PRINGLE HILL SAND QUARRY

RESTORATION PROJECT

NSGA ADAK, ALASKA
1993 - 1995
FINAL REPORT
DECEMBER 1, 1995

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San Bruno, California (1993)
Engineering Field Activity Northwest
(1994 - 1995)

ALASKA DEPARTMENT OF NATURAL RESOURCES

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Foreword

The Alaska Plant Materials Center's (PMC) involvement with coastal restoration and erosion control projects started in 1982. The techniques described in this report have evolved from previous projects on Shemya Island and Adak Island. These early projects pioneered the use of beach wildrye, *Leymus mollis*. Beach wildrye used in conjunction with red fescue, *Festuca rubra*, and Bering hairgrass, *Deschampsia beringensis*, has also been refined on numerous coastal rehabilitation projects on the Aleutians.

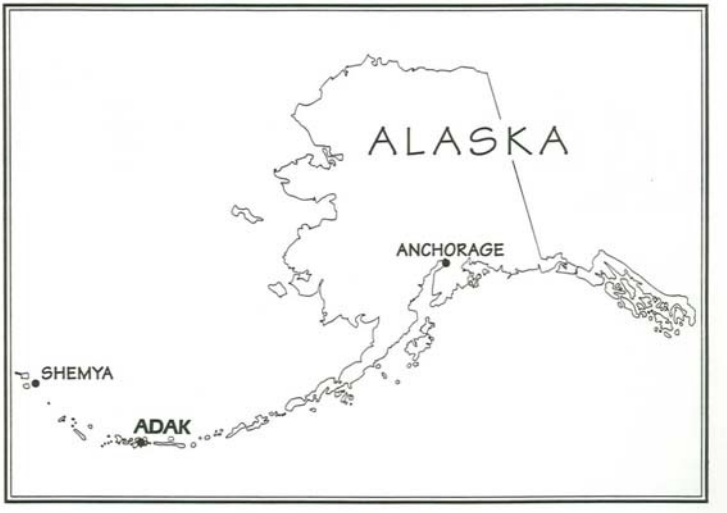
The PMC's role in the project described in this report was basic project design, materials acquisition and construction monitoring. All logistic support and labor was provided by the Naval Security Group Activity (NSGA) on Adak. Funding ($50,000) was derived from the Department of the Navy, Agricultural and Livestock Grazing Outlease Rental Receipt Program. Initially, administrative and area support was provided by Engineering Field Activity West, San Bruno, California. After Navy realignment, this function was transferred to Engineering Field Activity Northwest, Poulsbo, Washington.

Introduction

Adak Island, part of the Aleutian Island Chain, is approximately 1,200 air miles southwest of Anchorage, Alaska (Figure 1). The military installation occupies the northern half of the island. The U.S. Fish and Wildlife Service (USFWS) manages the southern portion of the island as a designated Wilderness Area within the Alaska Maritime National Wildlife Refuge system (USDA 1990).

The location of the naval land withdrawal on Adak Island with its individual commands, the Naval Air Facility (NAF), the Naval Security Group Activity (NSGA) and the Naval Facility (NAVFAC) is shown in Figure 2 (USDA 1990).

Figure 1. Location of Adak Island.



Pringle Hill Sand Quarry

The Pringle Hill sand quarry has been in active use since 1945 and continues to provide sand into 1995. A small portion in the northwest corner will continue to be available for future sand extraction. The quarry is located east of Clam Lagoon on the north end of Adak (See Figures 2 and 3). Three significant factors contributed to the decision to conduct an erosion control and reclamation project on the quarry. First, the quarry has become a source of blowing sand which was causing maintenance problems by blocking a nearby road. Constant removal of the continually forming dunes is a maintenance cost that could be substantially reduced.

The second reason for the erosion control and reclamation project was to protect the remnant dunes on the east side of the quarry. If this area eroded to the point of breaching to the sea, the entire quarry could be lost.

Finally, the reclamation project was put into effect as a resource protection measure. The need for sand on Adak has declined. Continued Navy presence is limited and as a result, areas of past disturbance are being restored to their former condition as funding and technology permit.

Figure 2. Adak Island.

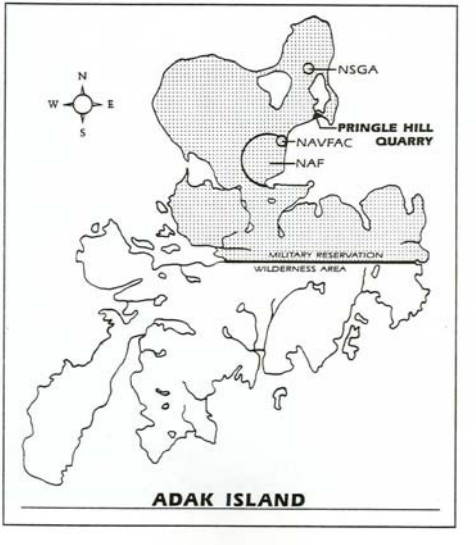


Figure 3. Air photograph of Pringle Hill Sand Quarry and surrounding features prior to restoration.

