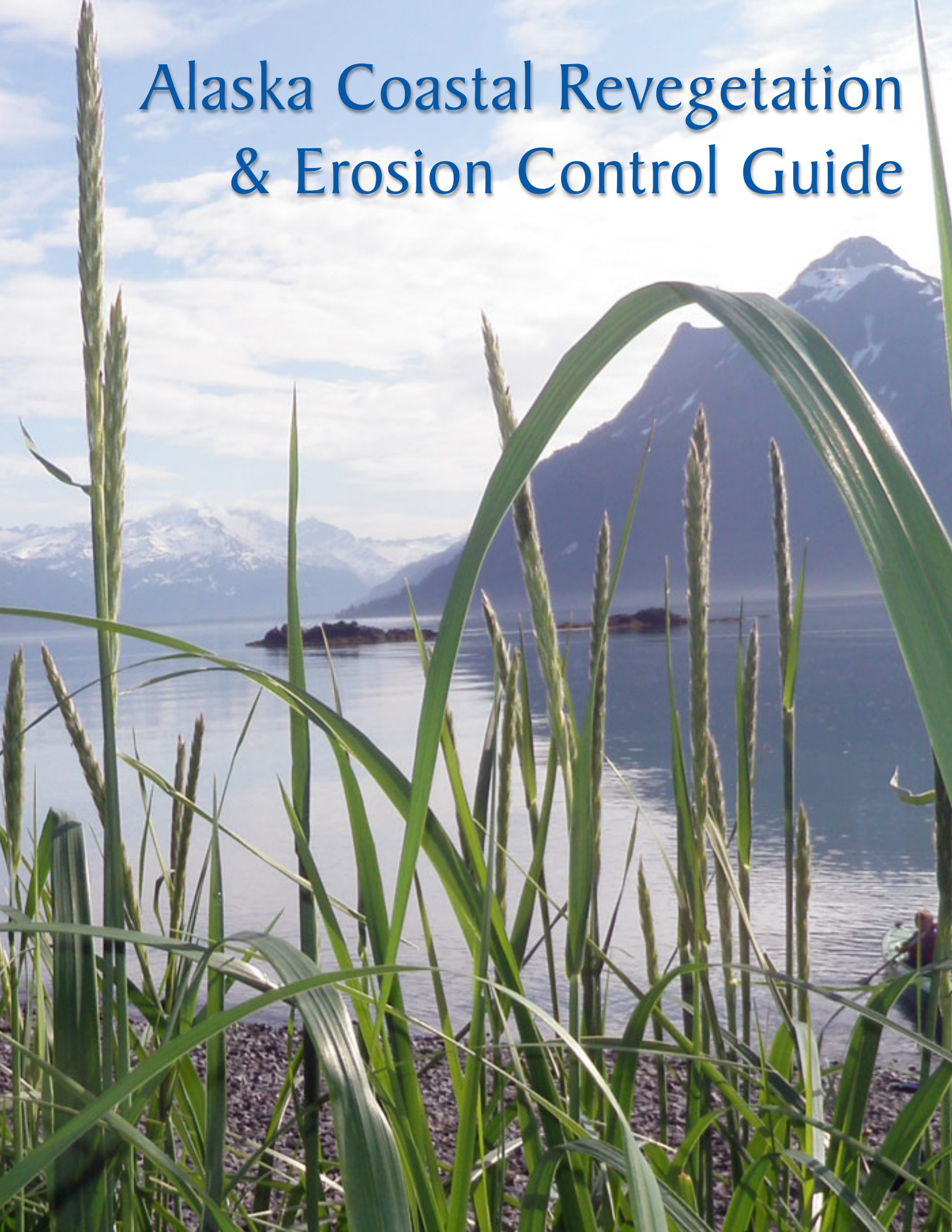
Alaska Coastal Revegetation & Erosion Control Guide



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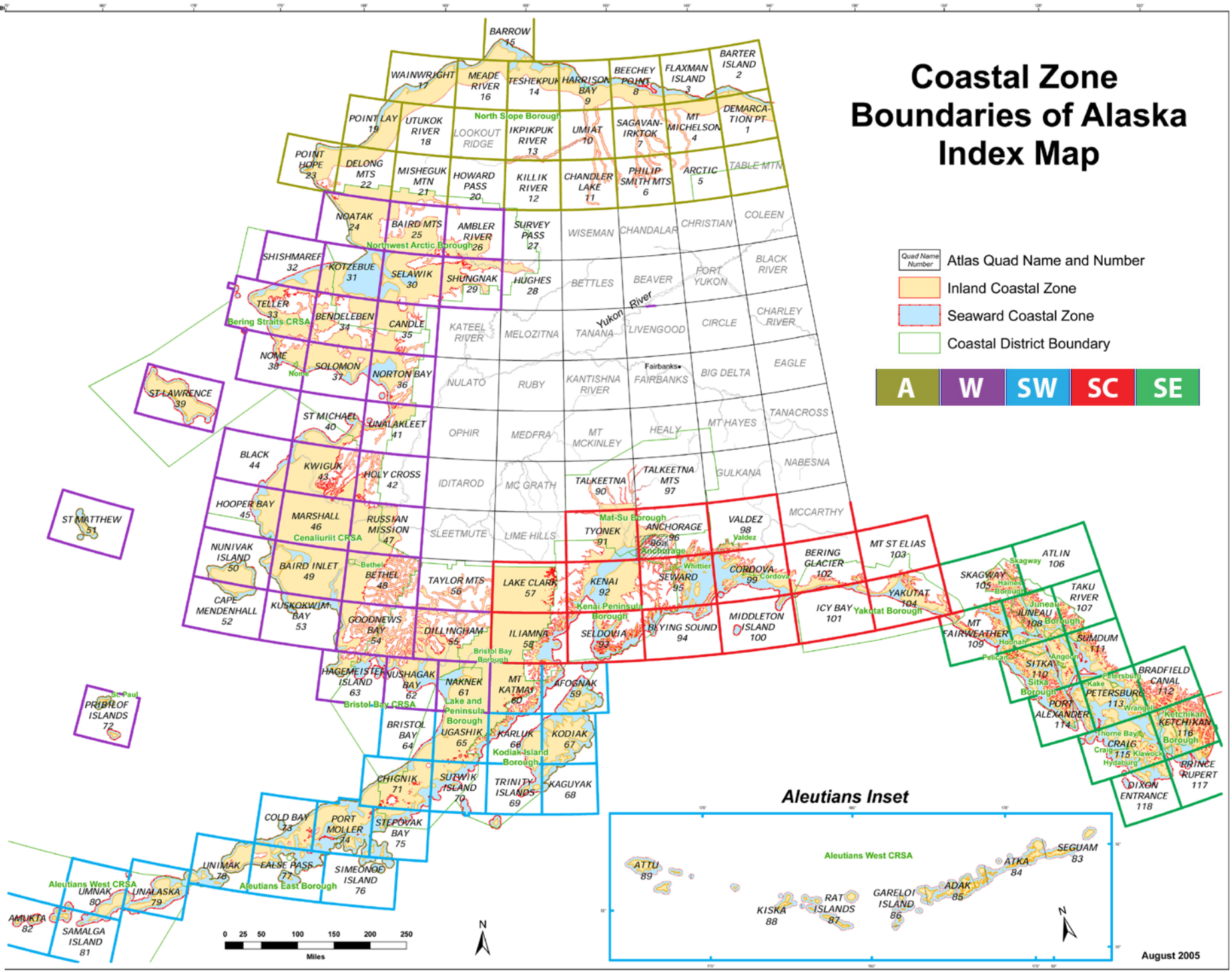

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Alaska Coastal Revegetation & Erosion Control Guide

By

Stoney J. Wright

and

Philip K. Czapla

Editing, Layout, and Design: Brennan Veith Low

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State of Alaska
Plant Materials Center

Front Cover: A natural stand of Beach Wildrye in southeastern Prince William Sound

Photo: Brennan Veith Low (AK PMC)

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Dear Alaskans,

Born and raised in Alaska, from a long-time Alaskan family, I love our great state. The immense grandeur and unrivaled landscape provides an abundance of natural resources that have provided for the development of Alaska as well as vistas that nourish the Alaskan spirit. I know Alaskans will continue to responsibly develop our resources, while also conserving and enhancing the natural environment for future generations. Commercial fishing, logging, mining, tourism, oil & gas production, and transportation are vital industries to Alaska and make up a large part of the state's economy. However, these activities can create disturbances that impact the natural wealth of Alaska. Proper stewardship dictates that these impacts be addressed.

Coastal areas are especially sensitive to disturbance, and especially at risk for erosion. As most of our population centers are near the coast, these areas deserve special attention. The human footprint need not cause negative environmental impacts. Reestablishment of a native vegetation cover by surface preparation, seeding, and fertilizing is a method of erosion control that is cost effective and has a high success rate.

Throughout my career with the Alaska Department of Natural Resources (DNR), I have promoted responsible resource exploration and development. This includes the restoration of previously disturbed areas to their natural condition. The State of Alaska now takes the initiative and mitigates ecological impacts as they occur. This guidebook provides Alaskans a reference for coastal areas and, as such, supports the growing awareness and action occurring in coastal revegetation today.

The reintroduction of vegetation is a proven method of erosion control, and can enhance the aesthetic value of an area as well. We hope that those Alaskans undertaking revegetation or erosion control projects will find this guide useful. The guidebook includes case studies, making it unique, and helps to move forward the art and science of revegetation. Projects from each climatic region of Alaska are represented, providing details of methods and species used, as well as results and lessons learned. These case studies will serve as a helpful reference in the design of any revegetation project.

DNR and I would like to thank you for your interest in revegetation and your commitment to keeping Alaska healthy and vibrant!

Sincerely,

Marty Rutherford

Author's Preface

Aerial photo: ShoreZone (NOAA)

A narrow strip of sand, called a tombolo, connects two islands in this photograph from western Prince William Sound

I have always been fascinated with coastal areas. They are a magical area where the sea (or in some cases large freshwater lakes) meets land. That interest matured fully in 1995, during a seed collection project in an area near the Port Clarence LORAN Station in northwest Alaska. Traveling south from the station on a 4-wheeler, the peninsula narrowed to the point that both the left and right tires were in sea water. This was my first encounter with a tombolo, a depositional land form that is created when waves refract around an island to create a spit, tieing the island to the shore. Ahead of the tombolo, I could just make out additional above-water portions of the peninsula.

The lure of collecting additional seed to the south kept me inching ahead, even as the water was getting deeper and the sides of the tombolo were getting narrower. Looking around in a complete circle, I saw only water, and the 4-wheeler looked very small. I felt even smaller as I looked at a land vehicle in a watery world. As I put the machine in reverse and started to back out of the area, I saw the sand of the tombolo begin to slide laterally, and the front of the 4-wheeler begin to sink deeper. Fear took over. I'd never before realized just how fast a 4-wheeler could go in reverse, or how high those tires could throw water into the air! A charging bear could not have caused the adrenaline to flow through my body any faster.

What a truly fascinating place - that area where land meets water.

This guide is intended for use in coastal areas of Alaska, specifically the areas designated by the Alaska Inland Coastal Zone Boundaries. Coastal areas have been my primary focus with regard to revegetation and erosion control activities during the past 32 years. Consolidating and publishing the research and information gathered during that period motivated the development of this document.

The guide is divided into sections detailing steps that should be followed for a successful revegetation project. The guide is dedicated to the Great Land and its immense and fragile coastal region. It is my intent to raise awareness across the state of the need to protect and restore coastal environments as necessary in the land we call Alaska.

Researchers and environmental professionals from across Alaska were invited to share case studies for this publication, to showcase some outstanding revegetation and erosion control projects, as well as alternative approaches and ideas in restoration. These case studies demonstrate what can be accomplished or learned by recreating vegetation communities, landforms or controlling erosion using vegetation. The guide also provides an overview of work performed in Alaska's coastal regions by the Alaska Plant Materials Center (PMC) during the past three decades.

In the first section of this guide, the reader will find useful background information. A short history of the major impacts to the coast of Alaska is presented, along with an introduction to the principles of revegetation. A primer on coastline types and terminology, as defined by coastal geomorphologists is also included.

The **Project Implementation** section will guide the reader through the basics of the entire process of a revegetation project, from the initial project planning phase to obtaining necessary permits, seeding, and mulching. This section includes an introduction to soil science and planting methods, as well as other forms of planting stock used in Alaska. Information about seed quality and specifications is also presented. The Project Implementation section details various techniques used to prepare the planting surface, as well as other specialized planting methods. As many sites require additional protection to preserve important land features or critical habitats, conservation and protection methods are also covered.

Section 3, **Species Selection**, consists of a survey of available plant species appropriate for revegetation across Alaska. A description of vegetation communities in each region is included, along with lists of primary and secondary species adapted to that region. A table for each region will guide the reader in determining what species mixture will work best in the area. Each individual species is color-coded to the regions of Alaska to which is adapted, and this information is presented along with details of its growth habit and tolerances in the Plant Species chapter.

The **Case Studies** section consists of reports from past revegetation and restoration projects, provided by researchers and environmental professionals across the state. These projects, conducted in each region of Alaska, will expose readers to the realities of revegetation in the field; successes, challenges, and lessons learned. It is our hope that the case study section will become a useful resource for future projects. These reports, as well as case studies of future projects, are available on the web, at plants.alaska.gov/reveg/.

The final section of the manual lists the work cited, as well as a list of agencies and organizations that have an interest or statutory responsibility related to the coastal zone is also provided. We chose to include a reprint of the 1994 Beach Wildrye Planting Guide for Alaska as an appendix. This publication, though out of print, has continued to generate interest, warranting its inclusion. Also included as appendices are the amended State of Alaska seed regulations, and descriptions of other other publications of interest.

I hope you find this guide worthwhile and informative.

Stoney J. Wright

Acknowledgements

This guide was written to assist land owners, land managers, engineers and environmental professionals in making decisions regarding revegetation and the use of vegetation in soil erosion control and soil conservation. The information contained in the guide builds upon past revegetation manuals including:

Wright, Stoney J. (1994) - Beach Wildrye Planting Guide for Alaska. State of Alaska. Alaska Department of Natural Resources, Plant Materials Center. 28 pp.

Wright, Stoney J. and **Moore, Nancy J.** (1994) - Revegetation Manual for Eareckson Air Force Station Shemya, Alaska. State of Alaska, Division of Agriculture, Plant Materials Center. 34 pp.

Moore, Nancy J. and **Wright, Stoney J.** (1994) - Revegetation Manual for King Salmon Air Force Base, King Salmon, Alaska. State of Alaska, Division of Agriculture, Plant Materials Center. 51 pp.

2001 Alaska Highway Drainage Manual (2001) - Chapter 16: Erosion and Sediment Control. State of Alaska, Department of Transportation and Public Facilities.

Wright, Stoney J. (2008) - A Revegetation Manual for Alaska. Edited by Peggy Hunt. State of Alaska, Department of Natural Resources, Division of Agriculture, Plant Materials Center.

The authors would like to thank the individuals named below for their participation in this project.

Harvey Smith, **Ruth Carter**, **James Bowers** and **Janet Hall-Shempf** at the Alaska Department of Transportation, **Carrie Bohan** and **Marty Rutherford** with the Alaska Department of Natural Resources, and **John Whitney** at the National Oceanic and Atmospheric Administration.

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Background

A disused cabin falls into the Beaufort Sea in this photograph, victim to climate-driven coastal erosion

Section 1:

1. Introduction
- *Geography*
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2. Coastlines
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Introduction

Coastal Revegetation & Erosion Control Guide

Photo: Harvey Smith (AK DOT)

Melting permafrost is a natural coastal erosion process, shown in this photograph of the Beaufort Sea coast. This guidebook will address methods using vegetation to mitigate and reduce erosion caused by human activity.

Alaska is known as a land of superlatives. It is the northernmost state, the westernmost state and by some definitions, the easternmost state (the Near Islands and the Rat Islands being west of the 180th Meridian). The state's name is derived from the Aleut word "Alyeska", translated as "the object towards which the action of the sea is directed", and generally taken to mean "Mainland" or "The Great Land".

Alaska is by far the largest state within the United States of America; having more than twice the area of the next largest. Indeed, Alaska by itself covers 1% of the land mass on Earth, and is larger than all but 19 countries on the planet. Its massive land mass notwithstanding, Alaska is first and always a coastal state.

Alaska has more miles of coastline than the contiguous United States

The coastal community of Seldovia, on Kachemak Bay, is bordered by intertidal mud flats

GEOGRAPHY

The Alaska Department of Natural Resources estimated the Alaska coastline to be 44,500 miles long, as measured on the most detailed maps available. Alaska's coastline is larger than the remainder of the United States' combined coastline.

Nearly three quarters of the Alaska's population live in communities along this coastline. The coastal region supports industries like commercial fishing, logging, tourism, and oil and gas production. Production industries, though responsible for a large portion of Alaska's economic product, can have significant impact on coastal areas, and any adverse effects should be mitigated.

HISTORY

Alaska has been peopled for several thousand years. Humans entered Alaska from Asia, either by walking over the Bering Strait or by boat (Mason et al, 1997). Although the earliest known archeological remains in Alaska are just 12,000 years old, radiocarbon dating of a peat bed 150 feet below the surface of the Chukchi Sea show that the land bridge remained exposed until 11,000 years ago; plenty of time for a land crossing (Mason et al, 1997). Complex societies first developed in the Bering Straits region, on Kodiak Island, and in Southeast Alaska, 2000 years ago. Alaska remains home to several indigenous cultures & tribes, such as the Athabascan, Eyak, Haida, Tlingit, Tshimian, Yupik & Inupiat Eskimo, and Aleut peoples.

The area now known as Alaska was first colonized by Tsarist Russia, beginning in 1732. The basic shape of Alaska was established by treaty between Britain and Russia in 1825. Exploitation of Alaska's natural resources was almost exclusively restricted to the coastline until 1867, when the territory was sold to the United States, by Alexander II. A border dispute with Canada over the southeastern portion of the territory was resolved in 1908, when a treaty between the USA and Britain finalized the border.

The 1867 purchase of the territory of Alaska, instigated by Secretary of State William H. Seward, was criticized by contemporaries, and commonly referred to as 'Seward's Folly' or 'Seward's Icebox'. Despite this derision,

Image: US National Archives

1867 U.S. Treasury warrant for the purchase of Alaska from Russia

a $7.2 million treasury warrant was issued, and the purchase made. The United States received the 586,412 square miles, or approximately 365 million acres of land, to be known as the Department of Alaska. Alaska would be classified twice more, as a district and as a territory, before becoming a state. Alaska's constitution was ratified in 1956; "The Great Land" became a state on January 3rd, 1959.

IMPACTS

Many natural events have impacted Alaska's dynamic coastal environment. Impacts such as the 1964 Good Friday Earthquake can cause upheaval on an unprecedented scale, though very little can be done to correct or restore uplift or subsidence of land. Volcanic eruptions, glacial advance and tsunamis can also massively disrupt existing coastlines. These processes are part of the natural progression of landforms, and it is unlikely that human intervention to correct or reverse the resulting changes will ever be effective or practical.

Human caused impacts, both accidental and intentional, have also disrupted natural ecosystems in Alaska. During the early 1940s, the Aleutian Islands were host to a number of military actions and battles associated with World War II. The legacy and impact of this conflict remains today; not only in the lost lives, destroyed villages, and acres of war debris, but also in the form of actual scars on the land surface. These reminders of past actions remain, a lasting impact that has affected generations of coastal residents.

Even after the Second World War, other threats to peace caused the coastline of Alaska to take center-stage. In the Cold War drama that began in the 1950s and continued for decades, the Defense Early Warning System was established at several locations in the Aleutian Islands, and along the Western and Arctic coastlines of Alaska. These 'D.E.W. Line' sites were not in themselves detrimental, but what was left behind often was. Debris, petroleum contamination, and toxic substances all contributed to coastal impact. Environmental remediation and cleanup activities at many of these remote sites was undertaken by the Department of Defense in the 1980s and 1990s. Federal legislation, notably the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and its subsequent amendment, the Superfund Amendments and Reauthorization Act of 1986 (SARA), was instrumental in accomplishing the cleanup.

Construction impacts associated with industrial progress and commerce are expected with a growing society and its communities. One example of this is the construction of the Valdez Marine Terminal, the

Cannakin nuclear warhead being lowered into position on Amchitka Island in 1971

southern terminus of the Trans Alaska Pipeline System (TAPS). This 1,000 acre terminal was carved out of a mountainside, allowing tanker ships to load north slope crude oil for transport to market. Before the first drop of oil was transported through the TAPS, the coastal impact of this development was considerable.

On occasion, progress can seem to take a step backward. Alaska's coastline witnessed the underground detonation of three nuclear devices between 1965 and 1971, in the western Aleutians. These three events were collaborative efforts between the Atomic Energy Commission and the Department of Defense. Amchitka Island, in 1965, saw the detonation of an 80 kiloton device, followed by a 1 megaton blast in 1969, and in 1971, the detonation of the largest nuclear weapon ever on US soil, under Project Cannikin. Amchitka Island was selected as the test site because the warhead was too large to be safely detonated in Nevada. The continued impact is only now being determined.

The quest to use nukes on coastal Alaska actually started earlier than the Amchitka exercises, with the 1958 Project Chariot study near Point Hope. Project Chariot was a part of a national effort known as Operation Plowshare, an attempt to use the nuclear arsenal for peaceful projects like construction. While the intended goal of the project, the excavation of a harbor using nuclear detonations, never came pass, the environmental impacts of the study remained until the site was rehabilitated in the 1990s.

Impacts to the coastal environment continued with the development of the Alaskan economy. These impacts, though not as large as the events previously mentioned, were expected and often mitigated. As oil development on the Arctic Coast ramped up in the 1970s and 1980s, impacts to the coastline were managed, and lasting disturbances minimized. Methods have been developed to mitigate these impacts, such as limiting travel along the arctic coastal plain to the winter months, when snowpack protects the fragile tundra. These techniques reinforce the age-old maxim that an ounce of prevention is worth a pound of cure.

Cleanup efforts underway in Prince William Sound in May of 1989.

Alaskans' view of their coastline was changed forever, just a few minutes into the morning of March 24, 1989. Residents awoke to the news that the oil tanker Exxon Valdez was hard aground on the largest charted reef adjacent to the shipping lanes near the port of Valdez. The tanker was leaking its load of crude oil into Prince William

Sound. Eventually, 1,300 miles of pristine coastline was covered with a 30 million gallons of crude oil (AK DOL, 1990; Ott, 1996). This single occurrence is widely viewed as the most significant event to impact the Alaska coastline, severely affecting beaches, wildlife, plant communities, and the region's industries. Paradoxically, in some areas more damage may have resulted from misguided cleanup efforts than the oil itself.

In a 2005 assessment of remaining impacts, the National Oceanic and Atmospheric Administration's Office of Response and Restoration made the following observation: "..rocky sites ... stripped of heavy plant cover by high-pressure, hot-water cleaning remain mostly bare rock" (NOAA, 2005). As the nation continues to deal with the ongoing impacts from the oil disaster in the Gulf of Mexico, the lessons learned from the Exxon Valdez Spill are taking center stage.

Two halves of the freighter *Selendang Ayu*, adrift north of Unalaska Island - December, 2004

The 1989 spill, though the largest, was by no means the last maritime event to strongly impact the Coast of Alaska. In late 2004, a freighter laden with over 60 tonnes of soybeans, en route from Seattle, Washington to Xiamen, China, suffered engine problems near Dutch Harbor. Heavy seas and a strong wind complicated rescue efforts, pushing the stricken vessel towards the coast of Unalaska Island. The ship subsequently broke in two, spilling its cargo, along with 350,000 gallons of bunker oil and diesel fuel (PAME, ongoing). Wave action deposited large quantities of the cargo onto the north coast of Unalaska Island. In 2006, the Alaska Department of Environmental Conservation determined that the decomposing beans presented no danger to human health, and all incident response activities were suspended.

A rocky beach on Unalaska Island coated with spilled soybean cargo from the wrecked *Selendang Ayu*

PURPOSE

This guidebook was developed to aid in the process of coastal revegetation. The intended audience is private property owners, as well as state and local government.

For the purpose of this document, revegetation is defined as:

> *The re-establishment of plant cover by means of seeding or transplanting on a site disturbed by natural or man-caused actions.*

Impacts, both large and small, will continue to disrupt the coastal regions of Alaska. The coasts experience natural soil erosion

caused by water (fluvial), wind (eolian), and gravity. Combinations of waves, frost heaving and unobstructed fetch along miles of coastline present ample opportunities for soil loss. Removal of vegetation and soils proceeds at unsustainable rates in some areas, changing the dynamics of natural ecosystems. Recovery (defined as the presence of self-sustaining vegetation cover, and limited erosion) of most sites will require human intervention to correct limitations and guide the ecosystem towards a desired end state. Material presented in this manual focuses on the "soft approach" to erosion control, using vegetation. While the "hard approach" (i.e. the use of rip-rap) is an effective means of stabilizing an area, these non-vegetative methods will be left to Coastal Engineers.

Numerous approaches are available for reintroducing vegetation on a site. This manual details a logical sequence of surface preparation, fertilization, and seeding. When followed on a site, this sequence will usually result in a self-sustaining native plant community that requires minimal management input. When conditions allow, most disturbed sites will naturally be re-colonized with plants from the surrounding area. This "do-nothing" approach is rarely used, however, as it does not provide aesthetic cover quickly enough for highly visible areas. Natural Reinvasion, as this technique is known, is effective, but it may take years for a plant community to become established. As nearly three quarters of the state's population lives in communities along the coast, political and aesthetic consideration frequently preclude this option.

METHOD

The sheer size of the state, along with considerable differences in climate and vegetation in different areas, necessitated the division of Alaska into five coastal regions: Arctic, Western, Southwest, Southcentral, and Southeast Alaska. Vegetation communities present in each region are described in detail, and a list of appropriate revegetation species for the region is included in the Adapted Plants section.

A map of Coastal Zone boundaries, included on the inside front cover, is used to define what is 'Coastal'. These zones vary in size considerably, depending on the terrain and elevation. Coastal zones can extend inland over several atlas quads in western Alaska, or stop very near the coastline in southcentral parts of the state.

A sizable portion of this manual is dedicated to case studies, highlighting past revegetation projects that have occurred on coastal sites in each region of Alaska. These and future case studies can also be found online, at plants.alaska.gov/reveg/.

Coastlines

Steep, vegetated cliffs dominate this beach on Walrus Island, near Togiak, Alaska

Alaska has a long and diverse coastline, representing several unique eco-regions. An eco-region can be defined as a large area of land and waters containing vegetation communities that share ecological dynamics, environmental conditions, and interactions that are critical for their long-term persistence (Nowacki, et al, 2001). It is necessary to address the issue of revegetation in the context of an eco-region, as this will effect species selection and other planting requirements.

Within each eco-region, and across Alaska, several different types of coastline exist. In this section, you will find a short description of several coastline types and the geomorphic factors that influence each.

Coastal Glossary:

Fetch:

An extent of open water across which the wind is blowing (Bird, 2008).

Beach:

The area between high tide and the coastline. The beach is defined as an accumulation of loose sediment, sand, gravel, or boulders (Bird, 2008).

Shore Zone:

The area influenced by tidal forces. Stops at the border with the coastline.

Coastline:

The edge of the land at highest tides, at the upper limit of the shore platform. Frequently indicated by the seaward boundary of terrestrial vegetation.

Intertidal Zone:

The area between high tide and low tide, below the beach.

Shore Line:

The edge of the waterline, moving as the tide rises and falls. Typically measured at low, mid, and high tides (Bird, 2008).

Shore Platform:

The shore platform includes the area defined by the tidal range, up to the coast line, typically demarcated by a cliff or steep slope.

Intertidal Mud Flats:

Mud flats consist of sediment built up along coastlines. Mud Flats are found in sheltered areas such as bays, lagoons and estuaries, near salt marshes.

Coastline Types:

Graphic: Eric Bird: Coastal Geomorphology, 2nd Edition. © J. Wiley & Sons, Ltd.

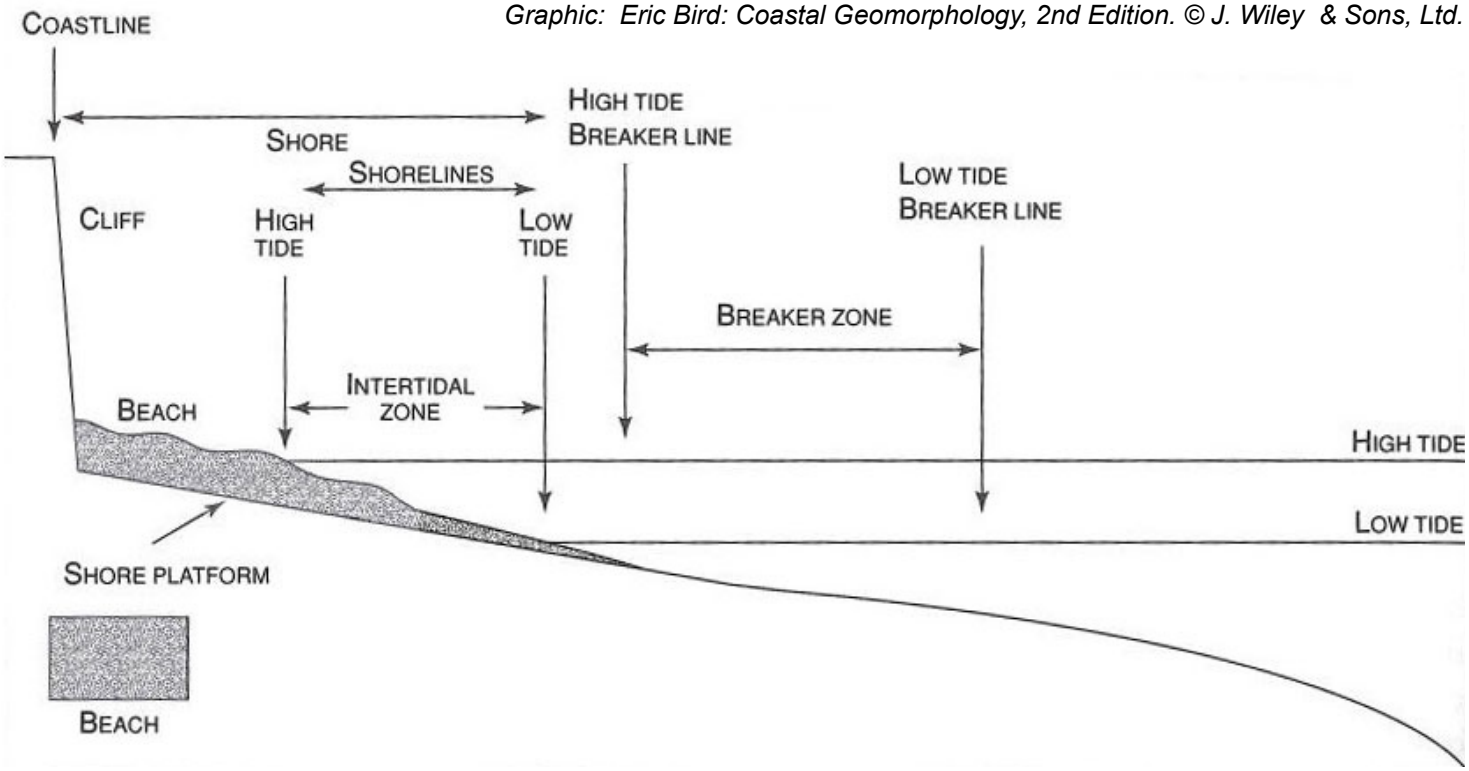
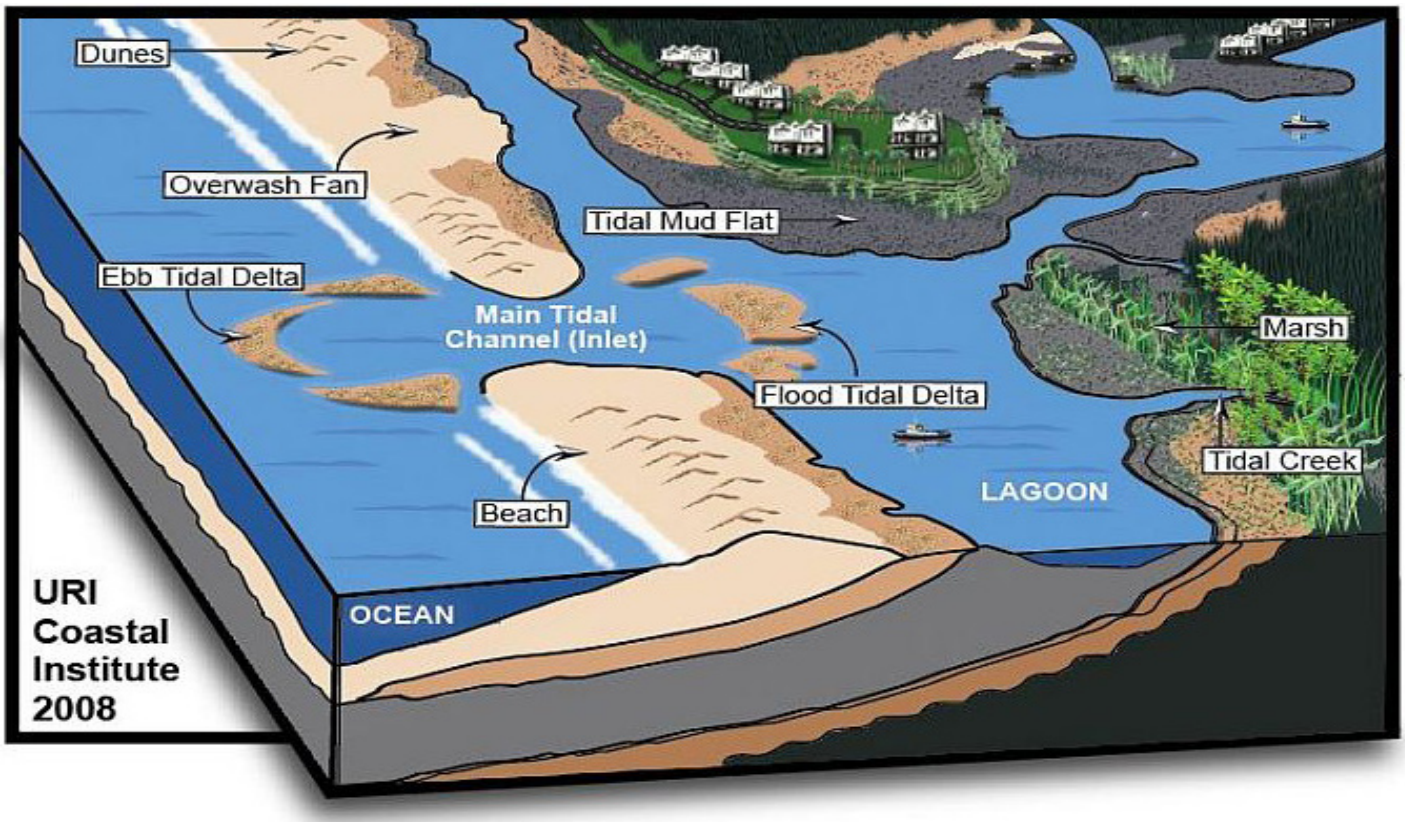


Figure 1: Coastal Terminology



Graphic: Nate Dibble (University of Rhode Island, Coastal Institute)

Figure 2: Diagram of barrier island, tidally influenced areas

Coastline Types:

Mendenhall Wetlands State Game Refuge

Intertidal Wetlands:

Intertidal wetlands refer to a range of the shore between high and low tides. This zone experiences regular tidal inundation, and is typically cut by meandering channels branching out to the ocean.

This type of coast occurs predominantly in Southern Alaska.

Coastal Lagoons:

Coastal lagoons are areas of relatively shallow water that have been separated from the sea by coastal barriers. These areas can exhibit high variability in salinity, changing from brackish to hypersaline (Davis, Fitzgerald, 2004).

Like estuaries, these areas have a mixture of fresh and sea water (Bird, 2008). Species diversity is typically low, although the hardy species that can tolerate the high salinity are found in abundance.

Lagoons occur across Alaska, especially in the northwestern region.

James Lagoon, McCarty Fjord, near Seward, Southcentral Alaska

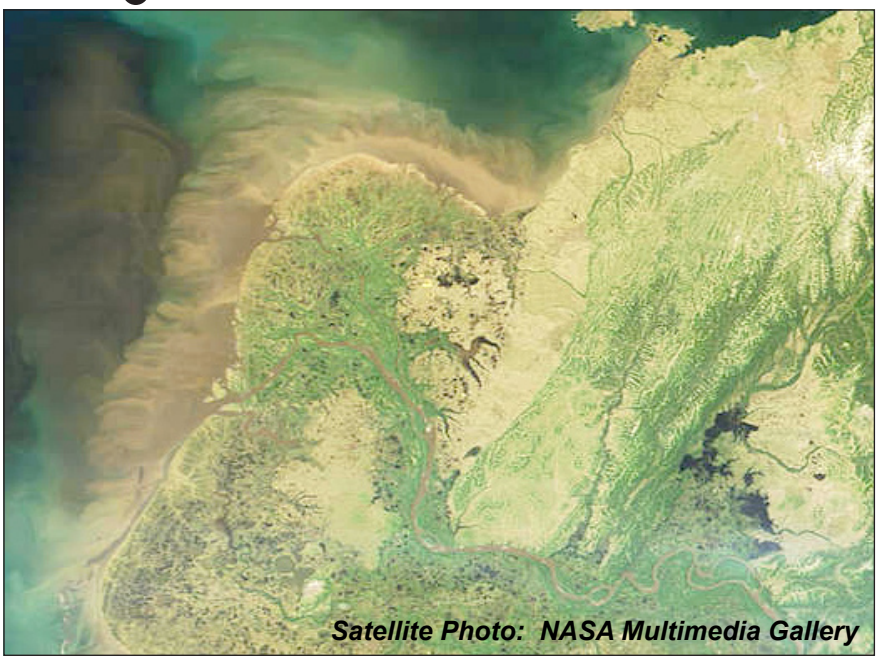
Chickimin River estuary, Southeast Alaska

Estuary:

An estuary is a zone where freshwater from rivers and streams meets the sea, mixing with salt water from the ocean. Estuaries are among the most productive ecosystems, harboring unique plant communities, specially adapted to this brackish mix of waters (NOAA, 2007).

Gradual elevation gains in these areas can extend the coastal habitat range inland for several miles. Saline tolerant species should be selected for an estuarine vegetation mixture.

Coastline Types:



Yukon River delta, Western Alaska. Note sediment fan.

Deltas:

Deltas form at the mouths of large rivers. Sediment deposition creates enlarged intertidal areas, making the shore-zone shallower.

Silts and clay soils are prevalent in Deltas. On cold and arid coasts, delta vegetation is sparse and sediments are coarse with large amounts of sand and gravel (Bird, 2008).

In Alaska, the major river deltas are the Yukon-Kuskokwim, the Copper River, and the Colville, on the north slope.

Sheer Cliffs:

Sheer cliffs are areas where the coastline rises steeply from the end of the shoreline. Vertical cliffs occur in homogenous geologic strata, such as sandstone and limestone (Bird, 2008).

The shore zone may be all but non-existent in Fjords. When a cliff rises 500 meters vertically within 50 meters of the shore line, the coastal vegetation can be very different from that which is present on the shore.

A sheer cliff rises from the shore in the McNeil River State Game Refuge, Southwest Alaska

Rocky Coastline in Prince William Sound, near Whittier

Rocky Beaches:

Rocky Beaches are the norm in Alaska. These beaches have low erosion potential, and low dynamics.

Sparse vegetation cover and gravelly soils typify these areas. Pebbles and rocks dominate the shore zone. Terrain tends to be stony right up to the coastline, where terrestrial vegetation begins.

Coastline Types:

Atsakirak Mound, a coastal barrier island northwest of Kivalina

Coastal Barriers:

Coastal barriers and barrier islands are elongated land forms formed by the deposition of beach materials offshore. Barriers consist of sand or gravel deposited by long-shore drifting or carried in from the sea floor (Bird, 2008). The landward side of these features often enclose lagoons and wetlands. Coastal barriers are a prevalent geomorphic feature in northwest Alaska.

Typically, grassy vegetation is prevalent on these coastlines.

Coastal Dunes:

Coastal dunes are characterized by high quantities of sand and exist in a place of significant tidal action. Dunes have a very dynamic and transitional nature.

Typically, dunes support Beach Wildrye communities. This species is uniquely able to tie together loose-grained, sandy soil. Coastal dunes provide critical protection for beaches and inland areas against storm surges.

Coastal dunes on the Kenai peninsula. Note stabilizing vegetation.

The Homer Spit protrudes 4.5 miles into Kachemak Bay, about 19 feet above sea level

Spits:

Spits are beaches built up above the high tide level, protruding into the water, usually ending in one or more landward hooks or recurves (Schwartz, 1972). Spits are deposition landforms, caused when waves hit the coast at oblique angles, moving sediment down the beach. As spits grow, a salt marsh is likely to develop behind them, in the area sheltered from the wind and waves.

The Homer spit and the Port Clarence spit are examples of this geomorphic feature in Alaska.

Coastline Types:

A sandy beach in Prince William Sound

Sandy Beaches:

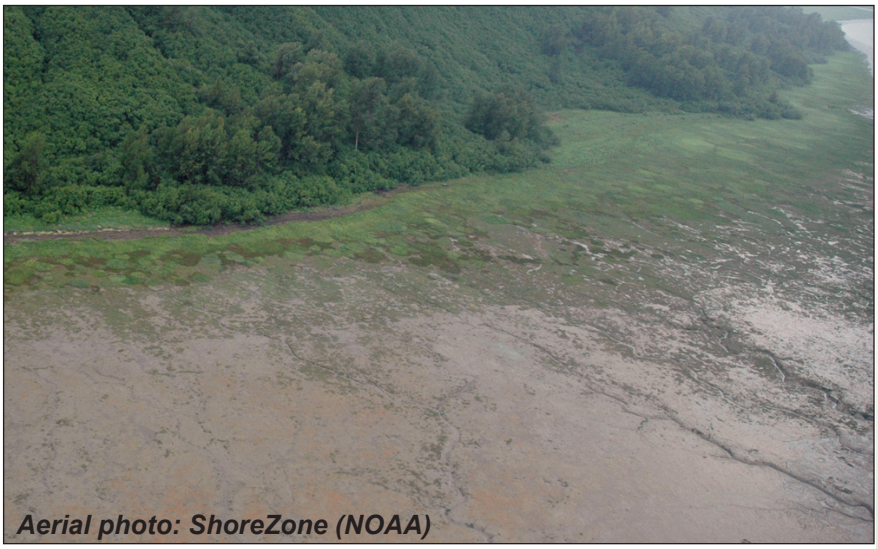
Sandy beaches can be found in Alaska. This one is from the western edge of Prince William Sound, at the edge of the Chugach National Wildlife Refuge.

