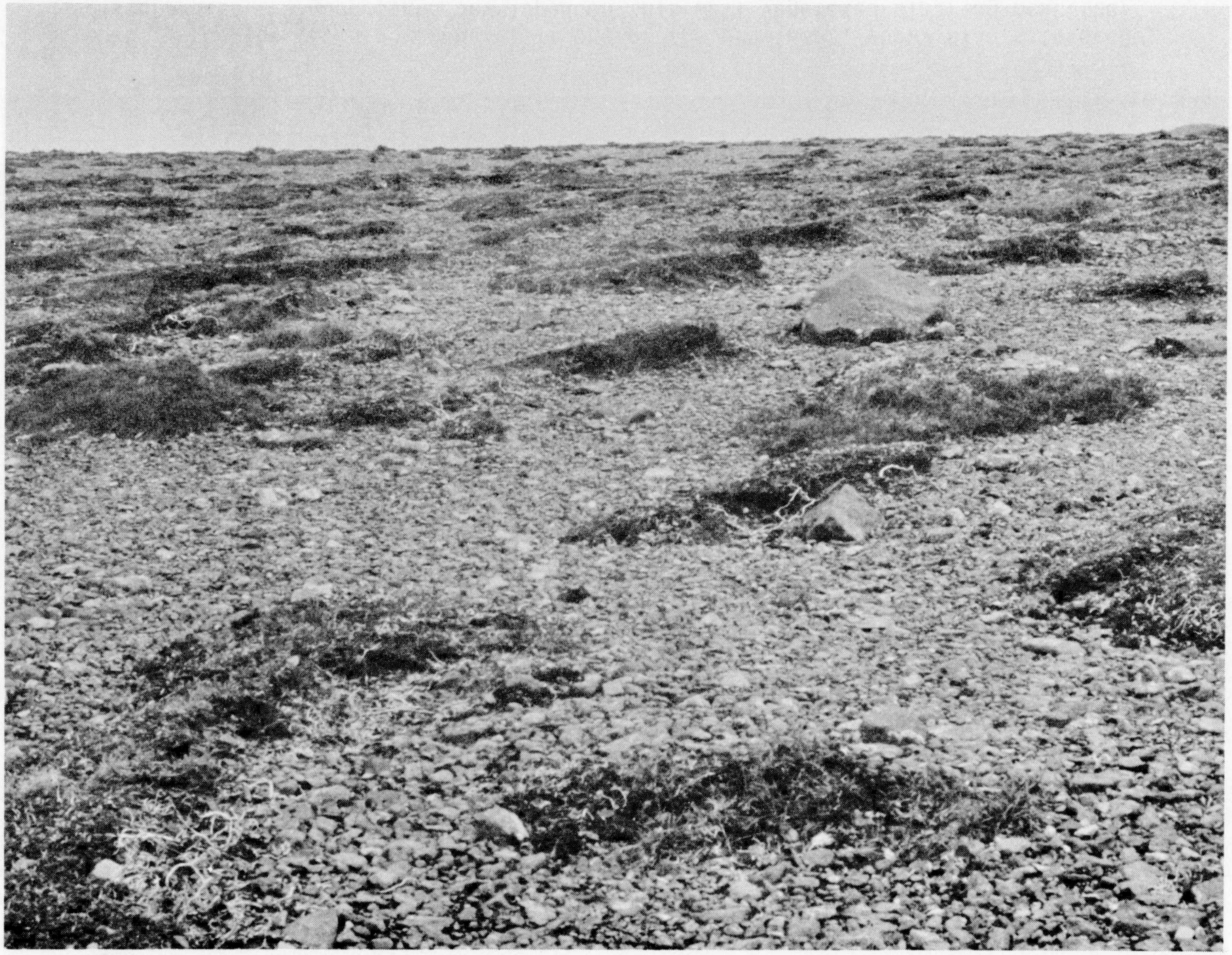


FIGURE 8. Only partial cover perseveres at the higher elevations on Amchitka Island (about 300 m. at this site). Severe winds and frost action maintain considerable barren ground with the surface covered with rocks and gravel.

unfeasible. One test station was established at a drill site (F Site) at 480 ft elevation, judged to be about the altitudinal limit for revegetation efforts. The other stations were located in the southeastern lowland portion of the island, which is covered by a more or less continuous tundra mat on the undisturbed areas (Shacklette, 1969; Koranda et al., 1969; Amundsen, 1971, 1972).

Planting Sites

Four sites (Sites 1-4) were chosen for the primary planting trials (Fig. 9). A smaller planting was conducted at a fifth site.

Site 1 at the lower end of the island, consisted of a cleared area near Mile 2 along the infantry road which runs most of the length of the island. There was an almost total absence of native plant growth in the study area. The dark reddish brown soil was deep and loamy with lag gravel at the surface and small rocks throughout the profile.

Site 2, at the lower end of the island, was on the gravel pad at "Long Shot," the site of the first underground nuclear test conducted on Amchitka Island. It was gravelly with some fine material mixed in.

Site 3, at the lower end of the island, was on another roadside clearing similar to Site 1 with a deep, dark reddish brown loam soil containing some medium and small gravel sized rocks throughout. Only a few native plants were growing in the clearing. The site was located near Mile 11 along the infantry road a short distance from "Cannikin," the site of the last nuclear test conducted on Amchitka.

Site 4, on high ground near the middle of the island, was at F drill site near Mile 20. The area had been scraped rather deeply to a light brown subsoil which contained small to large sized rocks.

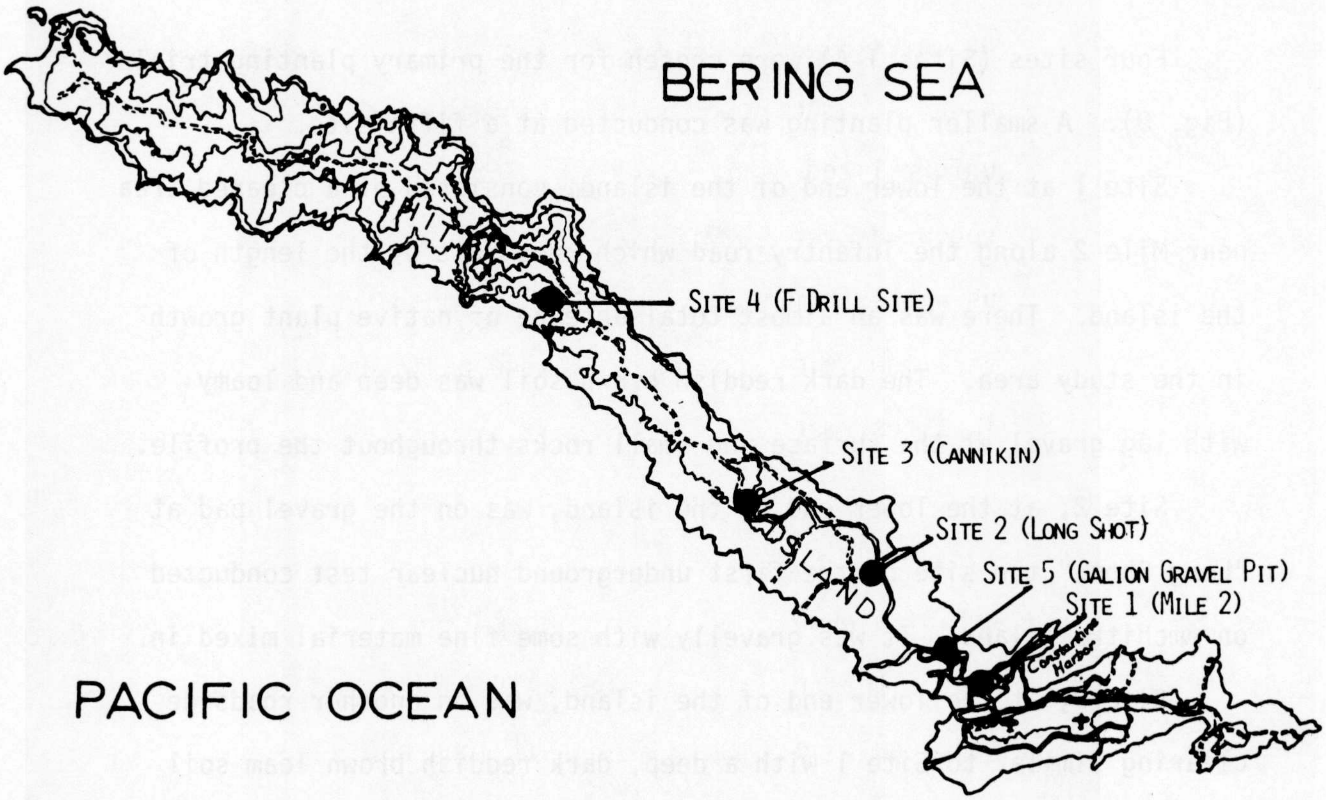


FIGURE 9. Location of test sites on Amchitka Island.

This study site was at a sufficiently high altitude so that the surrounding area had an incomplete vegetative cover due to wind and frost action.

Site 5, at the lower end of the island near mile 3 was in the Galion gravel pit on a southward-facing slope covered with small rocks and including some fine material in the profile.

Table 1 presents characteristics of soil samples obtained from fertilized and unfertilized portions of the plots near the completion of the study. Nitrogen was very low and present mainly in the ammonium form. Phosphorus was extremely low while K was moderately high to high. Sites 2 and 4, very low in organic matter, were basic while the other three, more humic sites, were acidic.