Methods

Plant Species Used

The restoration plan for the Pringle Hill sand quarry relied on three native species: red fescue, *Festuca rubra*, Bering hairgrass, *Deschampsia beringensis*, and beach wildrye, *Leymus mollis*. The red fescue and Bering hairgrass were seeded; the beach wildrye was sprigged, a form of transplanting. The species used can be described as follows:

Beach Wildrye, *Leymus mollis*, has been the most effective plant species in controlling coastal erosion. Beach wildrye is an easily identifiable grass species common throughout coastal and insular Alaska (Figure 4). This species has been referred to by a number of common and scientific names. Klebesadel (1985) listed no less than 12 common names including: dune grass, American dune grass, lyme grass, beach ryegrass, sea lymegrass, Siegle de mer, strand wheat, strand oats, wild wheat, sand-meal grass, dune wildrye, and beach wildrye.

The scientific names applied to this species are nearly as confusing as the common names. Presently, *Leymus mollis* is being used. It has also been called *Elymus mollis, Leymus arenarius* and *Elymus arenarius*. To further muddle the issue of nomenclature, species of *Amomophilia* are at times confused with beach wildrye because of that genus' common name "beach grass" (Wright 1994).

Figure 4. Beach wildrye stand near Pringle Hill Quarry.

Beach wildrye, *Leymus mollis*, is the North American species or variety of the *Leymus* complex. The range of beach wildrye is described as being along the coast of Alaska to Greenland, south to Long Island, New York and central California, along lakes Superior and Michigan, also eastern Siberia to Japan (Hitchcock 1950). Within this range, the species occupies a specific niche, most often on sandy beaches forming belts along the shore (Hulten 1968). This includes sandy beaches along the north shore of Lake Superior (Dore 1980). The species habitat is further defined as being spits, sea beaches, tidal flats, sea cliffs and lakeshores (Welsh 1974). While usually associated with coastal dunes, the species can be found along large inland lakes occupying the same relative shoreline areas as in the marine coastal areas (Klebesadel 1985).

Leymus mollis is a perennial grass with stout culms, pubescent below the spike. It ranges in height from 60 to 120 cm with numerous overlapping basal leaves. The strong, stout rhizomes spread widely. Leaves are 7 to 25 mm wide (Hitchcock 1950). Both seed and seed heads are relatively large. This grass is not a heavy seed producer in Alaska because many of the potential florets do not produce seed. The rhizomes of beach wildrye are large and vigorous, promoting rapid spread of individual plants to cover large areas (Klebesadel 1985).

The beach wildrye evaluation program started in 1976 with off-site investigation on the Aleutians and coastal Alaska, has resulted in two cultivars being released by the Plant Materials Center. The first cultivar, 'Reeve', (of Norwegian origin, therefore the nomenclature *Leymus arenarius* applies) was released as a seed producing variety (Wright 1991a). Natural stands of beach wildrye are notorious for not producing seed. Reeve not only produces commercially viable quantities of seed, but also exhibited the hardiness and adaptation needed in Alaska. The second cultivar, 'Benson', is of Alaskan origin. It is intended for sprigging or transplanting on highly erosive sites where establishment by seed would be impractical or impossible (Wright 1991b). Both cultivars should be commercially available by 1998.

All beach wildrye sprigs used on this project were obtained within a 20 foot-wide band adjacent to .3 mile of road leading to the sand quarry (Figure 12).

Red Fescue, *Festuca rubra*, is a perennial grass with short creeping root stocks sometimes forming dense tufts (Hulten 1968). 'Arctared' red fescue was released in 1965 as a revegetation species showing extreme hardiness throughout Alaska (Hodgson 1978). The overly aggressive, sod-forming nature of this species often makes this cultivar unacceptable in reclamation. However, in erosion control the cultivar is outstanding (Wright and Moore 1994). The cultivar was cooperatively developed by the University of Alaska Agricultural Experiment Station and the USDA. 'Boreal' red fescue was developed by the Canadian Department of Agriculture Research Station, Beaverlodge, Alberta (USDA 1972). This hardy cultivar is similar to Arctared in adaptation and potential use in portions of Alaska. It is often substituted for Arctared as it is less expensive (Wright and Moore 1994).

Bering Hairgrass, *Deschampsia beringensis*, is a perennial tufted grass common to the Pacific coastal areas of North America and the Chukchi Peninsula in Asia. The species is usually found on muddy shores, however it also thrives on sandy and rocky coastal areas (Hulten 1968). 'Norcoast' Bering hairgrass was released in 1981 by the University of Alaska Agricultural Experiment Station as a forage and revegetation grass (Wright and Moore 1994). Norcoast is recommended for revegetation use in coastal regions of western Alaska to southwestern Alaska and possibly in the northern maritime regions (Mitchell 1985).

The Seed Mix

The seed mix used on the project consisted of a ratio developed and proven on past Aleutian projects. The mix was applied at a rate of 30 pounds per acre.

Table 1.