Sandy beaches form by accretion of sediment. Species that thrive in these areas must be adapted to loose-grained soils. Notable examples include Beach Wildrye (*Leymus mollis*) and Bering Hairgrass (*Deschampsia beringensis*).

Tidal Mudflats:

Mudflats form when fine sediments such as silts and clays are deposited along the shoreline. These areas can extend the intertidal zone significantly.

Vegetation is limited in tidal mud flats, due to the tidal fluctuations and salinity. Species most adapted to this type of coast include Seashore Alkaligrass (*Puccinellia sp.*), Seaside Arrowgrass (*Triglochin sp.*), and Seaside Plantain (*Plantago maritima*).



Vegetation along a tidal mudflat in Cook Inlet

A high energy beach in the Walrus Islands State Game Sanctuary

High Energy Coasts:

High energy coasts are those with very little natural protection from the ocean's waves. The continental slope tends to drop off sharply in these areas. A long fetch means that high energy coasts are subjected to strong wave action and erosive influences.

These beaches are characterized by large rocks and very little vegetation growth. Some high-energy beaches can be sandy, however, such as those in the western Aleutians.

High energy coasts are sometimes characterized by rugged cliffs and long, curving beaches. The long, curving type of high energy beaches are generally found where the continental slope is shallower. (Bird, 2008)

Project Implementation

Erosion control fabric supporting willow stakes and seeded plants, along the banks of the Matanuska River

Section 2:

1. Planning
   - *Goal Setting & Preparation*
   - *Identify Site Conditions*
   - *Construction Site Revegetation*
   - *Revegetation Objectives*
   - *Seeding Methods*
   - *Planting Time*
   - *Selection of Species*
   - *Planting Methods*
   - *Mulch & Erosion Matting*
2. Techniques
   - *Charged Overburden Veneer*
   - *Sod Clumps*
   - *Vegetation Mats*
   - *Enhanced Natural Reinvasion*
   - *Imprinting*
   - *Scarification*
3. Conservation & Protection
   - *Preventing Damage to Dunes*
   - *Protection of Eelgrass*
   - *Protection of Estuarine Habitats*
4. Wild Seed Collection

Planning

A constructed berm at Fishing Hole Inlet on the Homer Spit awaits revegetation in this 1999 photograph. The establishment of vegetation is a practical and effective means of maintaining a constructed grade.

Planning should be the first step for any project. The revegetation/restoration process requires careful planning and management, as the designer is working with biological processes that have specific timing and environmental requirements. When multiple stakeholders are involved in a restoration project, design decisions should be coordinated. This allows restoration goals to be implemented effectively.

Goal-Setting and Preparation

The planning phase of a restoration project encompasses several steps. These include

- gathering baseline data
- identifying site problems
- collecting reference plot information
- setting goals

Goals tell managers about the desired state of the ecosystem, as compared to a reference ecosystem. Objectives are measures taken to attain the goals, and are evaluated on the basis of performance standards (SER, 2002). Without clear goals, objectives and performance standards, a restoration project should not move forward.

Performance standards come from an understanding of the reference ecosystem and the realization that the trajectory of the degraded site should progress towards the desired state of recovery comparative to the reference site.

If data collected and interpreted during monitoring shows that performance standards have been met, then project objectives have been reached. Revegetation goals may include erosion control, visual enhancement, weed control, or other desired outcomes. Often, in coastal areas, the goal is erosion control.

Baseline Environmental Data Collection

After determining the revegetation objec-

tives, take note of factors influencing the site. These include climate, soils and vegetation. Climate includes temperature, precipitation, and wind, plus other factors. Climate records can be obtained online, through resources such as the National Oceanographic and Atmospheric Administration's National Climate Data Center, at www.ncdc.noaa.gov/.

A soils inventory involves identification of soil types and characterization of the soil types, as well as distribution. Soil surveys have been completed by the Natural Resource Conservation Service (NRCS) and are accessible online at soils.usda.gov/. If feasible, a sample of soil from the site should be sent to a soil testing lab. There, a lab analysis will check the physical (texture, density), chemical (pH, salts, organic matter) and biotic (activities of organisms) characteristics of the soil. All of this information aids in developing a seed and fertilizer mix.

Mapping of vegetation types and characterization of the vegetation types in regards to production, cover and density will be part of an in-depth vegetation analysis. Review available data for your region prior to creating a revegetation plan.

Reference Sites

A reference ecosystem serves as a model for planning a revegetation/restoration project, allowing for measurement of the progression of an ecosystem towards its desired end-state (SER, 2002). It's important to note that a restored ecosystem can never be identical to the reference site. A reference system is best assembled from multiple reference sites to account for the possibility that one particular site may be biased.

Many sources of information are useful in describing a reference site, such as lists of species present, maps of the site prior to damage, and aerial and ground-level photography (SER, 2002). Reference ecosystems should have high production and species composition in order for managers to evaluate the progress of the ecosystems towards its desired state of recovery. Eventually, the restored ecosystem should emulate the reference site (SER, 2002).

Collecting information from a reference site can quickly become expensive, and is often limited by available funds .

Permitting

Permits are required for some projects. Projects that disturb an acre or more, discharge storm water into a municipal separate storm sewer system (MS4), or into the surface waters of the United States require an Alaska Pollutant Discharge Elimination System (APDES) Permit. This permit is issued by the Alaska Department of Environmental Conservation (DEC), in accordance with the Federal Clean Water Act. APDES permits are issued as either a phase one or phase two permit depending on the size of the area disturbed and nearby population. More information about the APDES program can be found at the DEC website, at dec.alaska.gov/water/npdes/.

A dewatering permit is necessary if the total discharge volume is equal to or greater than 250,000 gallons and wastewater discharge is located less than one mile from a contaminated site. Other permits are necessary for projects that affect fish habitat, historic properties, endangered species, and other concerns.

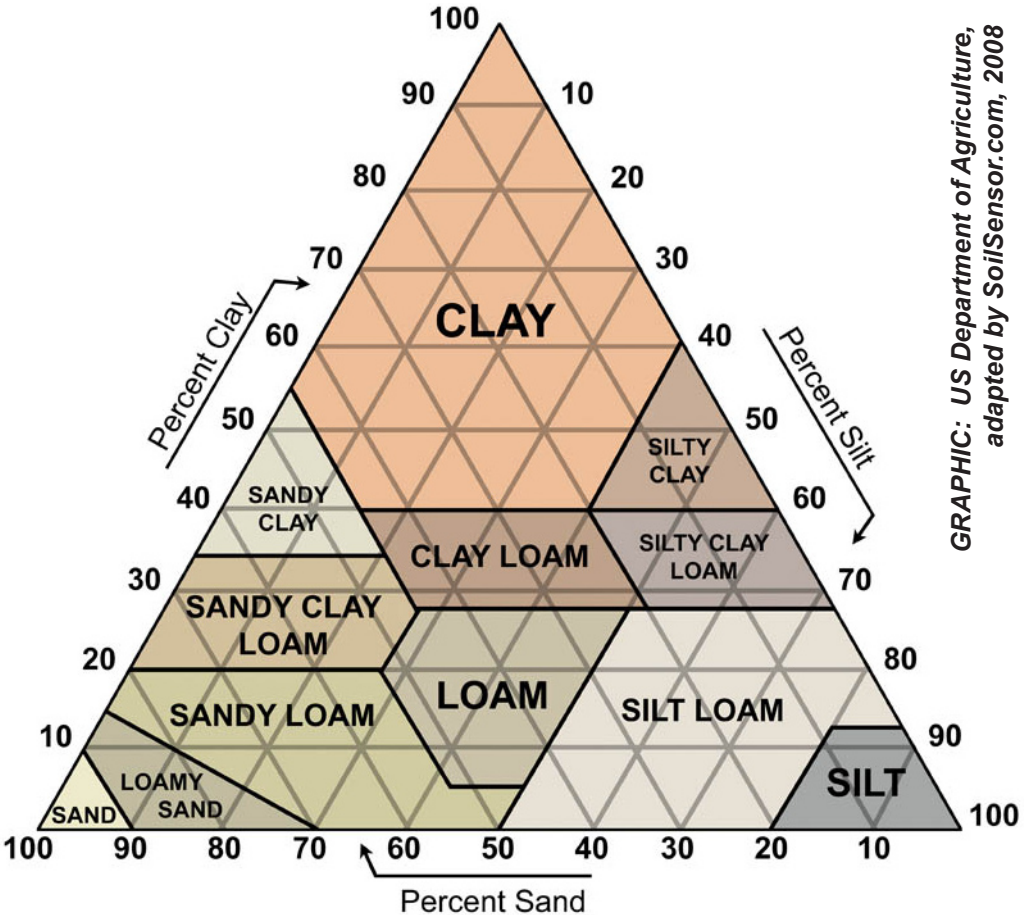
Identify Site Conditions and Develop Mitigation Measures

Potential limiting factors that will affect revegetation establishment are extensive, and a complete discussion is beyond the scope of this guide. This publication is focused is on the limiting factors that have been observed regularly on coastal sites in Alaska, and other parameters important for revegetation success.

Plant growth depends on water availability. The amount of water a type of soil can hold and how easily roots can penetrate the soil depend on the texture and structure of the soil.

Soil Texture

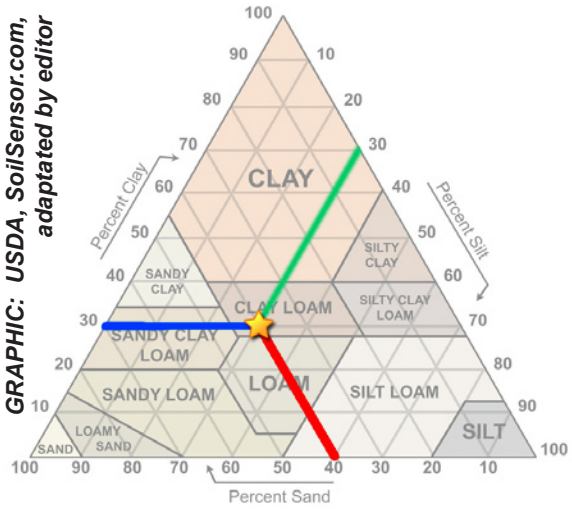
Soil is made up of mineral particles, organic matter, air, and water. Soil texture is determined by the composition of soil, expressed as % sand, % silt, and % clay. Seven classes of particle size are acknowledged with sands being the largest (2.0-.05 mm), silts (.05-.002 mm) intermediate in size, and clays (<.002 mm) being the smallest.



GRAPHIC: US Department of Agriculture, adapted by SoilSensor.com, 2008

Figure 3: USDA Agronomic Soil Textural Triangle

The Agronomic Soil Textural Triangle (Figure 3, Figure 4) is a tool used to determine the textural type of a soil. Field analysis of soil texture can also be done using the "By Feel Method" (Figure 5). This qualitative method is quick, easy, and fairly reliable. Testing procedure involves wetting a sample of the soil and working the soil between one's fingers. Water is often used to moisten the soil, but saliva is also suitable. Texture cannot be determined accurately when the soil is dry. Quantitative measures to determine soil texture are also available. Contact the Alaska Plant Materials Center for more information about testing and analysis of soils.



GRAPHIC: USDA, SoilSensor.com, adaptated by editor

Figure 4: Soil Triangle usage example

In the example above, the soil consisted of 40% Sand (red line), 30% Clay (blue line), and 30% Silt (green line). Thus, the soil is classified as clay loam, as indicated by the intersection of the three lines.

Some characteristics of clay soils are that they restrict air and water flow, have high shrink-swell potential, and are highly absorptive. Sand, in contrast, has a low water holding capacity, due to large pore spacing, and has limited absorptive capability for substances in solution.

Soil Structure

The aggregation of mineral soil particles (sand, silt, clay) is referred to as soil structure. The arrangement of soil particles create varying pore spaces allowing different quantities of moisture to be retained. This is referred to as the porosity of the soil, and will be noted on a soils test. A reduction in the pore space of the soil by pressure applied to the soil surface initiates soil compaction. Compaction compresses micropores and macropores, destroying the soil structure. This affects the uptake and movement of water and can inhibit plant and microbial growth.

Breaking up compacted layers can be accomplished by mechanical tillage. Equipment should be operated along the contour to reduce the potential of water entering furrows and creating soil erosion problems.

Nutrients

In most forms of revegetation, the application of fertilizer at the time of seeding is necessary. Most commercial fertilizers meet minimum standards for quality. When problems do arise, they can usually be traced to the product becoming wet during storage or shipment.

Fertilizer is described by a three number designator, referred to as N-P-K. These num-

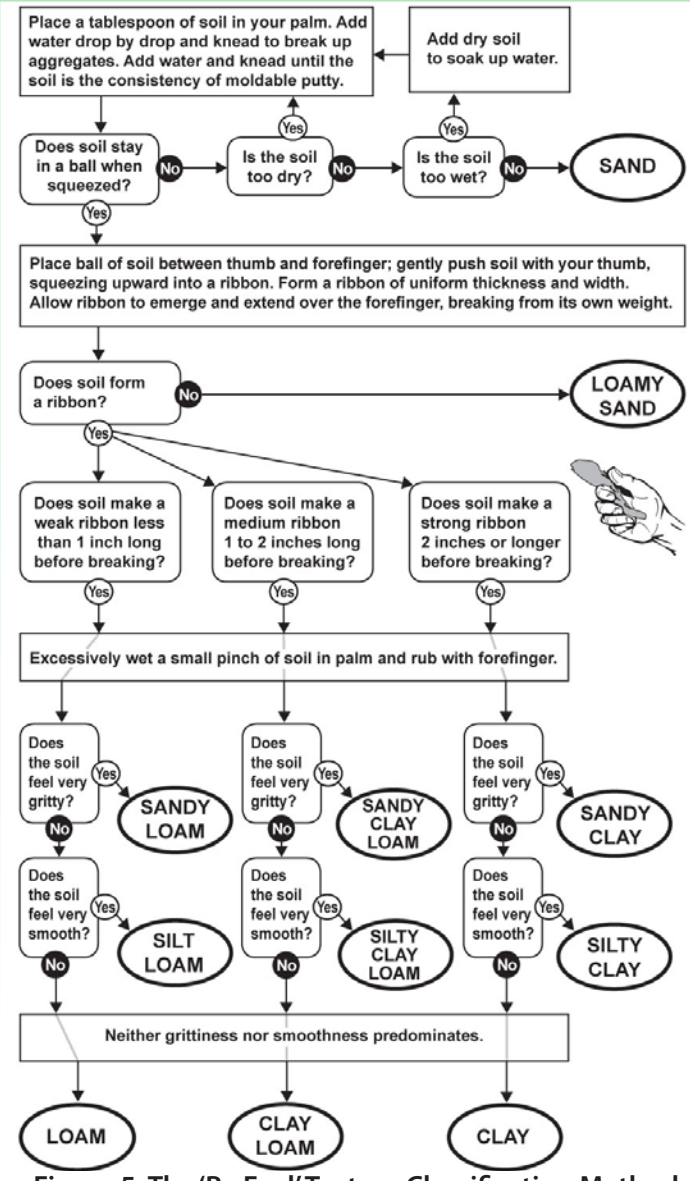


Chart: NRCS Irrigation Guide, USDA Natural Resources Conservation Service, 1997.

Figure 5: The 'By Feel' Texture Classification Method

Photo: Roadside Revegetation (Steinfeld et al., 2007)

Figure 6: Heavily compacted soil; Note platy structure. Water flow through this soil is poor.

bers refer to the percentages of three elements: **nitrogen**, **phosphorus**, and **potassium**, respectively. Therefore, 20-20-10 fertilizer contains 20% nitrogen, 20% phosphorus, and 10% potassium by weight.

If possible, fertilizer should be applied concurrent with or prior to seeding. Once the seed has been applied, no additional traffic should be allowed on the site, to avoid compaction and unnecessary disturbance of the seed bed.

Topsoil

The topsoil layer in undisturbed areas in Alaska is often very thin, and therefore expensive and impractical to salvage. However, this layer is a source of native seed, plant propagules, organic matter, and soil microbes which can enhance the quality of the substrate being revegetated. Top soil is a valuable resource in revegetation, and should be preserved or salvaged when possible.

Many construction sites in Alaska have exposed surfaces of gravel or gravely soils. Gravelly sites tend not to be highly erodible. If some fine particles are present in the gravelly soil, adapted species will grow without additional topsoil. In fact, the addition of a layer of topsoil on a gravel surface can increase erosion potential.

Photo: Stoney Wright (AK PMC)

Figure 7: Arctic Bluegrass, *Poa arctica*, established on a gravelly coastal spit near Port Clarance LORAN station

Construction Site Revegetation

Construction and mining sites rarely have intact soil horizons. The preceding discussion on soil profiles does not apply to most disturbed land. More basic measures of soil particle size, elasticity, and water holding capacity are usually applied to construction and mining sites. The uniform soil classification table is the best means of determining soil characteristics for revegetation purposes.

Major divisions			Group symbol	Group name
Coarse grained soils more than 50% retained on No. 200 (0.075 mm) sieve	gravel > 50% of coarse fraction retained on No. 4 (4.75 mm) sieve	clean gravel <5% smaller than #200 Sieve	GW	well graded gravel, fine to coarse gravel
			GP	poorly graded gravel
		gravel with >12% fines	GM	silty gravel
			GC	clayey gravel
	sand > 50% of coarse fraction passes No.4 sieve	clean sand	SW	well graded sand, fine to coarse sand
			SP	poorly-graded sand
		sand with >12% fines	SM	silty sand
			SC	clayey sand
Fine grained soils more than 50%	silt and clay liquid limit < 50	inorganic	ML	silt
			CL	clay
		organic	OL	organic silt, organic clay
	silt and clay liquid limit < 50	inorganic	MH	silt of high plasticity, elastic silt
			CH	clay of high plasticity, fat clay
		organic	OH	organic clay, organic silt
Highly organic soils			Pt	peat

Chart: American Society for Testing & Materials D 2487-83

Figure 8: Unified Soil Classification System (USCS)

The **Unified Soil Classification System** (USCS) describes both the texture and grain size of a soil. Symbols are composed of two letters; the first represents primary grain size division (>50% of soil). The second letter refers to the uniformity or plasticity of a soil, or to a second major soil type (>12% fines present). A complete symbol chart is included as Figure 8.

Revegetation Objectives

After receiving a project contract, immediately purchase seed and plant materials. This ensures that the revegetation portion of the project can be completed while equipment and personnel are available. Seed and plant materials must be properly stored in a dry, cool environment to prevent loss of viability.

Site Preparation

Seedbed preparation is the primary concern of most revegetation projects, since it is the most labor-intensive, energy consumptive, and often determines success or failure (Vallentine, 1989). The objectives of site preparation are to create environments that provide conditions favorable for seed germination and seedling growth.

The surface of the prepared seedbed should be relatively smooth for drilling and rough for broadcasting. Germination and survival increase with proper site preparation. An ideal seedbed should:

1. Be free of construction debris.
2. Have relatively few large rocks or objects.
3. Be free of ruts or gullies.
4. Have the top two inches in a friable, non-compacted condition (allowing a heel to make a 1/4 inch depression).
5. Be scarified to a depth of 6 to 8 inches if heavily compacted.
6. Devoid of non-native weeds. (To determine which non-native weeds are of concern, refer to **Invasive Plants of Alaska**, produced by the USDA, in cooperation with the Alaska Soil and Water Conservation District, or refer to plants.alaska.gov/invasives/).

If traditional surface preparation equipment such as disks and/or chisel plows are available, the conditions required for adequate surface preparation are the same as previously noted.

Note: If hydroseeding is chosen as a method of seed application, surface preparation as described in this section may not be applicable.

Seeding Methods

The objective of seeding is to place the seed where it is needed and in proper contact with the soil. The method used depends upon the plant

species being seeded and the characteristics of the site, such as soil type and topography.

Drill Seeding

Drill seeding is a method whereby the seed is placed in a soil furrow and covered with a relatively precise amount of soil. Drill seeders are used most often in agricultural settings. One type of drill seeder, the Brillion-style, is often used for revegetation of mine and construction sites (Figure 9). This seeder has been successfully used on most soil types, except very gravelly soils.

Figure 9: Brillion ® tow-behind drill seeder

Figure 10: Handheld broadcast seeder

Fertilizer cannot be applied with all drill seeders, however. The drill seeder delivers the seed into the soil, packs the seed in place, and applies seed with high accuracy. This method is considered by many to be the best method of distributing seed, however the need for specialized equipment may be impractical at many remote sites in Alaska.

Broadcast Seeding

The broadcast method scatters seed on the soil surface and relies on natural processes or harrowing to cover the seed. The recommended seeding rate for broadcasting is double that of drilling due to the lack of application control, seed predation, and the potential for reduced seed establishment and germination rates.

Figure 11: A truck-mounted hydroseeder applies a seed mixture

Broadcasting includes aerial seeding, hydroseeding, and hand-held methods. Hand-held and hand-operated spreaders (Figure 10) are commonly used on coastal sites due to their portability, speed, low cost and because they can be used for both seed and fertilizer application.

Hydroseeding

Hydroseeders are well suited for seeding steep slopes and rocky areas, as they apply mulch, seed, and fertilizer in a single step. Hydroseeders come in truck-mounted and trailer forms. Major contractors either have a hydroseeder or can easily subcontract one.

Hydroseeder manufacturers have claimed that hydroseeding promotes more vigorous plant growth, but that claim has not been proven. In fact, grass growth can be inhibited if too much mulch is applied.

The primary disadvantage of hydroseeding is the requirement for large quantities of water, which can result in numerous passes across land that is being revegetated. The equipment is complex, and potential mechanical problems can cause costly delays.

Hydroseeders are also useful as supplemental watering trucks once seed has been applied. Additional applications of water increase project costs, and are not always necessary to produce a good stand of vegetation. Even without additional water application, seed will remain dormant until rainfall provides sufficient moisture for germination.

A hydroseeding contract should state that seed will not remain in the hydroseeder for more than one hour. This will prevent seed from absorbing excess water and being damaged by the dissolved fertilizer.

Transplanting

Transplants, cuttings, and sprigs are all a form of planting where some portion of a live plant is placed directly into the soil. This is a labor intensive process, however there are times when it is the most appropriate revegetation method. Planting transplants, sprigs or cuttings is a way to jumpstart vegetation growth, as the transplanted species has already reached a certain state of development.

Planting Time

Timing is crucial to revegetation success. The optimum planting season is just before the longest period of favorable conditions. In Alaska, spring planting is optimum where the primary growing season occurs in the late spring and/or summer. The following table approximates the end of planting season across several regions of Alaska. The earliest time to plant is when the snow melts and the site is accessible.

Latest Date to Seed:	
Arctic Coast	**July 15**
Western Alaska	**August 15**
Southcentral region	**August 31**
Southeast Alaska & Aleutian Islands	**Sept. 15**

Selection of Species

One of the most important criteria for successful revegetation is species selection. A restoration project seldom relies on a single species, however. A classic definition states:

> *"Species selection strategies that emphasize diversity assume species-rich ecosystems are more stable and less susceptible to damage from unusual climactic events, disease, or insects." (Whisenant, 2005)*

Several characteristics are important in choosing a seed mixture, including reliable establishment, the ability to survive changing conditions, and ease of propagation (Coppin & Stiles, 1995).

The Alaska Plant Materials Center recommends including at least three species in a planting mixture. Plant species should be chosen based on their adaptation to the project site and whether or not it is native to the area being revegetated.

Species is Adapted to site

The harsh environments of Alaska limit species growth and production potentials. It is imperative that chosen species are able to survive and thrive in the local environment. Climatic, topographic, and soil conditions all influence plant performance, and should all be taken into account when selecting species.

Species is Native to the area

Native species, already adapted to Alaska, generally perform better than introduced materials. However, prices may be higher for native plants or seed. Availability is currently the primary obstacle to using native species for revegetation in Alaska. In-state production of native plants is increasing, however, due in part to state and federal mandates requiring the use of these species.

A list of potential commercially available native species is listed in the Native Plant Directory, a publication of the Alaska Plant Materials Center, available online at plants.alaska.gov/native/.

Planting Methods

After a species or species mixture has been selected, a decision needs to be made about which form of plant to use. Revegetation objectives, cost, and the availability of equipment are a few of the factors that influence this decision (Whisenhant, 2005). Refer to Figure 15, on page 24, to determine which planting procedures are most appropriate for your site.

Seed

Seed is the most commonly used plant material for revegetating disturbed areas, because it is easy to collect, clean, store, transport, mix and apply to the site using drill or broadcast methods. Grass and forb species are usually directly seeded onto disturbed sites.

Seed Specifications

Quality seed is critical to success. Specifying "certified" seed assures quality because the seed must meet certain standards for germination and purity; certification also provides some assurance of genetic quality.

Some native seed species are not available as certified seed. Seed quality can still be ascertained by examining percent germination and percent purity; information that will be clearly labeled for any seed sold in Alaska. This labeling is required by 11 AAC, chapter 34: Seed Regulations (included as Appendix B).

The true cost of seed can be determined

by the Pure Live Seed calculation. To calculate Pure Live Seed (PLS), use the equation:

$$PLS = \left[\frac{\text{Germination \%} \times \text{Purity \%}}{100} \right]$$

The true price of seed, then, can be determined using the equation:

$$\text{Price}_{PLS} = \left[\frac{\text{Bulk cost of seed / lb} \times 100}{PLS} \right]$$

These calculations can increase the accuracy of bid comparisons. PLS price is a good method of comparing different seed lots at time of purchase.

All seed sold or used in the state of Alaska must also be free of noxious weeds, under 11 AAC 34.075. This is noted on seed tags, along with germination and purity.

The seed mixes presented in this manual have been carefully developed and are based on results from trials throughout the state. Give careful prior consideration to any deviation from the suggestions. If problems occur or questions arise regarding seed, call the Alaska Plant Materials Center at (907) 745-4469.

Seed stored on site should be kept cool, dry, and in rodent-free areas. Remember seed is a living commodity. A bag may contain seed; however some percentage may be dead husks - the equivalent of cadavers. Always buy seed based on the PLS Calculation.

Certified Seed

The term “certified seed” can cause confusion because it is used to describe two different issues:

The official use of the term Certified seed (with a capital C) is to describe seed that has been grown under the rules of the Seed Certification Program. Certified seed is the usual commercial category of seed. Its ancestry can be traced back to Registered Class or Foundation Class seed. In addition, the Certified seed must meet variable standards of purity and germination. These standards are a means of verifying authenticity of a seed source. All the Alaska developed seed varieties or cultivars can be sold as either Certified or common.

Figure 12: Alaska Certified seed tags

Seed can also be certified (without a capital C) to be free of weeds or as meeting a minimum germination standard (11 AAC 34.075). This has nothing to do with variety identification - it simply indicates the quality of the seed. In other words, the buyer knows quality, but has no assurance of type (other than species).

Certified seed should be used when available. Seed produced in Alaska is easy to trace to its origin. It may be common (uncertified) ‘Arctared’, but it is still ‘Arctared’. Minimum purities and germination should always be stated with orders. Common seed is a usable product and may be used to meet demands. Common seed should meet Certified standards with regard to germination and purity, although these standards may need to be relaxed to acquire sufficient material for a large job. Lower germination rates can be overcome by increasing the seeding rate. Lower purities, however, should be avoided, as weeds can become a problem.

Other Certification Classes

Many new native seed sources are being developed in Alaska. For the most part, these

Figure 13: Pre-certified class seed tags

will not be sold as Certified seed. They may carry the following designations: 'Source Identified', 'Tested', or 'Selected'. These classes will be in keeping with the certification system and standards of germination and purity will be enforced, but the term 'Certified seed' will not apply. These classes are referred to as being 'Pre-certified' class.

Transplants

Transplants are plants growing in their native habitat that are transplanted directly into a restoration site, or into a nursery to be cultured for future use. Large transplants are able to establish and spread more quickly than other planting methods, and have a more immediate effect on visual aesthetics (Hoag, 2003).

Transplanting shock is a problematic and common occurrence, whereby the transplanted species fails to become established, for any number of reasons. These include lack of moisture or nutrients and stresses to the root system. Care should be taken to prevent transplant shock.

Sprigs

Sprigging is a method of transplanting whereby a plant clump is divided into individual sprigs, each of which is capable of growing into a new plant (Figure 14). On sites where coastal erosion is a concern, sprigging is an excellent means

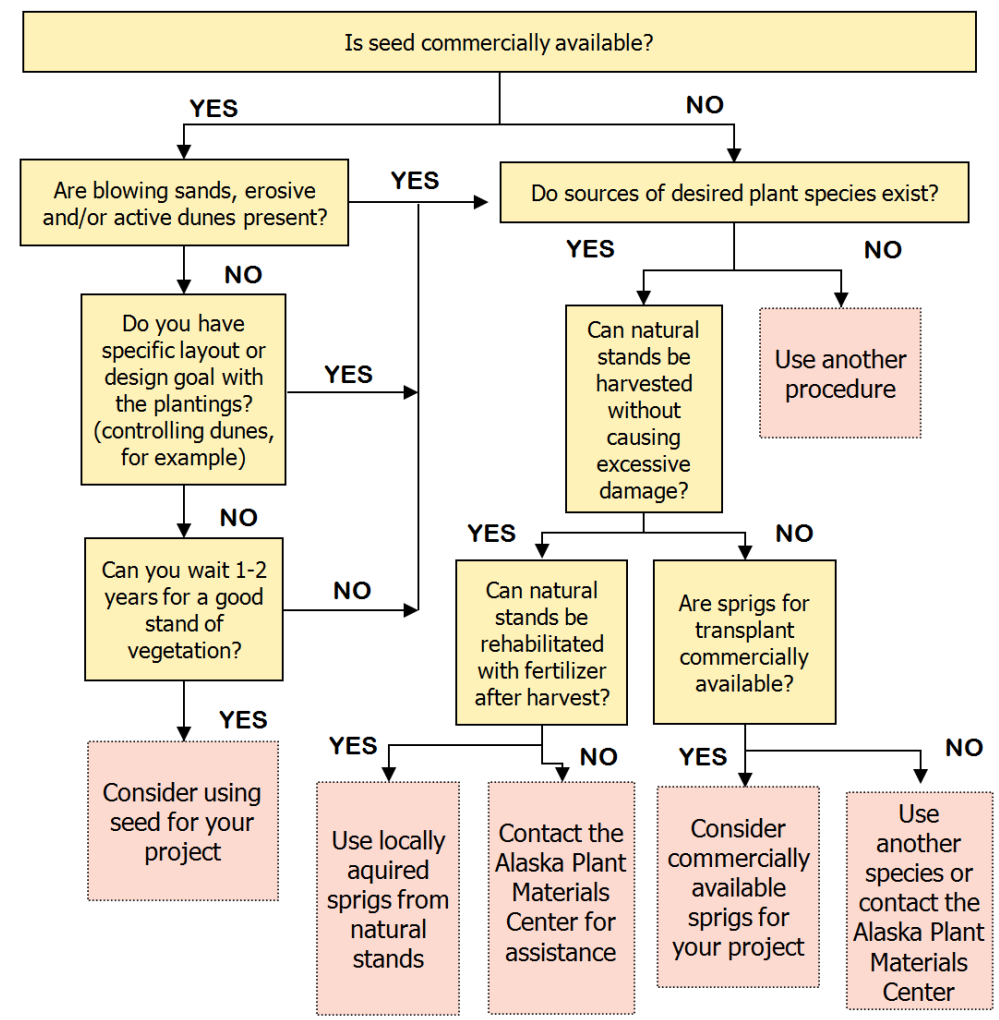


Figure 15: Planting procedure selection chart seeds vs. sprigs

Figure 14: A clump of Beach Wildrye suitable for division into sprigs. This plant could create three or four viable transplants.

The use of Beach Wildrye on sandy and gravelly coastal areas is a proven practice. To learn more about Beach Wildrye transplants and erosion control, refer to Appendix A: Beach Wildrye Planting Guide.

of reinforcement, as the roots of the transplanted species will create a rhizomatic web that ties together loose grained soils (Ffolliott *et al*., 1994).

Sprigs can be harvested from wild stands of vegetation, and planted without special equipment. A sprig does not need to have well-developed roots at planting time, only a portion of the below ground crown. The above ground portion of a sprig may die back after transplanting, however this is not cause for concern. New growth will start from the below ground portion. Sprigs

become established faster than seeded grass.

The planting procedure selection chart (Figure 15) may be used to decide which planting methods to use in a given situation.

Bare-root stock

Bare–root stock is commonly used to establish woody plants. Seedlings are grown in outdoor nurseries, lifted from the soil when dormant, and then stored in a cool and moist environment until transplanted (Munshower, 1994). Hardening, which induces dormancy, is often done in a 6-8 week period prior to transplanting, in order to expose the seedlings to conditions similar to the planting site.

Figure 16: A clam-gun is an effective means of harvesting sprigs of sedge

Container – grown stock

Container stock is grown in artificial growing media in a controlled environment, usually a greenhouse. When harvested, the root system forms a cohesive plug (Steinfeld, *et al*., 2007). Containers come in a variety of sizes and shapes. Container grown plants are able to tolerate harsh conditions more easily than bare-root transplants (Eliason & Allen, 1997).

Cuttings

The use of willow cuttings is the most commonly used method of vegetative planting in Alaska, both historically and today. The use of willow cuttings has proven successful in all areas of Alaska where willow occurs naturally. Because timing is critical to both collection and planting, prior planning is an absolute necessity.

For detailed instructions on the use of willow cuttings, please refer to Streambank Revegetation and Protection, published by the Alaska Department of Fish & Game. This publication is online, at www.sf.adfg.state.ak.us/sarr/restoration/techniques/techniques.cfm.

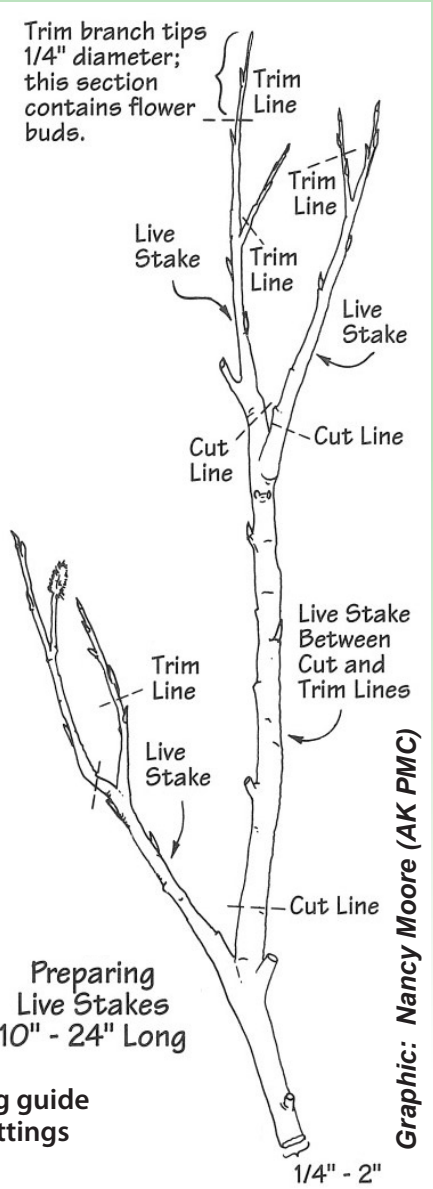


Figure 17: Trimming guide for vegetative cuttings

Figure 18: Willow cuttings were used to re-establish vegetative cover on the banks of the Kenai River

Mulch & Erosion Matting

When deciding a soil cover method to use (i.e. mulch or erosion matting), several factors should be considered. Erosion potential due to wind or water is the primary consideration. If the soil does not have a high erosion potential, then mulch and/or matting may be skipped. The second consideration is cost. Application of mulch and matting add significant costs to a project; not only in materials, but also in labor. The third consideration is safety. Sections of netting may come loose and cause hazards to wildlife and property. A final concern is that straw may introduce unwanted weeds.

The above concerns do not apply to wood and paper fiber or similar products used in hydroseeders. When hydroseeders are used, mulch is obligatory. The mulch fiber forms a slurry that acts as a carrier for the seed and fertilizer. Without mulch, seed and fertilizer would not suspend properly or efficiently in solution, and uniform distribution would be impossible. Mulch also serves as a visual indicator of areas that have been treated.

Figure 19: Erosion Control matting can stabilize a cut slope while seed or transplants become established

Wild Seed Collection

A pull-type seed stripper is an effective means of harvesting collections of wild seed

An alternative to obtaining seed commercially is to collect seed from the wild. Wild seed can be harvested from native grass, forbs, shrubs, and trees found at or near the project site (Steinfeld, et al, 2007). If seed collection occurs at a considerable distance from the project site, make sure the species is adapted to the site conditions before using it in a revegetation project. For an example of wildland seed collection, review the Girdwood Sedge Restoration case study in this manual.

Collection of wildland seed is a lengthy process that benefits from prior planning. The steps in this process are seed collection, processing, and increase. Seed collection includes locating donor plant communities, collecting seed, and choosing a method of harvest. When determining where to harvest, remember that there is no un-owned land in Alaska; collecting seed from any property, unless it is your own, requires the permission of the owner. If the potential seed collection site is state, federal, or tribally owned land, permits may be required. For a list of agencies and large land holders in Alaska, refer to the **Partner Agencies** section.

Figure 20: A tractor mounted potato harvester being used to harvest Beach Wildrye

Figure 21: When harvesting by hand, cut the stem just below the seed-head

Proper timing in the season is critical for successful seed collection. A number of field visits may be required in order to collect seed that is ripe and mature. Seeds go through different stages of maturity; being able to recognize these stages allows one to collect seed in the proper ripening window. This collection window may vary from a few days to several weeks. Additional collection trips in the following year may be required if this window is missed. Also, some species may not produce enough seed in a single year, requiring multiple collection trips before planting can commence.

Methods of recognizing seed maturity differ for grasses, trees, and shrubs. Color, taste, and hardness are factors to consider when determining if a seed is mature. Plants with fruits start green and change to red, blue, white, or other colors with maturity. A sour or bitter taste in fruits indicates a immature plant. With time, higher sugar content in the fruit signals maturity, giving it a sweet taste when eaten. Also, the hardness of the fruit will change when mature. When the fruit becomes soft and pulpy, it is usually mature.

Seed pods are another indication of maturity. If rattling can be heard when the pod is shaken, then the seeds are ready to collect. Cracks or breakage of the seed pod is another indicator of readiness. Lupine is a species that displays these traits.

Grass seed maturity can be determined by how the seed responds when it is pressed between the fingers. The stages of grass seed maturity are best expressed by *Steinfeld, et al.*

> • **Milk stage**: A milky substance is secreted when pressure is applied, indicating an immature seed lacking viability.
>
> • **Soft-dough stage**: Seed has a doughy texture, indicating it will have low germination and viability if collected.
>
> • **Hard-dough stage:** No excretion of dough or milky substance when squeezed. Seeds are collected at this stage. Seeds can be collected at the transition between soft-dough and hard-dough stages. If collection occurs between these stages, seed should not be stripped from the plant. Instead, seed heads should be cut and placed in collection bags where seeds will continue to mature.
>
> • **Mature:** Seed in this stage are usually too hard to bite. Collection should begin immediately, because the seeds can dislodge from the stem at any time.

Weather conditions at the collection site are another variable to consider. Seed collection should commence during dry weather with little wind. High wind can blow the seed off site and make collection difficult.

Seed collection methods are dependent upon the species being collected,

Figure 22: A Woodward Flail-Vac © seed stripper attachment is used to collect large amounts of wild seed, such as fireweed

Figure 23: Collected fireweed stays in the seed stripper until removed for processing

where collection occurs, and the scale of the project. Grass seed is often harvested by hand, usually by shaking it off the stem or cutting off the seed head with a knife or scissors (Figure 21). Shrub seed can be picked by hand or lightly shaken into a tarp or bucket for collection. Large-scale harvesting is usually accomplished by mechanical means. Collection bags should allow airflow; cloth bags are often used.

Terrain is another factor that determines how the seed is collected. Steep slopes may limit access by mechanical equipment, requiring alternate means of collection. For large, flat sites a combine (Figure 30) or Flail-Vac © type seed stripper (Figures 22 - 25) can be used. A pull type seed stripper can be mounted to an All Terrain Vehicle, facilitating collection on less flat ground.

Project scale is another consideration when collecting seed. The quantity of seed needed will often determine how seed is collected. Small quantities can be collected by hand, but large-scale projects requiring large amounts of seed will benefit from using mechanical implements.

For inaccessible sites that are too large for hand harvesting, a portable seed collector, such as a hand-held seed stripper (Figure 27) or a commercial leaf vacuum (Figure 28) can be utilized. A push-type chipper/shredder can also be used to collect seed (Figure 26), however some damage to the seed may occur, due to the nature of the equipment. Regardless of the method of collection, processing is required before the seed can be used for revegetation.

Diagram courtesy of Aaron Beisel.