<u>Planting Trials</u>

Row plantings of a number of perennials and annuals (Table 2) were established at four sites from May 19 to 25, 1971. The seed was planted with a hand-pushed V-belt seeder in rows 25 ft long and 15 inches apart. The entries were randomly located in each of two replications at each site. Additionally, two seed mixtures were hand broadcast in 4 ft x 25 ft plots replicated twice at the same sites.

Fertilizer was applied with a calibrated spreader in 6-ft bands perpendicular to the rows and across the broadcast plots at the following three rates in lb/acre (unless noted otherwise, P and K will be stated in the elemental form rather than in the oxide form):

a) 50 N + 44 P (100 P_2O_5) + 50 K (60 K_2O)

b) 100 N + 44 P + 50 K

c) 150 N + 44 P + 50 K

TABLE 1. Chemical characteristics of soil from plot sites on Amchitka Island. Samples were obtained in September 1973.

Site	Pounds per Acre: $N(NH_4)$ U.[a]	F.[b]	$N(NO_3)$ U.	F.	P U.	F.	K U.	F.	pH U.	F.	% O.M.[c] U.	F.
Site 1 (Mile 2)	6	4	2	5	2	3	736	824	5.15	4.93	6.6	5.1
Site 2 (Long Shot)	3	2	0	0	4	16	325	433	8.22	8.06	.6	.3
Site 3 (Cannikin)	3	10	3	4	3	3	406	455	5.38	5.20	6.2	6.7
Site 4 (F Drill Site)	6	6	2	4	4	8	465	539	8.03	7.71	.4	.7
Site 5 (Galion Pit)	10		1		2		443		5.32		3.2	

[a] Unfertilized soil obtained adjacent to the plots.

[b] Soil obtained from fertilized portion of plot.

[c] Organic matter.

TABLE 2. Grasses and legumes placed in trial on Amchitka Island.

Species	Cultivar	Location of Selection or Collection
Perennials:		
Red fescue (*Festuca rubra*)	Creeping types	
	Boreal	Canada
	Arctared	Alaska[1]
	Pennlawn	Pennsylvania
(var *commutata* Gaud.)	Tufted type	
	Highlight chewings	Holland
	Common chewings	Unknown
Sheep (hard) fescue (*Festuca ovina* L.)	Durar	Oregon
	Experimental	Alaska
Kentucky bluegrass (*Poa pratensis* L.)	Nugget	Alaska[2]
	Merion	Pennsylvania
	Common	Unknown
Meadow foxtail (*Alopecurus pratensis* L.)	Common	Unknown
Creeping foxtail (*Alopecurus arundinaceus* Poir.)	Garrison	North Dakota
Timothy (*Phleum pratense* L.)	Engmo	Norway
Reed canarygrass (*Phalaris arundinacea* L.)	Frontier	Canada
Redtop bentgrass (*Agrostis gigantea* Roth)	Common	Canada
Bering hairgrass (*Deschampsia beringensis*)	Experimental	Alaska[3]
Alkaligrass (*Puccinellia grandis* Swallen)	Experimental	Alaska[3]

TABLE 2. Continued.

Species	Cultivar	Location of Selection or Collection
Bromegrass (*Bromus inermis* Leyss.)	Manchar	Manchuria, China
	Polar	Alaska[4]
Crested wheatgrass (*Agropyron desertorum* [Fisch.] Schult.)	Summit	Siberia, USSR
Streambank wheatgrass (*Agropyron riparium* Scribn. & Smith)	Sodar	Oregon
Russian wildrye (*Elymus junceus* Fisch.)	Sawki	Siberia, USSR
White clover (*Trifolium repens* L.)	Common	Unknown
Alsike clover (*Trifolium hybridum* L.)	Aurora	Canada
Annuals:		
Spring rye (*Secale cereale* L.)	Common	Unknown
Barley (*Hordeum vulgare* L.)	Edda	Sweden
Oats (*Avena sativa* L.)	Rodney	Canada
Annual ryegrass (*Lolium multiflorum* Lam.)	Common	Unknown

[1] Collected in Alaska, probably native to state.

[2] Collected in Alaska, probably an introduction.

[3] Native collections.

[4] Hybrid material involving native *Bromus pumpellianus* and introduced *B. inermis*.

Plots were fertilized again in mid summer of the planting year when serious stress signs were observed in many of the plants at two sites. A mix of 30 N + 33 P + 25 K lb/acre was applied across 3 feet of each 6-ft fertilizer band, thus producing six fertilizer rates--50-44-50, 80-77-75, 100-44-50, 130-77-75, 150-44-50, and 180-77-75--occurring in 3-ft bands across the plots in that order. Consequently two fertilizer series resulted, i.e., Series A maintaining P and K at 44 and 50 lb/acre, respectively, and Series B maintaining P and K at 77 and 75 lb/acre, respectively. The remaining 6 to 7 ft at the ends of the rows and broadcast plots were left unfertilized. The four sets of plots were refertilized at 85 N + 70 P + 75 K at the end of May 1972 in their second growing season.

An additional planting was established on July 27, 1971 at Site 1 to test a mid summer planting date. Seven taxa were planted in rows, replicated twice, and fertilized at 100 N + 44 P + 50 K lb/acre. The rows were refertilized in May 1972 at 85 N + 70 P + 75 K.

A gravelly, southward-facing slope in a gravel pit (Site 5) was planted to 10 grasses in 3 ft x 15 ft broadcast plots in late May 1971. The plots were hand-fertilized at about 150 N + 44 P + 50 K lb/acre.

Plant heights were measured within each fertilizer level of the rows and broadcast plots in 1971. Coverage was estimated on a 1-5 scale. In 1972 and 1973 height of fully extended leaves was measured and coverages estimated at 3 locations in each row and broadcast plot and the data averaged for each entry and the 2 replications. Coverage was estimated by class (1-7) with the aid of a 20 cm x 50 cm quadrat and the classes converted to percentages according to the following schedule:

1 - 2.5%	5 - 70 %
2 - 12.5%	6 - 87.5%
3 - 30 %	7 - 97.5%
4 - 50 %	

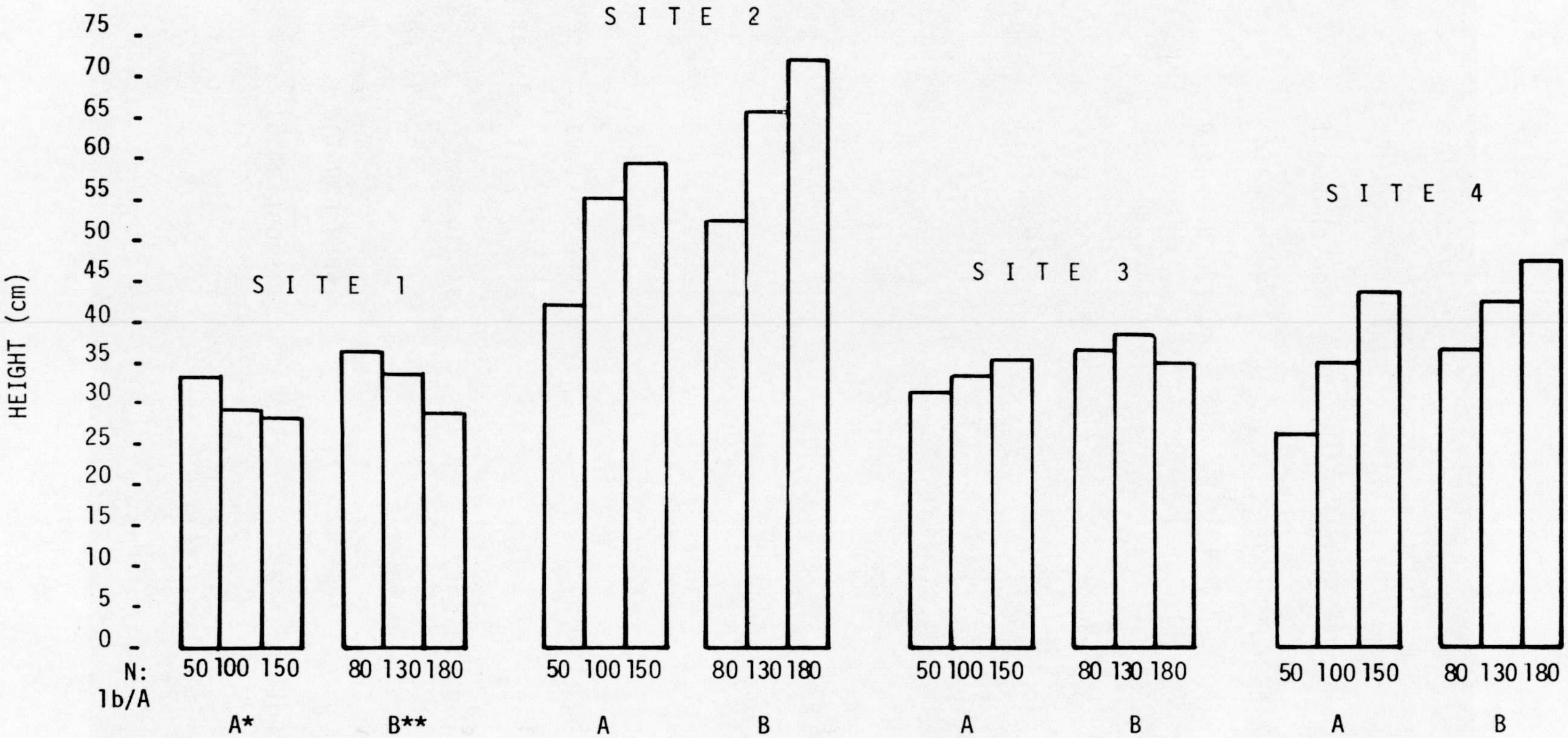
Fertilizer Trial on Bare Area

A fertilizer trial was established on a disturbed area that was undergoing natural revegetation. An area that had been bulldozed clear for a quonset hut during World War II was chosen for this study. Most of the growth at the site consisted of *Deschampsia beringensis*. Three fertilizer rates--50 N + 44 P + 50 K, 100 N + 44 P + 50 K, and 150 N + 44 P + 50 K--were applied with a calibrated spreader on plots about 6 ft x 18 ft in two replications. Fertilized plots alternated with unfertilized plots. These plots were not refertilized after the initial application in late May 1971.