Botanical Name	Common Name	% of Seed Mix by Weight
Deschampsia beringensis	Norcoast Bering Hairgrass	60
Festuca rubra	Boreal Red Fescue	20
Festuca rubra	Arctared Red Fescue	20

Sprigging Beach Wildrye

The specifications called for beach wildrye to be sprigged three to four feet on center with none exceeding five feet on center.

The techniques used to harvest and plant the beach wildrye sprigs were developed on previous Adak and Shemya projects. Failure of these techniques has not been encountered on any previous projects with similar environmental conditions.

The method of planting is usually referred to as "drop and stomp". Very little training is needed by planting crews to effectively and economically plant the beach wildrye sprigs.

Figure 5. Sprig of beach wildrye prior to planting.

Figure 6. Planting trenches being prepared in Pringle Hill Quarry.

Figure 7. Sea Bee crew planting beach wildrye, May 1994.

Figure 8. Typical area immediately after planting.

Seeding of Native Grasses

After the areas were sprigged with beach wildrye, the prescribed seed mix was applied by means of broadcast spreaders. In 1993, shoulder-held spreaders were used. This proved to be too time consuming. In 1994 and 1995, a mechanical broadcast spreader was used. This proved to be much more efficient. Incorporation of the seed by harrowing was not employed on this project as the sprigging activity rendered the soil surface sufficiently rough.

Figure 9. Shoulder spreader, type used on Pringle Hill project.

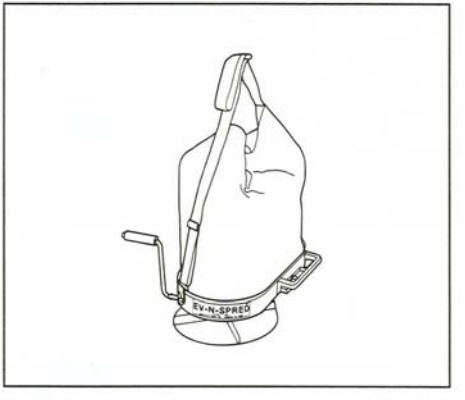
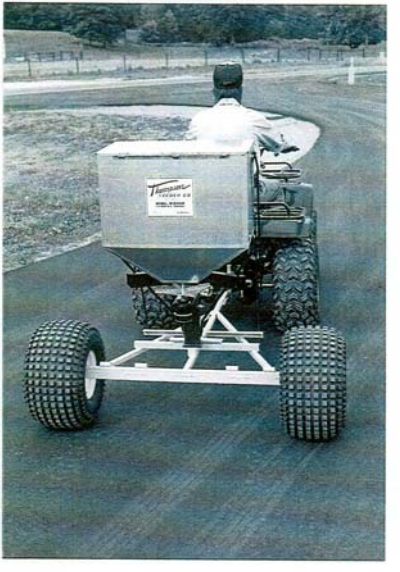


Figure 10. Type of mechanical spreader used on Pringle Hill project.



Fertilizer Applications

The specifications called for the use of granular 20-20-10 (20% Nitrogen, 20% Phosphorus, 10% Potassium) fertilizer. This formulation was proven to be effective on past Adak projects. Fertilizer was applied at a rate of 500 pounds per acre on the year of planting. During the spring of the year following planting, the previous year's planting area received an additional application of 20-20-10 at a rate of 300 pounds per acre. Fertilizer was applied using the same equipment described for seeding. The use of a mechanical spreader definitely improved efficiency and crew morale.

Figure 11. Photograph taken in 1994 showing the initial stages of dune building by beach wildrye as it traps sand. Note the presence of the invading species *Honckenya peploides* on the left side of the photo. This species was not present in the quarry prior to the revegetation activity.

Labor Requirements

All labor was provided by the Naval forces on Adak. NSGA provided the majority of the labor. The Naval Air Station also provided personnel. This program was classified as a "self-help" program, and all participants were volunteers. Sea Bees attached to NSGA accounted for the majority of the labor and also operated equipment when needed. In order to accomplish the project, a three-year program was established. This allowed for the use of Navy personnel without impacting normal Navy operations. The quarry was divided into three roughly equal sections (Figure 13).

Table 2.

Manpower Requirements		
Year	Date	Man Hours
1993	5/17 - 5/21	118
1994	5/16 - 5/20	98
1995	5/22 - 5/24	64

Overall, the labor force was rated excellent. Considering the weather conditions, all the needed work was conducted in a timely and professional manner.

Sprig Harvest Area

A single harvest area was used to collect all the sprigs needed for the project. The area used for harvest consisted of .3 mile by 20-foot wide band on the west shoulder of road leading to Candle Stick Bridge (Figure 12). Each year after harvest, the site was fertilized with 20-20-10 fertilizer at a rate of 400 pounds per acre.

Many of the areas were repeatedly harvested during the three-year period. This definitely shows the resilience of established beach wildrye stands.

Figure 12. Harvest area used for beach wildrye sprig acquisition.