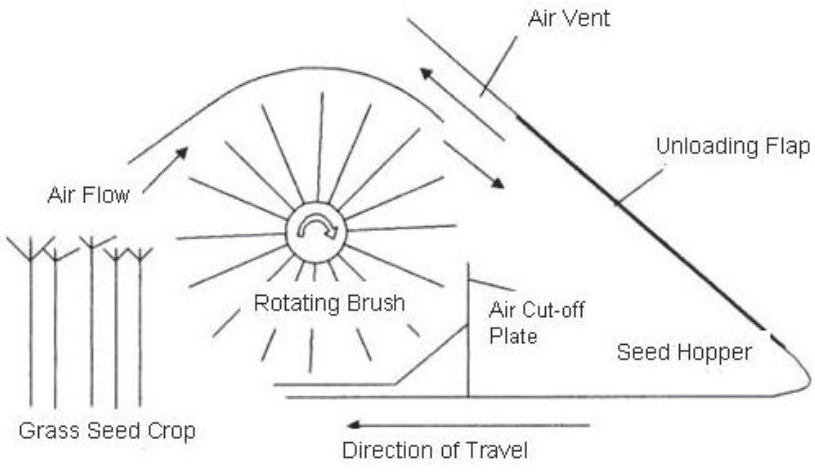


Figure 24: Schematic of a Woodward Flail-Vac © seed stripper

Seed processing involves separating weeds, chaff, dirt, stems, and other inert matter from the seed. This is generally done using specialized equipment, but seeds can also be processed by hand for smaller field collections. After cleaning, the seed is tested at a seed lab for purity and germination.

Seed increase involves taking cleaned wild seed and planting it in a nursery field. The field is then cultured for heavy seed production, which involves weeding and fertilization,

Photo: Brennan V. Low (AK PMC)

Figure 25: Using a seed stripper leaves the inflorescence (seed-head) intact, allowing for multiple equipment passes

amongst other treatments. When sufficient quantities of seed are available, the increased seed must then be collected and processed, as previously described, before planting can begin.

Harvested seeds from tree and shrubs species are often started at a nursery and grown in nursery beds (bare-root stock) or containers (container-grown stock) in a green-house. Seedlings are then transplanted to the site when ready.

Photo: Phil Czapla (AK PMC)

Figure 26: A chipper shredder with a vacuum used to harvest seeds

Photo: Prairie Habitats Inc.

Figure 27: A Hand-held seed stripper is an effective solution for medium volume collections in inaccessible sites

Photo: Troy-Bilt USA

Figure 28: A leaf blower with a vacuum function can be used to collect seeds

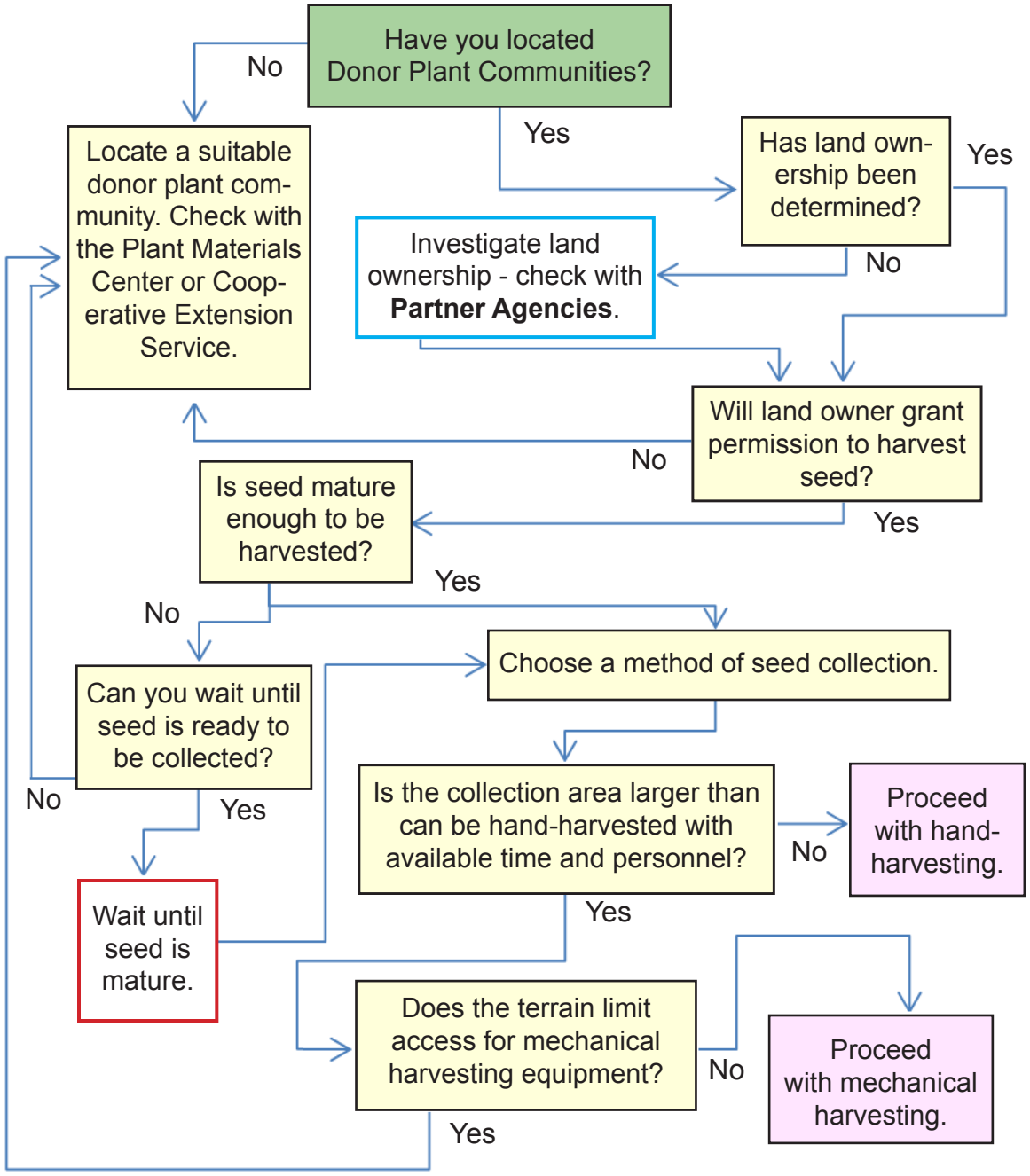


Figure 29: Wild seed harvest decision chart

Figure 30: Combine harvesting a wild Bluejoint Reedgrass (*Calamagrostis canadensis*) stand

Techniques

Many techniques exist for revegetation, including pre-prepared vegetation mats

In a number of situations, revegetation through seeding is not practical. There are several alternative methods that can be used to revegetate an area, in place of seeding. The different approaches highlighted in this chapter provide for greater flexibility to various site conditions and available materials.

Charged Overburden Veneer:

The charged overburden veneer technique promotes growth by spreading overburden (usually topsoil taken from a nearby work site) over the area to be revegetated. Seed and roots already present in the soil constitute the 'charge', and are relied upon to establish vegetation. The term "charged overburden veneer" was coined during the Shemya Island road close-out project included in the case study section. The drawback to this revegetation technique is that it may involve placing an erodible material on the site.

Special measures must be taken if the overburden material has the potential to be transported into storm sewer systems and / or surface waters. Numerous Best Management Practices (BMPs) exist to limit soil sediment transport. For more information, view appendix F of the Alaska Storm Water Pollution Prevention Plan Guide, available at dot.alaska.gov/stwddes/desenviron/resources/stormwater.shtml

Photos:James Bowers (AK DOT)

Spreading charged overburden - May, 2006

Topsoil being gathered onsite - November, 2005

Vegetation growth after 2 seasons - August, 2008

Heavy equipment used to spread topsoil - May, 2006

Vegetation cover fully established, using charged overburden technique - August, 2008

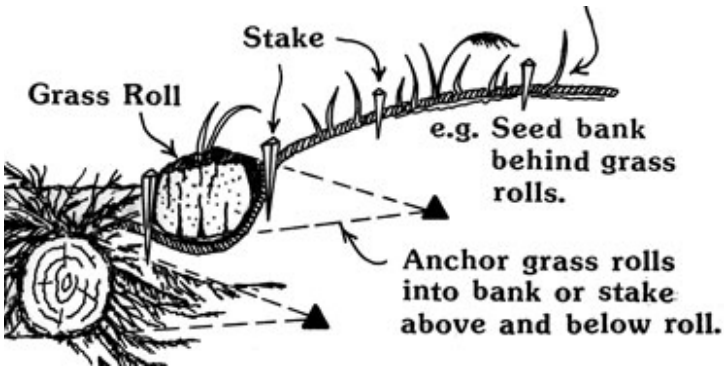
Sod Clumps:

The use of sod clumps is a form of transplanting whereby natural vegetation stands are harvested in block form. Dimensions of these blocks vary from one to several feet square (Muhlberg & Moore, 1998). Using sod clumps provides immediate vegetative cover on a site, and species are able to establish on a large area more quickly than with other forms of transplanting (i.e., using sprigs or individual plants).

Photo: Pentec Environmental / Hart Crowser Inc.

Clumps of sod deposited near an estuary to promote quick vegetation establishment

A prepared grass roll, consisting of sod clumps wrapped in an biodegradable fabric, with slits cut in the top for the shoots



Sod clumps are also used in the restoration of erodible stream banks. Grass rolls use sod clumps wrapped in biodegradable fabric to stabilize river banks and quickly establish vegetation cover.

For further explanation of this technique, refer to the ADF&G publication: 'Streambank Revegetation and Protection, a Guide for Alaska', available at www.adfg.alaska.gov/index.cfm?adfg=streambankprotection.

Vegetation Mats:

If clumps of sod are not readily available, a vegetative mat can be prepared in a nursery or greenhouse, and later transported to the site. In this technique, plantings are grown in a controlled environment until roots and rhizomes have become established.

Vegetation mats provide many of the same benefits of a sod clump, though at a greater cost in time, materials and labor. Prior planning is necessary when using vegetation mats, as the preparation of a mat will take at least one growing season. Some seeds may require stratification, while others may require scarification. All of these factors should be taken into account if you are using this technique.

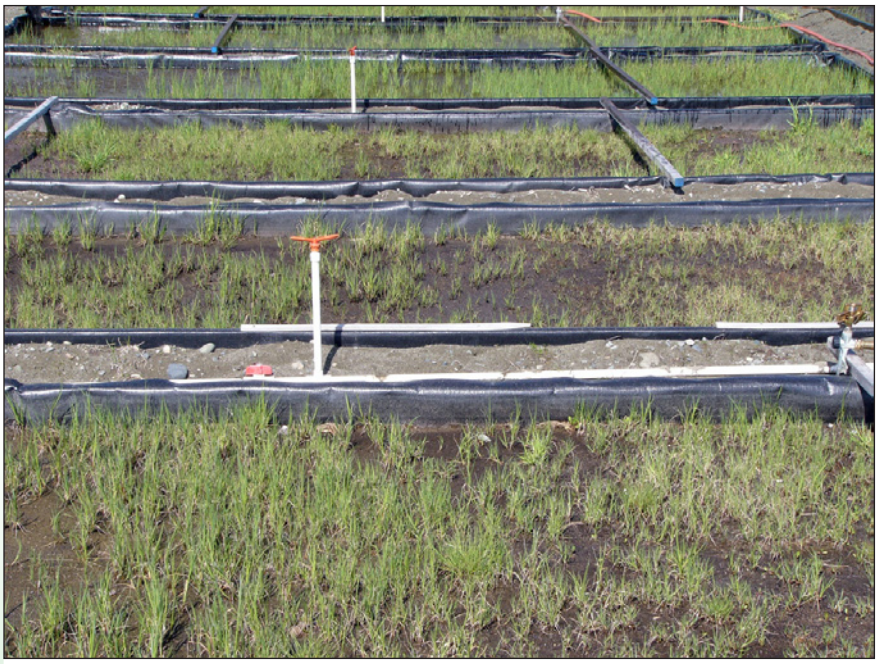
Photos: Nancy Moore (AK PMC)

Seeds in flats for cold / moist stratification over the winter. During the stratification process, seeds are placed in cloth bags, with a layer of peat beneath and above them. The cloth around the seeds provide a steady source of moisture.

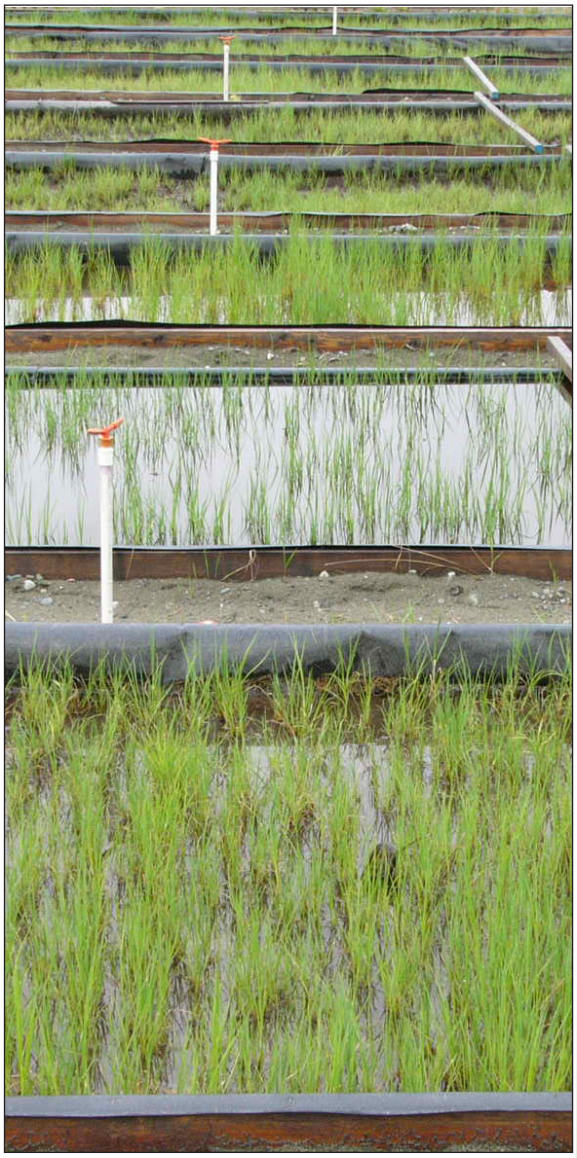
Soil spread on erosion control fabric provides a binding medium for roots

10' x 3' constructed mats framed with dimensional lumber, with thick plastic and erosion control matting used for the base. Only the biodegradable erosion control matting will remain once the mat is deployed.

Stratified seeds are sown on a vegetation mat, using hand seeders and a constructed grid to seed at a rate of 1 seed per 2 inch square



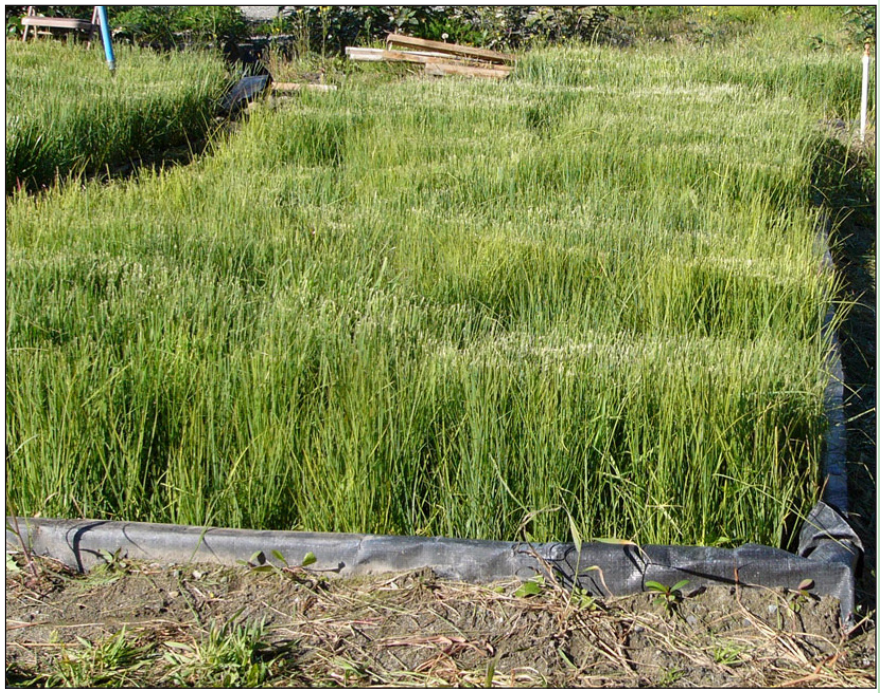
Germinated seeds take root in the constructed vegetation mats



In situ irrigation allows wetland species to thrive in the constructed vegetation mat

Photos: Nancy Moore (AK PMC)

Underside of vegetation mat, showing developed roots intertwined with erosion control fabric



Established water sedge mats ready for transport to site

Vegetation mats should be sized to fit available methods of transportation

Heavy plastic sheeting facilitates on-site transport of the vegetation mats

A line of vegetation mats, ready for placement

Vegetation mats being installed along the waters edge

Vegetation mats, one year after transplanting

Photos: Nancy Moore (AK PMC)

Enhanced Natural Reinvasion:

Natural reinvasion can be assisted or enhanced with any combination of surface preparation or modification techniques, fertilizers, and soil amendments. This technique is infrequently used in the field, as few sites offer ideal conditions. Additionally, the regulatory process precludes methods that cannot give specifics of final vegetative cover and/or composition.

The enhanced natural reinvasion method of revegetation is dependent upon seed arriving at the site by natural processes. This method is faster than natural reinvasion, but still has a relatively low success rate. Anyone wishing to apply this technique must understand the potential for failure, and be willing to move to an active form of revegetation if problems emerge.

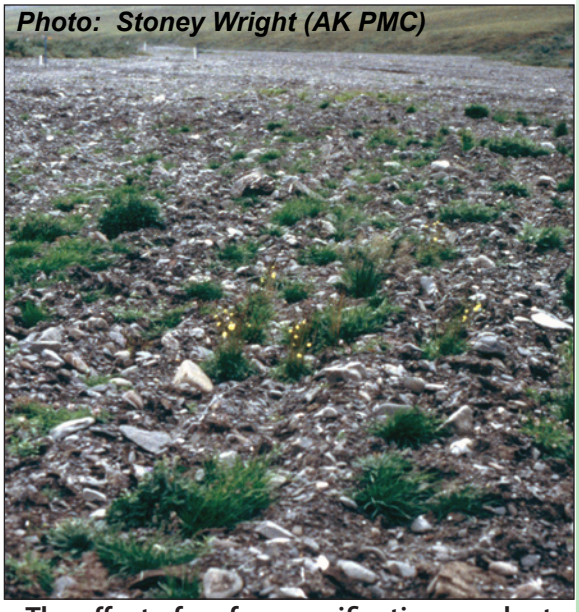
Photo: Phil Czapla (AK PMC)

Using a tow-behind broadcast seeder to apply fertilizer can ensure uniform distribution

Photo: Stoney Wright (AK PMC)

Fertilizer should be applied to edge of existing vegetation

Photo: Stoney Wright (AK PMC)



The effect of surface scarification on plant establishment and growth after two growing seasons. No seed was applied to the site, but it was fertilized with 20N-20P-10K fertilizer at a rate of 500 pounds per acre.

Imprinting:

Land imprinting is a method of seedbed preparation that uses heavy rollers to make a depression in the soil surface, creating basins in the soil that reduce erosion, increase water infiltration and capture runoff (Dixon, 1990). Imprinting can be accomplished with heavy equipment such as a compactor with a 'sheepsfoot' attachment. A broadcast seeder is often attached to the back of an imprinter to apply seed.

When the soil has been imprinted, uncovered seeds in the basin areas will tend to be covered by natural processes such as wind and rain. Imprinting creates micro-climates suitable for plant germination and growth. 'Track-walking' is a method of imprinting whereby the cleats on a track leave depressions on a soil surface. This technique is commonly used on sloping sites, before seeding.

Aerial Photo: Bill Quirk

A striated pattern is still visible one year after the above site was imprinted. Vegetative cover is a result of natural reinvasion; no seeding or fertilization occurred.

The wheels of this landfill compactor imprint the surface area, creating basins of micro relief in the seedbed

Imprinting creates pockets in the soil, each with a favorable micro-climate for vegetation growth

Imprinting:

Surface imprinting accomplished using the 'track-walking' technique

Vegetation grows in the depressions created by the cleats of a tracked vehicle

Alkaligrass grows in the depressions created by bulldozer tracks

Scarification:

Soil is scarified on almost all sites in preparation for seeding and fertilizer.

A harrow is a tool used to roughen the soil surface and kill shallow-rooted weeds. This process, called harrowing, can also break the compaction layer within the first few inches of the surface. When used after broadcast seeding, a harrow will help to cover the seed with soil.

Heavy equipment, such as graders and front-end loaders, are frequently used for scarification on highly compacted rocky soils. A dozer blade can be modified with 'tiger teeth' at regular intervals and used for scarification.

Photos: Stoney Wright (AK PMC)

Deep scarification of the soil surface can be accomplished with a grader with a 'ripper shanks' tool bar

A bulldozer, modified with 'tiger-teeth' attached to the blade, is an effective means of surface modification that promotes root growth by reducing soil compaction

Conservation & Protection

Eelgrass beds near Craig, Alaska

Coastal landforms and vegetation communities are especially vulnerable to damage, and care should be exercised to minimize impacts to these areas. Areas that need particular attention are coastal dunes, eelgrass beds, and estuarine habitats. This chapter will address protection methods and regulations that affect these resources.

Preventing Damage to Dunes:

Coastal dunes are a dynamic landform consisting of fine-grained material, such as sand, bound together with vegetation. The rhizomes and roots of dune adapted species hold the loose soil together. A unique coastal feature, dunes are susceptible to erosion caused by natural and human sources. Wind is the main transport mechanism for sand. Vegetation serves to protect sand dunes, preventing movement and stabilize soil. (Maia, et al., 2007). If erosion processes are allowed

to continue, a loss of plants and animal habitat, and / or, damage to scenic beauty could occur. Restoration and conservation of dunes will ensure continued protection from damage arising from natural and human forces.

For the purposes of this guide, dune restoration will focus on the "soft" (vegetative) approach, as an alternative to engineered structures. The soft approach relies on biodegradable erosion control blankets, native plant materials and / or seed for dune stabilization. Engineered structures such as stone and concrete walls are often not an acceptable approach, because of public opposition. Dune restoration activities should be undertaken for the purpose of reestablishment of dunes and vegetative cover, as well as controlling human impacts that can destabilize dunes (Rooney, 2007).

Coastal dunes can be damaged by foot and vehicle traffic, wave action, and extreme winds. Limiting traffic to a threatened area is a very effective way to preserve dune formations. This may be achieved by walkways through the dune area, access barriers (fencing), laws (fines), and informative signage. Dune degradation from wind and wave action can be mitigated with vegetation that provides the structural integrity for soil fixation and retention. A revegetation plant species with this characteristic is Beach Wildrye. More information about this species can be found in Appendix A: *Beach Wildrye Planting Guide*.

Photos: Brennan V. Low (AK PMC)

Dune protection measures in place near the mouth of the Kenai River

There are presently no regulations in Alaska prohibiting activities that may damage dunes. The city of Kenai has adopted an ordinance limiting access to dune environments and establishing fines. A physical barrier has also been constructed to protect threatened dunes. Previously, coastal dunes at the mouth of the Kenai River were routinely being damaged by camping and fishing traffic. The success of this approach is evident; dune formation is widespread and vegetation is well established.

Protection of Eelgrass:

Eelgrass is a sea grass primary found in shallow nearshore waters along coastlines. Its

Eelgrass is a sea grass that is a protected fish habitat; impacts to eelgrass beds must be mitigated in Alaska

preferred habitat is 3 to 12 feet below the surface of the water, a zone with abundant light. Eelgrass beds provide habitat for invertebrates and are utilized by a variety of fish species for spawning, rearing, and feeding. Eelgrass is also valuable in protecting the shoreline from erosion and wave action. The species has a narrow tolerance for turbidity, sediment disturbance, and eutrophication (McCracken, 2007). Eutrophication refers to high nutrient levels in the water depleting oxygen available for marine species, a process associated with algal blooms. The vulnerability of eelgrass to shoreline development warrants the protection of this coastal habitat.

There are numerous regulations and permits concerning habitat restoration projects. Some federal regulations of note are the Clean Water Act and the Magnuson-Stevens Fishery Conservation and Management Act. Section 404 of the Clean Water Act requires prior approval for any discharge of dredge or fill material, and prohibits discharge or filling if a practicable alternative exists. Dredging and filling activities represent a known threat to eelgrass habitat in Alaska. Good water quality and circulation are necessary for healthy eelgrass populations.

The Magnuson-Stevens Act requires the development of fishery management plans (FMPs) which include descriptions of Essential Fish Habitat (EFH) for documented species, and measures that can be taken to conserve and enhance these habitats. Eelgrass beds are protected because of the importance of this type of habitat for fish rearing. The National Marine Fisheries Service (NMFS), part of National Oceanic and Atmospheric Administration (NOAA), is tasked with implementing the Magnuson-Stevens Act.

NOAA's Office of Habitat Conservation conducts environmental reviews of non-fishing activities, and supports habitat restoration efforts through the Habitat Restoration Center. The goal of the Office of Habitat Conservation is to minimize impacts to marine resources; including eelgrass beds and estuaries.

Eelgrass beds are threatened by excessive sediment deposition, which can be a result of soil erosion. Strategies for erosion control include revegetation (detailed in this guide) and streambank restoration. The latter topic is covered in detail in 'Streambank Revegetation and Protection', published by the Alaska Department of Fish & Game. This document is available at www.adfg.alaska.gov/index.cfm?adfg=streambankprotection.main. NOAA fisheries will have additional recommendations for the conservation of sea grasses.

Within Alaska, the 'special aquatic site' designation affords additional protection and consideration to sensitive habitats, including eelgrass beds (Harris, 2008). Proposed development projects that may have an impact on these sites are reviewed by permitting agencies.

Protection of Estuarine Habitats:

An estuary is a body of water that is found along the coast and is formed when freshwater from a river flows into the salt water of the ocean. The mixing of nutrients from fresh and salt water supports an environment teeming with life. These areas provides food and shelter for wildlife and plant species. Estuaries also provide recreational opportunities, fishing and tourism jobs, aesthetic value, and food. Estuarine habitats include mudflats, salt marshes, wetlands, and eelgrass beds.

Years of disregard for estuaries has resulted in habitat loss, diminished economic opportunities for fishing and tourism, and negatively impacted the quality of life for coastal communities.

Estuaries throughout Alaska are quite healthy, and have seen with minimal development (Nature Conservancy, 2010). Potential threats include oil spills, sedimentation from erosion, dredging and filling activities, as well as pollution.

Laws and regulations exist for the protection of estuaries and the habitats they provide. One such law is the Estuary Restoration Act (ERA) of 2000. This act enhanced federal monitoring and research capabilities, provided funds for financial and technical assistance in estuarine habitat restoration, and established an Estuary Habitat Restoration Council, charged with coordinated federal restoration efforts. This Council is comprised of the National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA), Department of the Interior (U.S. Fish and Wildlife Service), Department of Agriculture (Natural Resources Conservation Service), and the Department of Army.

An estuary in the Copper River delta

Amendments were made to the ERA in 2007. One notable amendment was the delegation of small projects (less than $1,000,000) to NOAA, USFWS, EPA, and NRCS by the Secretary of Army. Also, NOAA, USFWS, EPA, and NRCS receive $2.5 million per fiscal year through 2012 to carry out restoration projects. Section 320 of the Estuary Restoration Act directs the Environmental Protection Agency to administer a National Estuary Program, and assist states in developing a 'Comprehensive Conservation and Management Plan' (CCMP). As of 2011, there is no CCMP for Alaska.

Species Selection

A lone specimen of Beach Fleabane (*Senecio psuedoarnica*) on a gravelly beach site in northwest Alaska, near Nome

Section 3:

1. Adapted Plants
   - *Coastal Regions of Alaska*
   - *Vegetation Communities*
   - *Revegetation Suggestions*
2. Plant Species

Adapted Plants

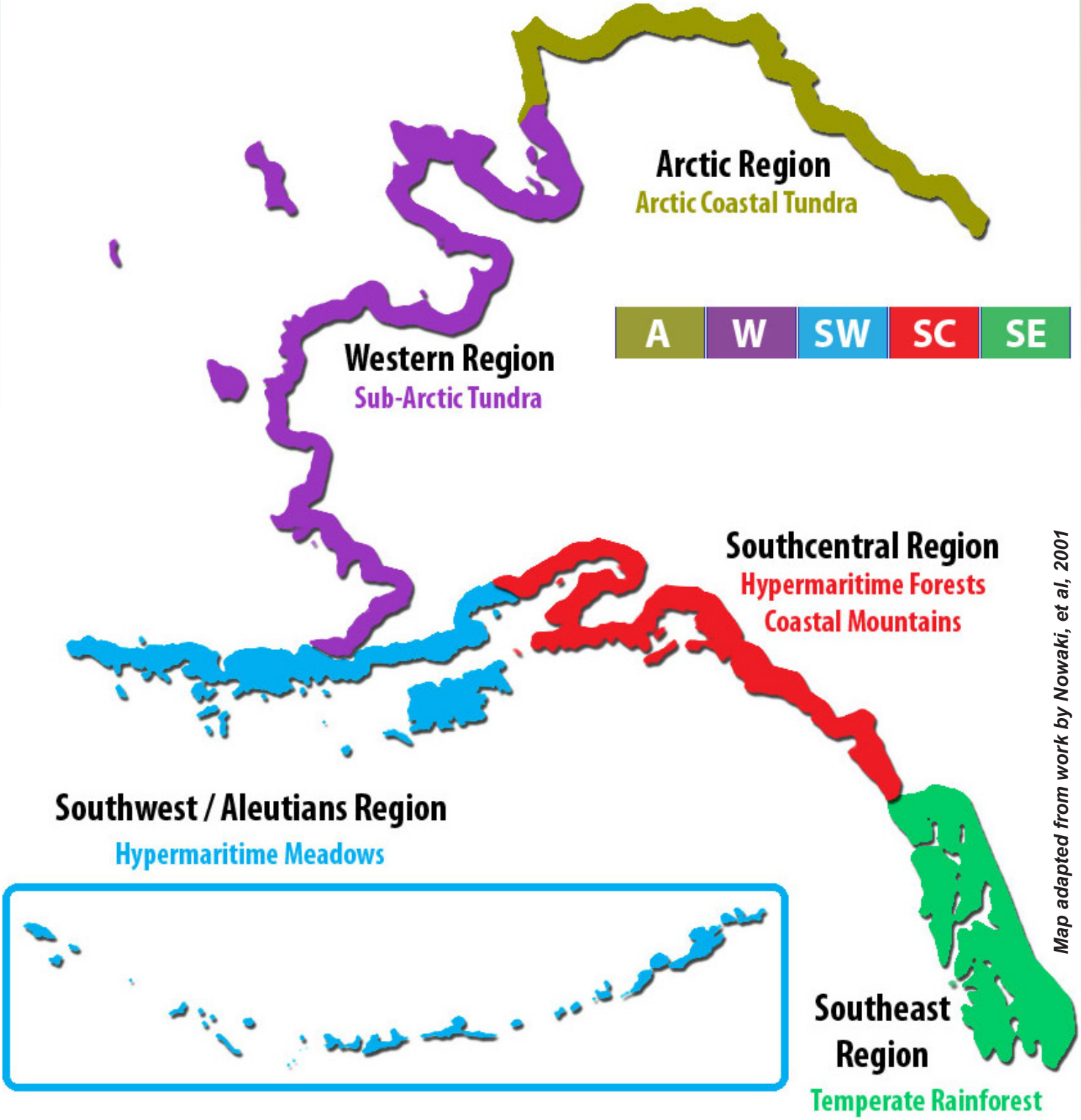
Selecting an appropriate species mixture

Reedgrass, Hairgrass, Alpine Bluegrass, and Red Fescue are present in this St. Lawrence Island plant community

Species diversity is a critical component of true revegetative success. Predicting which species will become established at a site is an inexact science. However, selecting native plant varieties which are adapted to the region and the specific characteristics of the site is key. The use of several different plant species increases diversity of the stand and increases the ability of the vegetated area to withstand unforeseen complications or changing site conditions. It is always prudent to use more than one species in a seed mix. The charts within this section can be used to develop adapted planting mixtures appropriate for each region of Alaska.

Coastal Regions of Alaska:

Alaska contains thirty-one unique eco-regions, defined as large areas of land and waters containing vegetation communities that share ecological dynamics, environmental conditions, and interactions that are critical for their long-term persistence. (Nowaki et al, 2001). Nineteen of these regions are coastal, and fall into five major zones. Each region of Alaska has a dominant vegetation community, and it is necessary to address the issue of revegetation in the context of these communities, as this will effect species selection and other planting requirements. The species suggestions in this section are color-coded by region, as indicated below.



Revegetation Suggestions:

How to use the Species Chart :

1. Estimate soil moisture conditions. (**Saturated, Average, Very Dry**)
2. Select the soil type based on the Uniform Soil Classification engineering soil classification table.

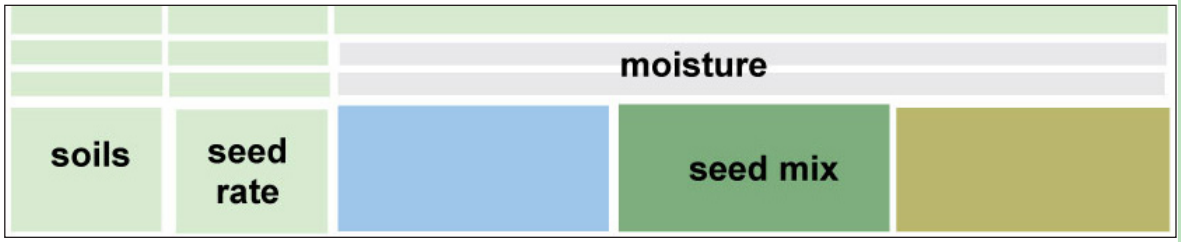
Uniform Soil Classification Table	
Symbol	**Soil Type**
GW	well-graded gravel
GP	poorly-graded gravel
GM	silty gravel
GC	clayey gravel
SW	well-graded sand
SP	poorly-graded sand
SM	silty sand
SC	clayey sand
ML	silt
MH	elastic silt
CL	lean clay
CH	flat clay
OL	organic clay/silt - low plasticity
OH	organic clay/silt -high plasticity
PT	peat - high organic

3. Select an effective seed mix from the of primary and secondary species lists for the region.

   Primary Species, selected from the primary species list for the region, should account for 80–100% of the seed mix. (relative weighting indicated by a '**1**' or '**2**' preceding the species name on chart for the region). If soil conditions at the site are uniform, a two or three species mix composed of exclusively primary species will suffice. Conversely, if soil conditions vary considerably, secondary species should be included as well.

   Secondary Species represent the smallest percentage of a seed mix, often species that are costly or in short supply. (indicated by a '**3**' on chart for the region). Secondary material adds a degree of variability to the mix and is recommended to address special environmental concerns such as stream crossings. Material for a given secondary species should not exceed 5% of the total mix.

4. Seeding rates for the entire mix are listed in the column "Seed Rate." This number is interchangeable for either lbs / acre or kg / hectare.
5. If the site is determined to be an erosion hazard, add no more than 10% Annual Ryegrass to the previously developed mix. This species, while giving temporary erosion protection, competes for nutrients with long-term perennial species. Also, Annual Ryegrass is a highly palatable forage species that can attract herbivores (i.e. moose and deer). Annual ryegrass cannot be used in conjunction with Alpine Bluegrass (*Poa alpina*). The allelopathic effects of Annual Ryegrass will kill Alpine Bluegrass.



Revegetation Suggestion Chart Structure

Vegetation Communities:

ARCTIC REGION

Above:
Thermal degradation, caused by melting permafrost, is evident within this sedge-grassland community in arctic Alaska

Left:
***Carex aquatilis* (Water sedge), and *Saxifraga cernua* (Drooping Saxifrage) on the arctic coastal plain**

Next Page:
***Leymus mollis* (Beach Wildrye) colonizes a dune in the Prudhoe Bay oilfield**

Revegetation Suggestions:

ARCTIC REGION

Photo: Stoney Wright (AK PMC)

Primary Species:

- 'Gruening' **Alpine Bluegrass**, *Poa alpina*
- 'Egan' **American Sloughgrass**, *Beckmannia syzigachne*
- 'Norcoast' **Bering Hairgrass**, *Deschampsia beringensis*
- 'Tundra' **Glaucous Bluegrass**, *Poa glauca*
- 'Alyeska' **Polargrass**, *Arctagrostis latifolia*
- 'Arctared' **Red Fescue**, *Festuca rubra*
- 'Nortran' **Tufted Hairgrass**, *Deschampsia caespitosa*

Secondary Species:

- Council **Arctic Bluegrass**, *Poa arctica*
- Tin City **Arctic Bluegrass** (viviparous form), *Poa arctica*
- **Annual Ryegrass**, *Lolium multiflorum*
- Kotzebue **Arctic Wild Chamomile**, *Tripleurospermum maritima*
- 'Sourdough' **Bluejoint Reedgrass**, *Calamagrostis canadensis*
- Black Rapids' **Field Oxytrope**, *Oxytropis campestris*
- Franklin Bluffs **Nodding Locoweed**, *Oxytropis deflexa*
- 'Caiggluk' **Tilesius' Wormwood**, *Artemisia tilesii*
- Safety **Viviparous Fescue**, *Festuca viviparoidea*

Revegetation Suggestions:

ARCTIC REGION

The northern portion of Alaska consists of the Beaufort Coastal Plain, Kobuk Ridges and Hills, and the Brooks Range Foothills eco-regions. The climate is dry, and experiences extremes of sunlight. During the growing season, the arctic sun does not set for several weeks. Summers are short and cool, and winters are long and cold. Continuous permafrost often results in saturated organic soils.

Arctic Alaska supports a mixed shrub-sedge tussock plant community. Vegetation communities have low species diversity, low plant biomass & slow rates of growth, which results in a delayed recovery from disturbance (Oceanographic Institute of Washington, 1979). Many grasses are available in 'hardy' varieties that are best suited for the harsh conditions on the North Slope of Alaska.

Soil Group *(Refer to Soil Type Chart)*	**Seed Rate** *(Refer to Directions)*	**Species/Cultivar Selection** *(Refer to Species/Cultivar Characteristic Chart For Category Ratings)*		
High Organic		Suggest fertilizer only. If seeding is stipulated use suggestions for SW, SP, SM, SC soils.		
GW, GP		Suggest scarification and fertilizer only. If seeding is stipulated use suggestions for GM, GC soils and moisture.		
		Soil Moisture Characteristics		
		Saturated (Hydric)	**Average (Mesic)**	**Very Dry (Xeric)**
GM, GC	**20**	**1** 'Arctared' red fescue **1** 'Alyeska' polargrass **2** 'Tundra' glaucous bluegrass **2** 'Norcoast' Bering hairgrass **3** 'Egan' American sloughgrass **3** 'Boreal' red fescue	**1** 'Arctared' red fescue **1** 'Alyeska' polargrass **1** 'Tundra' glaucous bluegrass **2** 'Nortran' tufted hairgrass **2** 'Gruening' alpine bluegrass	**1** 'Arctared' red fescue **1** 'Alyeska' polargrass **1** 'Tundra' glaucous bluegrass **2** 'Gruening' alpine bluegrass
SW, SP, SM, SC	**40**	**1** 'Arctared' red fescue **1** 'Alyeska' polargrass **1** 'Tundra' glaucous bluegrass **2** 'Gruening' alpine bluegrass **2** 'Nortran' tufted hairgrass **3** 'Norcoast' Bering hairgrass **3** 'Caiggluk' Tilesy wormwood	**1** 'Arctared' red fescue **1** 'Alyeska' polargrass **1** 'Tundra' glaucous bluegrass **2** 'Gruening' alpine bluegrass **2** 'Nortran' tufted hairgrass **3** 'Norcoast' Bering hairgrass **3** 'Caiggluk' Tilesy wormwood	**1** 'Arctared' red fescue **1** 'Alyeska' polargrass **1** 'Tundra' glaucous bluegrass **2** 'Gruening' alpine bluegrass **2** 'Nortran' tufted hairgrass **3** 'Norcoast' Bering hairgrass **3** 'Caiggluk' Tilesy wormwood
ML, CL, OL **MH, CH, OH**	**30**	**1** 'Arctared' red fescue **1** 'Alyeska' polargrass **2** 'Tundra' glaucous bluegrass **2** 'Norcoast' Bering hairgrass **3** 'Egan' American sloughgrass		

Vegetation Communities:

WESTERN REGION

Photo: Andy Nolan

Photo: Stoney Wright (AK PMC)

Above: Typical Beach Wildrye community, adapted to the sandy and gravelly soils of Safety Sound

Right: *Ligusticum scotium (*Beach Lovage)

Below: Both *Honckenya peploides* (Sandwort) and *Leymus mollis* (Beach Wildrye) are adapted to sandy environs, such as this beach near Nome

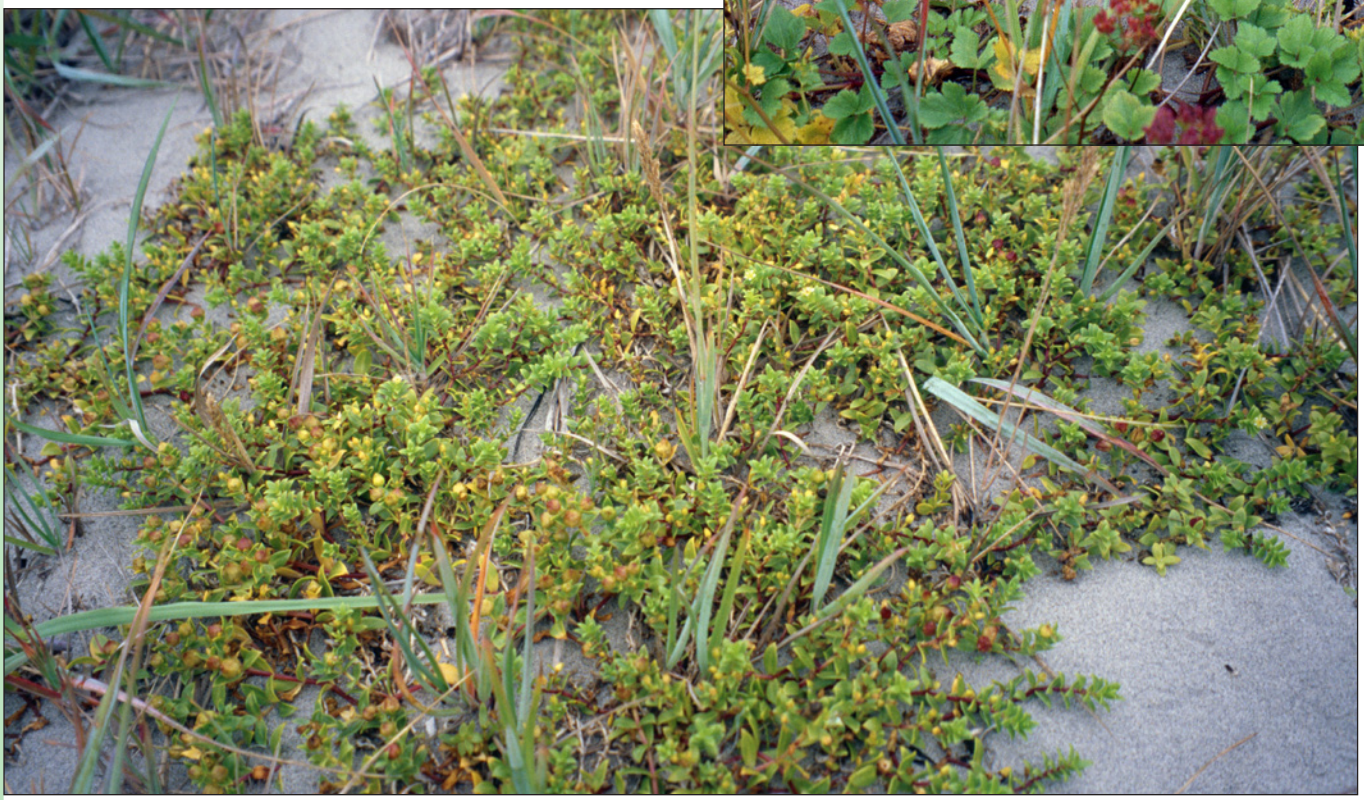


Photo: Stoney Wright (AK PMC)

Revegetation Suggestions:

WESTERN REGION

The western Alaska region stretches from the Kotzebue Sound lowlands to the Bristol Bay lowlands, encompassing the Seward Peninsula, the Yukon-Kuskokwim Delta, and the Bering Sea islands. Bering tundra is present at Kotzebue, transitioning to a subarctic tundra plant community all the way south to Bristol Bay.