RESULTS AND DISCUSSION

1971 Performance

The growth of the annuals, which established fair to good stands at all sites in 1971, characterized each site. Site 2 on the gravel pad over the Long Shot nuclear test produced the most vigorous growth (Fig. 10), and Site 1 the least growth (Table 3). Soil analyses indicated a critical deficiency of N at all sites; however, only at Sites 2 and 4 were decided responses to N treatments above the 50- to 80-lb levels achieved (Fig. 11). Growth responses were negatively related to increased levels of N at Site 1 and inconsistent at Site 3.



* With 44 lb of P and 50 lb of K
** With 77 lb of P and 75 lb of K

FIGURE 10. Responses of annuals to two series of fertilizers at four sites in 1971.

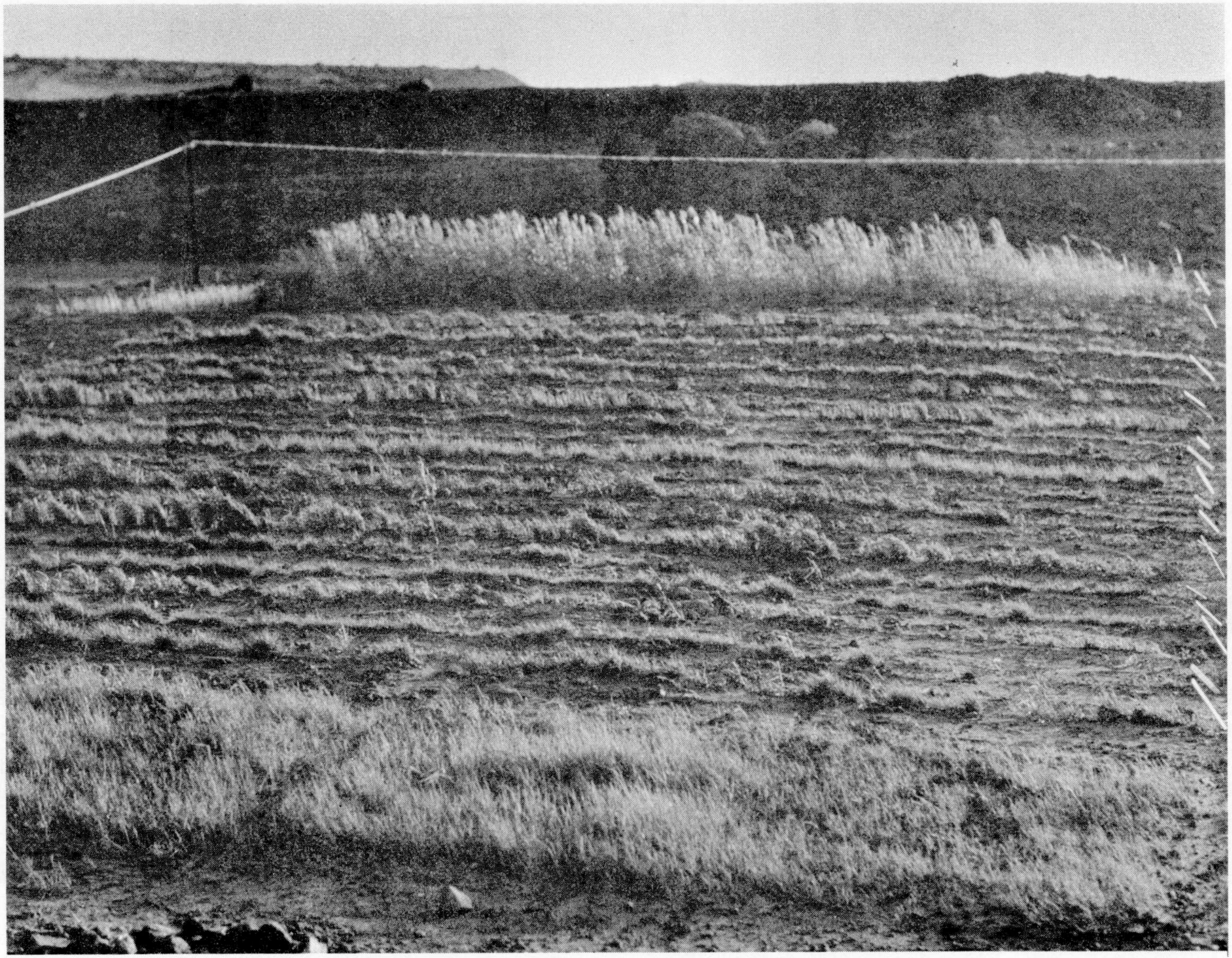


FIGURE 11. First year's growth at Site 4 (subsoil medium at high elevation). N treatments increase from right to left. Increasing heights of annuals, tall rows in background, reflect positive response to added N at this site.

TABLE 3. Height measurements (cm) of annuals for first growing season (1971) at Sites 1-4.

Entries	Site 1	Site 2	Site 3	Site 4	Avg.
Spring rye	49.4	76.6	49.9	48.3	56.1
Edda barley	24.3	60.3	32.5	42.5	39.9
Rodney oats	30.3	48.0	32.3	33.9	36.1
Annual ryegrass	22.5	46.8	25.7	32.7	31.9
Average	31.6	57.9	35.1	39.4	41.0

Site 2, a gravel pad, and Site 4, a deeply scraped area at a drill site, were very low in organic content. The higher humic content and acidity of the other two sites apparently confounded the fertilizer responses. Additional P and K, most likely the former (K was abundant) were required to increase growth with added N above the 50-lb level at Site 1. The response to added N remained negative, however, within each fertilizer series at this site. Series A employed 44 lb of P and 50 lb of K, while Series B utilized 77 lb of P and 75 lb of K. Eighty lb of N in Series B produced more growth than 100 and 150 lb of N in Series A at Sites 1 and 3 and more than 100 lb of N in Series A at Site 4.

The similarities between Sites 1 and 3 and between Sites 2 and 4 were reflected in first-year performances of the perennials as well (Table 4). As with the annuals the perennials in general grew best on the gravel pad, particularly at the higher nitrogen levels. Site 1 was the most difficult for most of the grasses. Without fertilization

TABLE 4. Height measurements (cm) of perennials for the first growing season (1971) at Sites 1-4.

Entries	Site 1	Site 2	Site 3	Site 4	Avg.
Redtop bentgrass	13.3	16.7	14.3	11.6	14.0
Summit crested wheatgrass*	5.1	21.8	8.0	13.5	12.1
Sodar streambank wheatgrass*	7.6	16.5	7.8	13.1	11.3
Meadow foxtail	8.3	13.6	7.8	11.0	10.2
Frontier reed canarygrass	9.5	11.7	8.0	7.2	9.1
Manchar bromegrass*	5.4	16.1	5.7	8.0	8.8
Bering hairgrass	8.1	10.1	7.7	6.8	8.2
Garrison creeping foxtail*	1.9	11.2	2.9	10.9	6.7
Polar bromegrass*	4.5	9.9	6.0	5.6	6.5
Boreal red fescue	5.7	8.6	5.2	6.5	6.5
Durar hard fescue	4.2	8.9	4.4	8.1	6.4
Sawki Russian wildrye*	3.5	10.6	4.5	**	6.2
Pennlawn red fescue	4.2	8.3	4.9	4.8	5.6
Engmo timothy	4.1	5.5	4.4	5.0	4.8
Highlight chewings fescue	4.6	5.3	4.5	4.2	4.7
Grandis alkaligrass*	1.3	7.2	2.8	5.0	4.1
Arctared red fescue	3.3	4.3	3.2	3.6	3.6
Merion Kentucky bluegrass	3.2	4.3	**	2.3	3.3
Sheep fescue	2.5	3.7	2.6	3.3	3.0
Nugget Kentucky bluegrass	2.7	3.9	2.5	2.4	2.9
Aurora alsike clover	1.1	3.8	.9	1.9	1.9
Average	5.0	9.6	5.4	6.7	6.7

* Weak appearing plants at most sites.

** Data not available.

the plants developed only to the seedling stage and were obviously under severe stress. The unfertilized plants were less stressful on the gravel pad than at the other sites.

The broadcast mixture that included Bering hairgrass, Boreal red fescue, redtop, Durar hard fescue, and white clover provided better coverage than the mixture including meadow foxtail, Arctared fescue, Nugget bluegrass, and alsike clover (Table 5). Bering hairgrass, Boreal red fescue, and redtop grew the most vigorously in the first mixture. Meadow foxtail grew the strongest in the second mixture. The clovers did poorly in both mixtures.

TABLE 5. Coverage of broadcast mixtures estimated on a 1-5 scale (5 = best) in 1971.