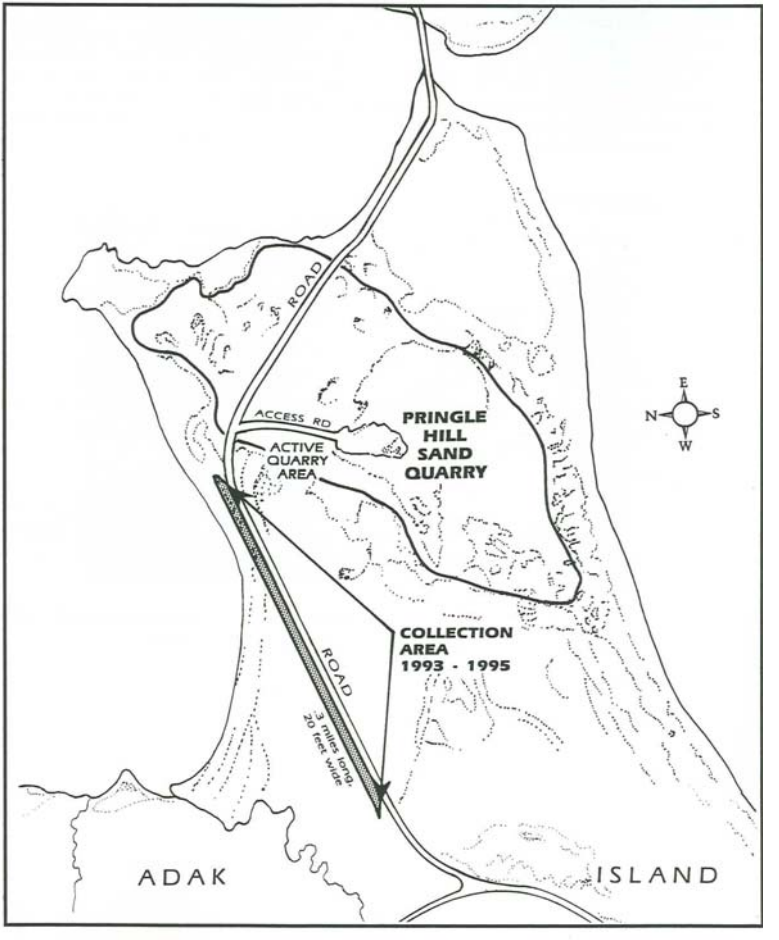
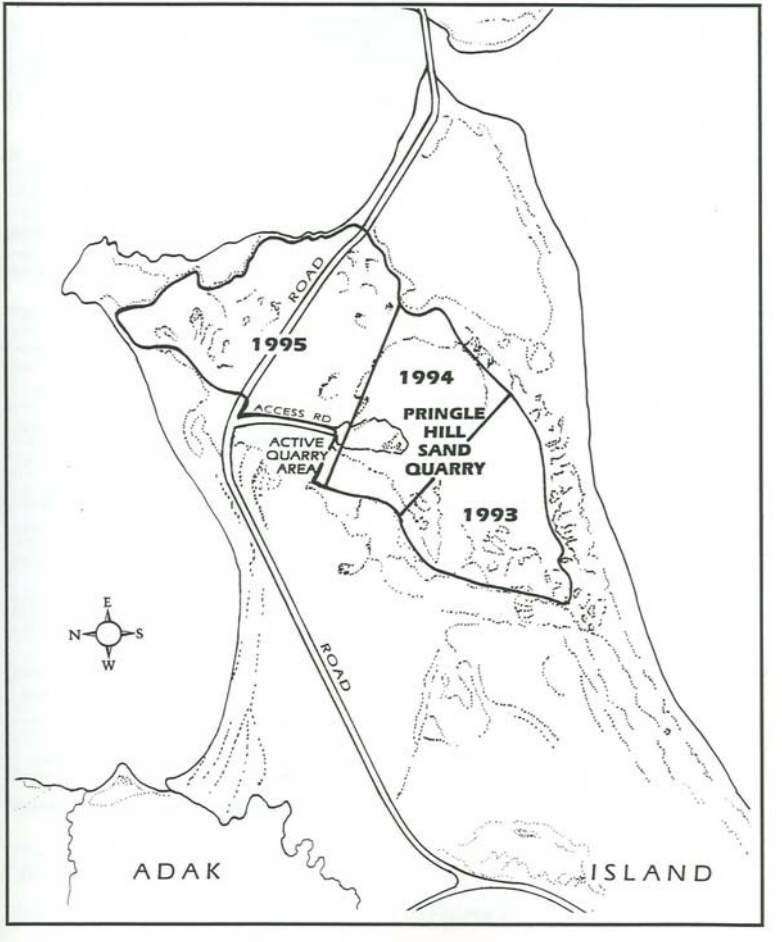


Figure 13. Quarry restoration schedule by year.



Results

Evaluations of the project were conducted annually from 1993 to 1995. These evaluations occurred in either September or October and determined percent ground cover, species composition and survival. The evaluations also noted invading species; i.e., those species not on the site prior to revegetation and not in either the seed mix or transplanted.

The following narrative will outline the quantifiable results obtained from the evaluations conducted between 1993 and 1995.

Table 3.