Primary Species:

- 'Gruening' **Alpine Bluegrass**, *Poa alpina*
- 'Egan' **American Sloughgrass**, *Beckmannia syzigachne*
- 'Norcoast' **Bering Hairgrass**, *Deschampsia beringensis*
- 'Tundra' **Glaucous Bluegrass**, *Poa glauca*
- 'Alyeska' **Polargrass**, *Arctagrostis latifolia*
- 'Kenai' **Polargrass**, *Arctagrostis latifolia*
- 'Arctared' **Red Fescue**, *Festuca rubra*
- 'Boreal' **Red Fescue**, *Festuca rubra*
- Wainwright **Slender Wheatgrass**, *Elymus trachycaulus*
- 'Nortran' **Tufted Hairgrass**, *Deschampsia caespitosa*

Secondary Species:

- Teller **Alpine Bluegrass**, *Poa alpina*
- Paxson **Alpine Sweetvetch**, *Hedysarum alpinum*
- **Annual Ryegrass**, *Lolium multiflorum*
- Council **Arctic Bluegrass**, *Poa arctica*
- Tin City **Arctic Bluegrass** (vivparous form), *Poa arctica*
- Kotzebue **Arctic Wild Chamomile**, *Tripleurospermum maritima*
- Clam Lagoon **Beach Fleabane**, *Senecio pseudoarnica*
- Casco Cove **Beach Lovage**, *Ligusticum scoticum*
- 'Sourdough' **Bluejoint Reedgrass**, *Calamagrostis canadensis*
- Twenty Mile **Boreal Yarrow**, *Achillea millefolium*
- Kobuk **Dwarf Fireweed**, *Chamerion latifolium*
- Black Rapids **Field Oxytrope**, *Oxytropis campestris*
- Nome **Glaucous Bluegrass**, *Poa glauca*
- Lowell Point **Meadow Barley**, *Hordeum brachyantherum*
- Franklin Bluffs **Nodding Locoweed**, *Oxytropis deflexa*
- Ninilchik' **Nootka Alkaligrass**, *Puccinellia nutkaensis*
- Pioneer Peak **Nootka Reedgrass**, *Calamagrostis nutkaensis*
- Nelchina **Spike Trisetum**, *Trisetum spicatum*
- 'Caiggluk' **Tilesius' Wormwood**, *Artemisia tilesii*
- Safety **Viviparous Fescue**, *Festuca viviparoidea*
- Knik **Wild Iris**, *Iris setosa*

Revegetation Suggestions:

WESTERN REGION

Western Alaska has a polar climate. Summer temperatures are moderated by the Bering Sea, but winter temperatures are more continental in nature due to sea ice that forms in the winter. Precipitation is light in the region, averaging between 12 and 24 inches per annum. (WRCC, ongoing). Dominant plant species include sedges, forbs, and low-shrubs.

Soil Group *(Refer to Soil Type Chart)*	**Seed Rate** *(Refer to Directions)*	**Species/Cultivar Selection** *(Refer to Species/Cultivar Characteristic Chart For Category Ratings)*		
High Organic		Suggest fertilizer only. If seeding is stipulated use suggestion for MH, CH, OH Hydric.		
GW, GP		Suggest scarification and fertilizer only. If seeding is stipulated use suggestions for SW, SP, SM, SC soils.		
		Soil Moisture Characteristics		
		Saturated (Hydric)	**Average (Mesic)**	**Very Dry (Xeric)**
GM, GC	**20**	**1** 'Norcoast' Bering hairgrass **1** 'Arctared' red fescue **1** 'Egan' American sloughgrass **2** 'Nortran' tufted hairgrass **2** 'Boreal' red fescue **2** 'Alyeska' polargrass **3** 'Caiggluk' Tilesy wormwood	**1** 'Arctared' red fescue **1** 'Norcoast' Bering Hairgrass **1** 'Tundra' glaucous bluegrass **2** 'Boreal' red fescue **2** 'Alyeska' polargrass **2** 'Nortran' tufted hairgrass **2** 'Gruening' alpine bluegrass **3** 'Caiggluk' Tilesy wormwood	**1** 'Arctared' red fescue **1** 'Norcoast' Bering Hairgrass **1** 'Gruening' alpine bluegrass **2** 'Nortran' tufted hairgrass **2** 'Tundra' glaucous bluegrass **2** 'Boreal' red fescue **3** 'Sourdough' bluejoint reedgrass **3** Wainwright slender wheatgrass
SW, SP, SM, SC	**40**	**1** 'Arctared' red fescue **1** 'Norcoast' Bering hairgrass **1** 'Nortran' tufted hairgrass **1** 'Gruening' alpine bluegrass **2** 'Alyeska' polargrass **2** 'Kenai' polargrass **2** 'Tundra' glaucous bluegrass **3** 'Sourdough' bluejoint reedgrass	**1** 'Arctared' red fescue **1** 'Norcoast' Bering hairgrass **1** 'Nortran' tufted hairgrass **1** 'Gruening' alpine bluegrass **2** 'Alyeska' polargrass **2** 'Kenai' polargrass **2** 'Tundra' glaucous bluegrass **3** 'Sourdough' bluejoint reedgrass	**1** 'Arctared' red fescue **1** 'Norcoast' Bering hairgrass **1** 'Nortran' tufted hairgrass **1** 'Gruening' alpine bluegrass **2** 'Alyeska' polargrass **2** 'Kenai' polargrass **2** 'Tundra' glaucous bluegrass **3** 'Sourdough' bluejoint reedgrass
ML, CL, OL **MH, CH, OH**	**30**	**1** 'Norcoast' Bering hairgrass **1** 'Egan' American sloughgrass **1** 'Arctared' red fescue **2** 'Alyeska' polargrass **2** 'Boreal' red fescue **3** 'Caiggluk' Tilesy wormwood	*Note: If the area to be revegetated is adjacent to a coast line, consider using local Beach Wild-rye transplants instread.*	*Note: If the area to be revegetated is adjacent to a coast line, consider using local Beach Wild-rye transplants instread.*

Vegetation Communities:

SOUTHWEST REGION

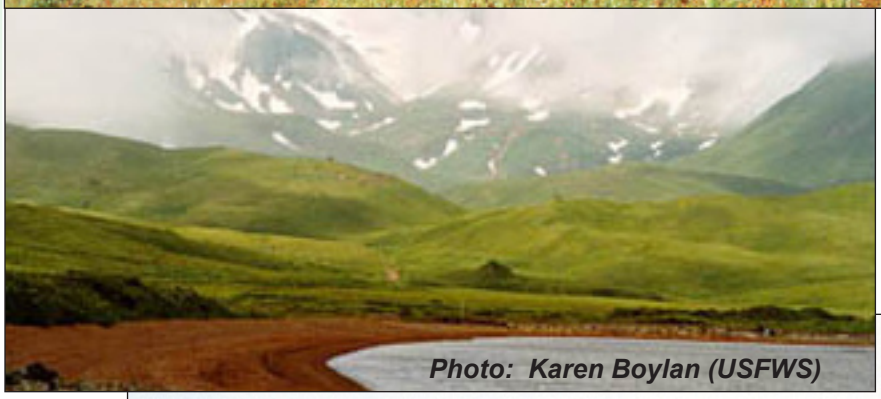


Photo: Karen Boylan (USFWS)

Above: Hypermaritime meadow environment, characteristic of southwestern Alaska and the Aleutian Islands

Left: Adak island grassland community

Below: Beach Wildrye is a large component of this hypermaritime grassland on Adak Island

Photos: (top, bottom of page): Stoney Wright (AK PMC)

Revegetation Suggestions:

SOUTHWEST REGION

The area of southwest Alaska is vast, stretching from Kodiak Island to the island of Attu at the end of the Aleutian Chain. This area also encompasses the southern edge of Bristol Bay, and is home to several distinct eco-regions, including Bristol Bay, the Alaska Peninsula, the Aleutian Islands, and Kodiak Island. The southwest region has a maritime climate with seasonal temperatures of 34 to 41 degrees. Climatically, the Aleutian islands are classified as arctic environment, based on the 10˚ C isotherm, defined as a region where the mean temperature does not go above 50˚ degrees Fahrenheit in July. Precipitation is abundant and these eco-regions are void of permafrost.

Primary Species:

- 'Gruening' **Alpine Bluegrass**, *Poa alpina*
- 'Norcoast' **Bering Hairgrass**, *Deschampsia beringensis*
- 'Kenai' **Polargrass**, *Arctagrostis latifolia*
- 'Arctared' **Red Fescue**, *Festuca rubra*
- 'Boreal' **Red Fescue**, *Festuca rubra*
- 'Caiggluk' **Tilesius' Wormwood**, *Artemisia tilesii*
- 'Nortran' **Tufted Hairgrass**, *Deschampsia caespitosa*

Secondary Species:

- Teller **Alpine Bluegrass**, *Poa alpina*
- **Annual Ryegrass**, *Lolium multiflorum*
- Adak (viviparous form) **Arctic Bluegrass**, *Poa arctica*
- Council **Arctic Bluegrass**, *Poa arctica*
- Clam Lagoon **Beach Fleabane**, *Senecio pseudoarnica*
- Casco Cove **Beach Lovage**, *Ligusticum scoticum*
- 'Benson' **Beach Wildrye**, *Leymus mollis*
- 'Reeve' **Beach Wildrye**, *Leymus arenarius*
- 'Sourdough' **Bluejoint Reedgrass**, *Calamagrostis canadensis*
- Twenty Mile **Boreal Yarrow**, *Achillea millefolium*
- Shemya **Dusty Miller Artemisia**, *Artemisia stelleriana*
- Nome **Glaucous Bluegrass**, *Poa glauca*
- Andrew Bay **Large-glume Bluegrass**, *Poa macrocalyx*
- Attu **Longawn Sedge**, *Carex macrochaeta*
- Lowell Point **Meadow Barley**, *Hordeum brachyantherum*
- Pioneer Peak **Nootka Reedgrass**, *Calamagrostis nutkaensis*
- Henderson Ridge **Red Fescue**, *Festuca rubra*
- Safety **Viviparous Fescue**, *Festuca viviparoidea*
- Knik **Wild Iris**, *Iris setosa*

Revegetation Suggestions:

SOUTHWEST REGION

Shrub communities of willow, birch, and alder are present along coastlines in the eastern portions of the Aleutian island chain (Nowacki, et Al, 2001). Lichen and grass communities are also interspersed throughout the region. Moist tundra is found along the lower elevations of the Alaska Peninsula. Mixed forests of spruce, Balsam Poplar, cottonwood, Quaking Aspen, and Paper Birch are also present.

Kodiak Island has trees of Sitka Spruce and Black Cottonwood. Shrubs of willow and alder thickets as well as forb/grass meadows predominate most of the island.

Soil Group *(Refer to Soil Type Chart)*	**Seed Rate** *(Refer to Directions)*	**Species/Cultivar Selection** *(Refer to Species/Cultivar Characteristic Chart For Category Ratings)*		
High Organic		Suggest fertilizer only. If seeding is stipulated use suggestion below.		
GW, GP		Suggest scarification and fertilizer only. If seeding is stipulated use suggestions below.		
		Soil Moisture Characteristics		
		Saturated (Hydric)	**Average (Mesic)**	**Very Dry (Xeric)**
GM, GC **SW, SP, SM, SC** **ML, CL, OL** **MH, CH, OH**	**40**	**1** 'Norcoast' Bering hairgrass **1** 'Boreal' red fescue **2** 'Arctared' red fescue **2** 'Nortran' tufted hairgrass **2** 'Caiggluk' Tilesy wormwood **3** 'Sourdough' Bluejoint reedgrass *Note: If the area to be revegetated is adjacent to a coast line, consider using local Beach Wild-rye transplants instread.*	**1** 'Norcoast' Bering hairgrass **1** 'Boreal' red fescue **2** 'Arctared' red fescue **2** 'Nortran' tufted hairgrass **2** 'Caiggluk' Tilesy wormwood **3** 'Sourdough' Bluejoint reedgrass *Note: If the area to be revegetated is adjacent to a coast line, consider using local Beach Wild-rye transplants instread.*	**1** 'Norcoast' Bering hairgrass **1** 'Boreal' red fescue **2** 'Arctared' red fescue **2** 'Nortran' tufted hairgrass **2** 'Caiggluk' Tilesy wormwood **3** 'Sourdough' Bluejoint reedgrass *Note: If the area to be revegetated is adjacent to a coast line, consider using local Beach Wild-rye transplants instread.*

Vegetation Communities:

SOUTHCENTRAL REGION

Photo: Josh Brekken (Oasis Environmental)

Photo: Stoney Wright (AK PMC)

Above: A vegetation community, consisting of *Puccinellia, Deschampsia*, and *Leymus* species on the coastal mud flats, near the Port of Anchorage on Cook Inlet

Right: A spruce - alder community along the southern coast of Homer. Note the steeply sloping terrain and the Cow parsnip in the foreground

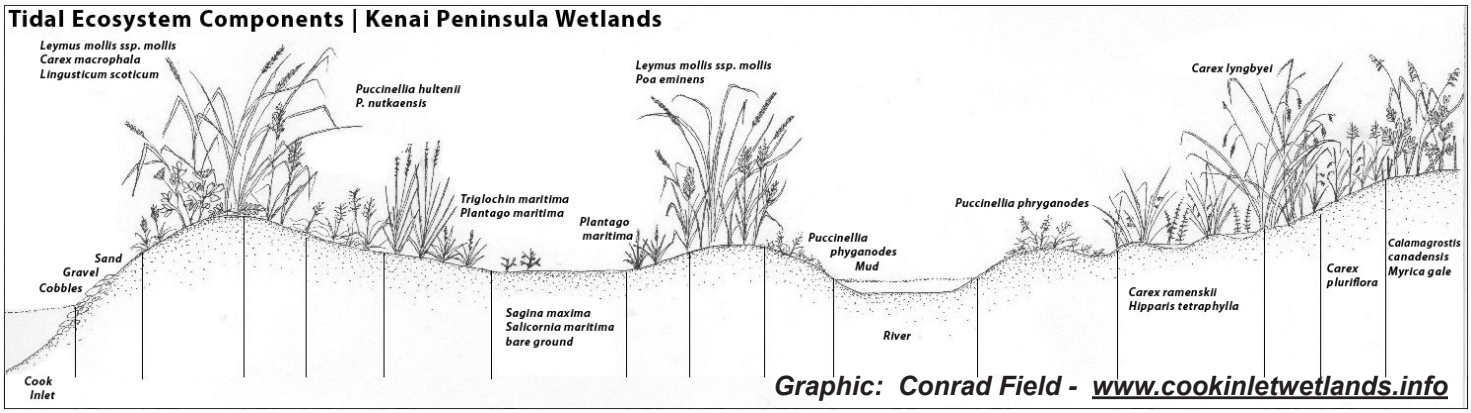
Below: Hairgrass, Fescue, Alkaligrass and Beach Wildrye are present in this Kenai Peninsula vegetation community

Photo: Stoney Wright (AK PMC)

Revegetation Suggestions:

SOUTHCENTRAL REGION

Coastal species visible in this photo of the upper Cook Inlet include spruce, mosses and sedges and grass



Primary Species:

- 'Gruening' **Alpine Bluegrass**, *Poa alpina*
- 'Egan' **American Sloughgrass**, *Beckmannia syzigachne*
- 'Norcoast' **Bering Hairgrass**, *Deschampsia beringensis*
- 'Alyeska' **Polargrass,** *Arctagrostis latifolia*
- 'Kenai' **Polargrass,** *Arctagrostis latifolia*
- Wainwright **Slender Wheatgrass**, *Elymus trachycaulus*
- 'Boreal' **Red Fescue**, *Festuca rubra*
- 'Nortran' **Tufted Hairgrass**, *Deschampsia caespitosa*

Revegetation Suggestions:

SOUTHCENTRAL REGION

Southcentral Alaska is classified as a temperate coastal hypermaritime forest, although the northern portions of Cook Inlet are best described as a continental boreal forest. Eco-regions found in southcentral are the Alaska Range, Cook Inlet Basin, Chugach-St. Elias mountains and the Gulf of Alaska coast. This region is generally free of permafrost, but it does exist in portions of the Alaska Range and Cook Inlet basin.

Willow, birch, and alder occupy the lower valleys of the Alaska Range. Forests of spruce can be found growing in the wet organic soils of Cook Inlet with aspen and birch growing on less waterlogged soils. Willow and alder communities grow along the basin slopes.

Secondary Species:

- Teller **Alpine Bluegrass**, *Poa alpina*
- Paxson **Alpine Sweetvetch**, *Hedysarum alpinum*
- **Annual Ryegrass**, *Lolium multiflorum*
- Adak (viviparous form) **Arctic Bluegrass**, *Poa arctica*
- Council **Arctic Bluegrass**, *Poa arctica*
- Clam Lagoon **Beach Fleabane**, *Senecio pseudoarnica*
- Casco Cove **Beach Lovage**, *Ligusticum scoticum*
- 'Benson' **Beach Wildrye**, *Leymus mollis*
- 'Reeve' **Beach Wildrye**, *Leymus arenarius*
- Butte **Beautiful Jacob's Ladder**, *Polemonium pulcherrimum*
- 'Sourdough' **Bluejoint Reedgrass**, *Calamagrostis canadensis*
- Twenty Mile **Boreal Yarrow**, *Achillea millefolium*
- Kobuk **Dwarf Fireweed**, *Chamerion latifolium*
- Nome **Glaucous Bluegrass**, *Poa glauca*
- Tok **Jakutsk Snow Parsley**, *Cnidium cnidiifolium*
- Andrew Bay **Large-glume Bluegrass**, *Poa macrocalyx*
- Attu **Longawn Sedge**, *Carex macrochaeta*
- Lowell Point **Meadow Barley**, *Hordeum brachyantherum*
- Ninilchik **Nootka Alkaligrass**, *Puccinellia nutkaensis*
- Pioneer Peak **Nootka Reedgrass**, *Calamagrostis nutkaensis*
- Nelchina **Spike Trisetum**, *Trisetum spicatum*
- 'Caiggluk' **Tilesius' Wormwood**, *Artemisia tilesii*
- Safety **Viviparous Fescue**, *Festuca viviparoidea*
- Knik **Wild Iris**, *Iris setosa*

Revegetation Suggestions:

SOUTHCENTRAL REGION

The Gulf of Alaska eco-region is a temperate rainforest of spruce and hemlock with wetland sedge and grass communities growing along. Snow is abundant in this region. The Chugach-St. Elias mountains are part of a transitional zone, from maritime to continental. Alder shrublands grow in the lower elevations with Sitka Spruce and Mountain Hemlock growing in the valleys. Temperatures in southcentral Alaska are moderated by the Pacific Ocean.

Grass / sedge meadows are prevalent at low elevations along the coasts (Selkregg, 1977). Cordova and Valdez, situated along the eastern edge of Prince William Sound, hold records for the highest recorded rainfall and snowfall in Alaska, respectively (WRCC, ongoing).

Soils in the Anchorage basin consist largely of glacial silt, with peat bogs existing in lowland areas. Mud-flats are prevalent in the intertidal zone in upper Cook Inlet, while rocky and sandy beaches define most of Prince William Sound's coastline.

Soil Group *(Refer to Soil Type Chart)*	**Seed Rate** *(Refer to Directions)*	**Species/Cultivar Selection** *(Refer to Species/Cultivar Characteristic Chart For Category Ratings)*		
High Organic		Suggest fertilizer only. If seeding is stipulated use suggestions for MH, CH, OH Mesic or Xeric depending on site.		
GW, GP		Suggest scarification and fertilizer only. If seeding is stipulated use suggestions for GM, GC and soil moisture.		
		Soil Moisture Characteristics		
		Saturated (Hydric)	**Average (Mesic)**	**Very Dry (Xeric)**
GM, GC	**20**	**1** 'Norcoast' Bering hairgrass **1** 'Egan' American sloughgrass **1** 'Kenai' polargrass **1** 'Arctared' red fescue **2** 'Nortran' tufted hairgrass **2** 'Boreal' red fescue **2** 'Alyeska' polargrass **3** 'Sourdough' bluejoint reedgrass	**1** 'Norcoast' Bering hairgrass **1** 'Arctared' red fescue **1** 'Gruening' alpine bluegrass **2** Wainwright slender wheatgrass **2** 'Boreal' red fescue **2** 'Kenai' polargrass **2** 'Nortran' tufted hairgrass **3** 'Caiggluk' Tilesy wormwood **3** 'Sourdough' bluejoint reedgrass	**1** 'Arctared' red fescue **1** Wainwright slender wheatgrass **1** 'Nortran' tufted hairgrass **1** 'Gruening' alpine bluegrass **2** 'Norcoast' Bering hairgrass **2** 'Boreal' red fescue
SW, SP, SM, SC	**40**			
ML, CL, OL				
MH, CH, OH	**30**	**1** 'Norcoast' Bering hairgrass **1** 'Arctared' red fescue **1** 'Egan' American sloughgrass **2** 'Alyeska' polargrass **2** 'Gruening' alpine bluegrass	*Note: If the area to be revegetated is adjacent to a coast line, consider using local Beach Wildrye transplants instread.*	*Note: If the area to be revegetated is adjacent to a coast line, consider using local Beach Wildrye transplants instread.*

Vegetation Communities:

SOUTHEAST REGION

Above:
Honckenya peploides **(Sandwort),** ***Leymus mollis*** **(Beach Wildrye), and** ***Deschampsia sp.*** **(Hairgrass) on a beach near Petersburg**

Left:
Characteristic understory vegetation in southeast Alaska's coastal temperate rainforest

Photos: Andy Nolan

Revegetation Suggestions:

SOUTHEAST REGION

Southeast Alaska has a maritime climate, with cool summers, warm winters and annual precipitation rates reaching 200 inches per year (WRRC, ongoing). The region includes the Alexander Archipelago eco-region consisting of large, mountainous islands, alluvial fans, uplifted estuaries, and old-growth forests.

Soils in this region fall into three broad groups: well-drained soils (largely consisting of stones), mineral soils of impeded drainage, and organic soils such as peat and loam. The mineral soils of impeded drainage tend to occur in drainage ways, outwash plains, and the sidewalls of sloping valleys (Selkregg, 1977).

Southeast Alaska is part of the coastal temperate rain forest. Dominant conifer tree species are Sitka Spruce, Western Hemlock, Mountain Hemlock, Western Red Cedar and Alaskan Yellow Cedar. Alder, cottonwood, and birch are dominant in low lying areas and major river channels. Tree species diversity diminishes as latitude increases (Strittholt et al, 2006).

Primary Species:

- 'Gruening' **Alpine Bluegrass**, *Poa alpina*
- 'Egan' **American Sloughgrass**, *Beckmannia syzigachne*
- 'Norcoast' **Bering Hairgrass**, *Deschampsia beringensis*
- 'Kenai' **Polargrass**, *Arctagrostis latifolia*
- 'Boreal' **Red Fescue**, *Festuca rubra*
- 'Nortran' **Tufted Hairgrass**, *Deschampsia caespitosa*

Secondary Species:

- **Annual Ryegrass**, *Lolium multiflorum*
- Clam Lagoon **Beach Fleabane**, *Senecio pseudoarnica*
- Casco Cove **Beach Lovage**, *Ligusticum scoticum*
- 'Benson' **Beach Wildrye**, *Leymus mollis*
- 'Reeve' **Beach Wildrye**, *Leymus arenarius*
- 'Sourdough' **Bluejoint Reedgrass**, *Calamagrostis canadensis*
- Twenty Mile **Boreal Yarrow**, *Achillea millefolium*
- Andrew Bay **Large-glume Bluegrass**, *Poa macrocalyx*
- Lowell Point **Meadow Barley**, *Hordeum brachyantherum*
- Ninilchik **Nootka Alkaligrass**, *Puccinellia nutkaensis*
- Pioneer Peak **Nootka Reedgrass**, *Calamagrostis nutkaensis*
- 'Caiggluk' **Tilesius' Wormwood**, *Artemisia tilesii*
- Knik **Wild Iris**, *Iris setosa*

Revegetation Suggestions:

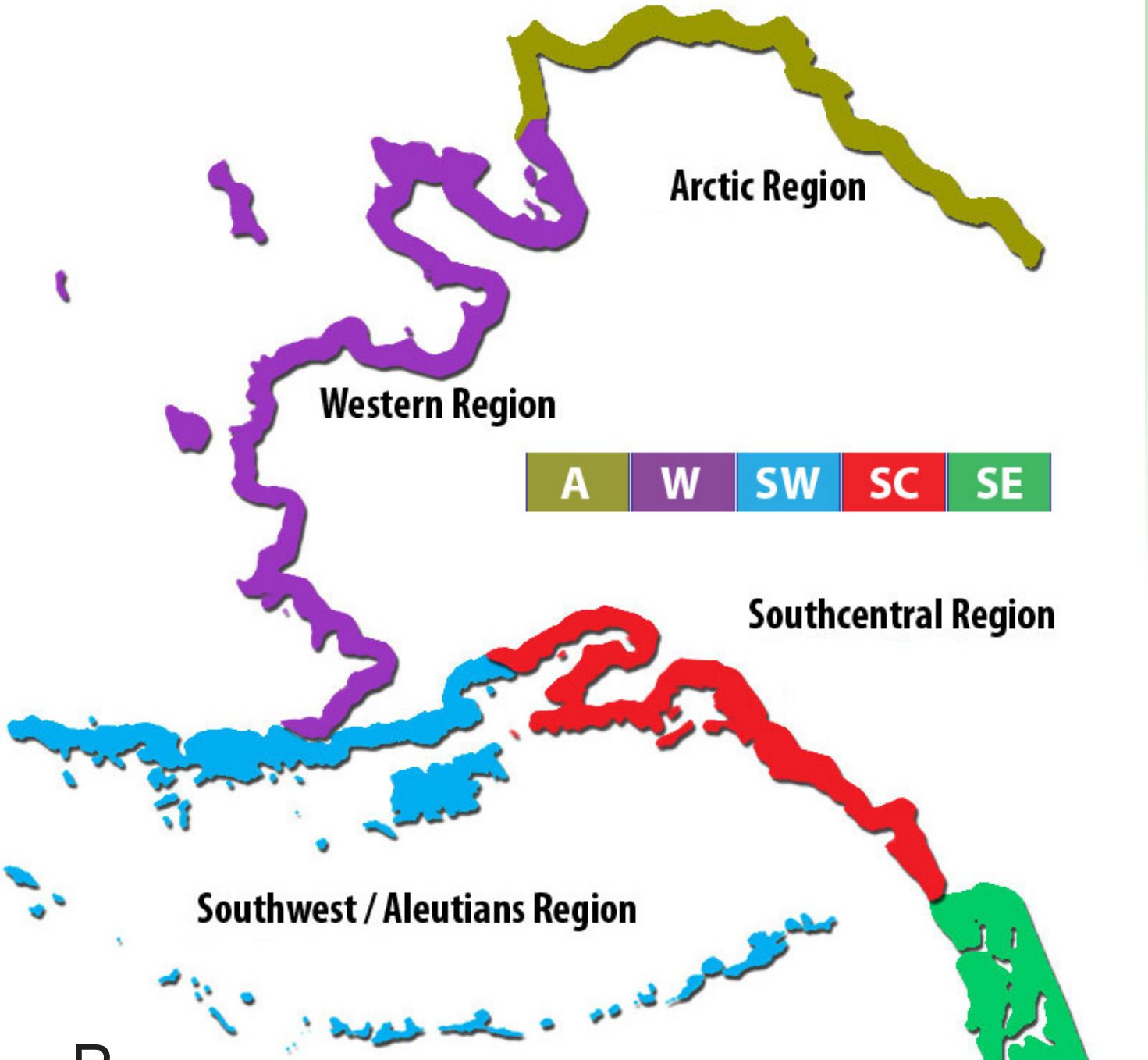
SOUTHEAST REGION

Wetlands are prevalent across the region. Coastal areas support willows, sedges, and mosses. Understory vegetation includes shrubs and young conifers. Shrub species include Sitka Alder, Rusty Menziesia, Devils Club, salmonberry, huckleberry, and currant. Meadows are found at low elevations along the coast, and consist of grasses such as Beach Wildrye, Fescue, and Bluejoint Reedgrass, as well as sedges and Arrowgrass (Selkregg, 1977).

Soil Group *(Refer to Soil Type Chart)*	**Seed Rate** *(Refer to Directions)*	**Species/Cultivar Selection** *(Refer to Species/Cultivar Characteristic Chart For Category Ratings)*		
High Organic		Suggest fertilizer only. If seeding is stipulated use suggestion below.		
GW, GP		Suggest scarification and fertilizer only. If seeding is stipulated use suggestions below.		
		Soil Moisture Characteristics		
		Saturated (Hydric)	**Average (Mesic)**	**Very Dry (Xeric)**
GM, GC **SW, SP, SM, SC** **ML, CL, OL** **MH, CH, OH**	**30**	**1** 'Norcoast' Bering hairgrass **1** 'Boreal' red fescue **2** 'Arctared' red fescue **2** 'Nortran' tufted hairgrass **3** 'Caiggluk' Tilesy wormwood **3** 'Sourdough' bluejoint reedgrass **3** 'Gruening' alpine bluegrass *Note: If the area to be revegetated is adjacent to a coast line, consider using local Beach Wildrye transplants instread.*	**1** 'Norcoast' Bering hairgrass **1** 'Boreal' red fescue **2** 'Arctared' red fescue **2** 'Nortran' tufted hairgrass **3** 'Caiggluk' Tilesy wormwood **3** 'Sourdough' bluejoint reedgrass **3** 'Gruening' alpine bluegrass *Note: If the area to be revegetated is adjacent to a coast line, consider using local Beach Wildrye transplants instread.*	**1** 'Norcoast' Bering hairgrass **1** 'Boreal' red fescue **2** 'Arctared' red fescue **2** 'Nortran' tufted hairgrass **3** 'Caiggluk' Tilesy wormwood **3** 'Sourdough' bluejoint reedgrass **3** 'Gruening' alpine bluegrass *Note: If the area to be revegetated is adjacent to a coast line, consider using local Beach Wildrye transplants instread.*

Plant Species

for use in Coastal Revegetation & Erosion Control



Plant species listed in this section are known to be useful in revegetation. Each species is listed with the most commonly available varieties and cultivars. Primary species - those which should compose the bulk of a seed mixture - are also labeled. Tabs at the bottom and top of each page indicate the regions of Alaska to which a species is adapted. If not all varieties will grow in that region, the variety or varieties that will are listed above the tab at the bottom portion of the page.

Boreal Yarrow,
Achillea millefolium

Boreal Yarrow does well in coastal settings, but has sufficient adaptability to be useful in inland areas also. Yarrow has the ability to create the appearance of a natural meadow stand in reseeded areas; the presence of the white/cream flowers breaks up the usual homogeneity of grass plantings.

Boreal Yarrow is a colonizer, found in meadows and fields, in both wet and dry areas. It grows on soil and gravel. It is a long lived perennial.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Twenty Mile selected class germplasm

Twenty Mile **Boreal Yarrow**, *Achillea millefolium*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Sod	24 in.	6.0-8.0	Poor	Good	Good	Strong

Polargrass,
Arctagrostis latifolia

Polargrass is a species that is ideal for forage and revegetation in Alaska (Mitchell, 1987). Polargrass is adapted to moderately wet areas (Wright, 1992). It is tolerant of low temperatures and acidic soils. Polargrass is a pioneer species in disturbed areas, especially those that are moist and acidic (Walkup, 1991). Polargrass does not grow well with fertilization or competition.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Kenai' is from southern Alaska, and should be planted appropriately.

'Alyeska' is suitable for revegetation in western and arctic Alaska (Mitchell, 1980).

'Alyeska' **Polargrass**, *Arctagrostis latifolia*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Fair	Sod	24 in.	4.9-6.8	Poor	Poor	Good	Weak

'Alyeska' 'Alyeska' 'Kenai' 'Kenai' 'Kenai'

Dusty Miller,
Artemisia stelleriana

Dusty Miller can be used in landscape applications throughout Alaska where the species does well. The best performance can be expected on sandy to gravelly soils (Wright, 2007). *Artemisia stelleriana* grows naturally in sunny, sandy conditions. It is found in coastal areas and is tolerant of ocean spray.

Artemesia stellerania is an interesting species because it is native to North America only on the western-most Aleutian Islands, including Shemya Island. The concept of Dusty Miller being native to such a limited region of North America discounts the fact that the original Aleut population conducted trade with societies in Asia, where the species is native and widespread. Other common names for this plant are Old Woman, Beach Wormwood, and Hoary Sagebrush - all referring to the characteristics of it leaves.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Shemya selected class germplasm

Shemya **Dusty Miller**, *Artemisia stelleriana*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Stolons	12 in.	5.0-7.5	Good	Good	Good	Strong

Tilesius' Wormwood,
Artemisia tilesii

Tilesius' Wormwood is a broadleaf forb with a wide range of adaptations throughout Alaska (Wright, 1992). Tilesius' Wormwood is a perennial, non-woody sagebrush species. It has been found on many different soil types. Tilesius' Wormwood prefers sun. The common name, stinkweed, refers to its smell when the leaves are crushed.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Caiggluk'

'Caiggluk' **Tilesius' Wormwood**, *Artemisia tilesii*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	20 in.	4.0-8.5	Poor	Excellent	Good	Strong

American Sloughgrass,
Beckmannia syzigachne

American Sloughgrass has a high potential for wetland reclamation. Additionally, the species benefits wildlife by providing forage and seed for waterfowl. Revegetation and erosion control plantings in seasonally wet places between 60 degrees north latitude and the Arctic Circle will benefit from including Sloughgrass as part of the seed mix.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Egan'

'Egan' **American Sloughgrass**, *Beckmannia syzigachne*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Good	Bunch	18 in.	5.5-7.5	Good	Poor	Excellent	Moderate

Bluejoint Reedgrass,
Calamagrostis canadensis

Bluejoint Reedgrass is found throughout Alaska on both dry and wet sites. Commercial availability can be limited, and the seed expensive. Bluejoint provides good erosion control because of its aggressive rhizomes and root structure. It can be used to successfully reclaim strip mine sites and oil spills. Bluejoint Reedgrass can thrive in very cold conditions.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Sourdough'

'Sourdough' **Bluejoint Reedgrass**, *Calamagrostis canadensis*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Fair	Sod	36 in.	4.5-8.0	Poor	Good	Good	Strong

Nootka Reedgrass,
Calamagrostis nutkaensis

Nootka Reedgrass is appropriate for revegetation throughout southeast and southcentral Alaska. Nootka Reedgrass is a perennial, tufted grass with short rhizomes. It grows in clumps, and requires wet soil (NRCS, 2007). This reedgrass species is found in bogs, marshes, and freshwater swamps.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Pioneer Peak selected class germplasm

Pioneer Peak **Nootka Reedgrass**, *Calamagrostis nutkaensis*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Sod	24 in.	5.5-8.0	Good	Poor	Excellent	Strong

Longawn Sedge,
Carex macrochaeta

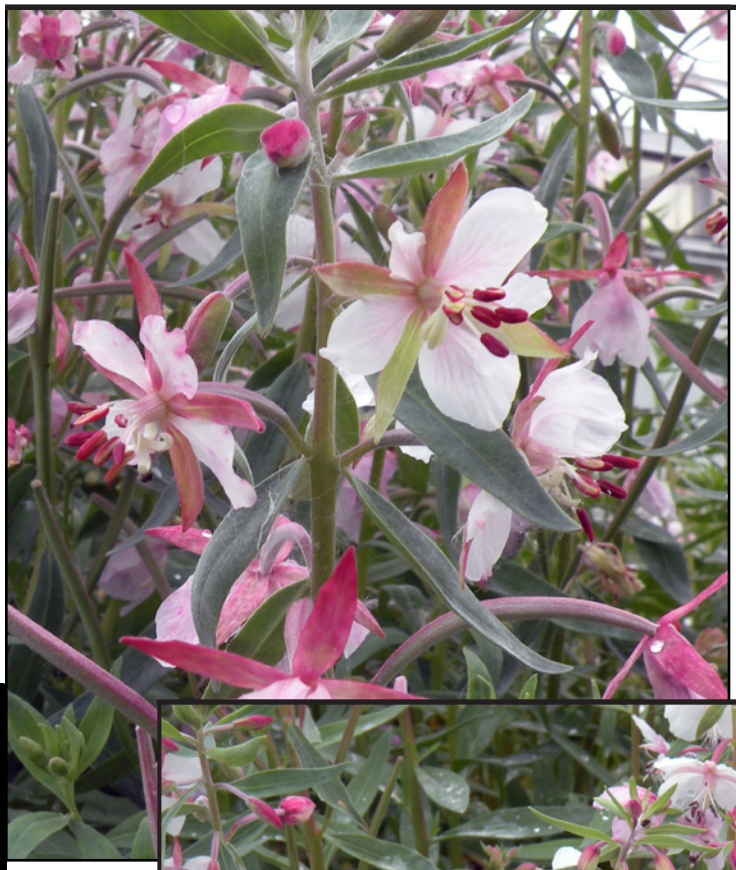
Longawn sedge is quite common along coastal areas of Alaska, growing in wet places both in the mountains and along the shore. It is rare inland. Longawn Sedge is suggested for use in revegetation if coastal wetlands are impacted. It is best for revegetating disturbed and eroded coastal grasslands.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Attu selected class germplasm

Attu **Longawn Sedge**, *Carex macrochaeta*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Sod	12 in.	5.0-6.0	Good	Poor	Excellent	Strong



Dwarf Fireweed,
Chamerion latifolium

Dwarf Fireweed is a common species found on river gravel bars throughout Alaska; hence it's other common name - river beauty. Dwarf Fireweed grows on sandy river bars, roadsides, and foothills (Hunt & Moore, 2003). It grows where the soil is dry to medium-wet. Dwarf Fireweed is a natural perennial colonizer; it will live for several years and helps stabilize the soil.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Kobuk selected class germplasm

Kobuk **Dwarf Fireweed**, *Chamerion latifolium*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	12 in.	4.8-7.0	Poor	Poor	Good	Weak

Bering Hairgrass,
Deschampsia beringensis

Bering Hairgrass is recommended for revegetation use in coastal regions of western and southwestern Alaska, and in some northern maritime regions (Mitchell, 1985). Bering Hairgrass is found along muddy shores in southern Alaska. It grows well in waterlogged soils. Bering Hairgrass is tolerant of moist and salty conditions.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Norcoast'

'Norcoast' **Bering Hairgrass**, *Deschampsia beringensis*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Good	Bunch	20 in.	5.5-7.2	Excellent	Poor	Good	Strong

Tufted Hairgrass,
Deschampsia caespitosa

Tufted Hairgrass is well adapted to northern regions of Alaska (Mitchell, 1985). Tufted Hairgrass is a cool season bunch grass. It will grow in most any soil. In the wild, Tufted Hairgrass is found in moist or boggy areas. An arctic species, Tufted Hairgrass is well suited for many of Alaska's harshest environments. It is not recommended for revegetation of streambank areas, however, since the tufted fibrous roots provide limited bank stabilization (Mitchell, 1986).

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Nortran'

'Nortran' **Tufted Hairgrass**, *Deschampsia caespitosa*

Availability	Growth Form	Average Height	PH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Good	Bunch	20 in.	4.8-7.2	Poor	Good	Good	Strong

Slender Wheatgrass,
Elymus trachycaulus

Slender Wheatgrass is a natural colonizer, adapted to dry rocky and gravelly soil. Slender Wheatgrass is the largest commercially produced perennial grass in Alaska, both in volume and in the number of producers. This species can be found in the wild on moist to dry soils, under trees and in full sun. Slender Wheatgrass grows on either alkaline or acidic substrate. Although it is short lived, Slender Wheatgrass can colonize and stabilize an area, allowing other plants to subsequently become established.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Wainwright selected class germplasm

Wainwright **Slender Wheatgrass**, *Elymus trachycaulus*

Availability	Growth Form	Average Height	PH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Excellent	Bunch	20 in.	5.6-9.0	Excellent	Excellent	Good	Strong

Red Fescue,
Festuca rubra

Red Fescue is outstanding for erosion control, although the overly aggressive, sod-forming nature of this species often makes the species unacceptable in reclamation. Red Fescue's aggressive nature may be utilized to prevent the invasion of native shrub species such as alder and willow.