Mixture	Sites: 1	2	3	4
A*	3.3	3.5	3.5	3.6
B**	2.0	2.8	1.7	3.3

* Bering hairgrass, Boreal red fescue, redtop, Durar hard fescue, and white clover

** Meadow foxtail, Arctared fescue, Nugget bluegrass and alsike clover

The performance of the plants in broadcast mixtures in the first season was generally equal to or better than that in the rows. The plants in the broadcast plots at Site 1, in particular, outperformed those in the rows. As in the row plantings, the broadcast plantings exhibited a negative response to increasing levels of nitrogen within each of the fertilizer series at Site 1, and the Series B treatment produced much better growth than Series A (Fig. 12).

All grasses entered in the July 27 planting at Site 1 established good stands about 2 to 4 cm in height in 1971. Bering hairgrass grew the most vigorously of the seven grasses tested.

First year growth on the gravelly slope at the gravel pit was extraordinarily good relative to the growth at the other sites. Redtop and meadow foxtail provided particularly lush covers in these broadcast plots with Bering hairgrass, Pennlawn red fescue, and Engmo timothy also doing well (Table 6). The exceptional growth at this site was surprising in that the soil was acidic with a large quantity of small rocks through the profile. Greater insolation of the southward-facing slope and possible sheltering effects from wind action may have accounted for the improved growth.

1972 and 1973 Performance of Row Plantings

Since the revegetation effort was scheduled for early summer 1973, seeding recommendations were necessarily based on results obtained in the second growing season (1972). However, the following discussion concerns results obtained in both 1972 and 1973.

The test of a midsummer planting at Site 1 indicated that plantings could be conducted successfully as late as the end of July. The grasses planted July 27 were generally shorter in the second season than the same grasses planted May 20 at the same site (Table 7). But most differences were small, and growth of the better adapted grasses was sufficient to provide good cover (Fig 13).

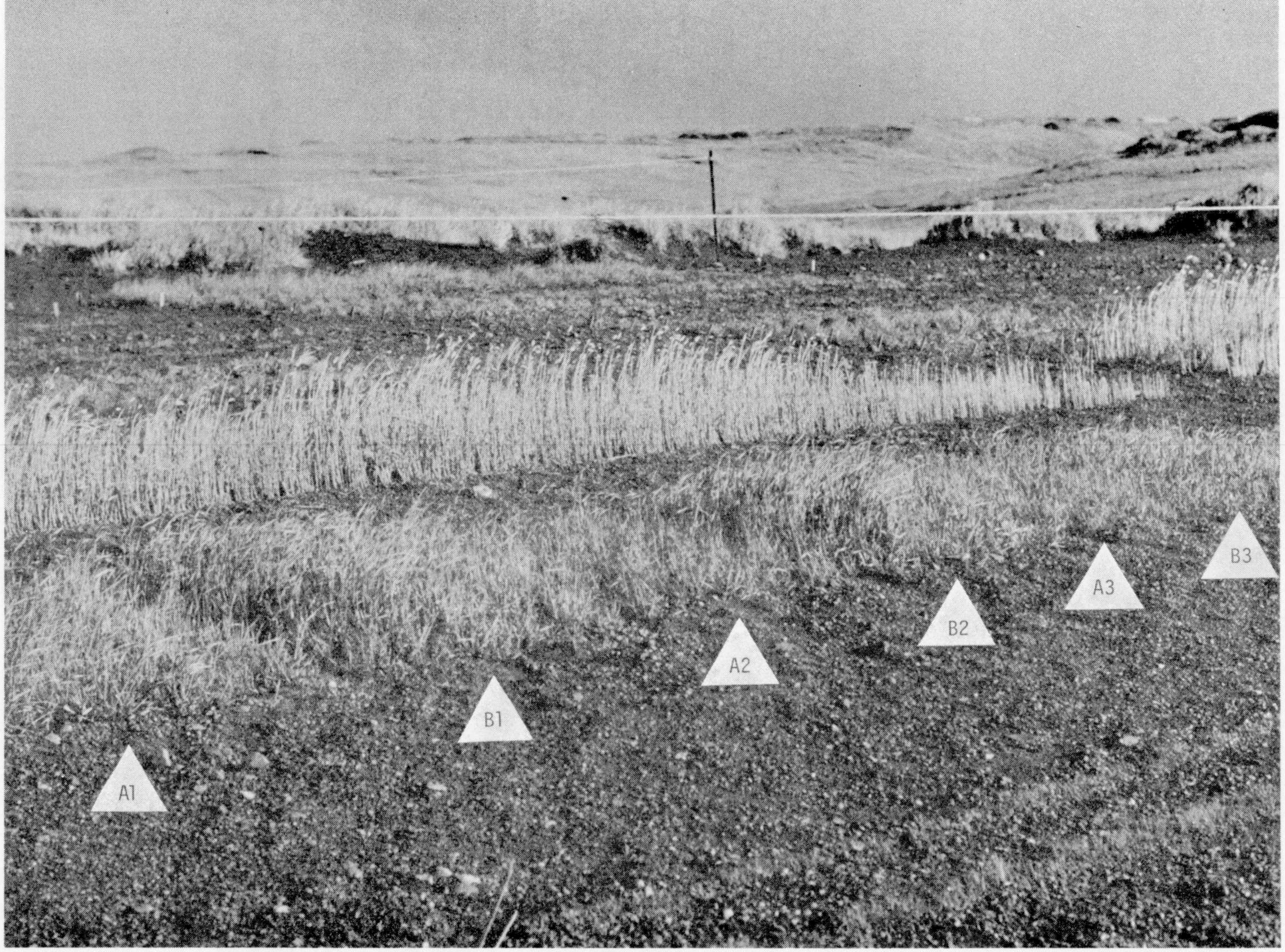


FIGURE 12. Response of broadcast mix at Site 1 in first year of growth to two series of fertilizers (A & B) at increasing levels of N (1-3). Treatments were applied in 3-ft sections. Series B with higher P and K provided most growth, but response did not increase with added N within each series. Similar responses were obtained by the annuals (taller growth behind perennial mix).

TABLE 6. Height measurements and coverage estimates of broadcast plantings on slope at rock quarry in 1971 (first year growth).

Entries	Ht (cm)	Coverage (1-5, 5 = best)	Index (ht x covg)
Redtop bentgrass	37	5	185
Meadow foxtail	26	5	130
Bering hairgrass	17	4.5	76.5
Pennlawn red fescue	15	4.5	67.5
Engmo timothy	12	4.5	54
Durar hard fescue	12	3.5	42
Polar bromegrass	10	2.5	25
Nugget bluegrass	6	3.5	21
Sawki wildrye	11	1.5	16.5
Arctared fescue	4	3.5	14

FIGURE 13. Second season growth of July 27 planting at Site 1 (humic, acidic soil). Rows from left to right: Engmo timothy, Bering hairgrass, Polar bromegrass, Durar hard fescue, Nugget bluegrass, Pennlawn red fescue, and Arctared fescue. End portions of Nugget bluegrass and Bering hairgrass rows on far right.

TABLE 7. Height comparisons of spring and mid summer plantings at Site 1 after their second season of growth.

Entries	May 20 Planting	July 27 Planting
Engmo timothy	54.7 cm	50.4 cm
Bering hairgrass	34.2	26.7
Polar bromegrass	15.2	13.3
Durar hard fescue	7.3	7.3
Nugget bluegrass	5.5	5.4
Pennlawn red fescue	24.3	20.8
Arctared fescue	8.7	6.7

Though the plots were not fertilized in 1973, shoot heights in 1973 generally exceeded that achieved in 1972 (Table 8). The taller growing plants included Engmo timothy, redtop bentgrass, Bering hairgrass, Garrison creeping foxtail, Frontier reed canarygrass, meadow foxtail, the various red fescues (except Arctared), crested wheatgrass, and the bromegrasses. Because the two clovers achieved exceptional growth in length at Site 2 in 1973, they also ranked high in the height ratings. Growth in height, alone, was not a particularly good index of performance, however, as revealed by results obtained for coverage.

Relatively small changes in cover were registered for most of the plants from the second to third growing season (Table 9). Those providing the most coverage were Highlight chewings fescue, Bering hairgrass, Boreal red fescue, and Pennlawn red fescue, followed by common chewings fescue, Nugget bluegrass, Engmo timothy, Arctared fescue,

TABLE 8. Height measurements (cm) of row plantings for second and third growing seasons at Sites 1-4, ranked according to 1973 averages*.

Entries	Site 1		Site 2		Site 3		Site 4		Avg.	
	'72	'73	'72	'73	'72	'73	'72	'73	'72	'73
White Dutch clover	0	0	20	54	6	0	0	0	13	54
Engmo timothy	55	50	58	44	62	44	58	61	58	50
Aurora alsike clover	0	0	17	70	0	0	10	29	14	50
Redtop bentgrass	31	43	40	55	28	41	34	29	34	42
Bering hairgrass	34	42	31	36	31	35	35	34	33	37
Pennlawn red fescue	24	34	34	45	26	31	31	33	29	36
Garrison creeping foxtail	3	0	40	43	0	0	35	28	26	36
Frontier reed canarygrass	32	41	34	48	20	29	28	26	29	36
Meadow foxtail	31	32	42	51	28	30	36	25	34	35
Boreal red fescue	29	25	34	37	30	32	36	37	32	33
Highlight chewings fescue	24	28	23	33	29	35	22	30	25	32
Summit crested wheatgrass	1	0	37	46	4	0	27	18	17	32
Common chewings fescue	24	26	23	34	18	27	22	30	22	29
Polar bromegrass	15	15	35	47	19	24	23	31	23	29
Manchar bromegrass	22	21	40	55	19	18	22	23	26	29
Sodar streambank wheatgrass	0	0	26	31	9	0	12	12	16	22
Merion Kentucky bluegrass	10	9	23	30	18	19	31	27	20	21
Common Kentucky bluegrass	10	11	22	26	17	17	28	29	19	21

TABLE 8. Continued.