Results of Evaluations			
	Evaluation Year		
	1993	1994	1995
Percent Overall Plant Cover	-60% cover on 1993 portion of project	-1993 portion of project - overall cover 85% -1994 portion of project - overall cover 70%	-1993 portion of project - 95% cover overall -1994 portion of project - 100% cover overall -1995 portion - 50-60% cover
Species Composition	Not Rated	-1993 portion of project - 60% hairgrass, 25% red fescue, 15% beach wildrye -1994 portion of project - 60% hairgrass, 30% red fescue, 10% beach wildrye	-1993 portion of project - 50% hairgrass, 20% red fescue, 30% beach wildrye -1994 portion of project - 75% hairgrass, 15% red fescue, 10% beach wildrye -1995 portion of project - 90% beach wildrye, 10% seed grass
Percent Survival Notations	-95% beach wildrye sprigs survived	-1993 portion - 100% of sprigs survived -1994 portion - 90% of sprigs survived	-1995 portion - 95%-100% beach wildrye sprigs survived

Invasion of Native Species

Prior to the revegetation program, the Pringle Hill Sand Quarry supported very little vegetation. The opportunity for natural revegetation existed throughout the area since 1989 when the majority of the quarry was abandoned or removed from active use status. Many of the species present in undisturbed areas around the quarry rely on wind dispersal of seed. This weather condition usually exists on Adak, yet invasion of native species was not occurring.

Immediately after revegetation was initiated in 1993, native species not seeded or sprigged started appearing in the treated areas. This process continued through 1995. Each year after 1993, the frequency and diversity of invading species progressively increased. The exact reason can only be speculated. However, it is believed that the seeded and sprigged grasses provided a degree of shelter and a microenvironment suitable for seed catch and germination. It can also be attributed to fertilization. This is worthy of additional investigation.

Table 4.

Invading Species Noted in Restored Areas			
Species	1993	1994	1995
Agrostis exerata		X	X
Poa macrocalyx	X	X	X
Bromus sitchensis			X
Luzula multiflora			X
Honckenya peploides	X	X	X
Lathyrus maritimus		X	X
Heracleum lanatum			X
Ligusticum scoticum			X
Achillaea borealis		X	X
Senecio pseudo-arnica		X	X
Calamagrostis canadensis			X

Photographic Documentation

The following series of photographs are intended to inform the reader of the actual changes in the quarry from 1993 to 1995.

Photo points and direction of view are noted on Figures 14, 15 and 16.