Red Fescue is a colonizer of disturbed areas, and it provides long-term stabilization as well. It needs little maintenance, establishes quickly, and survives for many years. Red Fescue will survive in sun and shade; in cold and hot; in dry and moist; and in a broad range of pH (in both acidic and alkaline soils).

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Arctared' is the most winter-hardy variety of Red Fescue. It is especially well adapted to the harsh arctic environment.

'Boreal' is adapted for use across Alaska, including western Alaska and along the southern coast.

Henderson Ridge selected class germplasm is best adapted to the western Aleutians. In coastal and southcentral Alaska, Henderson Ridge can be used for revegetating mines, highways, and similar sites.

'Arctared' **Red Fescue**, *Festuca rubra*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor - Excellent	Sod	14 - 18 in.	5.0-7.5	Poor	Good	Good	Strong
	'Arctared' 'Boreal'	**'Arctared', 'Boreal' Henderson Ridge**	**'Arctared' 'Boreal' Henderson Ridge**		**'Arctared' 'Boreal'**	**'Arctared'**	

Viviparous Fescue,
Festuca viviparoidea

Viviparous Fescue reproduces by an asexual means called vivipary. Instead of producing seed, Viviparous Fescue produces small plantlets where the seed heads would be in other grasses. When these plantlets are sufficiently developed, they separate from the parent to fall to the ground. If the plantlet finds a suitable habitat, it will grow. Viviparous Fescue is intended for use in arctic, western, southcentral, and southwest Alaska. Viviparous Fescue can be a colonizer in mountainous country. In the wild, it is found in alpine tundra and on rocky slopes. If the purpose of a revegetation project is to stabilize soil in an arctic to sub-arctic area, then Viviparous Fescue is ideal.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Safety selected class germplasm

Safety **Viviparous Fescue**, *Festuca viviparoidea*

Availability	Growth Form	Average Height	PH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	6 in.	6.0-7.5	Poor	Excellent	Poor	Strong

Alpine Sweetvetch,
Hedysarum alpinum

Alpine Sweetvetch is an easily recognized and frequently encountered legume. This species is most often found on dry, gravelly soils, especially near rivers. It is suspected of being a nitrogen-fixing species. Alpine Sweetvetch is recommended for use in southcentral and western Alaska.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Paxson selected class germplasm

Paxson **Alpine Sweetvetch**, *Hedysarum alpinum*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	24 in.	6.0-8.0	Poor	Poor	Good	Strong

Meadow Barley,
Hordeum brachyantherum

Meadow Barley is an important coastal grass species, frequently found in wet areas and often on fine soils such as clays. Meadow Barley is not found north of the Brooks Range. At times, it grows on rocky or gravelly sites, provided adequate moisture exists. Meadow Barley has a moderate lifespan, and it propagates well by seed. It starts growth after snowmelt, with seed maturing in September. Meadow Barley is competitive with annual grasses.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Lowell Point selected class germplasm

Lowell Point **Meadow Barley**, *Hordeum brachyantherum*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	24 in.	6.0-8.5	Good	Good	Good	Weak

Wild Iris,
Iris setosa

Wild Iris is best used on wet soil and in seed mixes with non-competitive grasses. It is best adapted for southcentral, southeast, and southwest Alaska. Wild Iris can be found throughout most of Alaska in bogs, meadows, and on lake shores. It is also found in drier areas where the seed has taken hold.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Knik selected class germplasm

Knik **Wild Iris**, *Iris setosa*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Sod	12 in.	5.0-7.5	Good	Poor	Excellent	Strong

Beach Wildrye,
Leymus arenarius

Beach Wildrye has high potential in coastal restoration, especially in foredunes and other sandy sites throughout coastal Alaska (Wright, 1994). Beach Wildrye grows wild in Alaska mainly along the coast on sandy beaches. It can successfully revegetate areas unsuitable for other species. Prior planning is essential, however, as Beach Wildrye does not tolerate excessive foot traffic. Beach Wildrye does not compete well with other grasses (Wright, 1994).

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Reeve' is available as seed. This cultivar was developed from European sources.

'Reeve' **Beach Wildrye**, *Leymus arenarius*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Sod	24 in.	6.0-8.0	Excellent	Good	Good	Weak

Beach Wildrye,
Leymus mollis

Beach Wildrye should be used in sandy areas with high erosion potential. Revegetation with sprigs is a preferred method of revegetating highly erodible areas (Wright, 1994). Beach Wildrye sprigs can effectively and quickly recolonize coastal areas, especially where there are dunes and blowing sand conditions. It provides good erosion control because of its aggressive vegetative growth.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Benson' is available only from vegetative cuttings (sprigs). Seed is not available.

'Benson' **Beach Wildrye**, *Leymus mollis*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Sod	24 in.	6.0-8.0	Excellent	Good	Good	Weak

Beach Lovage,
Ligusticum scoticum

Beach Lovage is in the parsley family. The species is quite common on coastal sites and is an important native plant to include in revegetation seed mixes. Along the sea coast look for Beach Lovage in crevices where rocks have eroded, with soils formed. This plant can grow in many locations, but prefers sunny, well-drained soil. As its name implies, Beach Lovage can withstand salt sprays from the ocean.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Casco Cove selected class germplasm

Casco Cove **Beach Lovage**, *Ligusticum scoticum*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	16 in.	6.0-8.5	Excellent	Poor	Good	Strong

Annual Ryegrass,
Lolium multiflorum

Annual Ryegrass provides a quick, temporary cover. It should be limited to 10% or less of a seed mix, because Annual Ryegrass uses nutrients intended for the perennial species in the mix. Also, a heavy plant cover can slow the growth of perennial species. Annual Ryegrass is also very attractive to herbivores, which can increase potential vehicle/animal conflicts.

Annual Ryegrass, *Lolium multiflorum*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Excellent	Annual	16 in.	5.0-7.9	Excellent	Poor	Good	Moderate

Field Oxytrope,
Oxytropis campestris

Field Oxytrope is a legume adapted to rocky and gravelly dry soils. Field Oxytrope is an early colonizer of disturbed sites. As with most legumes, Field Oxytrope fixes nitrogen in the soil, and may increase soil fertility.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Black Rapids selected class germplasm

Black Rapids **Field Oxytrope**, *Oxytropis campestris*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	8 in.	5.5-8.5	Poor	Excellent	Poor	Strong

Nodding Locoweed,
Oxytropis deflexa

Nodding Locoweed is highly adapted to gravelly sites, and it is intended for use in reclamation and revegetation in the northern and western portions of Alaska. Nodding Locoweed is a perennial legume found growing along riverbanks, meadows, and waste places in nature (Hulten, 1968). It is a natural colonizer of dry, rocky soils. Many of its characteristics are common to many arctic plants; low-growth habit, taproot, hairy leaves, and prolific flowering.

Large seeds enable Nodding Locoweed to survive in inhospitable environments. Since it is a legume, it adds nitrogen to the soil, helping other plants to survive and create a healthy ecosystem. Arctic plant studies of nitrogen fixing plants in Alaska have found that rhizobia are associated with locoweed (Allen et al., 1995). This indicates the importance of adding legumes to a revegetation mix.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Franklin Bluffs selected class germplasm

Franklin Bluffs **Nodding Locoweed**, *Oxytropis deflexa*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	8 in.	6.5-8.0	Poor	Excellent	Poor	Weak

Alpine Bluegrass,
Poa alpina

Alpine Bluegrass is a species widely adapted throughout Alaska. As the name implies, the species is adapted to high elevation areas. It also performs well on drier sites. Seed availability is limited. Availability of seed should be researched before Alpine Bluegrass is included in a planting plan.

Alpine Bluegrass grows in a wide range of habitats and soil conditions in the wild. Some of these are: dry slopes, gravelly sites, rocky sites, alpine and sub-alpine sites, and meadows. *Poa alpina* is a perennial grass that can serve as the pioneer species for a revegetation project. Once established, other plants can follow. *Poa alpina* is tolerant to climatic, soil, fire, and drought conditions. This flexibility makes the species important for high altitude revegetation. Alpine Bluegrass also has low nutrient needs.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Gruening' is a variety that can be established on dry soil as long as there is some irrigation.

Teller selected class germplasm is a native collection of *Poa alpina* intended for general revegetation projects throughout Alaska.

'Gruening' **Alpine Bluegrass**, *Poa alpina*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor - Fair	Bunch	6 - 8 in.	5.0-7.2	Poor	Good	Poor	Weak

'Gruening' Teller | Teller | 'Gruening' Teller | 'Gruening' | 'Gruening'

Arctic Bluegrass (viviparous form), *Poa arctica*

Arctic Bluegrass (viviparous) is unique in that it reproduces via asexual reproduction. These varieties produce small plantlets in the seedhead in place of true seed. These varieties are adapted to the entire Aleutian Archipelago, performing best on dry upland sites in the region. ***Adak*** and ***Tin City*** Arctic Bluegrass are both the same species - the difference is the environmental conditions where they were collected.

In the wild, viviparous Arctic Bluegrass is found as raised clumps on gravel, wet meadows, and soils near wetlands. It is a cosmopolitan species, being able to grow on both acidic outcrops and calcareous substrate. Viviparous Arctic Bluegrass can be found on rocks, gravel, soil, moss, sand, silt, and clay (Aiken, et al., 1995). Geese graze specifically on *Poa arctica*, which means that, in terms of restoration, viviparous Arctic Bluegrass will attract geese to the project- thus creating a more diverse habitat (Aiken et al., 1995).

Tin City **Arctic Bluegrass** (viviparous form), *Poa arctica*

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Adak selected class germplasm

Tin City selected class germplasm

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	12 in.	5.0-7.8	Good	Good	Good	Strong

Adak Adak Tin City Tin City

Arctic Bluegrass,
Poa arctica

Seed producing varieties of **Arctic Bluegrass** are available. This species can be used on a wide variety of soils throughout Alaska, but it will work best in the western and arctic regions. In the wild, Arctic Bluegrass is found as raised clumps on gravel, wet meadows, and soils near wetlands. It is able to grow on both acidic outcrops and calcareous substrate. It can be found on rocks, gravel, soil, moss, sand, silt, and clay (Aiken, et al., 1995). Arctic Bluegrass's tolerance of acidity is an important characteristic for mine reclamation. A wetness loving species, Arctic Bluegrass, can effectively grow where other grasses might die due to too much water.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Council selected class germplasm produces true seed.

Council **Arctic Bluegrass**, *Poa arctica*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	12 in.	5.0-7.8	Poor	Good	Good	Strong

Glaucous Bluegrass,
Poa glauca

Glaucous Bluegrass can be found on many types of soil - from slightly acidic to slightly basic; in very dry to slightly moist areas; and on gravel, sand, or organic matter. It is a pioneer species, forming tussocks in disturbed areas. This provides a cover where willows and forbs can become established (Aiken, et al., 1995). In the extreme arctic, Glaucous Bluegrass's growth form is short and erect. In other areas of Alaska, it is more spreading.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

'Tundra' is a variety best suited for revegetation in extreme northern areas with severe environmental conditions (Mitchell, 1980).

Nome selected class germplasm is a relatively common grass on dry mineral soils in the state. This variety has a wider use range than 'Tundra'; however, it is not recommended for use in the arctic region.

'Tundra' **Glaucus Bluegrass**, *Poa glauca*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor - Fair	Bunch	10 - 12 in.	5.0-8.0	Good	Excellent	Poor	Strong

Nome Nome 'Tundra' Nome 'Tundra'

Large-glume Bluegrass,
Poa macrocalyx

Large-glume Bluegrass is a perennial bunch grass found along coastlines inland of the primary coastal dunes and Beach Wildrye communities. It is found wild in Alaska along seashores from the Panhandle to the Aleutians and along western Alaskan coastlines. For coastal tundra and seashore revegetation with a native grass, Large-glume Bluegrass requires very little maintenance. It grows well on sandy beaches, marshes, slopes, and medium wet substrate.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Andrew Bay selected class germplasm is intended for use in revegetation and erosion control in coastal regions of Alaska from the Juneau area westward through the Aleutians, and northward on the western coast to roughly Scammon Bay.

Andrew Bay **Large-glume Bluegrass**, *Poa macrocalyx*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	16 in.	5.0-8.0	Excellent	Excellent	Good	Strong

Beautiful Jacob's Ladder,
Polemonium pulcherrimum

Beautiful Jacob's Ladder is highly adapted to gravelly soils. It has a colorful appearance, and can add to the visual impact to a revegetation project. Using this species enhances diversity, in addition to aesthetic considerations. It grows in alpine, subalpine, mid and low elevation sites. When used in seed mixes at 5% by weight, Beautiful Jacob's Ladder performs vigorously.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Butte selected class germplasm

Butte **Beautiful Jacob's Ladder**, *Polemonium pulcherrimum*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	16 in.	6.5-8.5	Good	Excellent	Poor	Weak

Nootka Alkaligrass,
Puccinellia nutkaensis

Nootka Alkaligrass is a species that occupies a very specific niche in coastal Alaska. It is used on revegetation projects where the site is sometimes flooded by extremely high tides or storm surges. This species does best on silty or gravelly coastal soils and is most often found in southcentral and southeast Alaska. *Puccinellia nutkaensis* is a common grass found in the nooks and crannies of rocks and boulders in the tidal zone.

Since Nootka Alkaligrass is a grass of the seacoast and salt marshes, it grows naturally in salty soil; it requires lots of water to grow, but does not like to be submerged (USDA, 2004). Plants that coexist with Nootka Alkaligrass, and yet do better in submerged, more salty areas, are *Carex lyngbyei* and *Poa eminens* (Snow et al., 1984).

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Ninilchik selected class germplasm

Ninilchik **Nootka Alkaligrass**, *Puccinellia nutkaensis*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Sod	8 in.	6.0-8.5	Excellent	Poor	Excellent	Weak

Beach Fleabane,
Senecio pseudoarnica

Beach Fleabane commonly occurs in coastal areas of Alaska, often in association with Beach Wildrye (*Leymus mollis*). Beach Fleabane is used primarily for revegetation and erosion control, but may have some secondary value as an ornamental. This forb is a rhizomatous perennial in the composite (aster) family. Growing on gravelly and sandy seashores, Beach Fleabane withstands the salt spray from the ocean.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Clam Lagoon selected class germplasm

Clam Lagoon **Beach Fleabane**, *Senecio pseudoarnica*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Sod	24 in.	6.0-8.0	Excellent	Excellent	Good	Strong

Arctic Wild Chamomile,
Tripleurospermum maritima

Arctic Wild Chamomile, a perennial forb, grows on Alaska's northwestern seashores and the arctic coast. This species is used for revegetation, restoration, and landscape seeding. Arctic Wild Chamomile seeds are often incorporated into revegetation mixes for northern Alaska. It grows on most types of soil and drainage. Arctic Wild Chamomile will add color and beauty to vegetation establishment.

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Kotzebue selected class germplasm

Kotzebue **Arctic Wild Chamomile**, *Tripleurospermum maritima*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	8 in.	4.0-8.5	Good	Excellent	Good	Strong

Spike Trisetum,
Trisetum spicatum

Spike Trisetum is used for revegetation of dry sites with mineral soils. The species has nearly a world-wide distribution and is one of the more cosmopolitan grasses. *Trisetum spicatum* is a common grass, found in the wild on disturbed sandy or silty soils, on both acid and alkaline substrates, and on rocks, gravel, clay, or tilled earth (Aiken et al., 1999). Spike Trisetum has a high root / shoot ratio. This enables it to be useful for soil building and erosion control (Hardy, 1989).

ADAPTED COMMERCIAL VARIETIES OR RELEASES:

Nelchina selected class germplasm

Nelchina **Spike Trisetum**, *Trisetum spicatum*

Availability	Growth Form	Average Height	pH Range	Saline Tolerance	Drought Tolerance	Wet Soil Tolerance	Competitiveness
Poor	Bunch	18 in.	4.9-7.5	Poor	Good	Good	Strong

Case Studies

Kongiganak airport apron protected with jute matting, two weeks after seeding with *Puccinellia nutkaensis*

Section 4:

1. Arctic Region
   - *Arctophila fulva, Kuparuk*
   - *Vegetation Study, Sagavanirktok River*
   - *Project Chariot Site, Ogotoruk Valley*
2. Western Region
   - *Red Dog mine port site, NW Alaska*
   - *M/V All Alaskan Cleanup, St. Paul*
3. Southwest Region
   - *Lateral Clear Zone, Shemya*
   - *Natural Reinvasion, Shemya*
   - *Pringle Hill Sand Quarry, Adak*
   - *Coastal Dune Restoration, Adak*
   - *Landfill Restoration, Adak*
   - *Wetland Revegetation, Kodiak*
4. Southcentral Region
   - *Sedge Restoration, Girdwood Area*
   - *Chester Creek Restoration, Anchorage*
   - *Fish Creek Wetland, Anchorage*
   - *Jet Fuel Pipeline Restoration, Anchorage*
5. Southeast Region
   - *Jordan Creek Wetland, Juneau*
   - *Nancy Street Wetland, Juneau*
   - *Airport Estuary Restoration, Gravina*

Case Studies

Acknowledgements:

The case studies section of this publication would not have been possible without the participation and involvement of professionals across the state. Special thanks go to **John Hudson** and **Neil Stichert** at the USFWS, **Shannon Seifert** & **Beverly Schoonover** of the Juneau Wetlands Partnership, **Michele Elfers** with the City & Borough of Juneau, **Dave Ward** with Jacobs Engineering, **Estrella Campellone** at the US Army Corps of Engineers - Alaska District, **Josh Brekken** with Oasis Environmental, **Sirena Brownlee** of HDR Engineering, **Stacy Havron**, from Alaska Pacific University, **Phil Smith** of PSA Inc., **Jon Houghton** of Pentec Environmental, and **Jane Gendron** from the Alaska Department of Transportation.

Photo: Stoney Wright (AK PMC)

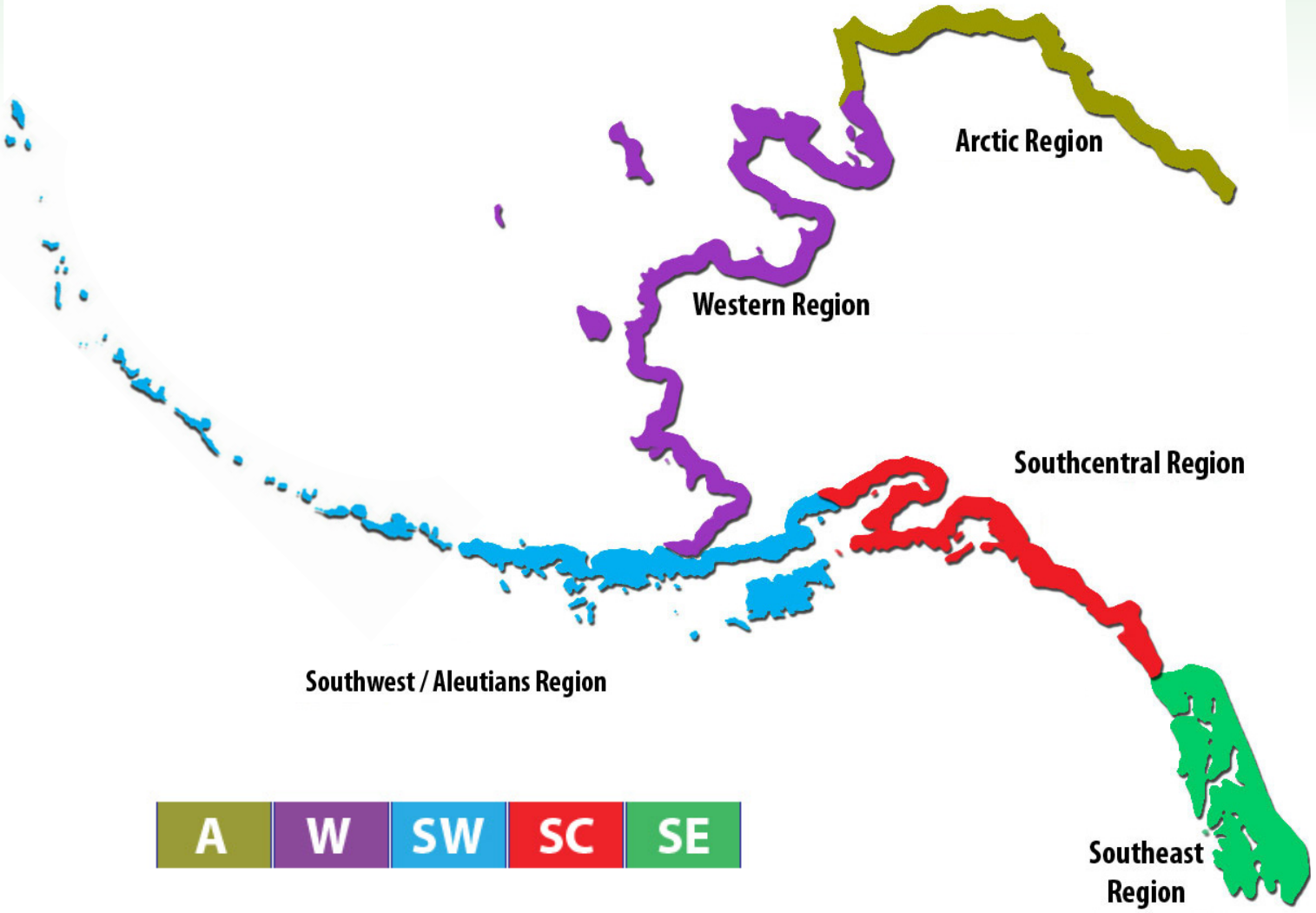
Kongiganak airport apron vegetation growth, six weeks after seeding with *Puccinellia nutkaensis*

Case Studies

Usage Notes:

The following case studies are grouped by region, organized by the same color-coded tabs used previously in this guide. The map below shows the borders of each region. Be aware that vegetation communities and climate zones do not adhere to cartographic distinctions; it may therefore be helpful to review case studies from adjacent regions when planning a revegetation project. Each case study includes an analysis of methods of revegetation, species used, results, conclusions, and lessons learned.

These case studies are also available on the Coastal Revegetation & Erosion Control Guide website - plants.alaska.gov/reveg/. As more revegetation and coastal erosion control projects occur in Alaska, they will be added to this resource. If you have been involved in such a project, please visit plants.alaska.gov/reveg/add-project/, and share your experience with the community of Alaskan environmental professionals.



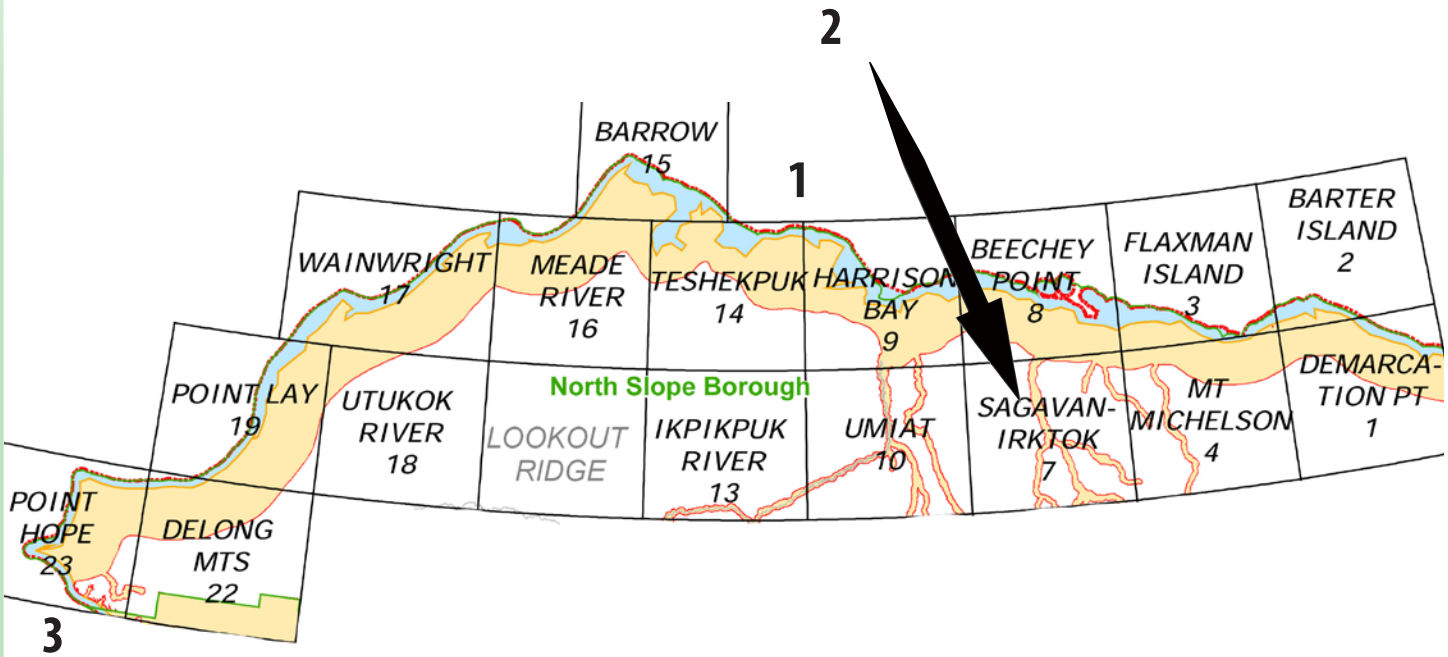
Case Studies of Revegetation Projects

Arctic Coastal Plain

The Arctic coastal plain extends west from the border with Canada, to Cape Krusenstern on the Bering Sea. Permafrost, tundra, and low elevations are the norm for the North Slope, interrupted only by the Brooks Range Foothills south of Point Hope.

Projects in this area generally come about because of the resource development industries. Demonstration projects for oil and gas industry have done much to advance the science of revegetation in the region.

1. **Revegetation with *Arctophila fulva*, Kuparuk**
2. **Floodplain Vegetation Establishment, Sagavanirktok River**
3. **Project Chariot Site Revegetation, Ogotoruk Valley**



Revegetation with Arctophila fulva, Kuparuk

Introduction / Objective:

From 1985 to 1989, the Plant Material Center in cooperation with Arco Alaska conducted studies investigating techniques for transplanting Arctic Pendant Grass, *Arctophila fulva*, in the Kuparuk Oil Field on the North Slope of Alaska. This area is immediately west of Prudhoe Bay. The study was primarily focused on the harvest, preparation and transplanting of Arctic Pendant grass into natural or man-made lakes primarily for waterfowl enhancement or habitat mitigation.

Species Used:

The species used was Arctic Pendant Grass, *Arctophila fulva*

Coastline Type:

The Kuparuk field is part of the Arctic Coastal plain. Vegetation in this area generally consists of coastal tundra.

Methods of Revegetation:

Annual plantings of Pendant grass took place from 1985 -1988. The plantings were made in lake environments having water depths of 45 centimeters or less. Planting and harvesting was conducted both spring and fall. No plantings were made in 1989 in order to evaluate the success of the previous years' plantings.

Two harvesting and planting methods were tried. The first harvest method used a potato harvest fork to lift Arctic Pendant Grass sprigs from the collection site. This effort resulted in an entangled mat of shoots and roots. This mat was then divided into planting units (individual sprigs) which consisted of culm and a new shoot. Separating and preparing the units took twice as much time as the digging process. Digging and preparation of 100 planting units took less than three man-hours.

The second harvesting technique employed a 3-inch, portable water pump. This technique relied on discharged water to flush the substrate from the root mass. After hydraulically up-rooting the clumps of pendant grass they were lifted from the lake bottom with a potato fork. These clumps were planted without additional separation, eliminating the extra step of further dividing the clumps into sprigs, therefore saving time and making large scale revegetation more feasible and economical.

Strong wind created considerable wave action during planting, making it difficult to assure the pendant grass would remain in place. This was mitigated by securing the grass to the lake bottom with six-inch rolled erosion mat staples. Fertilizer was in the form of 20-10-5 tablets. The tablet was dropped in the water next to the sprig or clump and stepped on so it would become embedded in the lake bottom. Planting was conducted by two people. One person would lay a sprig or clump on the surface of the water while the other would secure it to the lake bottom with a staple.

Results:

The study identified the most successful transplanting techniques which had the least impact on the donor community. The following points summarize the findings of the study:

1. Arctic Pendant Grass should be harvested with a potato harvest fork and separated into clumps consisting of shoots, roots, and rhizomes.
2. Plantings made with clumps have had higher survival rates and vigor than plantings with a smaller, single sprig planting unit.
3. Plantings should occur at sites with minimal wave energies and preferably at sites with a relatively firm lake bottom.
4. Each clump should be anchored to the lake substrate with one or two rolled erosion mat staples, and fertilized.
5. Harvesting and planting is best conducted by teams of two.
6. Plantings can occur in either fall or spring, however, harvesting is easier in the fall. Roots may still be embedded in ice during the spring.

Conclusions / Lessons Learned:

The study indicated that transplanting Arctic Pendent Grass, *Arctophila fulva,* for revegetation is feasible from the biological perspective; i.e., it is possible to successfully transplant the species. The economic feasibility of transplanting the species was not determined by the study. However, the group that funded the project retained the right

to determine economic feasibility.

There was no advantage in using either an individual sprig or a clump of Arctic Pendent Grass in terms of speed of harvesting and planting. The primary advantage of the clump, again, appears to be a higher survival rate and vigor which would allow clumps to be planted at a lower density than individual sprigs to provide the same cover per unit area. Also, clumps are easier to work with because they require less work to prepare than an individual sprig which requires careful separation.

References:

Moore, N. J., and Wright, S. J., 1991. Revegetation with Arctophila Fulva, a Final Report 1985-1989 for ARCO, Alaska Inc. State of Alaska, Division of Agriculture, Plant Materials Center, 50 pp.

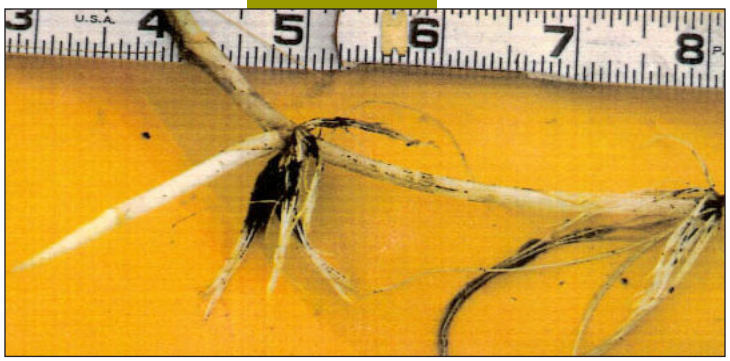
Project Location :

Mouth of the Kuparuk River.
North slope of Alaska

Clumps of *Arctophila fulva*

Transect 2, Nest Lake - July 1, 1985

Transect 2, Nest Lake - Mid August, 1985



Individual *Arctophila fulva* sprig

Uprooting *Arctophila fulva* root clumps using the hydraulic extraction method

Collecting root clumps of *Arctophila fulva*

Arctophila fulva in fall colors - August, 2009

Photos: Stoney Wright (AK PMC)

Floodplain Vegetation Establishment, North Slope

Introduction / Objective:

Traditionally, the Alaska Plant Materials Center (PMC) did not become involved in transect-oriented studies. However, this study looked at the three most important practices associated with revegetation: seeding, fertilization and scarification. By contrasting individual processes and combinations of processes, techniques were evaluated against each other. This made the study an important resource for future projects in the region.

The purpose of this study, required by permit conditions from Alaska Department of Fish and Game and the U.S. Army Corps of Engineers, was to determine the effectiveness of various treatments in vegetation establishment and natural reinvasion of species native to an Arctic floodplain environment: The following alternatives were considered

1. Natural invasion (no treatment) of newly deposited gravel resulting from construction of river training structures in the Sagavanirktok River.
2. Soil amendments (fertilizer)
3. Surface alteration (scarification)
4. Determine the feasibility of a light supplemental seeding of at least two naturally occurring floodplain species.

Coastline Type:

The study was located on a gravel bed deposited on the north side of a river training structure the Sagavanirktok River, near Trans Alaska Pipeline mile post 22. This study was stipulated in the permit allowing Alyeska Pipeline Service Company to construct an overflow channel adjacent to Spur Dike 3.

Methods of Revegetation:

The study plot was approximately one acre in size, with twelve sub-units representing the various treatments. Within each sub-unit, twelve long-term photo plots were established.

Within each sub-unit, a single one-meter squared photo plot was permanently established and documented. Annual photos were taken and compared to evaluate percentage cover. This process continued for five years starting in 1995. Three photo points were also established to provide a distant view of the overall plot.

Five transects were established, traversing each sub-unit. Species identifications were made and species variation documented along these paths. Records were maintained of all vegetation and cover encountered along the length of each 360-foot transect. Data collection continued for a total of five years starting in 1996.

The study culminated in a single report following the last growing season of the study. The report's intent was to document and evaluate the variation in plant density and plant species diversity on the sub-plots over the study period.

Species Used:

A minimum of two species were targeted for collection and, if field conditions permitted, additional species associated with flood plains would also be collected. It was anticipated that the two primary species would be *Hedysarum alpinum* and *Artemisia arctica*.

A seed collection trip occurred during mid August, 1995. Seed collected in 1995 was planted in July of 1996.

The table below lists the amounts and species used in the supplemental seeding aspects of the study. **N** represents the number of collections, **% G** represents the average percentage germination, and **% Mix** denotes the percentage of the species used in the resultant seed mixture

Species	Clean Seed (g)	N	% G	% Mix
Astragalus alpinus	121.7	3	45	8
Hedysarum alpinum	130.5	2	50	9
Hedysarum mackenzii	34.8	1	66	2
Oxytropis campestris	259.3	7	30	17
Oxytropis deflexa	86.0	4	14	6
Oxytropis visicida	475.0	1	79	31
Artemisia arctica	308.8	2	92	21
Artemisia borealis	89.6	2	93	6
Total	**1505.7**			**100**

Results:

This study was conducted on a single site without replication on other gravel bars in the area. Therefore, all results and conclusions can be viewed as very site specific. During the study unforeseen factors became apparent. The first

was the gradual downhill grade leading to the river. Dynamic change and yearly variation of the physical properties of the site were expected. However, these were assumed to be uniform over the entire site. This presumption proved false. The transects closest to the river were affected more by erosion than the more elevated transects. This had an obvious effect on the data as the study progressed.

Another factor not initially considered was the stilling affect on flowing water of the existing vegetation and inanimate objects, such as the rebar plot corner markers. This stilling affect allowed for silt and fines to drop out of the water column during high water periods. This resulted in a tail of silt down-stream from each rebar post. Therefore a degree of bias was built into the study, based on the location and elevation of the plots. These factors may have influenced the results. Multiple plots, varied plot location, and varied orientation would have clarified the issue. Unfortunately, this was a single plot study.

The most significant oversight in plot design was the failure to adjust for age of the non-scarified portion. By whatever measure, the non-scarified portion of the plot is significantly older than the newly scarified section. The untreated area represented a plant community perhaps 25 years old, albeit on a very dynamic land form. The newly scarified portion was at most representative of a four-year old plant community. Expecting them to match in cover or diversity is questionable.

Conclusions / Lessons Learned:

The study, while somewhat flawed, did lead to conclusions. Keeping in mind the limited coverage and lack of sufficient replication inherent in the study, the following conclusions were reached:

1. Supplemental seeding did increase plant cover and the number of individual plants encountered on the transects. The value of this increase could not be approximated. Nor could the long-term effects of the increased populations on overall community health and vigor be determined.
2. Scarification of the soil surface had a more positive impact on re-establishing the vegetation community than any other treatments, as compared to a stand of existing vegetation.
3. Fertilizer application had no positive overall affect on the results.
4. This study, though valuable, was unfortunately too small in scale. An expanded, more sophisticated study could fully answer remaining questions and verify the conclusions reached.

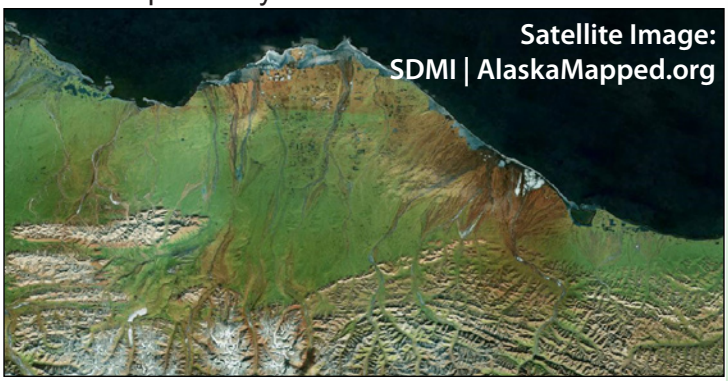
A more in-depth study could also quantify the basic question of habitat value. If a habitat value for the floodplain communities can be established, the direct habitat improvement values of constructing river training structures can be quantified and documented. Improving habitat through terrain modification is a proven method of aiding waterfowl and other species. Future river training structures may serve a two-fold purpose: habitat improvement and protection of a man-made structure.

References:

Wright, S. J., 2000. Final Report – Mile Post 22 Revegetation Study. State of Alaska, Division of Agriculture, Plant Materials Center. 24 pp.

Project Location:

Sagavanirktok River, North Slope. Near milepost 22 of the Trans-Alaska Pipeline System



Site Photos:

Gravel bed along river bank, characteristic of area

Plot 6 - July, 1996
(seeded once, fertilized twice, scarified)

Plot 1 (scarified only) - September, 1996

Plot 6 - September, 2000
(seeded once, fertilized twice, scarified)

Plot 1 (scarified only) - August, 2000

Plot 10 (seeded, fertilized once) - July, 1996

Plot 8 (control - no treatment) - September, 1996

Plot 10 (seeded, fertilized once) - September, 2000

Plot 8 (control - no treatment) - August, 2000

Photos: Stoney Wright (AK PMC)

Project Chariot Site Revegetation Program

Introduction / Objective:

In April 1993, the Alaska Department of Environmental Conservation (ADEC) and the U.S. Fish and Wildlife Service (USFWS) requested that the Alaska Plant Materials Center (PMC) assist with the revegetation of the Project Chariot site. The PMC's role was limited to developing seed and fertilizer specifications. The PMC also agreed to supervise the revegetation work and monitor vegetation growth following the seeding program.

The 1993 Project Chariot Rehabilitation project was initiated to remove soils contaminated by radioactive experiments conducted at the Project Chariot site in 1959-1962. The clean-up project was requested by the villages of Point Hope, Kivalina, Kotzebue, Barrow and others on the North Slope and Northwest Arctic Boroughs.

In 1957, the Atomic Energy Commission started the Plowshare Program to study and develop peaceful uses for nuclear explosives. In 1958, the Ogotoruk Valley in northwest Alaska was selected for the Project Chariot site. The plan was to detonate a nuclear device and form a commercial deep-water harbor in northwest Alaska.

The Project Chariot site was in a region that had no prior nuclear test experimentation, and no scientific baseline existed to determine environmental effects or even if the blast or blasts could be safely conducted. Researchers conducted over 40 environmental studies on the site during a period from 1959-1962.

These research projects included quantities of radioactive material and roughly 15 pounds of soil containing radioactive fallout from other nuclear tests in Nevada. This contaminated soil material was buried in the soil mound left on the site after the experiments were concluded.

Local residents and other groups questioned the merits of blasting a harbor in the region. The project was dropped in 1962, due to public pressure and lack of state support for the plan.

Coastline Type:

The Ogotoruk valley is part of the Arctic Coastal plain. Vegetation in this area generally consists of coastal tundra.

Methods of Revegetation:

The revegetation and restoration specifications and suggestions used for on the project were co-developed by the PMC and USFWS. The following practices were employed:

After grading, areas to be seeded were in a smooth, non-compacted condition. Final contours and elevations needed to match surrounding undisturbed tundra as much as possible. Seeding with native species occurred at a rate of 30 pounds per acre, followed by application of 20-20-10 fertilizer at a rate of 600 pounds per acre.

Following the seed and fertilizer application, one layer of Excelsior blankets was placed over the disturbed areas and pinned according to manufacturer's specifications. In areas where the potential for severe thermal erosion existed, two layers of blankets were used.

Seed and fertilizer application was accomplished using broadcast methods. The primary application method was to use heavy duty cyclone type chest seeders. A secondary method was 4-wheeler mounted, electrical cyclone type seeders. The Excelsior blankets were placed by hand.

The seed and fertilizer program started on August 27, 1993. Deep mud at the site (over two feet in some areas) created problems for the labor crew. When using hand spreaders, maintaining a constant stride is critical to successful and effective operation. Application of seed and fertilizer was less than satisfactory. However, seed and fertilizer application was completed in one day.

Spreading the excelsior blankets started on the 28th of August. Shortly thereafter, the labor crew looked back on the previous day's work with envy. The excelsior was very difficult to apply in the muddy conditions. Placement of the excelsior blankets was completed on the morning of August 29. This was an operation that was not conducted according to "text book" standards.

Species Used:

%	Common Name	Scientific Name
30	'Norcoast' Bering Hairgrass	*Deschampsia beringensis*
20	'Arctared' Red Fescue	*Festuca rubra*
20	'Alyeska' Polargrass	*Arctagrotis latifolia*

20	'Egan' American Sloughgrass	*Beckmannia syzigachne*
10	'Tundra' Glaucous Bluegrass	*Poa glauca*

The seeded grass mix was applied at a rate of 30 pounds per acre.

Results:

During the initial August 26, 1993 site assessment, it was noted that the tundra damage was more severe than anticipated. Frequent passes by tracked vehicles and four wheelers had churned the access trail into a muddy strip of land. In an effort to minimize damage on some areas of the trail, traffic lanes were widened in an attempt to avoid creating deeper mud-holes. This action helped to some extent, although in two areas it simply enlarged the surface area of the mud-hole.