Entries	Site 1 '72	Site 1 '73	Site 2 '72	Site 2 '73	Site 3 '72	Site 3 '73	Site 4 '72	Site 4 '73	Avg. '72	Avg. '73
Durar hard fescue	7	11	26	30	0	0	17	20	17	20
Arctared red fescue	9	14	17	23	10	19	16	20	13	19
Grandis alkaligrass	0	0	17	26	3	12	21	20	14	19
Sheep fescue	10	15	10	13	8	11	8	11	9	13
Nugget Kentucky bluegrass	6	7	11	13	7	9	12	11	9	10
Sawki Russian wildrye	0	0	14	0	0	0	0	0	14	0
Average	20	25	28	39	20	26	26	27	23	31

* Zeros were not tallied in calculation of averages.

TABLE 9. Percent coverage estimates of row plantings for second and third growing seasons at Sites 1-4, ranked according to overall averages in 1973.

Entries	Site 1 '72	Site 1 '73	Site 2 '72	Site 2 '73	Site 3 '72	Site 3 '73	Site 4 '72	Site 4 '73	Avg. '72	Avg. '73
Highlight chewings fescue	98	94	98	96	98	96	93	90	97	94
Bering hairgrass	93	88	93	90	93	91	98	93	94	91
Boreal red fescue	88	79	98	93	98	93	98	87	96	88
Pennlawn red fescue	88	76	98	92	93	91	98	88	94	87
Common chewings fescue	70	79	98	88	79	80	98	90	86	84
Nugget Kentucky bluegrass	50	47	88	94	79	87	93	87	78	79
Engmo timothy	60	60	93	87	79	79	93	79	81	76
Arctared fescue	60	47	98	90	88	82	88	82	84	75
Merion Kentucky bluegrass	30	43	93	95	60	73	98	90	70	75
Sheep fescue	60	69	98	91	50	61	74	74	71	74
Common Kentucky bluegrass	40	36	93	84	70	76	88	84	73	70
Meadow foxtail	60	53	93	85	60	70	70	63	71	68
Frontier reed canarygrass	60	63	88	77	40	37	60	57	62	59
Polar bromegrass	13	5	79	87	30	14	40	38	41	36
Redtop bentgrass	8	7	88	91	8	8	40	32	36	35
Grandis alkaligrass	0	0	88	70	6	6	98	63	48	35
Durar hard fescue	1	1	79	84	0	0	21	17	25	26
Manchar bromegrass	8	1	79	76	21	7	8	6	29	23
Aurora alsike clover	0	0	50	82	0	0	1	8	13	23

TABLE 9. Continued.

Entries	Site 1		Site 2		Site 3		Site 4		Avg.	
	'72	'73	'72	'73	'72	'73	'72	'73	'72	'73
Garrison creeping foxtail	1	0	98	57	0	0	70	18	42	19
Summit crested wheatgrass	0	0	70	67	1	0	8	6	20	18
White Dutch clover	0	0	30	71	1	0	0	0	8	18
Sodar streambank wheatgrass	0	0	79	57	6	1	3	2	22	15
Sawki Russian wildrye	0	0	22	0	0	0	0	0	6	0
Average	37	35	83	79	44	44	60	52	56	53

Merion bluegrass, sheep fescue, common bluegrass and meadow foxtail. Among the taller growing plants that provided just fair to poor coverage were reed canarygrass, the bromegrasses, redtop, creeping foxtail, and crested wheatgrass. A few clover plants that survived in each row at Site 2 grew much more vigorously in their third season than in the previous season. The clovers failed, however, at the other sites. Others that failed to survive, or essentially so, at one or more sites included Sawki wildrye, Sodar wheatgrass, Garrison creeping foxtail, Durar hard fescue, Summit crested wheatgrass, Manchar bromegrass, and grandis alkaligrass. Only Sawki wildrye failed at all sites. Creeping foxtail experienced a large decline in coverage in the third year at the two sites on which it survived.

The plantings continued to perform the best at Site 2 (gravel pad) in the second and third years (Fig. 14), as reflected in overall height and coverage averages (Tables 8 and 9). The next best coverage was

FIGURE 14. Second season growth of plantings on gravel pad (Site 2), where best overall performance was obtained. The six rows from right to left of the Aurora alsike clover row in left center are Sodar wheatgrass, Pennlawn red fescue, common chewings fescue, Summit crested wheatgrass, Highlight chewings fescue, and Polar bromegrass. The ten rows from left to right of the alsike clover row are meadow foxtail, Garrison creeping foxtail, white clover (obscured by grass material), grandis alkaligrass, Nugget bluegrass, Arctared fescue, redtop bentgrass, Manchar bromegrass, Engmo timothy, and common bluegrass. Row on far right is annual ryegrass, which regrew in second season.

obtained at the higher altitude station, Site 4, on the subsoil medium (Fig. 15). Fewer entries survived on the humic, acidic Sites 1 and 3 (Fig. 16).

According to an index derived by multiplying height x coverage, the top performers at the four sites were Engmo timothy, Bering hairgrass, Pennlawn red fescue, Highlight chewings fescue, and Boreal red fescue (Table 10). Others that provided good cover though growing shorter than the above, were Arctared fescue, the bluegrasses, and an experimental sheep fescue. The most consistent performers at all four sites were Highlight chewings fescue, Boreal red fescue, Bering hairgrass, and Pennlawn red fescue.

The uniform application of fertilizer in the second year and the effect of time appeared to have erased some of the differences in response to the original fertilizer applications. Growth was generally taller at the ends of the rows where the most N was applied in 1971. This was true at all sites. The plants either failed to survive or produced only negligible growth on those portions of the plots that received no fertilizer at Sites 1, 3, and 4. However, at Site 2 (gravel pad) the plants continued to grow on the unfertilized portion (Figures 17 and 18). Second-year fertilization of a portion of the plots that had not been fertilized in the first year at Site 1 saved many of the plants from dying but did not result in vigorous growth (Fig. 19). Fertilization was necessary at the time of establishment to develop healthy stands.

Ecotypic Differences

Differences in performances of closely related taxa are of particular interest. The red fescues in general were among the better adapted

FIGURE 15. Third season appearance of plots at Site 4 (higher altitude site on sub soil medium). Row plantings in foreground from left to right: Engmo timothy, Garrison creeping foxtail, Nugget bluegrass, grandis alkaligrass, sheep fescue, Aurora alsike clover (dead), Boreal red fescue, and Arctared fescue. Broadcast plots left of rows and reseeded area in background.