Figure 14. Photo points and direction of view for Figures 17-22

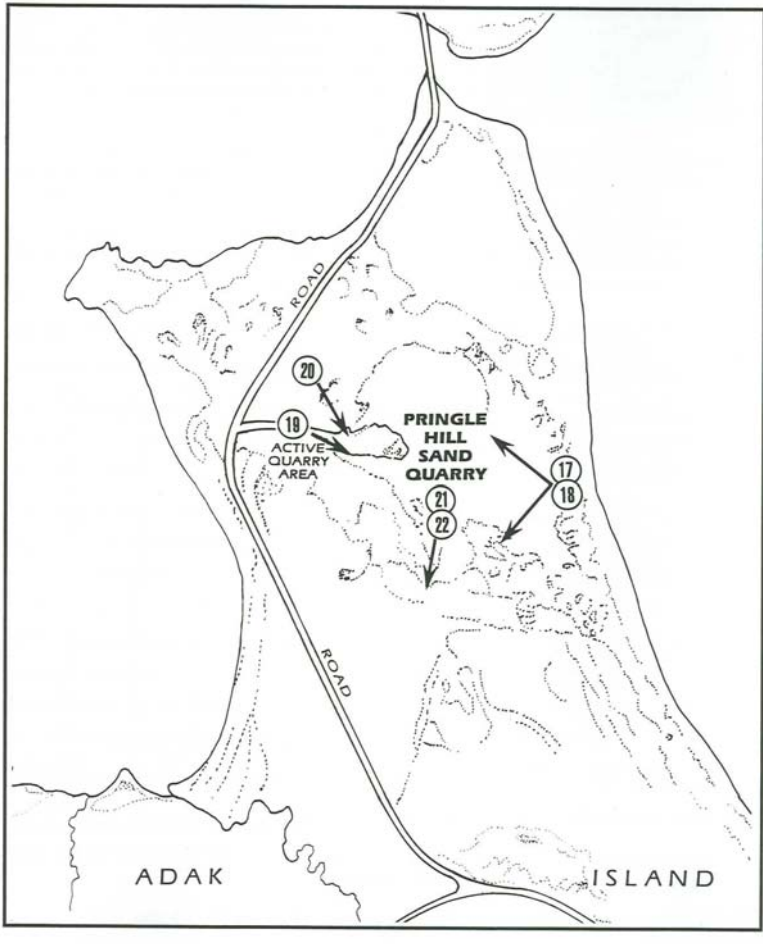


Figure 15. Photo points and direction of view for Figures 23-30

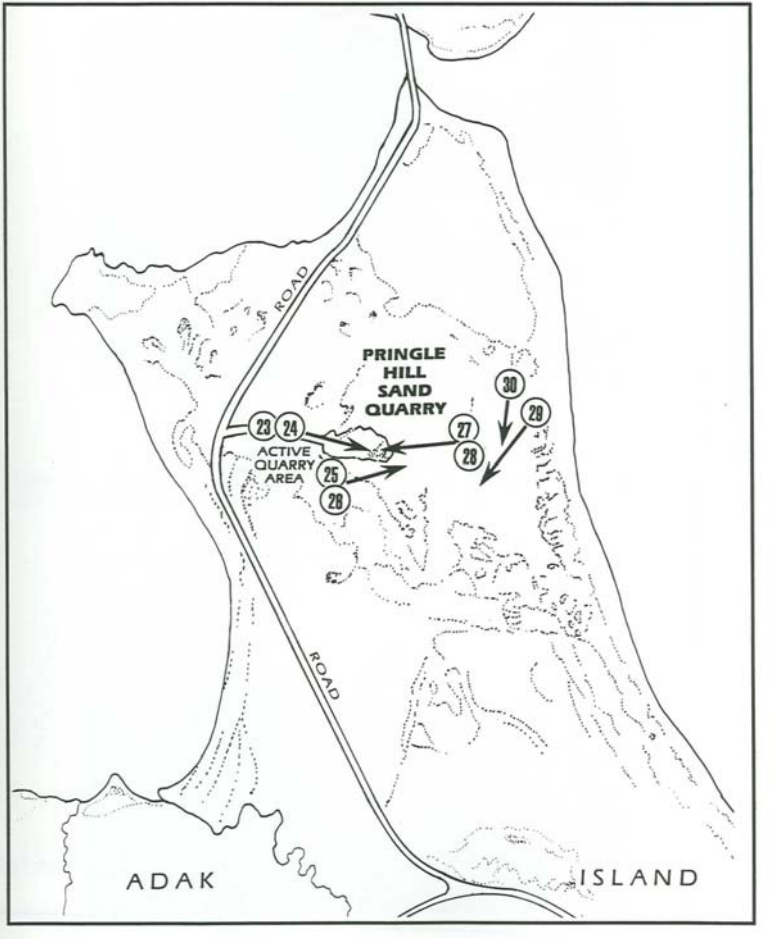


Figure 16. Photo points and direction of view for Figures 31-34

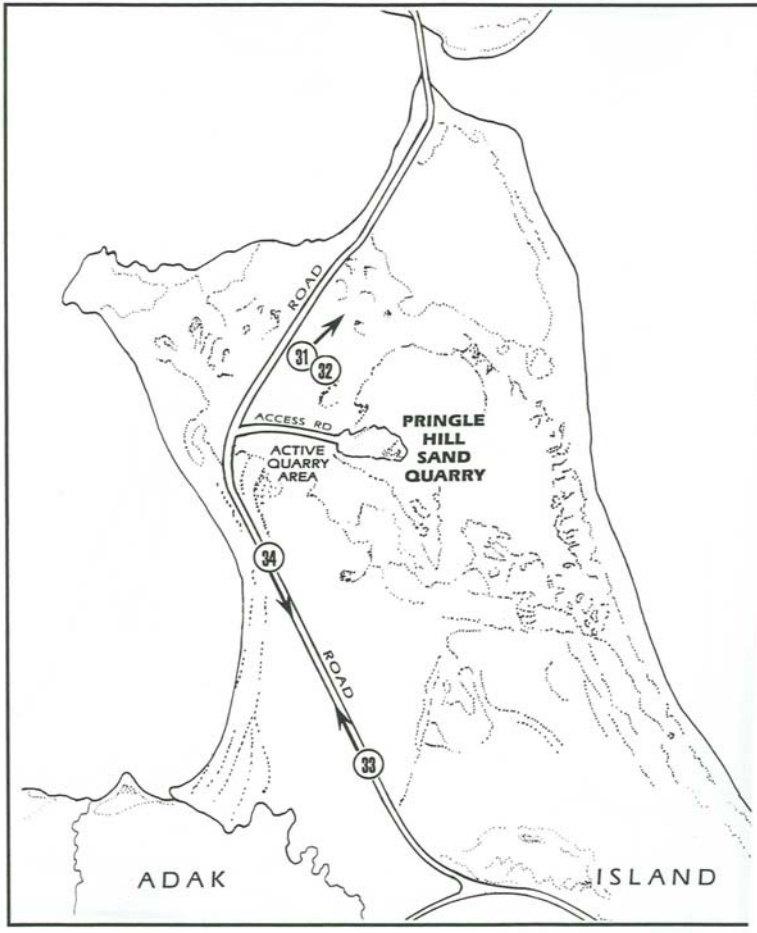


Figure 17. Pringle Hill, 1992 view to the south.

Figure 18. Pringle Hill, 1992 view to the north. The dark soil in the bottom of the quarry indicates the area of sub-surface induced flooding during high tides.

Figure 19. View in south easterly direction, May 1993.

Figure 20. Same relative view as Figure 19, October 1995.

Figure 21. View south, May 1994.