The extremely muddy condition of the trail was not anticipated in plan development. In present day Alaska, it is not common to find surface damage to the degree present at the Project Chariot site. In fact, the form of overland travel used at the Chariot site is permitted in very few Arctic areas. The majority of the surface damage could have been easily avoided by using the gravel bed and flood plain of Ogotoruk Creek as an access route for the mound site.

Two post-restoration evaluations of the site occurred. The final evaluation was on July 15, 1995. July is not an optimum time to evaluate an Arctic plot. Traditionally, by this date very little vegetative growth has occurred in Arctic areas; however, the evaluation was conducted in conjunction with a planned site visit from the Alaska DEC and the U.S. Department of Energy.

The mound area revegetation was found to be performing well. Most of the seeded grass had not yet grown above the excelsior blankets by July 15. When detailed examinations were conducted and the excelsior moved back, better measurements were taken. The southwest quadrant of the mound exhibited the best growth, achieving approximately 70% cover. This was followed by the southeast quadrant with 20-50% cover, the northwest quadrant with 25% cover and the northeast quadrant with approximately 20% cover.

Composition of the seeded grasses was 60% Hairgrass, *Deschampsia beringensis*, 20-30% Red Fescue, *Festuca rubra*, and 5-10% each of Sloughgrass, *Beckmannia syzigachne*, and Polargrass, *Arctagrostis latifolia*. Tundra Bluegrass, *Poa glauca*, although seeded, was not observed.

The trail leading to the mound site exhibited areas of excellent growth and areas of very poor growth. This was similar to observations made in 1994. The trail showed signs of reinvasion similar to the mound site. The ground cover for the trail ranged from 90% to less than 5%, with an overall cover of approximately 50%

No large areas of erosion were noted in 1995. One small area of thermal degradation was noted on the west side of Snowbank Creek. This may stabilize with time. Cross flow drainage patterns seemed to be reestablished.

Decomposition of the excelsior blankets did not occur at an acceptable rate. The plastic netting on the blankets tore loose from the excelsior and created mounds of netting. This plastic material resembles a gill net lying on the tundra. No wildlife was observed in the plastic netting, however, a potential for small animal entanglement did exist.

Conclusions / Lessons Learned:

- Excelsior blankets should be avoided in Arctic areas.
- The revegetation effort was successful in controlling erosion and thermal degradation.
- Overall, ground cover achieved by seeding the site was superior to simply allowing for natural reinvasion.
- Species used performed as well as expected.
- The revegetation project did not preclude the reinvasion or establishment of other native species.
- Allowing vehicular travel on the trail caused unnecessary surface damage.
- Excelsior blankets may have accelerated or encouraged moss growth on the disturbed soils.
- Tundra damage could have been prevented by routing overland travel to the mound site along the Ogotoruk Creek floodplain and riverbed to prevent tundra damage.

References:

Wright, S. J. 1995. Project Chariot Revegetation Program 1993 – 1995 Final Report. State of Alaska, Division of Agriculture, Plant Materials Center, Palmer, Alaska. 26 pp.

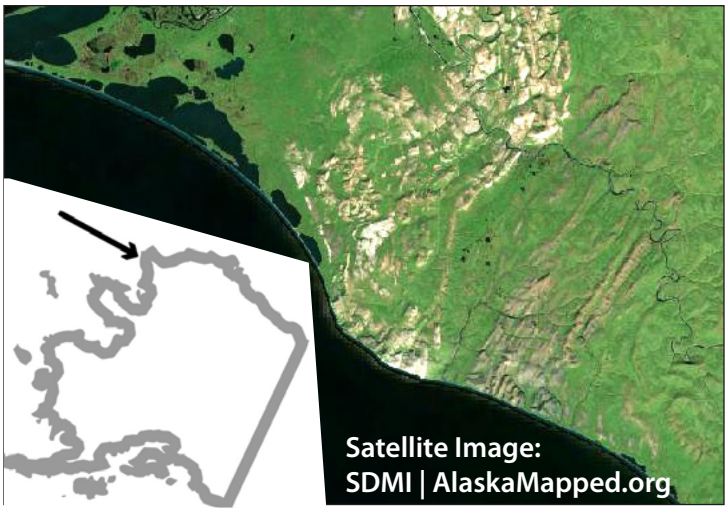
O'Neill, D. 1994 The Firecracker Boys St. Martin's Press, New York. 418 pp.

U.S. Department of Energy 1994. Project Chariot Site Assessment and Remedial Action Final Re-

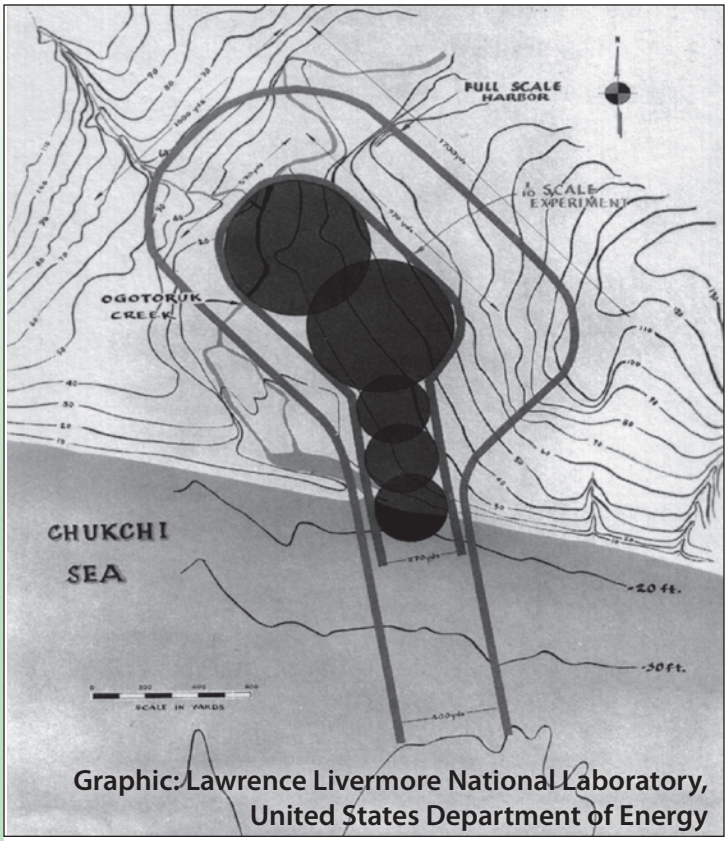
port. U.S. Dept. of Energy, Nevada Operations Office, Environmental Restoration Division. DOE/NV-386 UC70 226 pp.

Project Location:

The site is located in northwestern Alaska, four miles to the southeast of Cape Thompson, and 130 miles northwest of Kotzebue, within the Cape Thompson subunit of the Alaska Maritime National Wildlife Refuge.



Site Photos:



Map of proposed harbor. The outer outline shows the "full scale" plan, with detonations totaling 2.4 megatons. The inner outline, a scaled down version, would have required blasts of 460 kilotons.

Photos: Stoney Wright (AK PMC)

Single species evaluation plot - August, 1993

Flooded study plots - July, 1995

Trail and mound area, view to the west - August, 1994

Close-up of mound area, view to the east - August, 1994

Mound area - view to the east - August, 1994

Mound area - view to the northeast - July, 1995

Area of massive cross-flow on trail - August, 1993

Cross-flow area of trail, view east - July, 1995

Trail after placement of excelsior mat - August, 1993

Trail, showing effects of heavy traffic - August, 1994

Portion of trail, view to the east - August, 1994

Portion of trail, view to the east - August, 1995

Photos: Stoney Wright (AK PMC)

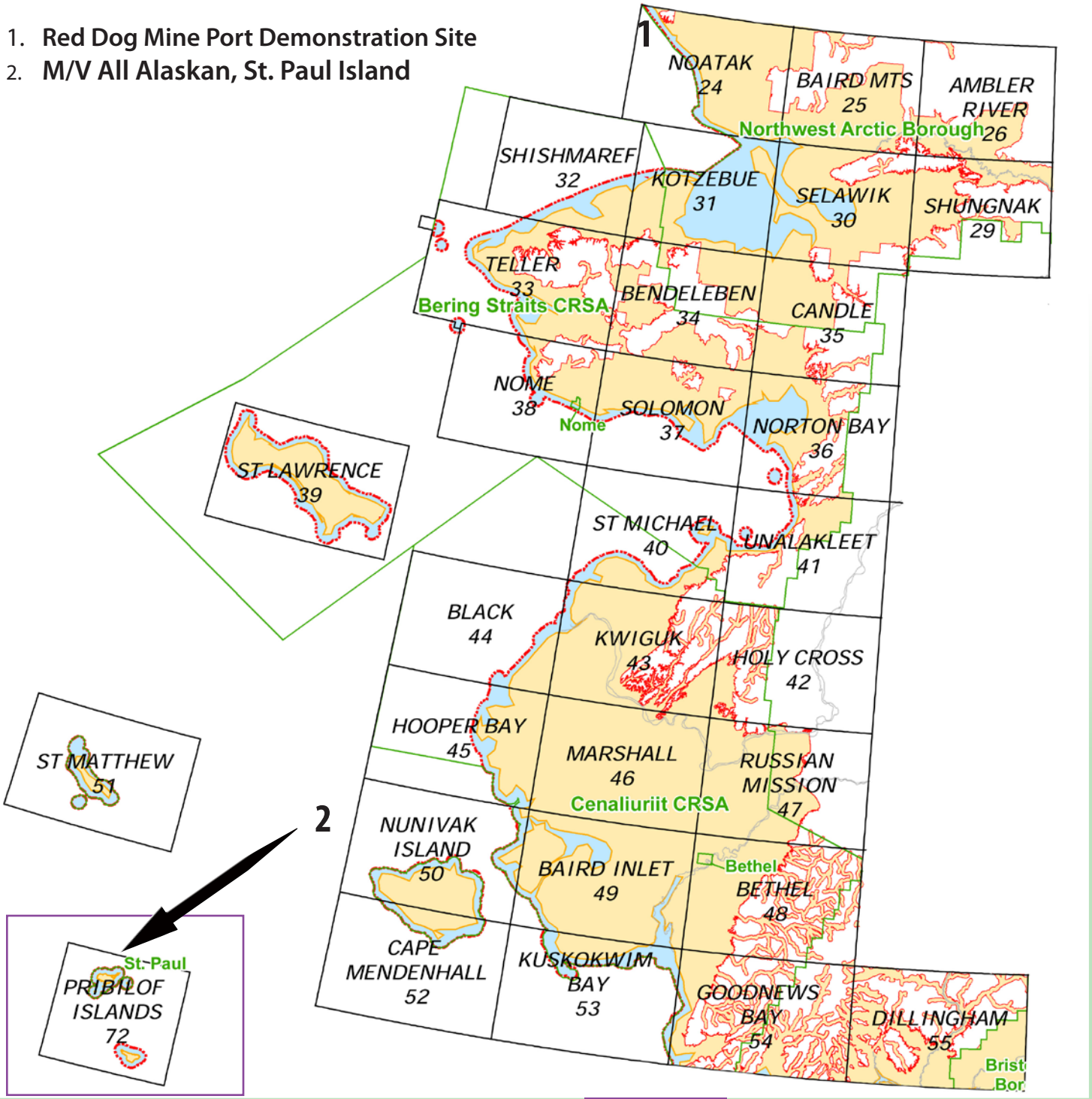
Case Studies of Revegetation Projects

Western Region

Western Alaska stretches from Cape Steppings to Bristol Bay, and encompasses Bering Sea islands such as St. Lawrence, St. Matthew, and the Pribilofs.

Projects in this area include the cleanup of the MV All Alaskan, on St. Paul Island, and an evaluation of reclamation grasses at the Red Dog Mine port site.

1. **Red Dog Mine Port Demonstration Site**
2. **M/V All Alaskan, St. Paul Island**



Red Dog Mine Port Demonstration Site

Introduction / Objective:

In 1987 Cominco Alaska and the Plant Materials Center entered into a partnership that benefited both parties. Cominco provided the Plant Materials Center with test plot sites at the Red Dog Mine and port site for advanced evaluations of potential and existing reclamation grasses.

In addition, Cominco provided a disposal site for a demonstration planting. This port site disposal site is the subject of this case study. During winter of 1988 the PMC developed a restoration plan for the solid waste disposal site. This trial intended to demonstrate methods of restoration and revegetation using adapted native species.

Coast Type:

The project site can be characterized as a Coastal Tundra lagoon. Coastal barriers trap water above the high tide, impounding sea water. This can create a brackish mix of salt and fresh water.

Methods of Revegetation:

Prior to seeding the abandoned disposal site, the existing berms of spoil along the edges were pushed back into the pit and the pit was then contoured to specification. Specifications called for the site to be blended into the surrounding tundra landscape.

Following the earth work, the site was fertilized using shoulder-held, broadcast spreaders. Granular 20-20-20 fertilizer was applied at a rate of 450 pounds per acre. The areas were seeded at a rate of 40 pounds per acre, followed by raking so that the seed and fertilizer were incorporated into the soil.

Species used on the site:

The contoured and graded disposal site was seeded with three different seed blends to account for differing levels of moisture in the pit. The project used the following species native to the region:

- 'Tundra' Glaucous Bluegrass, *Poa glauca*
- 'Arctared' Red Fescue, *Festuca rubra*
- 'Alyeska' Polargrass, *Arctagrostis latifolia*
- 'Norcoast' Bering Hairgrass, *Deschampsia beringensis*
- 'Egan' American Sloughgrass, *Beckmannia syzigachne*
- Tilesy Wormwood, *Artemisia Tilesii*

Results:

After one growing season the disposal pit seedings were performing well. Roughly 75% of the pit showed good to excellent stands of grass. This increased to 90% in 1989, with a final cover estimate of 95% in 1990. The site continued to be monitored until 1998. Eventually the site started matching the surrounding tundra in both appearance and species composition.

Conclusions / Lessons Learned:

The Cominco/Red Dog Port Disposal Site project allowed for the evaluation of newly developed native species cultivars in Northwestern Alaska. The plant material performed well and survived the rigors of the climate and soil conditions. While a cover of plants native to the region was established on the site, they were not necessarily native to the site. Over time the site did revert to a plant composition more closely matching the surrounding tundra.

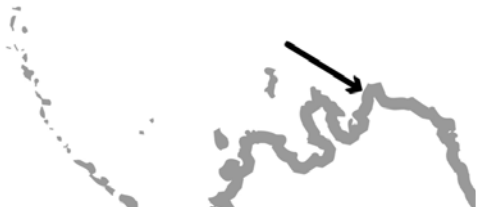
The rate of re-colonization by the surrounding sedge community was observed to be more rapid than similar areas where non-native species were used in revegetation efforts. The use of species not specifically native to the site did not prevent native species from reclaiming the disturbance. It can only be assumed however, that the seeding effort aided in the process in either reducing the time needed or actual cover attained by the sedge reinvasion.

References:

Wright, S. J. 1990. Final Report on Data and Observations Obtained From the Red Dog Mine Evaluation and Demonstration Plots. State of Alaska, Division of Agriculture, Plant Materials Center. 16 pp.

Project Location:

The demonstration plots were located just south of Point Hope, on the north western coast of Alaska.



Site Photos :

Disposal area prior to revegetation - July, 1988

Stand of native grass near port site - July, 1988

Seeding site using broadcast method - July, 1988

Disposal area, view to the east - September, 1989

Disposal area, view to the east - September, 1989

Performance of seeded grasses - September, 1990

Grass cover estimated at 95% - September, 1990

Vegetation fully established - September, 1996

Photos: Stoney Wright (AK PMC)

M/V All Alaskan Cleanup, St. Paul Island

Introduction / Objective:

On March 20th, 1987, a 340 foot long fish processor became grounded on the north shore of St. Paul Island, part of the Alaska Maritime National Wildlife Refuge. The ship and cargo became a total loss, and the wreck was subsequently cut up and removed.

Immediately after the grounding, the coast guard began removing volatile POLs – Petroleum, Oil, and Lubricants, from the ship. Once the immediate danger of contamination was over, cleanup of the M/V All Alaskan waited several years to commence. Tanadgusix Corporation (TDX), a local contractor, was hired to construct roads from the beach where the shipwreck occurred to the village of St. Paul, so that the pieces of the ship could be removed by barge. This necessitated cutting a sizeable hole in the dune formations on the island, as well as creating road beds strong enough to bear the weight of steel sections of the dismantled ship. Road beds were constructed of sand and scoria, a volcanic rock.

In 1993, the removal of the M/V All Alaskan was complete, and restoration efforts began on both the road bed and the damaged coastal dune.

Coast Type:

This cleanup effort took place on St. Paul Island, in the Bering Sea. St. Paul is the northernmost island in the Pribilofs, volcanic islands dominated by tundra and meadow vegetation. The coastline where the vessel ran aground was sandy, with large coastal dunes supporting a community of Beach Wildrye, *Elymus arenarius*.

Methods of Revegetation:

The dune area was reconstructed, and subsequently revegetated using sprigs of locally harvested Beach Wildrye. Sprigs were planted on 18' centers.

Natural reinvasion was the chosen method of revegetation for the .9 mile access road, augmented with 20-20-10 fertilizer at a rate of 400 lbs / acre. Fertilizer was applied using hand-held broadcast spreaders. Snow drift control fabric was erected as barrier fencing to prevent vehicular traffic from interfering with natural reinvasion.

Species used on the site:

Beach Wildrye, *Elymus arenarius*, was the only species used on the site.

Results:

The coastal dune along the beach was rebuilt from each side. Some doubt existed as to whether the sprigged vegetation would take hold on the beach side of the dune, and a gap was left in transplanted vegetation. Upon subsequent examinations, this was the only area where vegetation did not establish, underscoring the high saline tolerance of the species.

Conclusions / Lessons Learned:

Sprigging with Beach Wildrye was an effective means of restoring coastal dunes.

References:

Smith, Phil. 1993-1994 Personal Communications

Whitney, John. 1987 F/V All Alaskan Incident Report. National Oceanic and Atmospheric Administration. 2pp.

Project Location:

St Paul Island, Western Alaska

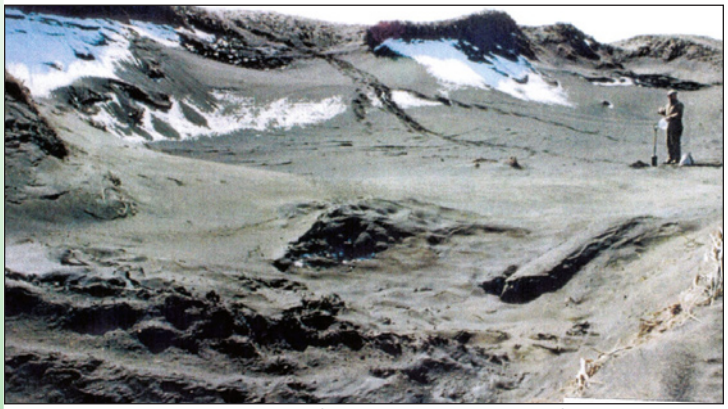
Site Photos:

The M/V All Alaskan, shipwrecked on St. Paul Island

Grounded M/V All Alaskan, Beach Wildrye community

Hairgrass and dunegrass community on St. Paul

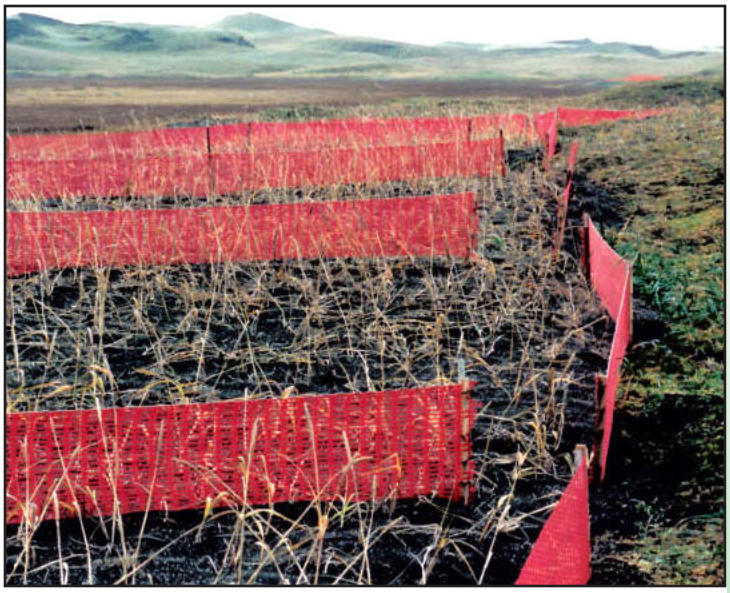
Areas damaged in the initial shipwreck response



Beach dune ridge, before construction of roadway

20 foot gap in dune ridge, along former roadbed

Newly sprigged roadway area protected from drifting sand using snow drift control fabric



Sprigged Beach Wildrye along disused roadbed

Overview of project area, after sprigging

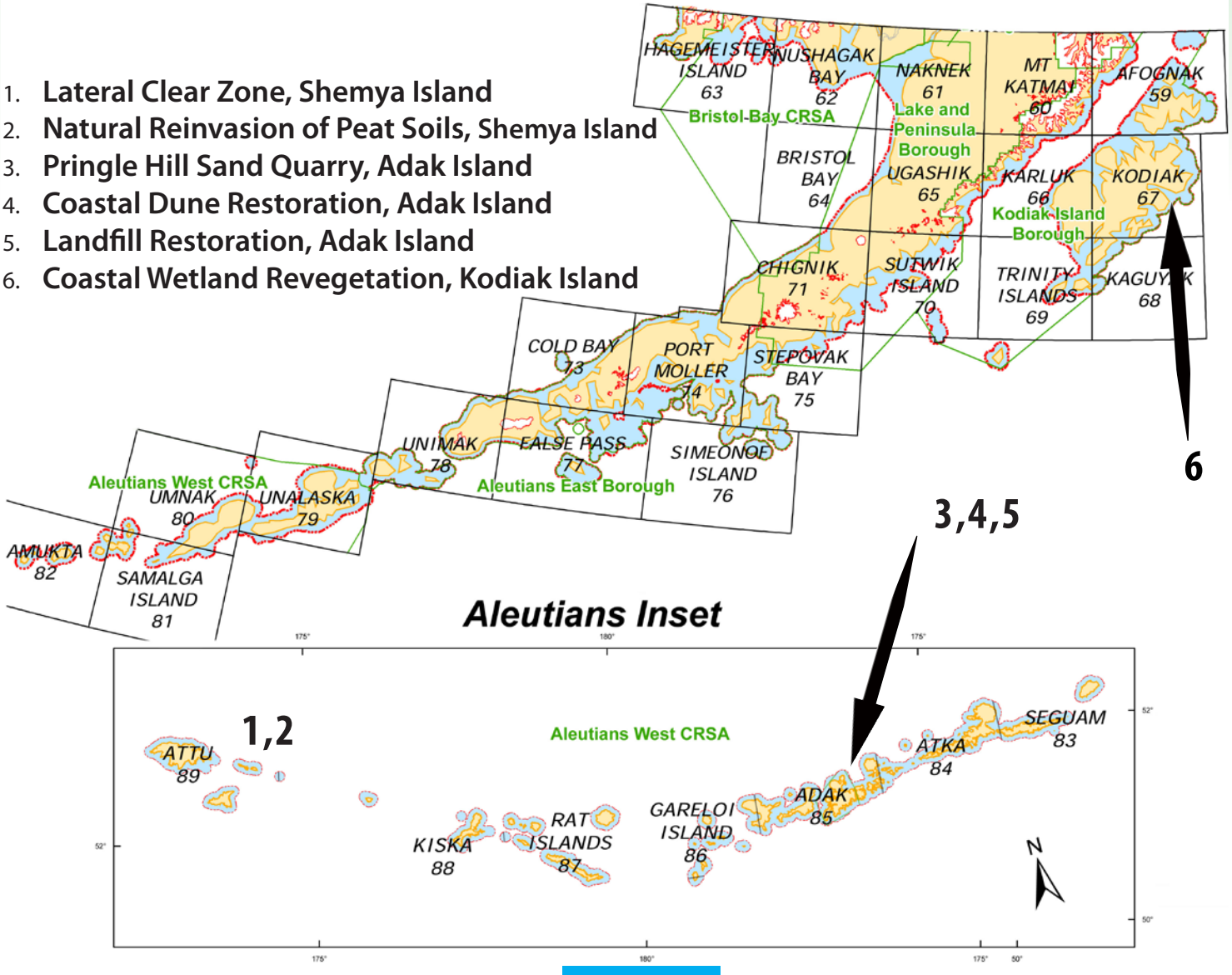
Photos: Phil Smith (PSA Inc.)

Southwest / Aleutians Region

The Aleutian Islands and Southwest Alaska are filled with history. From the Japanese invasion of Kiska and Attu during the Second World War, to the US nuclear activities on Amchitka and throughout the Cold War; this westernmost area of the United States has been a key strategic outpost. With the advent of long-range weapons radar and weapons systems, much of the military infrastructure in this region has fallen into disuse. Federal law requires that formerly used defense sites are restored to their pre-disturbance condition, wherever possible, and that was the impetus behind several projects reviewed in this section.

Two other projects were necessitated by safety considerations on Shemya and Adak Islands. Both made use of transplants of Beach Wildrye, a process that can greatly enhance sand retention on erosion prone beaches. For more in-depth information about sprigging with Beach Wildrye, please refer to Appendix A: *Beach Wildrye Planting Guide.*

1. **Lateral Clear Zone, Shemya Island**
2. **Natural Reinvasion of Peat Soils, Shemya Island**
3. **Pringle Hill Sand Quarry, Adak Island**
4. **Coastal Dune Restoration, Adak Island**
5. **Landfill Restoration, Adak Island**
6. **Coastal Wetland Revegetation, Kodiak Island**



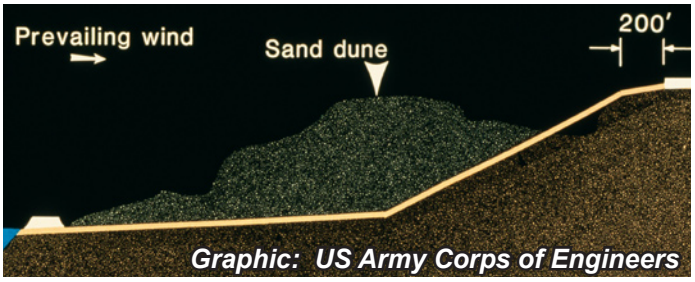
Lateral Clear Zone (LCZ) , Shemya Island

Introduction / Objective:

Initial Shemya Air Force Base, Lateral Clear Zone (LCZ) safety enhancement began in 1982. Clearing and grading of existing vegetated dunes exposed a sand layer to wind erosion and transport. Attempting to fix the problem of dunes in the LCZ created the more severe problem of sand on the active runway surface. This created a maintenance problem for Air Force personnel assigned to keep the runways clear. In addition, mechanical damage by the sand to aircraft was a concern.

Initial erosion control seeding took place in 1983, but failed as wind erosion would strip seed beds prior to establishment. In 1985, the Air Force contracted the services of the Plant Materials Center so that a revegetation and erosion control plan could be developed for the LCZ. A Beach Wildrye sprigging demonstration program was initiated utilizing Air Force personnel. A major contract was later awarded to a resident contractor on Shemya.

Typical cross-section of Lateral Clear Zone (LCZ)



Coastline Type:

Shemya Island receives less than 28 inches of precipitation per year. Seasonal variations in temperature are small, with average daily temperatures ranging from 31 degrees fahrenheit in January to 45 degrees in July. Soils consist of 83% sand, 12% silt, and 5% clay. The most prevalent climatic factors are wind and fog.

Severe winds, at times in excess of 70 knots, can lash the island, easily transporting erodible sands. The strongest winds occur during late fall, winter, and early spring.

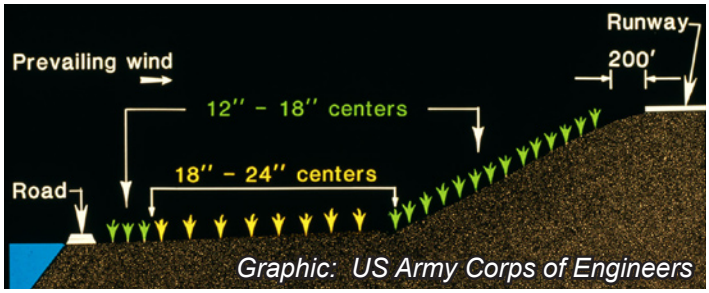
Methods of Revegetation:

Beach Wildrye sprigs were harvested from natural stands. One harvested clump of grass typically provided three usable sprigs. Mechanical harvesting was achieved using a standard track-mounted backhoe or front-end loader.

A small bulldozer was modified by placing 'tiger teeth' along the bottom of the blade. Back-blading on float with these teeth welded in place was found to be an effective means of creating furrows that met design planting criteria.

Sprigs were planted using the "drop and stomp" method. The on-site Brillion drill seeder was inoperable for seed distribution, so the seed mixture was applied using a broadcast method. Seed was incorporated into the soil by running the Brillion seeder over the broadcast seed.

Cross-section of LCZ Beach Wildrye planting plan



Species Used:

Beach Wildrye sprigs were planted first, and the area was subsequently over-seeded with the following mixture at a rate of 60 lbs / acre.

%	Common Name	Scientific Name
60	'Arctared' Red Fescue	*Festuca rubra*
35	'Norcoast' Bering Hairgrass	*Deschampsia beringensis*
5	Annual Ryegrass	*Lolium multiflorum*

Fertilizer was applied over the seed mixture at a rate of 400 lbs / acre. The fertilizer had a composition of 14-30-14. A single application of ammonium nitrate was applied 6 weeks after seeding and the initial fertilizer application.

Results:

The site was monitored from 1986 until 2008. The east end of the LCZ maintained an effective vegetative cover, redeveloped an effective and natural foredune and maintained the desired and designed ten percent grade. The west end of the LCZ did not receive the Beach Wildrye treatment and has reverted to natural dune complex similar to what existed prior to the safety enhancement project conducted in 1982.

Species composition, as examined in September 1987, was as follows:

75% Perennial grass, including Beach Wildrye
18% Annual grass
5% Bare ground
2% Invading plants

The overall ground cover was 80-85%, with the following composition:

41% Beach Wildrye
43% Perennial grass
15% Annual grass

Approximately 90% of the Beach Wildrye sprigs had become established by September 1987. The west end of the LCZ continued to perform as planned up to the last evaluation in 2008. The ten percent grade has been maintained by the vegetation cover, the nearly 100 percent vegetative cover has prevented erosion and Beach Wildrye dominates the site.

Conclusions / Lessons Learned:

Leymus mollis is an effective species for revegetation and erosion control on coastal dunes.

- Transplanting the species is cost effective: 350-400 sprigs can be planted per man hour.
- 90% survival can be expected.
- A one-acre natural stand of Beach Wildrye will provide enough material to plant 7 acres.
- Uniform spacing of planted sprigs produces uniform sand accumulation.
- Clump planting produced dune or irregular sand accumulation.
- Leymus can be used as an engineering tool to control or build dunes.

Beach Wildrye sprigging is a viable method to control erosion in areas that can support the species. This technique for dune / coastal restoration has, as a result of the Shemya and other similar projects, become a well-established practice, and the department of defense deserved credit for allowing this progressive research to continue.

References:

Wright, S. J., 2008. Long-term Monitoring of Dune Stabilization on the Eareckson AFS Lateral Clear Zone on Shemya Island, Alaska. 2008 Proceedings for American Society of Agronomy Annual Meeting. Houston, Texas.

Wright, S. J., 1998. Results of a Ten-Year Study of Beach Wildrye Establishment and Sand Control on the Eareckson AFS Lateral Clear Zone-Shemya Island, Alaska in Abstracts of the 1998 American Society of Agronomy Annual Meeting. Baltimore, Maryland. 1 pp.

Wright, S. J., 1987. Sand Stabilization Within the Lateral Clear Zone on Shemya Air Force Base. Abstracts of the American Society of Agronomy Annual Meeting, November 30, 1987, Atlanta, GA.

Wright, S. J., 1986. Beach Wildrye (Elymus arenarius) Sprigging on Shemya Air Force Base, Lateral Clear Zone – A Qualitative Study in Response to Questions Arising From Contract DACA 85-86-C-0042. State of Alaska, Division of Agriculture, Plant Materials Center, 37 pp.

Wright, S. J., Fanter, L. H. & Ikeda, J. M., 1987. Sand Stabilization Within the Lateral Clear Zone at Shemya Air Force Base, Alaska Using Beach Wildrye, (Elymus arenarius). State of Alaska, Division of Agriculture, Plant Materials Center and U. S. Army Corps of Engineers, Alaska District. 16 pp.

Project Location:

Shemya Island, Aleutians west region

Site Photos:

Mechanical trenching with 'Tiger Teeth' - May, 1987

Hand-sprigging underway at the LCZ - May, 1987

'Drop and Stomp' planting technique - May, 1987

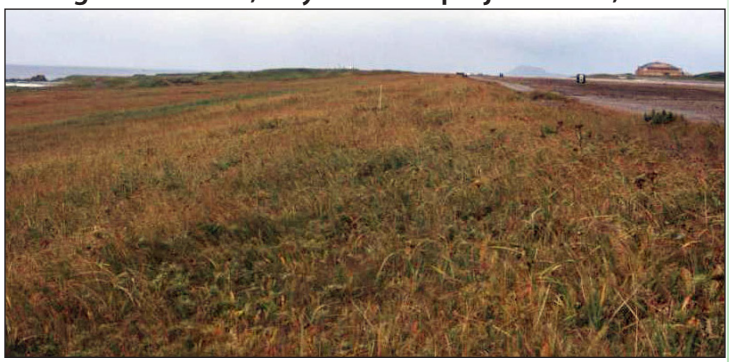
Sprigging of Beach Wildrye completed - May, 1987

Four months after planting - September, 1987

Vegetation on the LCZ - June, 1995

Beach Wildrye roots and rhizomes stabilize erodible soils

Vegetative cover, 20 years after project - June, 2006



Top of LCZ, abutting runway - September, 2008

View of west end of LCZ - September, 2008

Photos: Stoney Wright (AK PMC)

Natural Reinvasion of Peat Soils, Shemya Island

Introduction / Objective:

The revegetation effort took place on the island of Shemya, near the western edge of the Aleutian Chain. The entire four mile long and two mile wide island is a U.S Air Force installation.

In 1991, the Alaska Plant Materials Center received a request to help the USAF close unnecessary roads on Eareckson Air Station, Shemya Island. These roads were deemed to be problematic because they traversed a watershed area that supplied water needed to operate facilities. Fuel spilled from vehicles using these unnecessary roads would have put the total potable water supply of the island at risk.

To render the roads impassable, peat blocks from excavation activities on the island were dumped on the existing road surfaces. This action made driving on the roads impossible.

Coastline Type:

Shemya is a small island near the west end of the Aleutian Island chain with harsh environmental conditions. The island receives less than 28 inches of precipitation per year. Seasonal variations in temperature are small, with average temperatures ranging from 31 F in January to 45 F in July. The project area was located in upland sedge and grass communities.

Methods of Revegetation:

The Air Force was presented several options, including seeding, enhanced natural reinvasion, sprigging with Beach Wildrye, and charged overburden veneer.

The option selected was **charged overburden veneer**; the spreading of topsoil (containing naturally occurring seed and other propagules) over the abandoned roads. No efforts were made to scarify or otherwise prepare the underlying gravel road bed; peat from another construction project was simply dumped into place.

The process was observed for two years before all the other options previously mentioned were totally dismissed. At that point the natural reinvasion of native species was determined to be progressing at an acceptable rate.

Species Used:

This project relied upon natural reinvasion. The peat used was neither seeded nor fertilized.

Results:

The following species were first to establish a presence in the transplanted soils, as observed in 1993:

Beach Wildrye, *Leymus mollis,*
Spike Bentgrass, *Agrostis exarata,*
Cow Parsnip, *Heracleum lanatum,*
Beach Lovage, *Ligusticum scoticum,*
Kamchatka Thistle, *Cirsium kamtschicum*

In 1995, vegetative cover was approaching 60% on approximately 80% of the area. Several new species had colonized the area, including:

Alpine Timothy, *Phleum alpinum,*
Large-glume Bluegrass, *Poa macrocaylx,*
Arctic Rush, *Juncus articus,*
Pearly Everlast, *Anaphalis magaritaceae,*
Unalaska Mugwart, *Artemisia unalaskensis*

By the final evaluation (conducted in 1996), a 90-95% vegetative cover existed, and species composition had increased to 31 species:

Scientific Name	*Common Name*
Leymus mollis	Beach Wildrye
Poa macrocaylx	Big-leaf Bluegrass
Conioselinum chinense	Hemlock Parsley
Geranium erianthum	Geranium
Trisetum spicatum	Spike Trisetum
Lupinus nootkatensis	Nootka Lupine
Carex macrocheta	Longawn Sedge
Luzula multiflora	Woodrush
Lathyrus maritimus	Beach Pea
Ligusticum scoticum	Beach Lovage
Heracleum lanatum	Cow Parsnip
Cacalia auriculata	Indian Plantain
Taraxicum officinale	Dandelion
Atremisia unalaskensis	Unalaska Artemesia
Anapholis margenatius	Pearly Everlast
Senecio pseudoarnica	Beach Fleabane
Achillea borealis	Boreal Yarrow
Agrostis exarata	Spike Bentgrass

Juncus arctica	Arctic Rush
Juncus falcate	Rush
Festuca altaica	Altai Fescue
Festuca rubra	Red Fescue
Carex aqutaalis	Water Sedge
Taraxacum sp.	Dandelion sp.
Galium sp.	Bed Straw
Cardamine sp.	Cardamine
Angelica lucida	Angelica
Phleum alpine	Alpine Timothy
Equisetum sp.	Horsetail sp.
Epilobium sp.	Fireweed
Mosses	

The fill material used was taken from a more upland site, which resulted in a drastically different species composition, as compared to the surrounding tundra wetlands. An additional evaluation in 2008 reported a 100 percent cover on the former roads and charged overburden veneer.

Conclusions / Lessons Learned:

Allowing natural reinvasion to occur on peat soils was very successful. Often blocks of material dry out and become difficult to re-wet, however this was not a concern on Shemya, due to the island's wet climate. This method of restoration should be considered for use on sites in the Aleutian chain or areas with climates similar to the Aleutians.

Future users of the charged overburden veneer technique need to be aware of the potential hydrologic effects of using fill from different areas, as well as the likelihood that aggressive invaders may be present in the species composition of transplanted soils.

References:

Wright, S. J., 1997. Final Report – Natural Revegetation of Peat Soils on Eareckson Air Station, Shemya Island, Alaska – A Qualitative Study of a Natural Process. State of Alaska, Division of Agriculture, Plant Materials Center, Palmer, AK. 21 pp.

Wright, S. J., 1995. Natural Revegetation of Peat Soils on Eareckson AFS, Shemya, Alaska, Abstracts of the 1995 American Society of Agronomy Meeting, St. Louis, MO. Oct. 30-Nov. 3, 1995. 1 pp.

Wright, S. J. and Moore, N. J., 1994. Revegetation Manual for Eareckson Air Force Station Shemya, Alaska; State of Alaska, Division of Agriculture, Plant Materials Center, Palmer, Alaska. 65 pp + appendices.

Project Location:

Shemya Island,
Aleutians West region.

Site Photos:

Photos: Stoney Wright (AK PMC)

Hospital lane with peat overburden - 1992

Hospital lane, vegetation cover - 1996

Terminal way, view to the north - 1993

Terminal way, view to the north - 1996

Terminal way, vegetation cover - 1996

Terminal way, vegetation cover - 1996

Area east of Hanger 4 - September, 1992

Area east of Hanger 4 - 1996

Barst lane, view to the north - 1992

Barst lane, view to the north - 1994

Barst lane, view to the north - 1996

Barst lane, vegetation cover - 1996

Barst lane, vegetation cover - 1996

Photos: Stoney Wright (AK PMC)

Coastal Dune Restoration, Adak Island

Introduction / Objective:

This dune restoration project was intended to rebuild and protect a coastal foredune adjacent to a road on Adak Island. A major storm in 1987 destroyed most of the existing foredune formation through wind and wave action, and resulted in sand blowing onto the roadway.

Coastline Type:

Adak Island is characterized by severe winter storms and heavy ocean surf. The project site was on an open bay with significant fetch, allowing for severe storms to cause direct impact on the shoreline. During the study period it was determined the 94% of annual sand accretion or accumulation occurs between September and May.

Methods of Revegetation:

Beach Wildrye was chosen because it is native to the area, well adapted to sandy soils, and is usually found on foredunes and active dunes. Its aggressive growth tendencies and ability to survive burial by blowing and accumulating sand made it the best choice to quickly stabilize and re-establish the foredune.

Sprigs of Beach Wildrye were planted by hand, in rows spaced between 12 and 18 inches apart. Sprigging was the chosen method of planting due to the high likelihood of wind erosion and sand accretion. Availability also was a factor in the decision to use Beach Wildrye sprigs; seed of Beach Wildrye was simply not available.

Height markers were placed into the dune during re-planting, and used to measure sand accumulation. In 2009, final dune height measurements were taken using indirect measurements, as the fixes elevation markers were removed during metal clean-up programs.

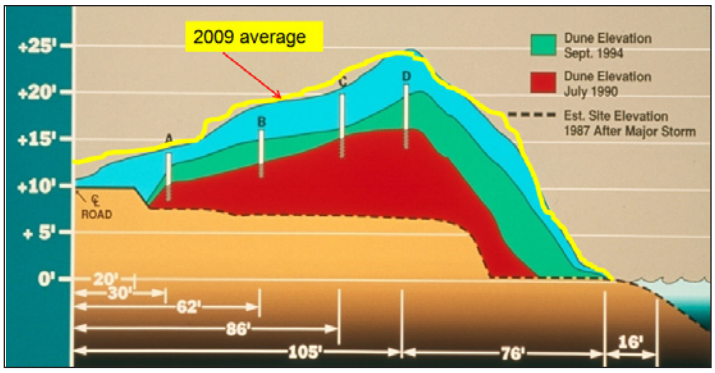
Species Used:

The only species used on this project was Beach Wildrye, *Leymus mollis*. No seeded grasses were used in the project. The area was fertilized once at the time of planting with 20-20-10 granular fertilizer at a rate of 500 pounds per acre.