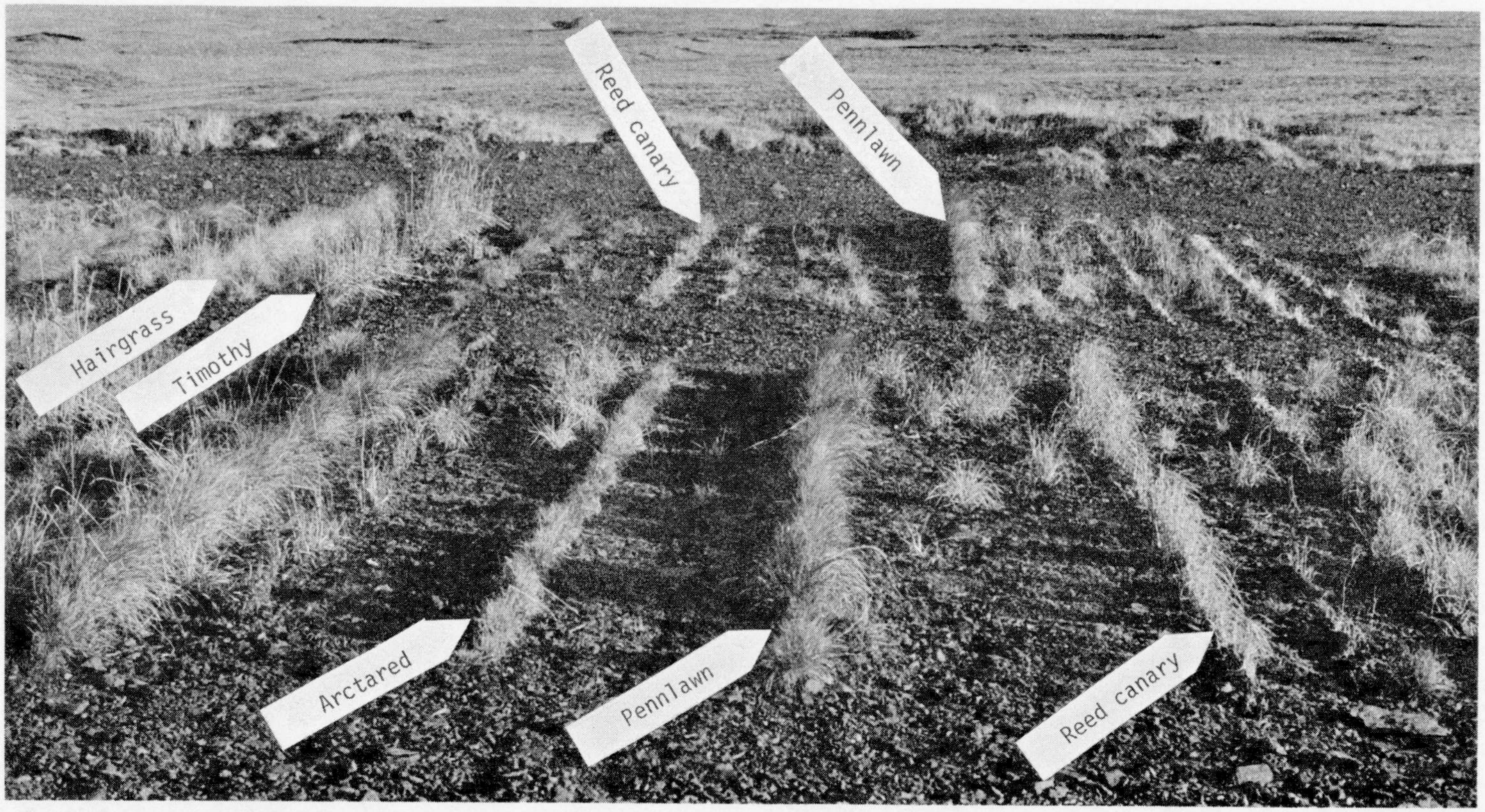


FIGURE 16. Second season growth at Site 3 (humic, acidic soil), near Cannikin test shot. Rows left to right in foreground beginning with first full row, dense growth: Boreal red fescue, Polar bromegrass (sparse growth), white clover (dead*), Arctared fescue (short, dense), Durar hard fescue (dead), Pennlawn red fescue (dense), Sawki wildrye (dead*), Aurora alsike clover (dead*), Frontier reed canarygrass (thin), and Summit crested wheatgrass (dead*). Rows in background left to right beginning with first full row: Highlight chewings fescue (dense, medium tall), Nugget bluegrass (short, dense), Merion bluegrass, Bering hairgrass (dense, light straw color), Engmo timothy (tall, heading), white clover (dead), common chewings fescue (short, dense), sheep fescue (short), Sawki wildrye (dead), Frontier reed canarygrass, grandis alkaligrass (sparse), Durar hard fescue (dead*), Polar bromegrass (sparse), Sodar wheatgrass (mostly dead), Pennlawn red fescue (tall, dense), redtop bentgrass (sparse), and Garrison creeping foxtail (dead*). Last four rows were planted to annuals in preceding year. Some ryegrass regrew in third row from end. Broadcast plot on far right. *Other material growing in row.

TABLE 10. Index ratings computed from overall averages of height and coverage measurements for row plants at sites 1-4 in second and third growing seasons ranked according to 1973 ratings. Index = height (cm) x coverage (%) ÷ 100.

Entries	1972	1973
Engmo timothy	47	38
Bering hairgrass	31	34
Pennlawn red fescue	26	31
Highlight chewings fescue	24	30
Boreal red fescue	31	29
Common chewings fescue	19	24
Meadow foxtail	24	24
Frontier reed canarygrass	18	21
Merion Kentucky bluegrass	14	16
Common Kentucky bluegrass	14	15
Redtop bentgrass	12	15
Arctared red fescue	11	14
Aurora alsike clover	2	12
Polar bromegrass	9	10
White Dutch clover	1	10
Sheep fescue	6	10
Nugget Kentucky bluegrass	7	8
Garrison creeping foxtail	11	7
Manchar bromegrass	8	7
Summit crested wheatgrass	3	6
Durar hard fescue	4	5
Grandis alkaligrass	7	4
Sodar streambank wheatgrass	4	3
Sawki Russian wildrye	1	0

FIGURE 17. Meager growth of unfertilized portion, from tall growth at left to shallow furrow at right, on gravel pad (Site 2) in year of planting. Tallest growth in mid foreground are the annuals, spring rye, Edda barley, and Rodney oats.

FIGURE 18. Unfertilized portion of plots, between arrows, on gravel pad persisted and developed moderately good growth by third season.

FIGURE 19. Seven-foot portion of plots at Site 1, from stake at left to tall growth at right, was left unfertilized when seeded. Three-foot portion, short growth to left of tall growth, was fertilized in second season. Remaining portion died out by third season.

entries. However, more southern-derived varieties (north temperate to boreal in origin) outperformed an Alaskan selection. Boreal red fescue, a Canadian selection, and Pennlawn, from Pennsylvania, grew better than Arctared, an Alaskan selection that has grown well on mainland Alaska. Both tufted red fescue entries, Highlight chewings, a variety developed in Holland, and common chewings also performed very well with Highlight doing better than common. Two entries of sheep fescue (*F. ovina*) were tested: Durar, developed from a collection in Oregon, and an experimental cultivar from the Alaska Experiment Station. The latter, though collected from a population found growing at the Palmer Research Center, most likely is an introduction. Durar grew well only on the gravel pad, failing at the two acidic sites, and providing meager coverage on the subsoil medium at Site 4. The experimental sheep fescue afforded fair to good coverage at all sites, doing the best on the gravel pad and the poorest on the acidic sites.

Pairs of closely related species showed distinct differences in adaptability to Amchitka conditions. Meadow foxtail grew well at three sites and moderately well at Site 1; whereas Garrison creeping foxtail failed completely at Sites 1 and 3, grew poorly at Site 4, and only moderately well at Site 2. The creeping foxtail diminished considerably in coverage at Site 2 in the third season. Both bromegrasses grew poorly at three of the sites, only doing well on the gravel pad. However, the Alaskan-derived cultivar Polar, including germplasm of *B. pumpellianus* Scribn. and *B. inermis,* outperformed Manchar (*B. inermis*), which is believed to have originated in Manchuria.

Two other entries, not closely related, can be paired on an ecological basis. Bering hairgrass and grandis alkaligrass are both native to Alaska. The seed of both species used for trial on Amchitka was collected from populations occupying the same tideland flat in southcentral Alaska. Bering hairgrass was one of the best performers at all four sites, while the alkaligrass failed at the two acidic sites and did poorly at the other two sites.

Redtop, a widely adapted bentgrass (*Agrostis*) recommended for acid soils, is related to several bentgrasses occurring on the island (Shacklette, 1969; Hulten, 1968; Amundsen, 1972). It was one of the best performers in the first year of growth but subsequently did very poorly at most of the sites.

Broadcast Plots at Sites 1-4

The two broadcast mixtures planted at Sites 1-4 produced over 75% coverage at all sites (Table 11). The mixture including Bering hairgrass, Boreal red fescue, redtop bentgrass, Durar hard fescue, and white clover outperformed the mixture including meadow foxtail, Arctared fescue, Nugget bluegrass, and alsike clover. Bering hairgrass and Boreal red fescue comprised the bulk of the first mixture at the end of the third growing season. Redtop bentgrass persevered better in this broadcast mixture than in monoculture in the rows. Meadow foxtail was most prominent in the second mixture.

As a rule, plants grow taller in row plantings than in broadcast plantings. However, the more vigorous plants grew as tall or taller in the broadcast mixes than they did in rows (Fig. 20). The less open stand of the broadcast mix may have provided an advantageous sheltering effect against winds under Amchitka conditions. However, some individual plants of Bering hairgrass established in an open area did remarkably well (Fig. 21).

FIGURE 20. Second season growth of broadcast plots at Site 1. Growth in right foreground plot comprised mainly of Bering hairgrass, Boreal red fescue and redtop bentgrass (which almost failed in row plantings at this site). Growth in right hand plot in background consisted mainly of meadow foxtail, Arctared fescue and Nugget bluegrass. Individual plants to left of broadcast plot in foreground are mainly Bering hairgrass started from windblown seed at time of seeding (see Fig. 20).

FIGURE 21. By third season Bering hairgrass plants that had established on fertilized ground outside of the broadcast plots had grown vigorously with profuse heading.

TABLE 11. Performance of broadcast mixtures at Sites 1-4 after three growing seasons.

		Site 1	Site 2	Site 3	Site 4	Avg.
Mixture A[1]	Ht.	44 cm	65 cm	43 cm	38 cm	48 cm
	Covg.	85 %	94 %	81 %	91 %	88 %
Mixture B[2]	Ht.	26 cm	46 cm	24 cm	24 cm	30 cm
	Covg.	76 %	85 %	79 %	82 %	81 %

[1] Boreal red fescue, Bering hairgrass, redtop bentgrass, Durar hard fescue, and white clover

[2] Meadow foxtail, Arctared fescue, Nugget bluegrass, and alsike clover

Broadcast Plots at Galion Pit

Most of the 10 broadcast plantings on the slope at the gravel pit provided 50 percent or more coverage (Table 12). Only Durar hard fescue and Sawki wildrye, which failed at all sites, provided less. Growth in general was taller at this acidic site (pH 5.32) than at the other two acidic locations (Site 1--pH 5.15, Site 3--pH 5.38). Pennlawn red fescue, Engmo timothy, and meadow foxtail grew particularly well (Fig. 22). Bering hairgrass was a good performer. Nugget bluegrass provided good coverage but very short growth.

Fertilizer Trial on Bare Area

The plots fertilized in 1971 at the quonset hut site undergoing natural revegetation produced dramatic results in the second and third years after fertilization (Figures 23 and 24). Coverage on the fertilized portions was about 3.0 to 7.5 times greater than on the unfertilized

TABLE 12. Performance of entries in broadcast plots on slope at rock quarry after third season of growth.