Figure 22. View south, October 1995.

Figure 23. Easterly view, May 1993.

Figure 24. Same view as Figure 23, May 1994.

Figure 25. Same view as Figures 23-24, September 1994.

Figure 26. Same view as Figures 23, 24 and 25, October 1995.

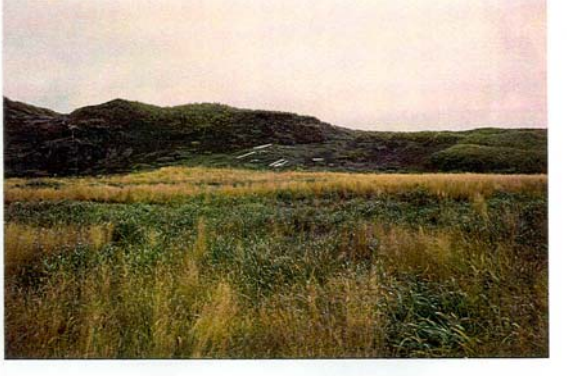


Figure 27. Westerly view, September 1993.

Figure 28. Same westerly view, October 1995.

Figure 29. View south, October 1995.

Figure 30. View southwest, October 1995.

Figure 31. 1995 planting area, May 1995.

Figure 32. Same May 1995 planting area, October 1995.

Figure 33. Harvest area, May 1993. View north to end of harvest area.

Figure 34. Harvest area, October 1995 view south to beginning of harvest area.

Conclusions

The three year project to control erosion and restore the Pringle Hill Sand Quarry was extremely effective and successful. The resulting vegetative cover exceeded expectations in most areas. The high rate and extent of natural invasion was not expected in the short period involved in the project. However, these results indicate the appropriate nature of using beach wildrye and the prescribed seeded grasses. The overall re-establishment of a native vegetation community has exceeded all previous attempts of true vegetation restoration on the Aleutians. This project may be the most successful restoration project completed in Alaska.

The project costs did not exceed original estimates. This can be attributed to the outstanding cooperation provided by the Navy. Future use of Navy personnel in restoration activities is strongly suggested based on the success in using Navy personnel. Navy support was without problem and the final results of the project can easily be measured by the degree of success.

Maintenance Program

The contract awarded to the Alaska Plant Materials Center for the Pringle Hill project noted that a maintenance program would be developed when restoration was complete.

Based on the results of the effort to date, additional maintenance of the vegetation is not seen as an issue. The established plant community is growing very well. The overall vigor and biomass production on the site indicate that healthy growth will continue without a maintenance program.

The site does, however, need protection from vehicle and equipment traffic. The revegetated areas must be posted or blocked to prevent access by vehicles. The northwest corner of the quarry and the access road are still usable for future sand extraction. This area was estimated as having sufficient sand for all the projected Navy needs on Adak.

Comments

Two items were overlooked in the original proposal:

1. A second year fertilization program of the 1995 planting was not considered. This oversight should not have an adverse effect on the success of the planting. However, vegetative expansion of the beach wildrye plants in the 1995 portion may be slower than the 1993 and 1994 planting. The rate and extent of native reinvasion may not be as great as the earlier planting due to the omission. This too will not pose a risk to final success.

2. An indepth (approximately three year) monitoring program with permanent transects should have been established to document natural reinvasion. This will not have an effect on the results, however, the knowledge gained would be invaluable.

   If these two items are deemed important by the Navy, the Alaska Plant Materials Center will develop a proposal. However, work should start in May 1996.

Acknowledgements

The Alaska Plant Materials Center wishes to thank the U.S. Navy for the outstanding cooperation given during the Pringle Hill Quarry project. Without cooperation, activities on the Aleutians can become absolute nightmares. This project, from beginning to end, was enjoyable and without significant problems.

A thank you needs to be extended to the Commanding Officers and staff stationed at NSGA during the project. Without the active support of NSGA, the project would not have been possible.

Mr. Dick Rugen, Engineering Field Activity West, is extended a very greatful "thank you" for the initial establishment of the project and his continued administrative support after his group no longer maintained jurisdiction on Adak following realignment.

Last, but not least, the PMC wishes to thank Mr. Kent Livezey, EFA Northwest, for his assistance in scheduling, travel, administrative tasks and project oversight. His efforts made the project easy.

The Department of the Navy also deserves acclaim and recognition. By funding this project, the U.S. Navy has increased the general knowledge in the use of beach wildrye and coastal restoration by an order of magnitude. This program and the resulting knowledge gained would not have come to fruition without the Navy's progressive committment to environmental protection.

APPENDIX

SPECIFICATIONS AS WRITTEN
SCHEDULE
REFERENCES

SPECIFICATIONS AS WRITTEN

Revegetation

1.0 GENERAL: Site is located on NSGA property on Adak Island, Alaska. Soils are mainly sand with some foreign materials present, < 1.0%.