Results:

The plantings were successful in re-establishing the coastal foredune. Areas closest to the road and more distant from the coastline had the highest initial cover. However, the vegetation began to advance towards the ocean over time. Most importantly, the height of the foredune increased significantly, as shown in the following chart:

(created in 1998, based on 1990-1994 data)



The height of the foredune, when measured in 2009, nearly matched the height predicted in 1998. Also, the prediction of road inundation did come to pass and clearing the road of sand is now a constant maintenance issue.

Conclusions / Lessons Learned:

Long-term revegetation with Beach Wildrye is an effective and practical means of stabilizing coastal dunes in sandy soils.

References:

Wright, S. J. 2009., Long-Term Monitoring of Dune Re-Establishment and Sand Quarry Restoration Utilizing Beach Wildrye, Leymus mollis On the Former Adak Naval Air Station On Adak Island, Alaska. in Proceedings: 2009 Annual Meeting of the American Society of Agronomy, Pittsburgh, Pennsylvania.

Wright, S. J., 2007. Alaska Coastal Dune Restoration and Stabilization with Beach Wildrye, *Leymus mollis*. In Proceedings: International Coastal Dune Restoration Conference, 3-5 October, 2007. Santander, Spain.

Wright, S. J., 1994. Effects of Beach Wildrye on Foredune Dynamics on Adak Naval Air Station, Adak, Alaska. Abstracts of 1994 American Society of Agronomy meeting. Seattle, WA. November 13-18, 1 pp.

Wright, S.J., 1989. Sand Control on Adak Naval Air Station. Abstracts of the 1989 Annual Meeting of the American Society of Agronomy, October 17, 1989, Las Vegas, Nevada.

Project Location:

Adak Island, West Aleutians

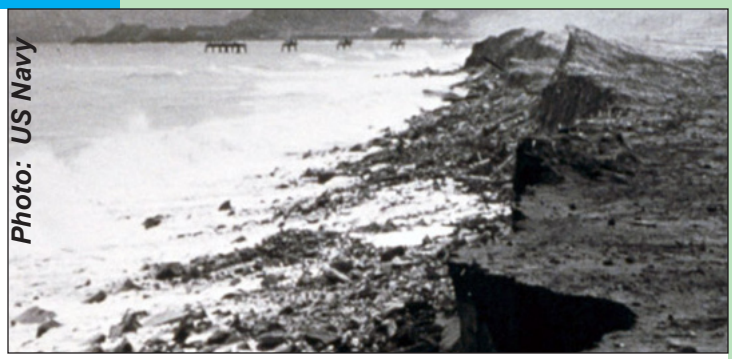
Site Photos:

Coastal dunes during winter of 1987

Sprigs of Beach Wildrye planted - 1989

Formation of coastal dune - 1994

Coastal dune formation - 2008



Foredune after major storm - 1987

Foredune development - 1992

Foredune development - 1994

Foredune development - 1996

Foredune development - 2009

Pringle Hill Sand Quarry, Adak Island

Introduction / Objective:

This project was initially conceived as a standard erosion control seeding with supplemental Beach Wildrye sprigging. The project took place at an abandoned sand quarry on Adak Island, approx. 1200 miles southwest of Anchorage. The quarry had been in use since World War II. The northern half of Adak island was at the time an active military installation, and the fifth largest town in Alaska. The southern half of the island is part of the Alaska Maritime National Wildlife Refuge, administered by the U.S. Fish and Wildlife Service.

The erosion control effort was initiated to close-out the quarry and prevent the pit from becoming a source of fugitive sand. Wind transport of sand was a constant maintenance problem. A more far reaching goal was the capture and recruitment of new sand from the windward beach in order to eventually replenish the sand quarry for future use.

Coastline Type:

The project site is a large coastal dune that has been mined to near sea-level. Adak Island experiences severe winds and consistent overcast conditions. Fog is present for approximately 1/2 of the year. The climate is moderate, with temperatures ranging from 20 - 60 degrees Fahrenheit, and 64 inches of precipitation received each year. Vegetation consists of mostly grasses and tundra, and is classified as a hypermaritime meadow.

Methods of Revegetation:

The revegetation program at the quarry was a three-year effort relying on local Navy Sea Bees as the planting crews. During one week periods in May 1993-1995 the quarry was fully seeded and sprigged. Back blading with a loader bucket created the trenches for the Beach Wildrye sprigs. The Beach Wildrye sprigs were planted by the 'drop & stomp' method.

Each year following the sprigging effort, the newly planted sprigs were over-seeded with commercially supplied 'Norcoast' Bering Hairgrass and two varieties of Red Fescue; 'Boreal' and 'Arctared'. Seed was applied at a rate of 30 pounds per acre and a ratio of 60% Hairgrass and 20% for each of the Red Fescue varieties.

Fertilizer was applied once at a rate of 500 pounds per acre. The locally acquired sprigs of Beach Wildrye were transplanted uniformly across the area on 3 to 4 foot centers.

Species Used:

Beach Wildrye, *Leymus mollis* was the species of choice. The majority of the revegetation effort was dedicated to work with this species. All Beach Wildrye was collected near the planting site. Harvest areas received an application of fertilizer to encourage rapid regrowth to replace harvested transplants.

Commercial seed mix used on the project consisted of a ratio of 60% 'Norcoast' Bering Hairgrass, *Deschampsia beringensis*; 20% 'Boreal' Red Fescue, *Festuca rubra* and 20% 'Arctared' Red Fescue, *Festuca rubra*.

Results:

As expected the Beach Wildrye dominated the project area, a site to which it was highly adapted. Surprisingly, native species not seeded or sprigged started invading treated areas immediately after revegetation. Each year, the frequency and diversity of invading species increased. Neither the Red Fescue nor the Beach Wildrye seemed to preclude the natural reinvasion process. Red Fescue has often been criticized for being too aggressive and sod forming to allow the re-establishment of less aggressive native species.

By 2009, virtually none of the seeded grasses were observed in the revegetated areas. The sprigged Beach Wildrye was universally present, and several native species had colonized the area. Invading native species consisted primarily of:

Scientific Name	***Common Name***
Heracleum lanatum	Cow Parsnip
Senecio pseudoarnica	Beach Fleabane
Honckenya peploides	Sea Sandwort
Calamagrostis canadensis	Bluejoint Reedgrass
Ligusticum scoticum	Beach Lovage
Lathyrus maritimus	Beach Pea
Poa macrocalyx	Big-leaf Bluegrass
Festuca vivipara	Viviparous Fescue

Agrostis exarata	Spike Bentgrass
Bromus sitchensis	Sitka Brome
Luzula multiflora	Woodrush

Conclusions / Lessons Learned:

Long-term revegetation with Beach Wildrye is effective and practical on dunes and sandy soils. The seeded grasses, though they did not persist, did stabilize the planting site in the early stage. Natural reinvasion of species native to the island could be attributed to the creation of a favorable micro-environment suitable for seed catch and germination. Fertilizer application may also have played a role in the success of invading species as they only appear in areas that were fertilized. The latter observation was clear and striking.

References:

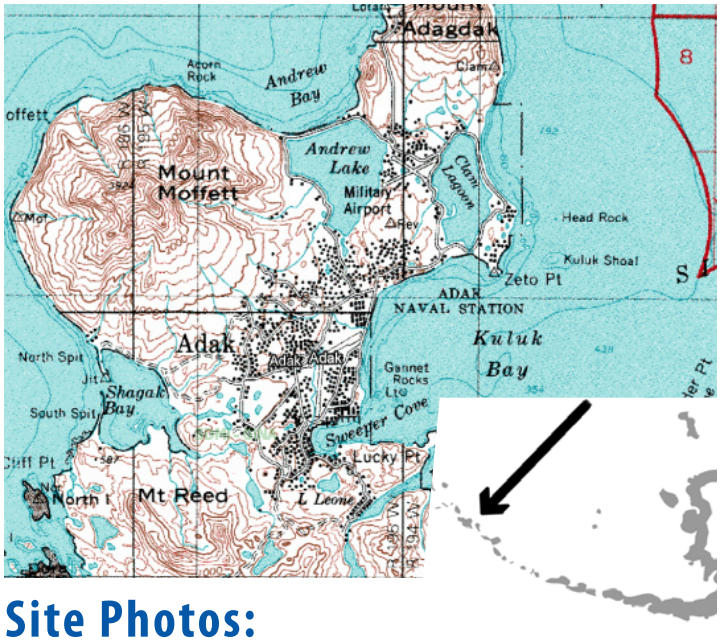
Wright, S. J. 2009. Long-Term Monitoring of Dune Re-Establishment and Sand Quarry Restoration Utilizing Beach Wildrye, On the Former Adak Naval Air Station On Adak Island, Alaska. Proceedings for the 2009 Annual Meeting of the American Society of Agronomy, Pittsburgh, PA. (Abstract).

Wright, S. J. 1995 Final Report – Pringle Hill Sand Quarry Restoration Project. Alaska Dept. of Natural Resource, Plant Materials Center, Palmer, AK. 36 pp.

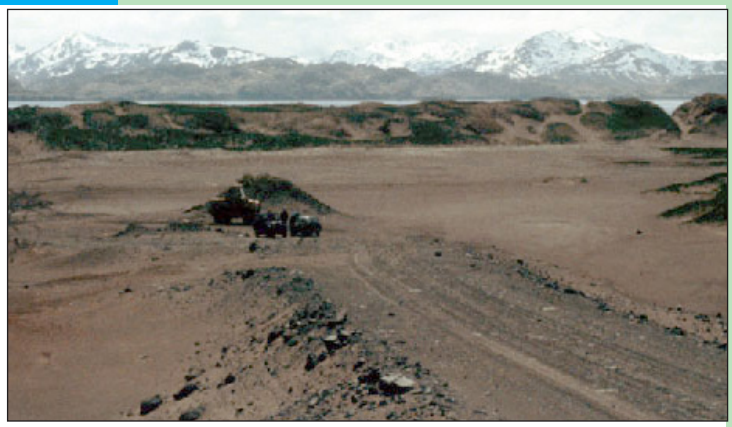
Wright, S. J. 1995. Restoration of a Sand Quarry Located at Adak NAF, Adak, Alaska. Abstracts of the 1995 American Society of Agronomy Meeting, St. Louis, MO. October 30 - November 3, 1995. 1 pp.

Project Location:

Adak Island, Aleutians west region

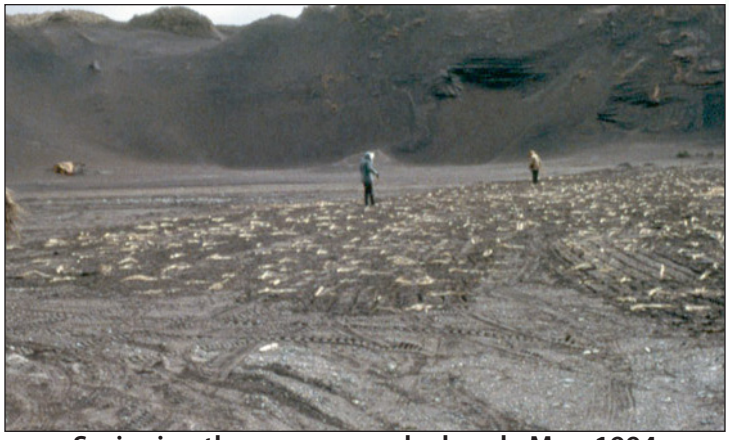


Site Photos:

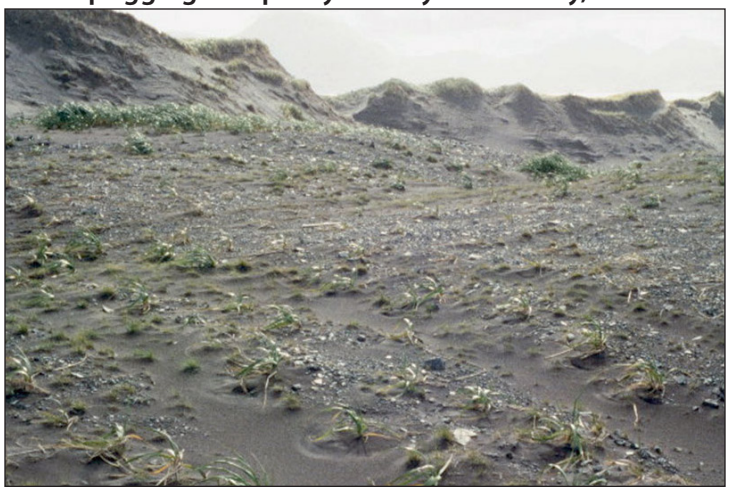


Pringle Hill sand quarry prior to revegetation - 1993

Quarry area preparation and sprigging - May, 1994



Sprigging the quarry area by hand - May, 1994



Beach Wildrye after one seasons growth - May, 1995

Photos: Stoney Wright (AK PMC)

Area over-seeded with seed mix - September, 1995

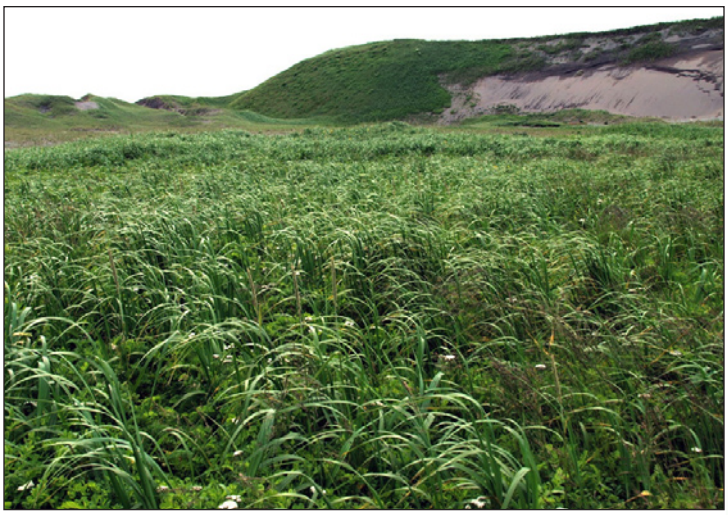
One year after seed mix applied - September, 1996

September, 1997

September, 1998

September, 1999

Photos: Stoney Wright (AK PMC)



Seeded grass presence nearly zero - August, 2009

Sand quarry species diversity - August, 2009

Landfill Restoration, Adak Island

Introduction / Objective:

In 1997, the Alaska Plant Materials Center entered into an agreement with the U.S. Navy to monitor and assist in the revegetation of four abandoned landfills on Adak Island. These landfills ranged in size from 9 acres to 70 acres.

The PMC was tasked with project plan review and field quality control assessment. This entailed reviewing project documents and making recommendations regarding revegetation methods, specifications, scheduling, and material procurement, as well as assessing site preparation, application and execution of the plan, and success of the revegetation activity.

Coastline Type:

The coastline type on Adak Island varies greatly. The abandoned landfills were located primarily on upland coastal areas, though some were on the coastline or in alpine environments.

Methods of Revegetation:

Construction services were contracted for hydroseeding. All sites were contoured and graded prior to seeding.

The White Alice and Roberts landfills were mulched with straw and covered with excelsior blankets after seeding. This resulted in poor vigor of the grasses, attributable in part to the insulating effect of the straw mulch and excelsior blankets.

Species Used:

The native seed mix used for the Palisades, White Alice, and Roberts's landfill consisted of:

%	Common Name	Scientific Name
60	'Norcoast' Bering Hairgrass	*Deschampsia beringensis*
20	'Boreal' Red Fescue	*Festuca rubra*
15	'Arctared' Red Fescue	*Festuca rubra*
5	Annual Ryegrass	*Lolium multiflorum*

Only erosion prone areas of the Metals Landfill were seeded. The majority of the site was identified for natural reinvasion by native species. Seeded areas received the seed mixture noted above.

The landfills were to be fertilized once at the time of planting with 20-20-10 granular fertilizer at a rate of 450-500 pounds per acre.

Results:

The Palisades landfill was revegetated in 1996, and by 1998 supported nearly a 100% cover of perennial grasses. Vegetation cover was thriving and reinvasion by other native species was noted. There were no signs of erosion.

Slope areas that were revegetated in 1997 at the Metals landfill supported a cover of 85-90% in 1998. No erosion was observed in these areas. Areas set aside for natural revegetation showed signs of initial reinvasion, although very minimal (<1%). It was noted that fertilizer application would assist natural revegetation, but that never occurred.

Revegetation occurred in 1997 at the White Alice landfill. 60% cover was estimated in 1998 although vigor of the grasses was poor. Revegetation at the Roberts landfill occurred in the spring of 1998, with nearly 60% cover achieved by the fall. There were no signs of erosion. Pieces of the plastic blanket reinforcement net were found throughout these landfills. For this reason, excelsior blankets are not recommended for use in windy areas. Straw is also not recommended because of possible weed seed content.

Conclusions / Lessons Learned:

None of the landfills areas showed signs of erosion, with the exception of the back slope areas of the Metals landfill. Upon final inspection, vegetation on the landfill sites was in decline and in need of remedial action (additional fertilizer).

A preoccupation with cost savings can jeopardize the success of a revegetation project. This was evidenced by changes made to the seed mixture and fertilizer formulations. The seed mix used did not correspond with the original suggestions.

Also, A 10-20-20 fertilizer composition was used, containing only half the recommended amount of nitrogen. Also, the seed mixture specifications were not followed for some of the landfill sites (White Alice, Roberts, Metals).

Poor plant establishment on these sites probably occurred because inexpensive non-native substitutes were made to the seed mix. On-site monitoring by Navy personnel was not adequate to assure a successful project.

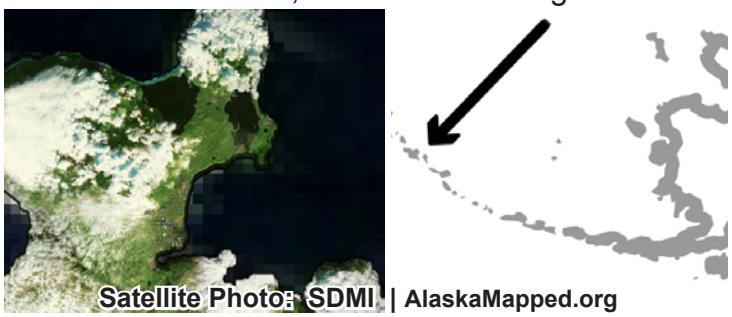
References:

Wright, S. J. 1999. Final Report – Landfill Restoration on Adak Island. State of Alaska, Division of Agriculture, Plant Materials Center. 31 pp.

Wright, S. J. 1991. Assessment of Revegetation on the Aleutian Islands – Adak, Amchitka, Shemya, and Attu. State of Alaska, Division of Agriculture, Plant Materials Center. 12 pp.

Project Location:

Adak Island, Aleutians west region

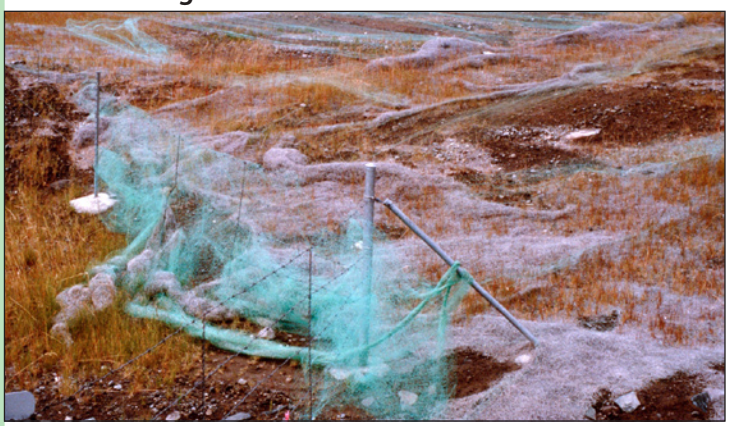


Satellite Photo: SDMI | AlaskaMapped.org

Site Photos:

Budding Annual ryegrass emerging through excelsior matting, White Alice landfill - Fall, 1997

Unraveling excelsior at White Alice landfill - 1998



Excelsior matting bunched up along fence - 1998

Excelsior matting on White Alice landfill - 1997

White Alice landfill after grading - 1997

Annual ryegrass emergence, Roberts landfill - 1998

Vegetation in decline, Roberts landfill - 1999

Vegetation stand in decline after 1998 seeding, at Roberts landfill - 1999

Photos: Stoney Wright (AK PMC)

Coastal Wetland Revegetation, Kodiak Island

By Dave Ward (Jacobs Engineering) & Estrella Campellone (USACE, AK District)

Introduction / Objective:

Under the Formerly Used Defense Sites Program, the U.S. Army Corps of Engineers contracted with Jacobs Engineering to clean-up and restore the Asphalt Disposal Area (ADA) located in Kodiak, Alaska. This effort sought to excavate pervasive heavy petroleum contamination and re-establish conditions similar to those which may have existed prior to contamination of the site by Kodiak Naval Station during or following World War II. The lowest portion of the 1.6-acre valley was probably a wetland while higher areas graded toward upland vegetation (grass, alder, and Sitka spruce).

Coastline Type:

The ADA Valley, located between Buskin Hill and Artillery Hill about 1 mile north of the Buskin River and 4 miles south of the city of Kodiak, opens onto St. Paul Harbor and Chiniak Bay. Although protected from the open ocean by a series of islands and reefs, the shingle beach and beach ridge at the mouth of the valley is occasionally overtopped by surf and storm surges created by hurricane-force easterly winds. The valley itself is sheltered by adjacent hills. Seawater usually seeps through the beach ridge at high tide, maintaining brackish conditions in a 0.45-acre pond. Heavy rains can raise the pond level, reversing the direction of seepage and thoroughly flushing the pond with fresh water. Precipitation at the nearby Kodiak Airport averages over 77 inches per year, with as much as 5 inches falling in 24 hours.

Methods of Revegetation:

In 2005, four years after the ADA valley was excavated and backfilled with shot rock, the Corps Environmental Resources Section and Jacobs Engineering teamed to design and re-establish emergent wetlands at the site. Work began by spreading a 6 to 12 inch layer of gravelly silty sand as subsoil followed, in the wetland area, by approximately 1 foot of organic-rich sandy silt topsoil. The topsoil was salvaged from a development project on Spruce Cape, a few miles to the north, and probably contained a significant bank of native seed, which augmented the intentional plantings. The upland area was hydroseeded with a standard Alaskan mix of equal parts perennial Ryegrass (*Lolium perenne*), Arctared Fescue (*Festuca rubra*), and Kentucky Bluegrass (*Poa pratensis*) plus mulch and fertilizer, applied at a rate of 20 pounds per 1,000 square feet.

In June 2006, the first attempt to revegetate the wetland utilized seed and commercially grown seedlings of species observed in other Kodiak wetlands. Species were planted in zones around the pond based on hydrology and soil conditions. The zones ranged from brackish and waterlogged soils at the normal pond level to soils saturated with fresh water during flooding, to well-drained soils at the edge of the uplands. From pond to upland, the project planted Lyngbye's Sedge (*Carex lyngbyei*, seedlings), Awl-fruited Sedge (*Carex stipata*, seedlings), American Sloughgrass (*Beckmannia syzigachne* as seed, 0.7 pounds per 1,000 square feet), Bering Hairgrass (*Deschampsia beringensis*, seedlings), and Large-flower Speargrass (*Poa eminens* as seed, 0.2 pounds per 1,000 square feet). Seedlings were planted on a 1.5 foot grid.

In late August 2006, when it became apparent that the planting was growing slowly, 20-20-10 fertilizer was applied at a rate of 13 pounds per 1,000 square feet (2.6 pounds nitrogen per 1,000 square feet). A gentle 0.5-inch watering followed. Although a significant portion of the planting appeared to be established by the end of the growing season in late September, winter wiped out most of the plants through frost-kill, ice movement, and heavy rains.

Bare areas were reseeded in June 2007 with a grass-seed mixture designed to grow over the full range of conditions ranging from brackish and palustrine wetlands to uplands. Seed was distributed at a density of approximately 2 pounds per 1,000 square feet and covered with approximately 1/8 inch of peat moss. In conjunction with reseeding, six large vegetative plugs from the Monashka Creek estuary tested the viability of transplantation. Four plugs of Lyngbye's Sedge from the upper intertidal zone were planted at the low-water edge of the pond, and two plugs of beach wild rye from the supra-tidal zone were planted at an elevation approximately 1 foot higher.

After reseeding, 8-32-16 fertilizer was applied to both uplands and wetlands at a rate of 12 pounds per 1,000 square feet (1 pound of nitrogen per 1,000 square feet). Although grasses require nitrogen primarily, this balanced fertilizer should

continue to provide some benefit, especially to non-grasses, after the nitrogen is exhausted.

Species Used:

Palustrine-Upland Seed Mix:

%	Common Name	Scientific Name
40	Arctared Fescue	*Festuca rubra*
25	Wainwright Wheatgrass	*Elymus trachycaulus*
25	Bering Hairgrass	*Deschampsia beringensis*
10	Annual Ryegrass	*Lolium multiflorum*

Transplanted Plugs*:

Quantity	Common Name	Scientific Name
4	Lyngbye's Sedge	*Carex lyngbyei*
2	Beach Wildrye	*Leymus mollis*

* Each plug consisted of a rootball approximately 8 inches in diameter, containing a mature clump of the given species.

Results:

Dominant Species after Two Seasons

Abundance*	Common Name	Scientific Name
5	Arctared Fescue	*Festuca rubra*
4	American Sloughgrass	*Beckmannia syzigachne*
3.5	Rough Bentgrass	*Agrostis scabra*
3.5	Moss (undifferentiated)	—
2	Wainwright Wheatgrass	*Elymus trachycaulus*
1.5	Timothy	*Phleum pratense*
1	Bering Hairgrass	*Deschampsia beringensis*
1	Annual Ryegrass	*Lolium multiflorum*
1	Sedge	*Carex sp.*
0.5	Scurvy Grass	*Cochlearia sessifolia*

* Five zones; awarded 0, 0.5 or 1 point per zone. 0 = absent or poor growth, 0.5 = acceptable growth with areas exceeding 25% cover, 1 = excellent growth with areas exceeding 75% cover.

Mulching, fertilization, irrigation, and wet weather produced lush growth by August 2007. Seed and plugs planted in June 2007 grew well along with American Sloughgrass (a survivor from June 2006 revegetation), Timothy (probably a contaminant in the seed mix), and Rough Bentgrass and moss (natural volunteers). Other survivors from 2006 included sedges and Bering Hairgrass. A site visit in 2008 showed that this assemblage survived the winter and appeared to be on its way to becoming naturalized.

Conclusions / Lessons Learned:

Restoration of the ADA wetland accelerated ecological succession and fostered the establishment of a diverse and adaptable assemblage of plant species. This was achieved by planting multiple species native to the region, each with distinct environmental preferences. Forage value was also considered in order to maximize habitat quality.

American Sloughgrass seed is especially attractive for restoration when conditions vary widely or are poorly known conditions. From light seeding in one zone in 2006, American Sloughgrass occurred in four of the five zones in 2007. Although the American Sloughgrass that sprouted in 2006 did not produce seed before the onset of winter, a portion of the seed remained dormant until scarified and scattered by winter conditions, resulting in wide distribution in 2007.

The excellent survival and growth of large plugs of sedges and Beach Wildrye transplanted from a nearby wetland suggest that a sparse distribution of such plugs would have revegetated the site more effectively than the dense planting of bare-root sprigs. Large plugs could be planted on a 4 or 5 foot grid, and the intervening areas could be seeded with a suitable mix of grasses.

Commercially grown ecotypes may not be suitable for local conditions. The seedlings planted in 2006, obtained from a nursery in Oregon, succumbed at least in part to an unusually cold winter. Coordination with local nurseries could yield better results if the material produced comes from local ecotypes adapted to harsh winters.

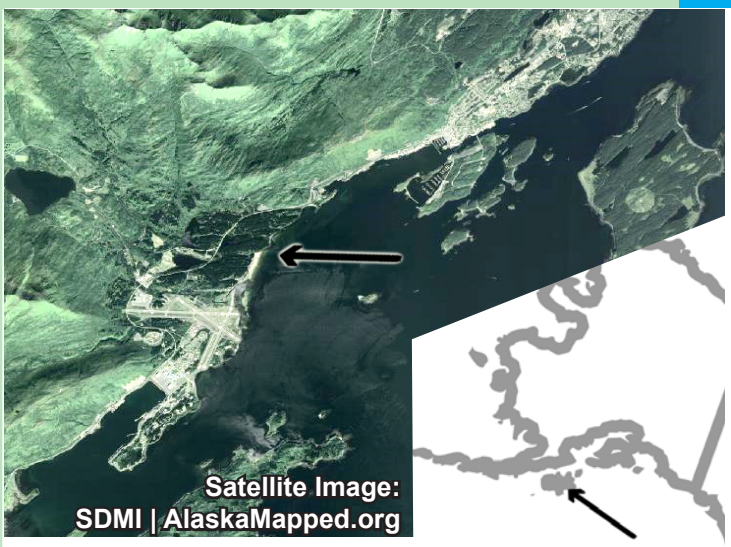
References:

Crayton, W., D.B. Ward, E. Campellone, and M. Te-Vrucht., 2007 (January). "Wetland Restoration of a Remediated World War II Dump on Kodiak Island, Alaska." In *Proceedings of the Remediation of Contaminated Sediments Conference*, Atlanta, Georgia, 22-25 January 2007. 8 pp.

U.S. Army Engineer District, Alaska, 2008 (January). 2007 Wetlands Monitoring Report, Asphalt Disposal Area, Kodiak, Alaska. Prepared by Jacobs Engineering, Anchorage, Alaska. 59 pp.

Project Location:

Kodiak Island, Southwest Alaska



Site Photos:

Project area, view to the west - October, 2006

Shot-Rock backfill before restoration - August, 2005

Subsoil and topsoil enhancement - August, 2005

Planting seedlings of Bering Hairgrass - June, 2006

Sedge at end of first season - August, 2006

Second season reseeding - 2007

Transplanted plugs of Rye and Sedge - June, 2007

High pond level after heavy rain - July, 2007

Second-season growth - August, 2007

Transplanted Sedge plug - August, 2007

Transplanted Rye plug - August, 2007

Third-season naturalization - June, 2008

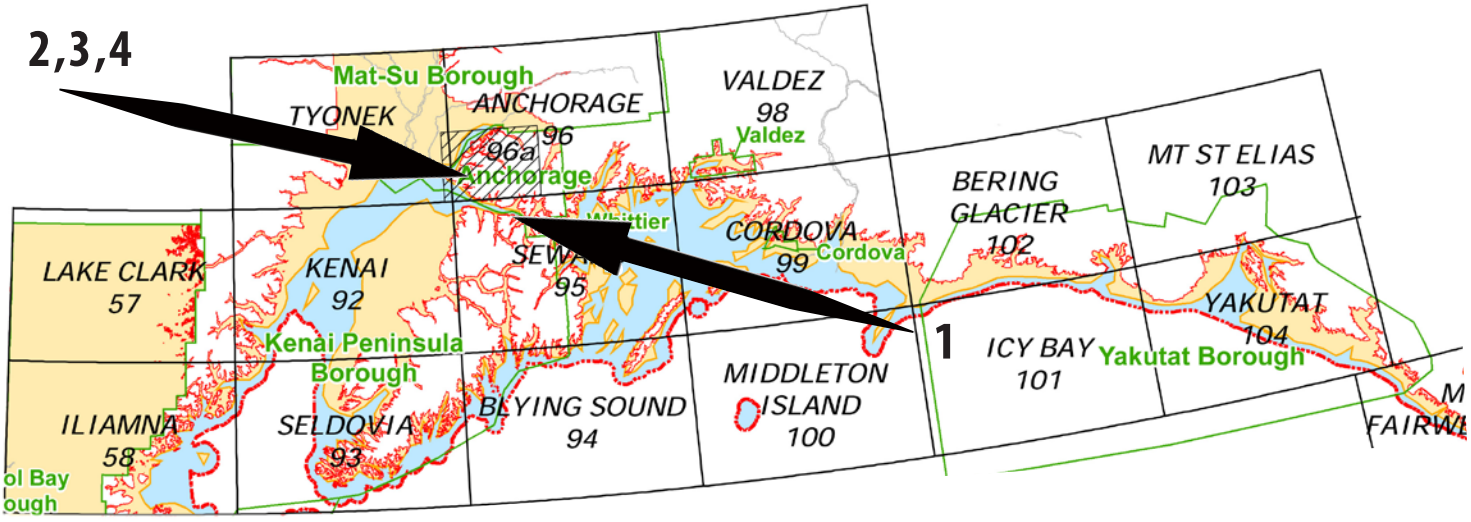
Photos: Jacobs Engineering

Southcentral Region

Southcentral Alaska is home to the Chugach National Forest, which stretches from the western Kenai Peninsula to the Copper River Delta, encompassing all of Prince William Sound. This region is rich with wildlife and plant diversity. Steep mountains and glaciers are prevalent along the entire south coast, notably along the Turnagain arm of Cook Inlet, and the northern edge of Prince William Sound. The Kenai Fjords feature rocky cliffs rising straight up from sea level, covered with vegetation.

This region is also home to two-thirds of the state's population, including Alaska's largest city, Anchorage. The infrastructure required to support this population causes this region to experience significant vegetation disturbance. Many of the projects reviewed in this section were brought about to mitigate the aesthetic effects of these construction projects. Specifically, revegetation projects near Girdwood and along the Anchorage coastal mud flats were designed with aesthetic enhancement in mind.

1. **Girdwood Area Sedge Restoration**
2. **Chester Creek Aquatic Ecosystem Restoration**
3. **Fish Creek Coastal Wetland Restoration**
4. **Anchorage Coastal Mud Flats Restoration**



Girdwood Area Sedge Restoration

Introduction / Objective:

This revegetation project was designed to address surface damage as a result of transmission line infrastructure maintenance between Girdwood and Ingram creek. The disturbed lands were primarily coastal wetlands.

Chugach Electric Association (CEA) contacted the Alaska Plant Material Center to assist in revegetation of the area. Quickly reducing visual impact was a major consideration for this project, as the adjacent Seward highway is heavily travelled by the general public and visitors to Alaska.

Coastline Type:

The eastern edge of Cook Inlet is an intertidal wetland zone. Soils in the area are composed of fine silts and clays. The area is also affected by extreme tidal fluctuations.

Maximum tides in the Turnagain Arm of Cook Inlet can exceed 42 feet, resulting in periodic flooding of the project area. The August, 1996 photo of access point 20-1A shows the effect of this exceptionally high tide has on the project area.

Methods of Revegetation:

Native species growing near the site were harvested mechanically or by hand, and then processed at the Alaska Plant Materials Center. Once the collected native species seed was cleaned and tested for both germination and purity, specific seed mixtures were developed for direct sowing at the disturbances.

The local availability of wild harvest native seed was very opportune and greatly enhanced the chances of successful revegetation. The use of native species also reduced the visual impact of introduced species in the more upland sites. Seed mixes were complemented with commercially produced native seed.

An error (spilled bag of fertilizer) on another coastal wetland revealed that unusually large quantities of fertilizer can be required for vegetation response. This is due in large part to the tight silty soils and tidal impact on these areas. The wetland areas received fertilizer at a rate of 1,000-1,500 lbs / acre. Both 8-32-16 and 20-20-10 fertilizer formulations were used on various sites. The 8-32-16 seemed to be more effective than 20-20-10 fertilizer for the restoration of disturbances in the lower elevation intertidal wetland areas.

Species Used:

The following locally collected native species were used on the project:

Lyngbye's Sedge, *Carex lyngbyei*
Boreal Yarrow, *Achillea borealis*
Beach Wildrye, *Leymus mollis*
Nootka Lupine, *Lupinus nootkatensis*
Largeflower Speargrass, *Poa eminens*

Lyngbye's Sedge was the target species in the restoration effort. This decision was based upon the species predominance and endemic distribution within the project area, especially near Girdwood. Most Lyngbye's Sedge seed was used in single species applications; not in a mix with other species.

The remainder of the collected species were incorporated into mixes with commercially acquired Bering Hairgrass (*Deschampsia beringensis)*, Bluejoint Reedgrass (*Calamagrostis canadensis)*, and a portion of the remaining Lyngbye's Sedge seed. This mix was reserved for higher elevation sites within the project area.

Results:

The seeded and fertilized areas performed well with regard to the restoration effort. All the seeded and fertilized areas supported strong stands of Lyngbye's Sedge one year after the initial seeding. The seeded sedge accounted for approximately 80% of the observed vegetation. Nearly 20% of the growth in some areas was Seashore Arrowgrass, *Triglochin maritima*, a species which was not seeded.

Those areas not seeded showed poor seedling growth relative to the seeded areas. Those areas not receiving fertilizer showed very little growth even if seeded. This indicated that heavy application of fertilizer in the area (1000 lbs / acre) was a crucial component in revegetation success. The unexpected growth of Seashore Arrowgrass can be directly tied to fertilizer application.

The access point around the circuit switcher was initially the least responsive area of the project. This site was seeded and fertilized twice, however growth did not recur as quickly at this site as

it had at other areas within the project. Evidence suggests that equipment induced compaction and tidal exposure negatively affected plant establishment.

Conclusions / Lessons Learned:

Seeding Lyngbye's Sedge is practical and effective. Managing and harvesting natural stands appears to be the best approach for obtaining significant quantities of the seed. High rates of fertilizer (1000-1,500 lbs / acre) produce excellent results. 8-32-16 fertilizer seems to be more effective than 20-20-10 fertilizer for the restoration of disturbed intertidal wetland areas.

Low impact practices employed by Chugach Electric Association aided in restoration. Fewer passes over an area allowed better final results. Rutting the soil produced the most obvious disturbances and this was minimized on the project by Chugach Electric Association's directive to the contractor.

The low impact seed harvest technique and equipment used to obtain the seed provided excellent results both in quality and quantity of seed and resulted in no harm to the existing vegetation or environment.

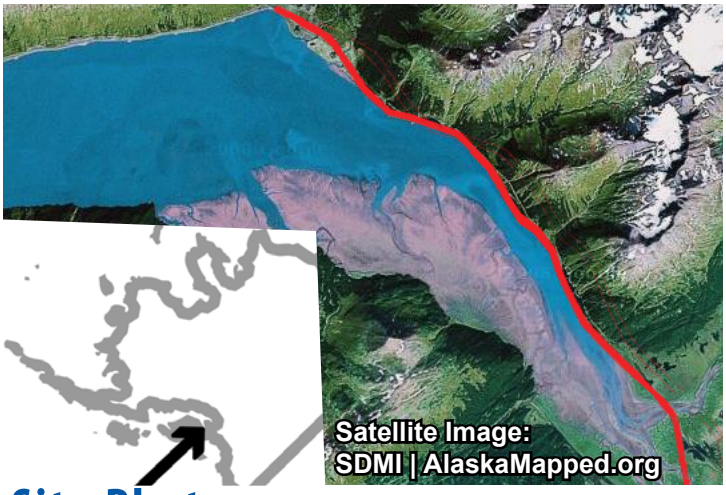
References:

Wright, Stoney J. 1998. Girdwood to Ingram Creek Restoration. Land and Water, Vol.42, No.4, pp. 26-28.

Wright, Stoney J. 1996 Final Report – Chugach Electric Association, Inc. – Girdwood – Ingram Creek Restoration Project. State of Alaska, Division of Agriculture, Plant Materials Center, Palmer, AK. 39 pp.

Project Location:

Eastern edge of Turnagain arm, Cook Inlet



Site Photos:

Photos: Stoney Wright (AK PMC)

Girdwood switching station - September, 1995

Vegetative cover completely re-established.
Girdwood switching station - September, 1996

Access point 21-1A - September, 1994

Access point 21-1A - September, 1996

Access point 20-1A, prior to restoration - July, 1995

Access point 20-1A - September, 1995

Access point 20-1A, at extreme tide - August, 1996

Access point 20-1A - September, 1996

Access point 20-2A - September, 1994

Photos: Stoney Wright (AK PMC)

Access point 20-2A - September 1995

Access point 20-2A - September, 1996

Seed stripper harvesting Lyngbye's sedge - 1995
Note: The flattened sedge in the photograph was due to construction equipment, not the harvester.

Chester Creek Aquatic Ecosystem Restoration

Contributor: HDR Alaska, Inc

Introduction / Objective:

Chester Creek was once a productive and diverse tidal estuary, but development activities (embankment construction, dam construction, etc.) starting in the 1930s and continuing until the early 1970s closed off the natural tidal flow to the area. This resulted in a loss of species diversity and colonization by less salt-tolerant plant species. Tidal flushing had once mitigated colonization attempts by these 'weedy' species. The installation of multiple culverts and an inoperable fish ladder had restricted fish passage between Cook Inlet and Chester Creek. The aforementioned development did, however, create Westchester Lagoon, a popular recreational area.

This project is located near the mouth of Chester Creek in Anchorage. Chester Creek originates in the Chugach Mountains and passes through a highly urbanized area, until draining into the Cook Inlet. The lower portion of the creek at the west end of Westchester Lagoon where it drains into Cook Inlet was the focus of restoration efforts.

The habitat restoration project was a collaborative effort between the Municipality of Anchorage (MOA), U.S. Army Corps of Engineers (USACE), MOA Department of Parks and Recreation, and HDR Alaska, Inc. In 2008, a new creek channel was created to provide fish passage between Chester Creek and Cook Inlet.

There were two wetland areas disturbed by construction activities that were the focus of revegetation efforts. These two areas are the freshwater wetland community between the Alaska Railroad Corporation and the lagoon and the Cook Inlet tide flats. The goal was to control erosion and produce a self-sustaining vegetation community reflecting the natural conditions of the surrounding undisturbed community. This was vital because of the high public usage and exposure of the area.

Coastline Type:

Westchester Lagoon is a tidal influenced freshwater emergent wetland and tidal flat.

Methods of Revegetation:

HDR Alaska Inc. surveyed the tide flats and freshwater wetland areas that were to be disturbed in order to define the existing vegetation communities. Species documented during these surveys were used to revegetate the areas. Both seeding and transplant methods were used.