Entries	Leaf Ht (cm)	Covg. (%)	Index Ht x Covg/100
Engmo timothy	67	85	57.0
Meadow foxtail	59	73	43.1
Pennlawn red fescue	40	91	36.4
Redtop bentgrass	55	63	34.7
Bering hairgrass	39	69	26.9
Polar bromegrass	53	50	26.5
Arctared fescue	29	50	14.5
Durar hard fescue	26	37	9.6
Nugget bluegrass	6	76	4.6
Sawki wildrye	0	0	0

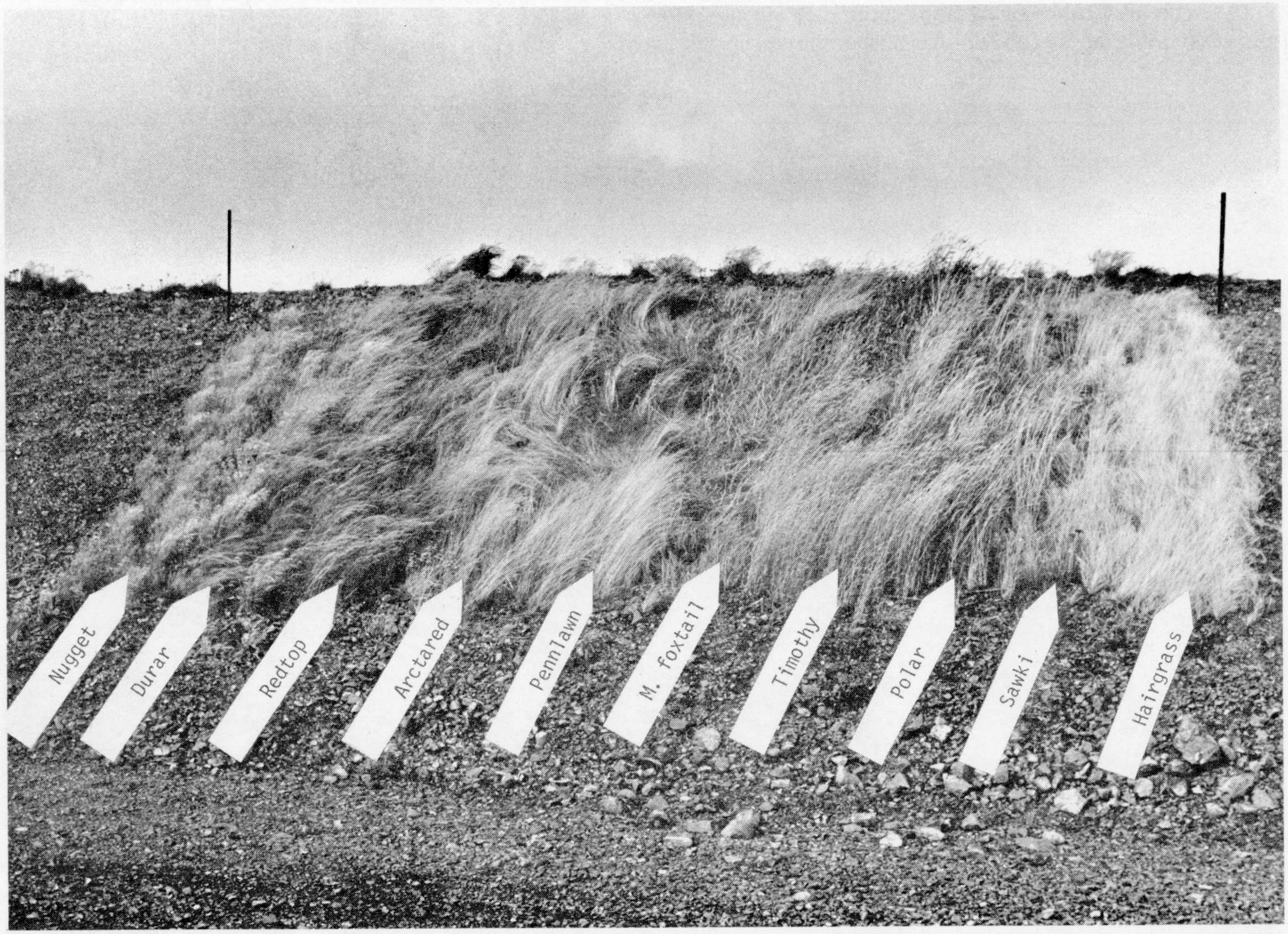


FIGURE 22. Very good growth was achieved by most of the broadcast plantings on the rocky slope at Site 5. The 3-ft wide plots from left to right with height (cm) and % coverage values are as follows: Nugget bluegrass, 6 cm, 76%; Durar hard fescue, 26, 37; redtop bentgrass, 55, 63; Arctared fescue, 29, 50; Pennlawn red fescue, 40, 91; meadow foxtail, 59, 73; Engmo timothy, 67, 85; Polar bromegrass, 53, 50; Sawki wildrye, 0, 0; and Bering hairgrass, 39, 69.

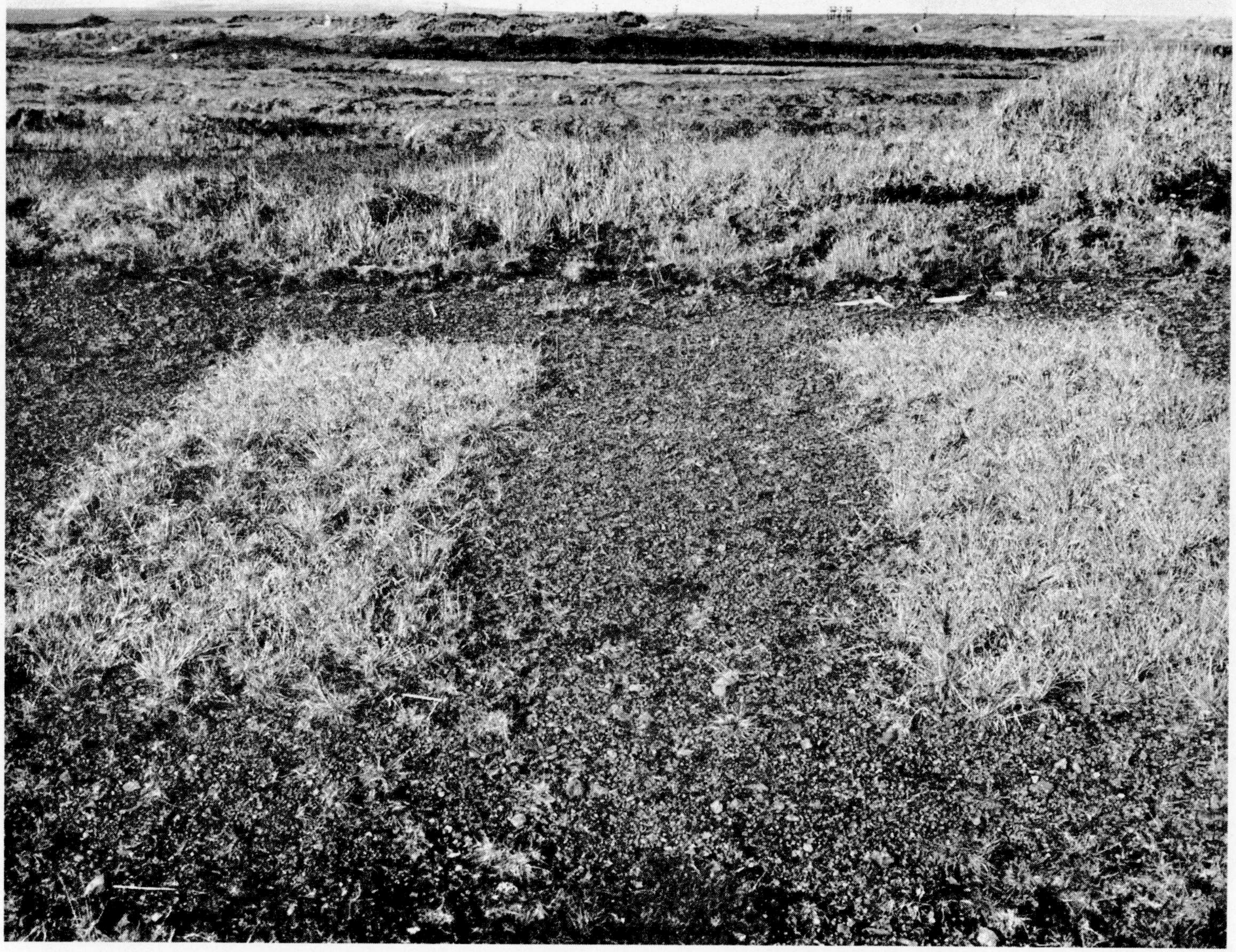


FIGURE 23. Fertilized and unfertilized plots on disturbed area undergoing natural revegetation. Plot at left fertilized at 100 N + 44 P + 50 K pounds per acre, center unfertilized, right hand plot fertilized at 150 N + 44 P + 50 K pounds per acre.