2.0 MATERIALS:

2.1 Seed: Shall be state certified seed, delivered in original sealed packages. Seed shall be labeled in conformance with U.S. Department of Agriculture rules and regulations under the Federal Seed Act of August 9, 1939 (53 Stat. 1275) and applicable state seed laws. Seed that has become wet, moldy, or otherwise damaged will not be acceptable. On-site mixing will not be allowed. Seed mixture shall be proportioned by weight as follows:

Botanical Name	Common Name	% of Seed Mix By Weight
Deschampsia beringensis	Bering hairgrass 'Norcoast'	60%
Festuca rubra	red fescue 'Boreal'	20%
Festuca rubra	red fescue 'Arctared'	20%

The seed mix shall be applied at a rate of 40 pounds per acre.

2.2 Sprigs: Sprigs shall be healthy living stems, stolons, rhizomes and attached roots of beach wildrye (*Elymus mollis* Trin.) or (*Elymus arenarius*) also commonly referred to as dune wildrye.

2.3 Harvest: Beach wildrye sprigs shall be harvested from natural stands approved/designated by the Contracting Officer or his designated representative. Transplants shall be pulled or dug from the sand. They shall be separated into transplant sprigs with at least one viable culm with roots attached. Care shall be taken to assure that natural dunes are not damaged by this harvesting action. Plants shall not be taken from foredunes or areas where erosion may be a concern. Harvesting can be safely conducted in protected areas behind the first duneline. During harvesting, portions of the harvest areas should be left undisturbed to allow for regeneration of the stand. Upon completion of harvesting, the harvest area shall be fertilized at a rate of 400 pounds per acre of the type specified under Fertilizer herein.

2.4 Topsoil: Topsoil shall consist of natural existing surface soils present.

2.5 Fertilizer: Fertilizer shall be of commercial grade, free flowing, uniform in composition, and shall conform to applicable state and federal regulations. Granular fertilizer shall conform to Federal Specification 0-F-241, Type I, Level B, and shall bear the manufacturer's guaranteed statement of analysis and be delivered in original unopened containers. Fertilizer shall contain a minimum percentage by weight of 20% nitrogen, 20% available phosphoric acid, and 10% potash. Any fertilizer which becomes caked or otherwise damaged making it unsuitable for use or reduces the quality will not be accepted. Fertilizer shall be uniformly applied at a rate of 500 pounds per acre.

2.6 Erosion control: Any slope steeper than 30% shall not be worked upon. No equipment nor hand labor shall be allowed on slopes in excess of 30%.

3.0 EXECUTION:

3.1 General: The limits of work are set as depicted on Figure "A".

3.2 Fertilization: Fertilizer shall be broadcast onto the soil surface at the rates specified herein.

3.3 Application:

3.3.1 Planting season and conditions: Planting shall be accomplished between 1 May and 30 July. The ground shall be in a satisfactory condition for planting prior to any sprigging or seeding. The Contracting Officer or his designated representative shall make this determination.

3.3.2 Sprigging: Sprigging shall be accomplished after site preparation and fertilizer application, and before any seed application. Not more than 24 hours shall elapse between initial harvesting and sprigging. Transplanting sprigs may be by hand or other acceptable means to the Contracting Officer or his designated representative. Planting holes or furrows shall allow for staggered planting of the sprigs to maximize erosion control and minimize wind movement of disturbed sand. All furrows shall be oriented perpendicular to the prevailing winds of the site. Sprigs shall be placed a minimum of 6 to 8 inches into the sand so that all stolons, rhizomes, roots are covered by sand.

3.3.2.1 Distribution of sprigs shall be uniform (36 to 48 inches on center) to insure that the maximum spacing of the sprigs will not exceed 60 inches with 80% of the area not exceeding 48 inches.

4.0 ESTABLISHMENT:

4.1 Protection maintenance: The site shall be secured to prevent any motorized vehicle from entering onto the site and posted to minimize any foot traffic onto the site.

4.2 Refertilization: The spring following the sprigging, fertilizer shall be applied at the rate of 300 pounds per acre of 20-20-10, using the broadcast method.

SCHEDULE

Duration of contract: Fiscal years 1993-95
Basic objective: Restore 15 acres per year

1993 Activities: Train and direct local Navy personnel in transplanting locally obtained beach wildrye sprigs. Use local Navy personnel during the work-week and volunteers on weekends, e.g., boy scouts, to sprig non-critical areas within the sand pit.

Use standard seeding methods to apply recommended seed mix on areas already seeded and those areas determined not requiring beach wildrye sprigs. Fertilize existing stands of beach wildrye in and adjacent to the sand pit to encourage natural spread of wildrye into unvegetated areas.

May 1993 - 3 weeks on Adak, starting approximately 1 May.

August 1993 - 3 days to evaluate plantings.

October 1993 - Report on 1993 activities.

1994 Activities: Same as 1993 except fertilization of 1993 sprigs. Two weeks from 15 May on.

August 1994 - 3 days to evaluate plantings

October 1994 - Report on 1993-94 activities

1995 Activities: Same as 1994 and fertilization of 93 and 94 sprigs. Two weeks from 15 May on.

September 1995 - 3 days to evaluate plantings

December 1995 - Final report covering 1993-95 activities and a maintenance program for Pringle Hill.

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