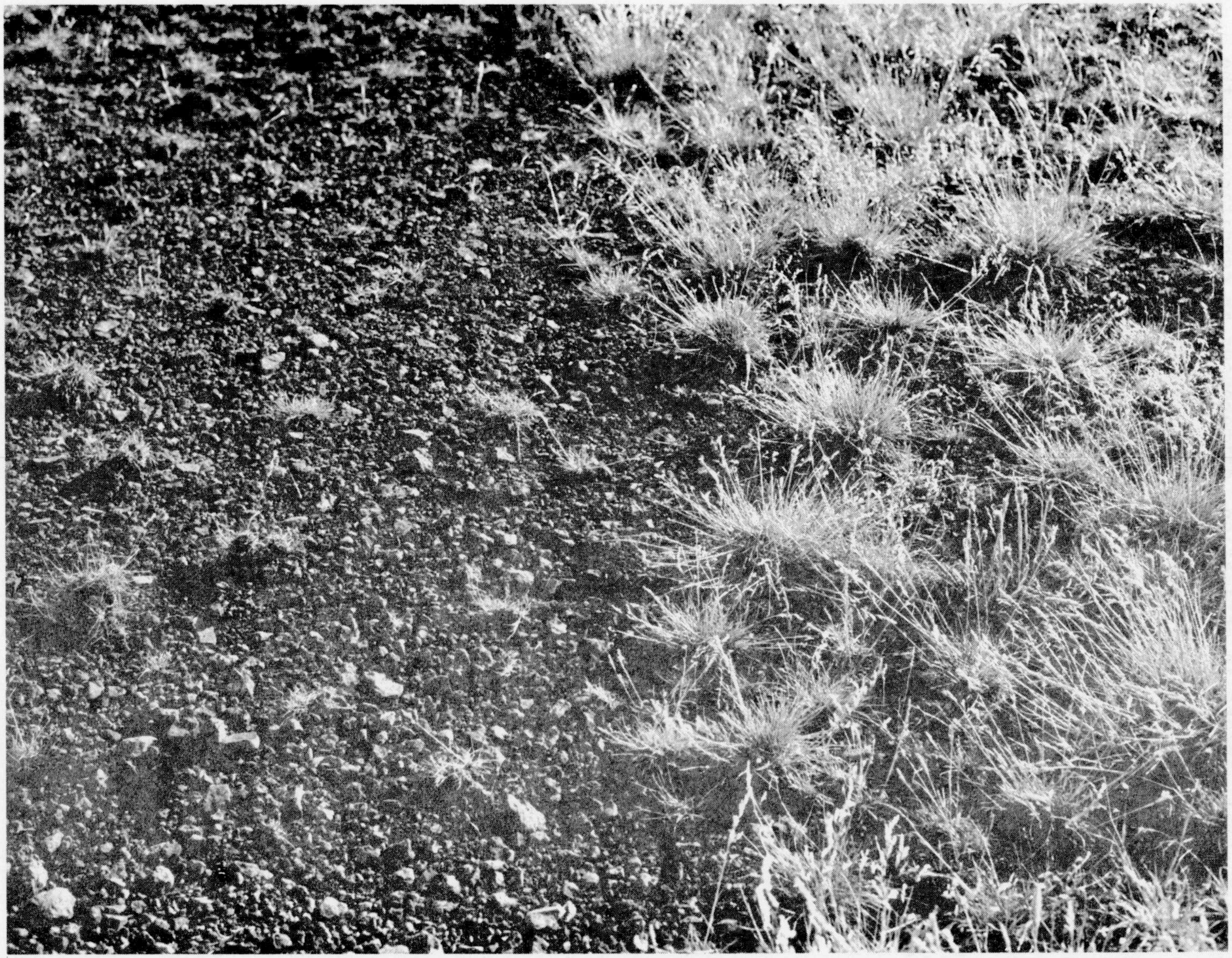


FIGURE 24. Results of fertilization on growth of individual plants on site disturbed during World War II. Plants colonizing this bare area consisted principally of *Deschampsia beringensis* with *Trisetum spicatum* and *Phleum commutatum* also present.

portions (Table 13). There was some reduction in coverage in the third season in both the fertilized and unfertilized plots. This may have been due to small errors in estimation, differences in conditions of the growing season, and diminished effect of the fertilizer in the treated plots. Plants on the unfertilized plots were extremely depauperate with a small amount of green tissue relative to the dead tissue present. Often the plants were only loosely attached to the soil. Their existence appeared tenuous. Fertilization increased the growth of the individual plants and produced a much greener color. However, in the third season the amount of green tissue in relation to dead tissue appeared to have decreased in the fertilized plants.

TABLE 13. Effects of fertilization on percent coverage of disturbed area undergoing natural revegetation. Fertilizer was applied in 1971.

	Rate of Fertilization				
Year	50-44-50	100-44-50	150-44-50	Avg.	0
1972	32.8[a]	61.5	69.0	54.4	9.3[b]
1973	23.8	33.1	59.1	38.7	7.8

[a] Coverage estimated with 20 x 50 cm quadrat placed 4 times in each plot in two replications of fertilized plots.

[b] Four unfertilized plots were analyzed.

Reproductive Fertility of Planted Materials

Flowering material was collected from plants that had headed at the different sites in both 1972 and 1973. Those plants that flowered to any extent included the red fescues, bluegrasses, timothy, meadow foxtail, Bering hairgrass, and sheep fescue. The only entry to produce any seed was Nugget bluegrass. It produced a small amount of poorly developed seed at Sites 1, 2, and 3 in 1972. None of the grasses examined produced seed in 1973.

Recommendations for Revegetation

The seeding of disturbed areas scheduled for revegetation was accomplished in early to mid summer of 1973 by private contract. Fertilizer recommendations were made following the 1971 growing season to accommodate a scheduled shipment that could transport the fertilizer. Seeding recommendations were made following the 1972 growing season to accommodate the 1973 planting date.

The fertilizer recommendation was tempered by results at Sites 1 and 3 in 1971 where there were indifferent to negative responses to N above the 80-lb level. On the more mineral sites higher N levels benefited growth, but the 80-lb application was adequate. Thus a rate of 90-160-80 ($N-P_2O_5-K_2O$) was recommended, obtainable by combining 500 lbs of 8-32-16 with 150 lb of NH_4NO_3 per acre of application.

Seeding recommendations were tempered by a stipulation requesting the use of perennials that were conspecific with plants occurring on the island. Those entries judged to be best adapted included Highlight chewings fescue, Boreal red fescue, Pennlawn red fescue, Engmo timothy, Bering hairgrass, common chewings fescue, and meadow foxtail. The perennials Highlight chewings fescue and Boreal red fescue, tufted and creeping forms of red fescue, respectively, and Bering hairgrass were recommended in a mix with annual ryegrass. Both red fescue and Bering hairgrass are important species in the native flora. The Bering hairgrass seed was obtained from native populations on mainland Alaska (Mitchell, 1973). Seed for the others was available from commercial sources. Good stands had been established in the seeded areas when observed in September 1973 (Figures 25 and 26).

SUMMARY

Revegetation research was conducted on Amchitka Island from 1970 to 1973 preparatory to reseeding of disturbances created during the nuclear testing program. The possibility of employing seed from plant populations native to the island was explored and determined to be unfeasible. Seed production of individual plants and native stands were insufficient to supply the amounts necessary for the revegetation project.

Trials were conducted to test the adaptability of commercially available materials and experimental materials of native populations found on mainland Alaska. Test sites were established on different soil types and at different elevations. Good stands of the better adapted grasses were obtained from near sea level to about 480 ft elevation. At the latter elevation wind and frost action are sufficiently severe to maintain barren areas in the native tundra.

Soils at all test sites were extremely low in available N and P contents. Responses to different fertilizer levels were erratic in the first growing season at two sites with humic, acidic soils. Nitrogen was utilized more effectively at higher rates of P and K, but the response to added levels of N at given levels of P and K were indifferent to negative at these two sites. Responses at two sites with gravelly or mineral soil types were more normal with growth increasing at added levels of N.

Certain plants succeeded at some sites but failed at others, indicating a tolerance to climatic conditions but not to certain edaphic conditions. The relatively humic sites with acidic reactions were less favorable

FIGURE 25. Road runs through reseeded strip of disturbed ground on approach to Cannikin nuclear test site.

FIGURE 26. First season growth of reseeding by AEC. Taller, broad-leafed material is annual ryegrass. The red fescues Boreal and Highlight chewings provide most of the perennial cover. A small amount of native Bering hairgrass seed also was included in the mix. First season growth was adequate for good establishment.

in general than the gravelly and more mineral sites with basic reactions. Grasses appearing stressed in the first year at the two humic sites either failed to survive or did very poorly in subsequent years. Fertilization was absolutely necessary to develop good stands in the first year. Plants continued to grow without fertilization only on the gravel pad, but much less vigorously than the fertilized plants.

Ecotypical differences were critical in this region of marginal growing conditions. Different entries of the same species and members of closely related species demonstrated distinct differences in adaptability. Some cultivars of temperate origin were among the better performers in the 3-year test.

Red fescues--Highlight chewings (tufted form), and Pennlawn and Boreal (creeping forms)--Engmo timothy, Bering hairgrass, and meadow foxtail were the best performers over the range of sites tested. Kentucky bluegrass entries and Frontier reed canarygrass were fair to good performers. Wheatgrass, wildrye, bromegrass, creeping foxtail, grandis alkaligrass, and redtop bentgrass entries were inconsistent performers, doing poorly at some or most of the sites.

Fertilization of disturbed areas undergoing natural revegetation greatly increased growth over that in unfertilized areas.

Previous to this research project no information was available on the possibility of establishing a plant cover under the severe climatic conditions of the western Aleutian islands. Frequent and often strong winds, a high incidence of cloud cover and fog, and cool temperatures characterize the growing season at this maritime tundra location. The results of this research project demonstrated that with proper fertilization plants now commercially available can be grown under these conditions. Native plants currently involved in selection programs offer further potential.

ACKNOWLEDGEMENTS

Financial support was provided for this study by ERDA (formerly AEC). I thank Raymond Brechbill and Ernest Campbell of ERDA for their fine support and cooperation; Carl Abegglen of the U.S. Fish and Wildlife Service for his cooperative efforts; Waldo Erickson and Allen Mansfield of the Alaska Agricultural Experiment Station for their assistance in the field; Ivan Branton, agricultural engineer retired, for his assistance in the initial survey; C. C. Amundsen, ecologist, for his instructional, guided tour; V. Q. Hale of Battelle and members of the experiment station publications committee for their critical review of the manuscript; and Kathy Moffitt for her persevering and fine secretarial service.

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