Tide Flats:

Approximately 5 acres of tidal flats were disturbed during project construction. They were restored to their pre-disturbed condition by grading, seeding, sprigging, and fertilizing. The Alaska Plant Materials Center (PMC) recommended collecting *Plantago maritima* and *Triglochin maritima* seed for use revegetating the disturbed area. These species were harvested in the fall of 2008 from coastal tide flats near Fish Creek. Collections of *Carex lyngbyei* seed were also obtained. Upon collection, seeds were delivered to the PMC for processing and winter storage.

A hand operated broadcast spreader was used for applying the seed and fertilizer. Fertilizer application was done once at the time of planting with 20-20-10 granular fertilizer at a rate of 800 pounds per acre.

Seed of *Plantago* and *Triglochin* collected in 2008 were propagated at the Plant Materials Center, yielding containerized seedlings. The seedlings were then transplanted at the site. Plantings were spaced three feet apart and above mean high tide line. Planting was followed by application of the 20-20-10 N:P:K granular fertilizer using broadcast methods.

Freshwater Wetland:

Grading of the site took place before seeding. Topsoil was spread evenly over the site with settlement achieved by rolling the topsoil with a water filled drum. Seed was applied at a rate of 5 lbs / 1,000 s.f. Straw/coconut erosion control blankets were placed within forty-eight hours after grading of the topsoil was completed and the seed mix was applied. To ensure good soil contact, the surface was smoothed (all rocks and clods removed) before the erosion control blankets were applied.

Species used on the site:

Seed mix for tide flat:

Seaside Plantain, *Plantago maritima*
Seashore Arrowgrass, *Triglochin maritima*

Lyngbye's Sedge, *Carex lyngbyei*

Seed mix for freshwater wetland community:

40%	'Norcoast' Bering Hairgrass, *Deschampsia beringensis*
35%	'Egan' American Sloughgrass, *Beckmannia syzigachne*
15%	'Nortran' Tufted Hairgrass, *Deschampsia caespitosa*
5%	'Sourdough' Bluejoint Reedgrass, *Calamagrostis canadensis*
5%	'Reeve' Beach Wildrye, *Leymus mollis*

Results:

Revegetation took place in summer 2009, and complete results are not available at the time of this publication. Monitoring of the tide flats will take place in summer 2011 and 2012 and include cover sampling and area-wide observations. Success criteria for the revegetated tide flats state that total cover of all vegetation must exceed 30%. Areas that naturally have less than 30% cover will considered a success when at least 15% of the total vegetative cover is native vegetation.

A fish passage channel was constructed to allow tidal flooding to occur in freshwater wetlands possibly affecting vegetation communities. Salt intolerant species will be replaced by more salt-tolerant species. Freshwater wetland monitoring will occur for a period of seven years or until success criteria are met. The objective of this monitoring will be to evaluate the natural progression of salt-tolerant and native species and to determine if additional efforts are needed to establish vegetation in areas that do not naturally revegetate with native species. Monitoring will begin in 2010 and end in 2017. Success will be established for the wetlands when native vegetation predominantly covers the ground surface and when there are no "dead" zones.

Conclusions / Lessons Learned:

Initial public reaction to the restored ecosystem has been positive. Vegetation growth is occurring at acceptable rates.

References:

Brownlee, Sirena, 2009 Final Chester Creek Aquatic Ecosystem Restoration Revegetation and Monitoring Plan, HDR Alaska, Anchorage AK 22pp.

Project Location:

Tidal flats near Westchester Lagoon, Anchorage

Westchester Lagoon, prior to the reconnection of the lagoon with Cook Inlet, as detailed in this case study

Site Photos:

Mouth of Chester Creek in the 1940s, showing the newly constructed railway bridge. The man-made lagoon was constructed in the 1970s.

Chester creek spillway at high tide - July, 2009

Transplanted vegetation along bank - July, 2009

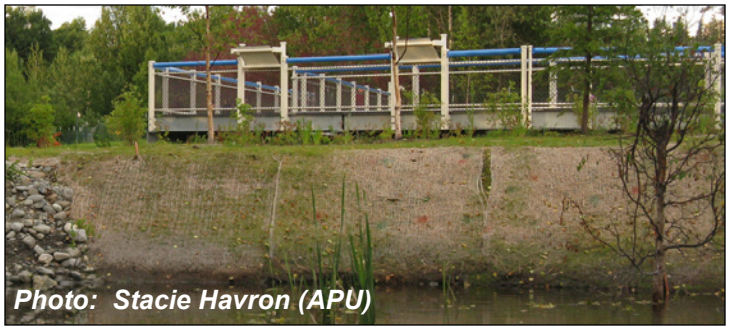
Transplanted vegetation performance - September, 2010

Vegetated slope, spillway outfall into Cook Inlet tidal mud flats - September, 2010

Flooding of spillway during high tide - July, 2009

Grass cover established along stream outfall - July, 2009

Stream outfall vegetation performance - May, 2010



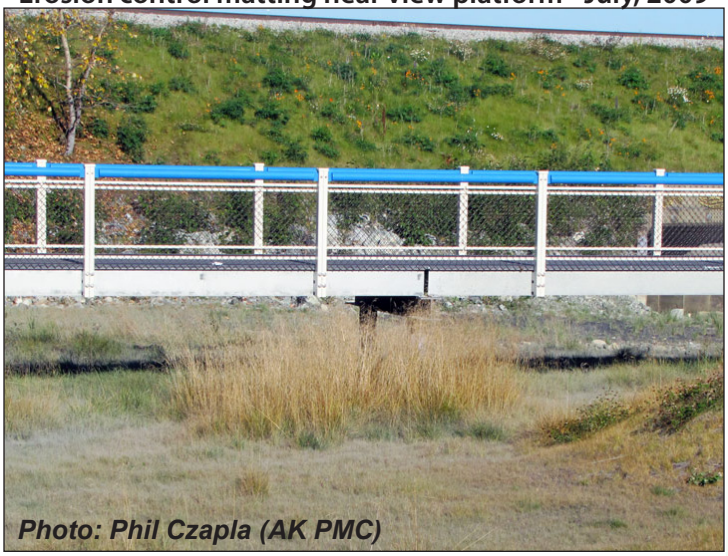
Steep vegetated grade, erosion matting - July, 2009

Erosion control matting near view platform - May, 2010

Vegetation along bank of spillway - May, 2010

Erosion control matting near view platform - July, 2009

Vegetation along bank of spillway - September, 2010



Vegetation under view platform , September, 2010

Vegetation fully established between view platforms - September, 2010

Fish Creek Coastal Wetland Restoration

Introduction / Objective:

In 1990 Anchorage Water and Wastewater Utility requested assistance from the Plant Materials Center for the restoration of a waterline adjacent to the Tony Knowles Coastal Trail and Fish Creek. Construction activities and additional site modifications left the area denuded of vegetation.

One feature of the mitigation effort for disturbing the wetland was a request by an adjacent land owner. The request was that small levees be constructed so water from high tides would be retained for waterfowl after the tide fell. This of course was problematic as the levees then needed protection from the erosive forces of the tides.

The Plant Materials Center developed a plan to reintroduce native species on to the disturbed soils and the newly created berms/levees. In addition, the PMC monitored the site through 1995.

Coastline Type:

Prior to construction, the site was a tidal influenced sedge/scirpus wetland common in the Upper Cook Inlet. The soils were consistent with tidal areas around Anchorage; tight fine silty-clay.

Methods of Revegetation:

Initially the project relied on seeded grasses and greenhouse grown seedlings for the sedges and other broadleaf species. Traditional fertilizer rates and formulations were used during the first phase (1991) of the Fish Creek Project.

In early 1992 the project was failing and plants were not surviving or growing well. The condition of the plants suggested low nutrient levels and salt/drought stress. However, one area was growing exceptionally well. That area was where a forty pound bag of fertilizer had been accidentally spilled. Normally this would have been a true dead spot with no vegetation.

On July 13-14, 1992, phase II started with additional seeding of hairgrass, sprigging of Beach Wildrye and transplanting container grown sedges (300 seedlings) and other native broadleaf species (200 seedlings of *Triglochin* and 100 *Plantago* seedlings) found in the area. In addition a few sedges were transplanted using a clam-gun to extract the sedges from adjacent stands. And to break with all traditional, practical and academic training; high rates (900-1500 pounds per acre) of fertilizer were applied to selected areas of the project. Both 8-32-16 and 20-20-10 fertilizers were used. All seeded areas were hand raked before and after seed application.

Species used on the site:

The Fish Creek project relied on species native either to the site or region. Those materials native from the site were:

Lyngbye's Sedge, *Carex Lyngbyei*
Bulrush, *Scirpus validus*
Seaside Plantain, *Plantago maritima*
Seashore Arrowgrass, *Triglochin maritima*
Beach Wildrye, *Leymus mollis*
Bluejoint Reedgrass, *Calamagrostis canadensis*
Tufted Hairgrass, *Deschampsia caespitosa*

Results:

By sheer accident this project succeeded. Had the bag of fertilizer not spilled, the need for the high fertilizer rates would have likely not been explored or tried. By September 1995 the area was well vegetated with in excess of 85% cover. The diversity reflected what was planted or seeded. The hair grass however, as expected did not persist in the lower areas and only remained on the berms.

This was the first project conducted by the Plant Materials Center that relied so heavily on greenhouse produced seedlings. This was also the first attempt to restore a coastal wetland.

Conclusions / Lessons Learned:

The significant lesson learned on the Fish Creek project was that the species used did in fact work as seedling transplants and to a lesser degree direct seeding. Coastal wetlands are capable of being restored by artificial means. The other major finding was the interesting observation that the high rates of fertilizer seemed to aid the revegetation work. More research needs to be done in this area before the practice is widely recommended.

Another interesting observation on this project was the importance of *Pucinnella nutkaensis* on tidelands. This species was selected for collection and study as a result of its active natural colonization of the site.

References:

S.J. Wright, Field Book 1990-1995

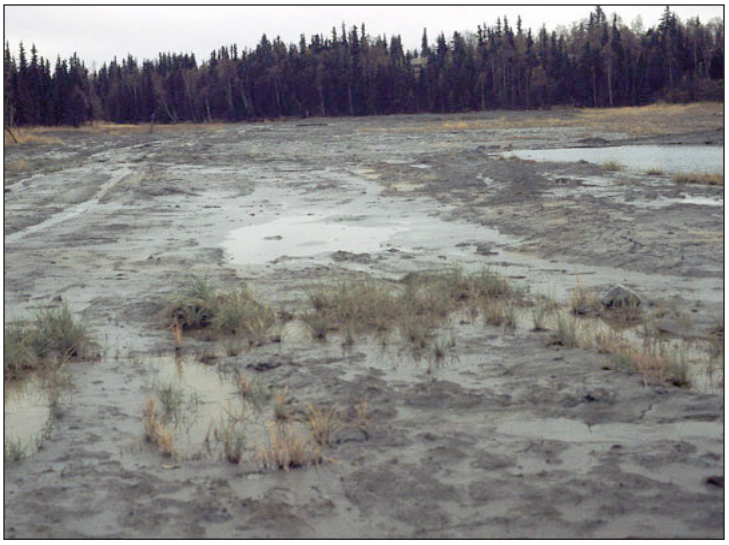
Parry, B.L & Seaman, G. 1994 Restoration and enhancement of aquatic habitats in Alaska: case study reports, policy guidance and recommendation. Alaska Department of Fish and Game, Anchorage AK p 51-53

Project Location:

Mouth of Fish Creek, Anchorage

Aerial view of the mouth of Fish Creek, Anchorage

Site Photos:



Photos: Stoney Wright (AK PMC)

Fish creek area, looking inland - June, 1988

Transplanting seedlings, looking inland - June, 1991

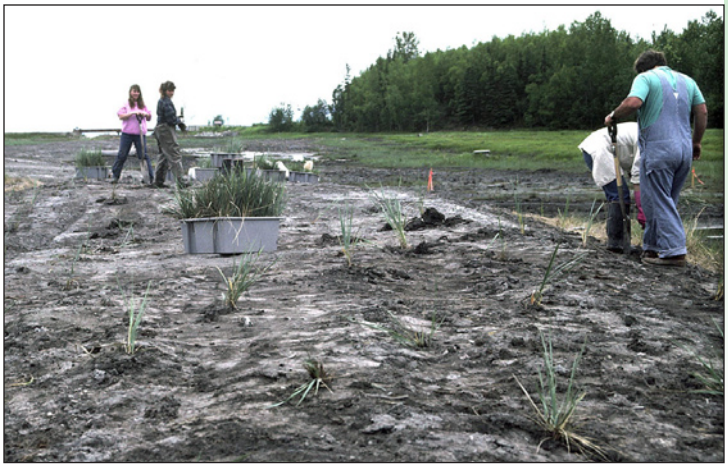
Vegetation cover, view to the north - June, 1991

Vegetation cover, looking inland - September, 1995

Transplanting in process - May, 1991

Newly transplanted sprigs along creek - June, 1990

Vegetation cover - October, 1995



Transplanting Beach Wildrye sprigs - May, 1991

Transplanted sprigs, fertilizer applied - May, 1991

Grass cover, looking seaward - August, 1991

Rock levee during high tide - October, 1992

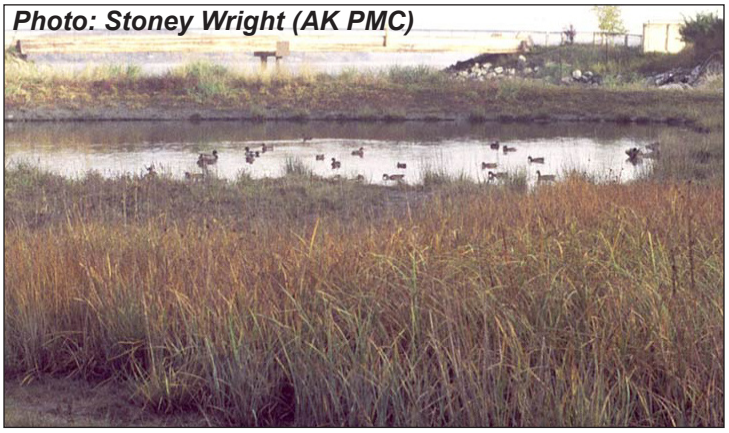
Photos: Stoney Wright (AK PMC)

Rototilling one of the upland areas - July, 1992

Grass cover, looking seaward - September, 1992

Established plant cover - September, 1994

Revegetated creek area - October, 1995



Waterfowl habitat created by impounded water

Levee, vegetation cover - September, 2010

Project area, looking upland - September, 2010

Closeup of rock levee bordering creek - September, 2010

Anchorage Coastal Mud Flats Restoration

Contributor: Oasis Environmental, Inc

Introduction / Objective:

In the fall of 1998, a 7.6-mile jet fuel pipeline was constructed between the Port of Anchorage and the Anchorage International Airport. A 3.5 mile segment of this pipeline was buried beneath intertidal mud flats in Knik Arm of Cook Inlet.

Physical disturbance resulted from construction activities. Heavy equipment travel created prominent ruts in the travel corridor, and persistent emergent vegetation was affected by equipment in the upper intertidal zone.

Reclamation and monitoring efforts began in June 1999, with the construction of silt dams at the north end of the corridor to inhibit further erosion. Signs of natural reinvasion were evident along the entire pipeline corridor. Seeding of vegetated areas of the upper intertidal zone began in July, and monitoring continued until October.

Coastline Type:

The intertidal substrates of upper Cook Inlet are characterized by silt, sand, and mud deposits. The silt and mud are primarily of glacial origin, deposited by ocean currents and tides. Areas crossed by the pipeline corridor are primarily unvegetated, although seasonal algal beds become established during the summer.

Within the project area, most of the persistent emergent vegetation is found above the mean high water line and is often associated with fresh water draining from storm sewers and creek outlets. Persistent emergent vegetation at the mouth of Fish Creek was avoided by the pipeline corridor.

Methods of Revegetation:

Seed collection occurred in summer 1998 & 1999. Final Grading and Scarification occurred in Fall 1998. Revegetation began in summer 1999.

Seeds of Seashore Arrowgrass, Seaside Plantain, and Bayonet grass were collected in the summer of 1998 and 1999. Mature seed and stalk were collected from the mud flats and placed in paper bags. The seeds were then removed from the stalk by hand, and stored in a cool, dry place. Seed was mixed in five-gallon buckets and distributed using a hand held spreader.

Due to limited germination and growth of seeded Alkali Grass at the southwest end of the corridor, the sprigging (transplanting) method was used. Transplants were obtained from within the permitted construction corridor. Field staff scooped entire blades and root systems from the top one to two inches of the mud flat surface. Small holes were dug and root clusters placed directly into mud flats. Mud was then compacted around the roots, leaving the blades exposed to the surface. These plantings occurred in areas where alkali grass was present prior to construction.

In August, 2000, Approximately 400 *Carex* plants were planted in the triangular area offshore and to the north of AWWU pump house. Plants were grown in a greenhouse until they had achieved a height of eight inches, and then transplanted to the mud flats.

In June, 2001, further planting occurred in the triangular area offshore from AWWU pump house. *Triglochin* and *Puccinellia* seeds were spread over the entire triangle, while Carex and Scirpus were planted in the NE corner of the triangle. *Plantago* was seeded in drier areas and near the rocks and rip-rap close to the Coastal Trail.

Species Used:

OASIS Environmental consulted Stoney Wright of the Alaska Plant Materials Center for species recommendations as well as the appropriate fertilizer type and amount to use. Based on these suggestions, the following species were selected for revegetation:

Triglochin maritima, Seashore Arrowgrass
Plantago maritima, Seaside Plantain
Scirpus paludosus, Bayonet Grass
Puccinellia phryganodes, Alkaligrass
Carex sp., sedge

A low-nitrogen (8-16-32) fertilizer mix was applied evenly across the project area at a rate of approximately 1,300 pounds per acre.

Results:

Pre-constuction and post-construction vegetation cover surveys were conducted by direct visual inspection of the pipeline route. A botanist inspected each segment and documented the relative cover of each habitat type.

Between Chester Creek and Hood Creek, a combination of vehicle ruts and trench subsidence occurred, causing receding tidewater or upland freshwater to be retained in construction ruts. Algae (*Vaucheria longicaulis*) cover was well established in pools, both inside and outside the corridor.

Seeding / sprigging of wetlands near the Port of Anchorage began in July of 1999. By July 2000, vegetative cover of over 50% was observed. 1999 seeding and sprigging activities were successful in this section of the corridor.

The 1999 vegetation survey indicated:

- Emergent vegetation occurring mostly at the north and south ends of the mud flats was impacted by construction activities including vehicle travel, trenching, and backfilling.
- The effects included burial, which crushed most of the vegetation within the corridor.
- In some areas, vegetation survived vehicle travel and shallow burial. This was most apparent in the south end where the substrate was frozen during construction.
- Vegetative reproduction resulted in some natural re-growth in all previously vegetated areas, providing a significant amount of biomass for future growth and reproduction. This was evident with the Slender Glasswort, which forms a dense cover throughout the disturbed areas of the north end.
- Vegetation loss of 75% - 95% total cover, compared to pre-construction cover, in northern portion of corridor.
- Vegetation loss of 40% - 65% total cover, compared to pre-construction cover, in southern portion of corridor.

The 2000 vegetation survey indicated:

- Vegetative reproduction, which provided a significant amount of biomass for future growth, has resulted in substantial plant cover in the north end of the corridor.
- Seeding, sprigging, fertilizing, and natural reinvasion have been successful in revegetating the north and south end of the corridor to pre-construction cover levels.
- Vegetation is recovering or has recovered in the northern portion of the corridor, compared to pre-construction cover.
- Vegetation cover is greater than or within 5% of pre-construction total cover, in southern portion of corridor. One exception is a small pond of about 500 square feet in size that was created next to the bluff in segment S1 (reduces the available area for vegetation). Bayonet grass (*Scirpus paludosus*) has colonized the pond and is used quite frequently by resting ducks.

The 2001 vegetation survey indicated:

- Emergent vegetation where algal beds previously were found has continued to surpass pre-construction cover in sections of the construction corridor where drier areas were created by the ditch spoils.
- Vegetation has recovered or is near recovery in the northern portion of the corridor.
- Vegetation in the southern portion of the corridor has recovered or is near recovery. Plugging of Alkaligrass proved to be the most successful method of revegetation for the south end of the construction corridor.
- Ponding of tidal water in the corridor has eliminated approximately 40% of the available area for vegetative growth in the north segments and 30% in segment S1.
- The pioneering plants for the drier portions of the affected mud flats are Sea Milkwort (*Glaux maritima*), Slender Glasswort (*Salicornia europaea*) and Seaside Plantain (*Plantago maritima*).

Conclusions / Lessons Learned:

The 1999-2001 post-construction monitoring results indicate that wetland functions had been reclaimed in all but the north segment, which comprises 20% of the mud flats corridor.

Between the lagoon and Chester Creek, construction impacts are still visible, but the depth of the trench is substantially mitigated. South of Chester Creek, visual effects are minimal. Visible signs of trench subsidence diminished over three monitoring seasons and are expected to continue.

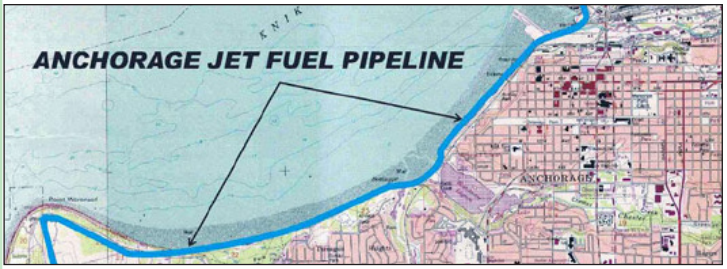
Revegetation efforts were very successful. Natural reinvasion is occurring through growth of seeded and transplanted material, as well as through colonization in all areas of the corridor. Ponding of water has limited the area available for plant colonization, although these effects are minimized through natural sedimentation.

References:

Athey, Patrick & **Brekken, Josh.** 2001 Post Construction Reclamation Monitoring Report. OASIS Environmental, Inc. 35 pp.

Project Location:

Anchorage, Alaska.
Coastline & mud flats,
from Port of Anchorage
to near Point Woronzof.



Triangle area north of AWWU pump house - 2001

Site Photos:

Site N5, view to the south - 1998

Site S2, view to the south - 1998

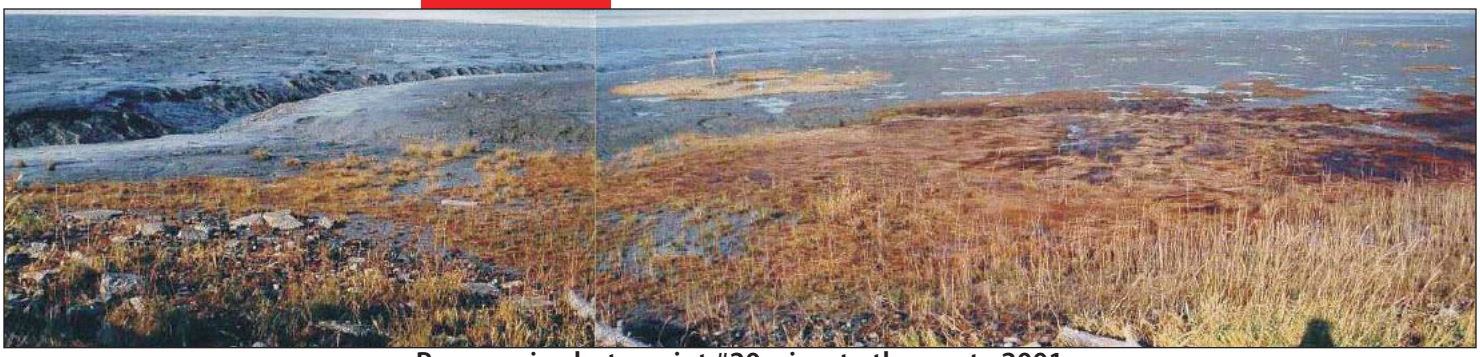
Site N5, view to the south - 2001

Site S2, view to the south - 2001

Panoramic photo point #8, view to the west. Very little vegetation present prior to construction - 1998

Panoramic photo point #8, view to the west. Note growth of algae along pipeline corridor - 2001

Photos: Oasis Environmental



Panoramic photo point #20, view to the west - 2001

Panoramic photo point #20, view to the west. Vegetation growth on both sides of channel - 2001

Panoramic photo point #21, view to the west - 1998

Panoramic photo point #21, view to the west - 2001

Panoramic photo point #30, view to the west - 1998

Panoramic photo point #30, view to the west - 2001

Photos: Oasis Environmental

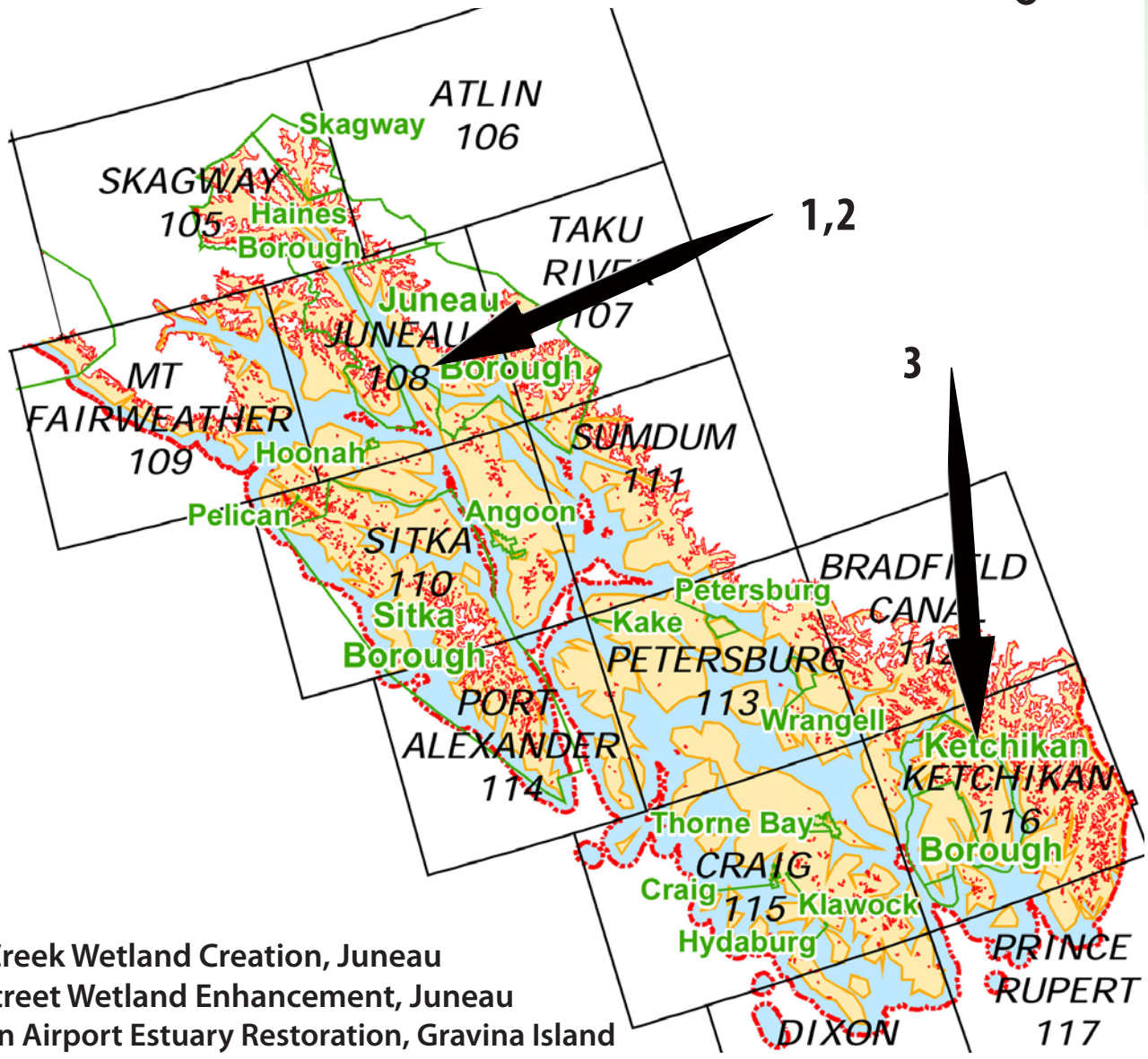
Case Studies of Revegetation Projects

Southeast Region

Southeast Alaska is one of only six or seven coastal temperate rain forests in the world. Much of the region is a part of the Tongass National Forest, and is thus closed to development.

Revegetation projects in this part of Alaska are near cities, and may not always be caused by a proximate disturbance. Unavoidable impacts to coastal wetlands can be mitigated with compensatory wetland creation. Improvements to the Nancy Street wetland in Juneau, for example, came about because of expansion of the airport, some distance away.

Both projects in the Juneau area were designed to enhance or repair existing wetland areas. The Gravina Island project was a truly massive undertaking, requiring a stream and an estuary to be moved to facilitate expansion of the Ketchikan Airport.



1. **Jordan Creek Wetland Creation, Juneau**
2. **Nancy Street Wetland Enhancement, Juneau**
3. **Ketchikan Airport Estuary Restoration, Gravina Island**

Jordan Creek Floodplain Rehabilitation, Juneau

By John Hudson and Neil Stichert (U.S. Fish and Wildlife Service)

Introduction / Objective:

Jordan Creek is an anadromous stream located on the east side of Mendenhall Valley in Juneau, Alaska. A major tributary, the East Valley Reservoir (EVR) Tributary, flows into Jordan Creek near Jennifer Drive. Historically, this tributary had deposited a large alluvial fan of sediment next to Jordan Creek. In recent years, the sediment has encroached upon Jordan Creek filling the channel with sediment and altering aquatic and riparian habitat. Of particular concern to the City and Borough of Juneau and nearby landowners was the increased flood risk caused by the fan's damming effect on streamflow. Eliminating the flood risk and managing future encroachment of the EVR Tributary fan provided an opportunity to revegetate the area with the goal of restoring important instream habitat and riparian functions.

With funding from the Alaska Department of Environmental Conservation (Alaska DEC), the Juneau Watershed Partnership (JWP) hired Inter-Fluve, Inc. to study the problem and provide several design alternatives to meet the project goals. The selected alternative entailed physically removing the fan sediment from the creek channel and floodplain and reconstructing both features. Revegetation of the site was essential to stabilize exposed soil and create a functional riparian community. Two additional project elements included the placement of rootwads in the channel and the construction of two sediment traps on the EVR Tributary. The root wads improved channel complexity by creating scour pools and overhead cover for fishes while the sediment traps were critical in managing future sediment transport from the tributary.

Species Used:

The project area soils and hydrology influenced the selection of plant species. Streambanks and other areas where the groundwater table was high were planted with leafed-out Barclay Willow and Red Osier Dogwood stakes. Live staking is typically done with dormant stakes collected in late winter and held in coolers until planting; this project provided an opportunity to test a simpler technique by using cuttings obtained on-site. Wetland species like Small Leaf Bulrush and Sitka Sedge seeds were broadcast along the stream, drainages, and the forest edge. Sitka Spruce and Western Hemlock were collected as young conifers and transplanted on the site. Lady Fern, Marsh Marigold, Sitka Sedge, Small Leaf Bulrush, and Skunk Cabbage from the surrounding area were transplanted on the site as plugs.

Methods of Revegetation:

Planting was done in three phases. The first phase involved a day of seed collection in late summer prior to stream channel construction. Using the help of local volunteers, seed was collected by hand, processed to remove impurities and then stored for use during the following summer.

The second phase involved applying a topsoil layer over the reconfigured stream channel and floodplain. A hydro-seeding mixture of Hairgrass, Fescue, Bluejoint, and Ryegrass was applied at a rate of 1 pound per 1,000 square feet. The Ryegrass was added for its fast growth and ability to stabilize the site. The site was then covered with coir fabric to protect seedlings and prevent erosion.

Seed mix for Jordan Creek floodplain:

50%	Tufted Hairgrass, *Deschampsia caespitosa*
30%	Red Fescue, *Festuca rubra*
10%	Bluejoint Reedgrass, *Calamagrostis canadensis*
10%	Annual Ryegrass, *Lolium multiflorum*

The final phase involved planting transplanted plugs along with the willow and dogwood cuttings. Transplanting was conducted by a SAGA Americorps crew.

Results:

Removal of the fan sediment from the channel and floodplain and construction of a new channel increased conveyance for Jordan Creek flow and mitigated flood risk. The excavated fan allowed for the creation of a floodplain adjacent to the channel. The placement of root wads in the channel created some channel complexity and provided pool habitat and overhead cover that was used immediately by juvenile coho salmon. Survival of rooted transplants and live stakes was highest in saturated soils. Growth of seeded grasses was excellent, with 80% cover achieved 3 months after seeding.

Conclusions / Lessons Learned:

No seed had to be ordered as local seed collection practices were an effective means of obtaining locally-adapted seed. Leafed-out willow and dogwood cuttings from the site can be used as an alternative to the use of dormant cuttings obtained in late winter. Care must be taken to place cuttings in saturated soil and 75% of leaves should be removed to ensure proper water balance within the cutting.

References:

Inter-Fluve, 2008. Hydrologic and Geomorphic Evaluation & Alternatives Analysis for Stream Rehabilitation for East Valley Reservoir Tributary Alluvial Fan on Jordan Creek, Juneau, Alaska. Inter-Fluve Inc. 73pp.

Inter-Fluve, 2008 Plan Documents, Jordan Creek Rehabilitation – Phase II. Inter-Fluve, Inc 15 pp.

Project Location:

Mendenhall Valley,
Juneau, Alaska.

Site Photos:

Alluvial fan sediment in Jordan Creek - April, 2006

Late stage of channel rehabilitation - July, 2009

Floodplain seeded, coir fabric applied - July, 2009

Revegetation processes complete - August, 2009

Vegetation cover after 3 months - October, 2009

Seeded grasses after 1 year - August, 2010

Photos: John Hudson (USFWS)

Nancy Street Wetland Enhancement, Juneau

Introduction / Objective:

The Nancy Street wetland enhancement project is the result of a partnership formed around the need for a waste disposal site for material extracted from the Mendenhall Valley high school construction project at Dimond Park. The City and Borough of Juneau (CBJ) purchased 6 acres of wetland to provide a fill disposal site only one mile from the construction site, satisfying development needs. Conservation goals from the Juneau Management Wetland Plan were also met because the fill material would improve wildlife habitat and water quality of the Nancy Street Wetland.

The Nancy Creek Wetland is located in Mendenhall Valley 10 miles northwest of Juneau, Alaska. In the 1950s-60s, the land was dredged for the extraction of gravel deposits and then left to fill with groundwater high in iron and low in dissolved oxygen content. This affected fish and other animals that require high levels of oxygen for survival. This contaminated water would eventually flow into the Mendenhall wetlands. Adding fill material to this site created a wetland community and provided plants that filter the water, thereby increasing overall habitat area for birds and salmon.

The manner in which fill was added to the Nancy Street wetland determined habitat diversity. Protruding fingers were created to allow access for equipment dumping the fill material in the middle of the wetland. The fingers became the low and high marsh habitat zones. Hauling and placing of fill material took place in September 2005. The fingers then received 6 to 8 inches of low organic rock/cobble topsoil to aid revegetation efforts.

Dam and channel outlet construction began in July 2006. Fill material was placed, the stream channel excavated, and the dam shaped in less than 2 weeks.

Methods of Revegetation:

Volunteers, members of the Southeast Alaska Guidance Association (SAGA), and Trail mix workers all participated in the revegetation effort.

Cuttings were taken on April 8. Barclays Willow, High Bush Cranberry and Black Cottonwood stakes were collected using hand pruners. These cuttings were kept in a cold storage facility until they were planted on June 7. Unfortunately, all of the Highbush Cranberry died in storage.

A SAGA crew contracted by the US Fish & Wildlife Service planted 3,600 plugs, shrubs, and small trees, and also seeded some of the wetland area. Plants were taken and moved from the source wetland and replanted on the remediation site.

Species Used:

Plants were selected based on success in previously constructed wetland sites in the region. The plants' ability to be transplanted or seeded, as well as potential for phyto-remediation of iron was also considered. Transplanting plugs was the primary method of revegetation. Cuttings of willow & cottonwood were also used, with some seeding.

The focus of the revegetation effort was transplanting local plants to preserve local gene stock and minimize the need to purchase plants. This is feasible for a 6 acre site, but for a larger freshwater wetland, a different strategy may be required.

Availability, accessibility and diversity of source wetlands determined the species chosen. Acquiring revegetation material was difficult because source wetlands were chosen to minimize cost and driving time. Only wetland accessible by a crew with a vehicle were considered, and obtaining permission was a challenge, due to the number of land owners involved.

Plants were divided into zones based on the depth of water in which they grow.

Low and High Marsh:

Marsh Marigold, *Caltha palustris*
Sitka Sedge, *Carex sitchensis*
Spike Rush, *Eleocharis palustris*
Small Leaved Bulrush, *Scirpus microcarpus*
Lyngbye's Sedge, *Carex lyngbyei*

Wet Meadow :

Western Columbine, *Aquilegia formosa*
Bluejoint Reedgrass, *Calamagrostis canadensis*
Tufted Hairgrass, *Deschampsia caespitosa*
Chocolate Lily, *Frittilaria camschatcensis*
Wild Iris, *Iris setosa*
Nootka Lupine, *Lupinus nootkatensis*
Sweet Grass, *Hierochloe odorata*

Upland Shrub :

Sitka Alder, *Alnus viridus,*
Goat's Beard, *Aruncus dioicus*

Red Twig Dogwood, *Cornus stolonifera,*
Salmonberry, *Rubus spectabilis*
Barclay's Willow, *Salix barclayi*
Red Fescue, *Festuca rubra*
Thimbleberry, *Rubus parviflorus*
Red Alder, *Alnus rubra*

Upland :
Red Alder, *Alnus rubra,*
Sitka Alder, *Alnus viridus*
Red Twig Dogwood, *Cornus stolonifera*
Sitka Spruce, *Picea sitchensis*
Black Cottonwood, *Populus balsamifera*
Salmonberry, *Rubus spectabilis*
Barclay's Willow, *Salix barclayi*
Thimbleberry, *Rubus parviflorus*
Red Fescue, *Festuca rubra*

Cornus stolonifera plugs were purchased by CBJ and planted. The species was chosen because it grows rapidly, provides berries for birds, and controls erosion.

CBJ also purchased and spread seed throughout the five month period of revegetation for erosion control and habitat enhancement.

Results:

At the end of the 2006 planting season there was approximately 70% survival rate of transplanted species.

Conclusions / Lessons Learned:

Community involvement showed great support and enthusiasm for the creation of a wetland. Local volunteers and community groups donated their time and money. Nearby property owners and the community at large have expressed appreciation for the completed wetland.

Choosing to fill and complete each finger and section of wetland individually allowed the species habitat to thrive. The other option; filling the entire site and returning to dredge the stream channel later would have resulted in less diversity of habitat.

A dry sunny period in June almost resulted in failure of the newly transplanted plants. The soil dried and cracked around the plantings. An irrigation plan would help to mitigate similar events that may arise at the site. Delaying the transplanting to a period of more favorable conditions (July), would assure more frequent precipitation. Applying topsoil with higher organic matter content will also help with moisture retention.

Lack of proper gear & equipment for the crew made harvesting and planting more difficult. Waterproof gloves, waders, rubber boots, and bigger buckets for transporting plants would have allowed the revegetation effort to progress more efficiently.

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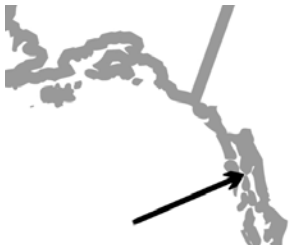
Michele Elfers, 2006,Nancy Street Wetland Enhancement: Assessment of Design and Construction. City and Borough of Juneau, Engineering Department, 69pp.

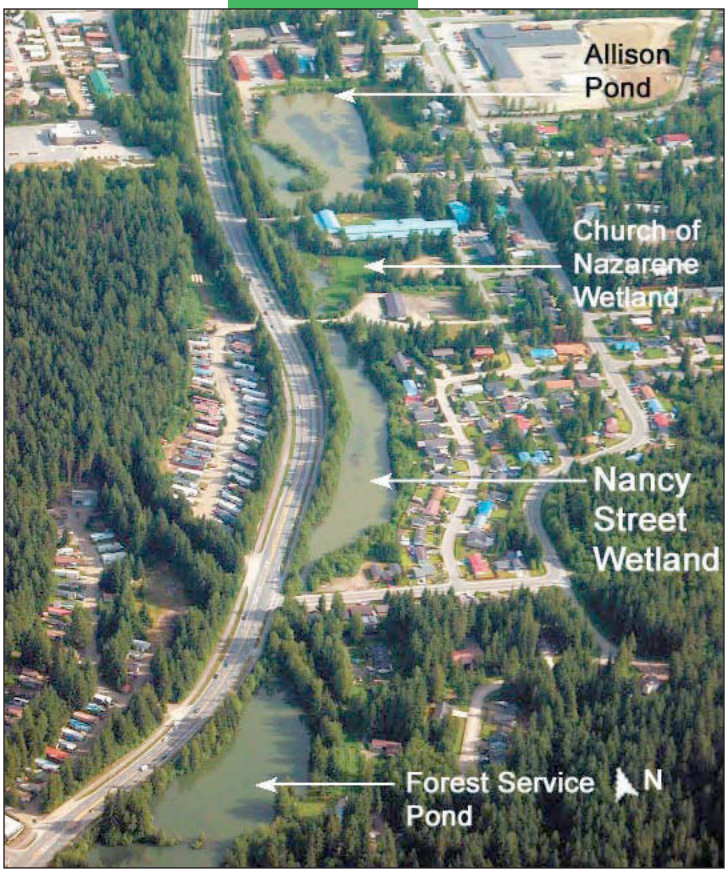
Project Location:

The Nancy Street wetland is located in the Mendenhall Valley, in the city and borough of Juneau, Alaska.



Site Photos:

Nancy Street Pond 2005, prior to reclamation



Aerial view of Nancy Street wetland area.

Early stages of filling - November, 2005

Digging outlet stream channel - July, 2006

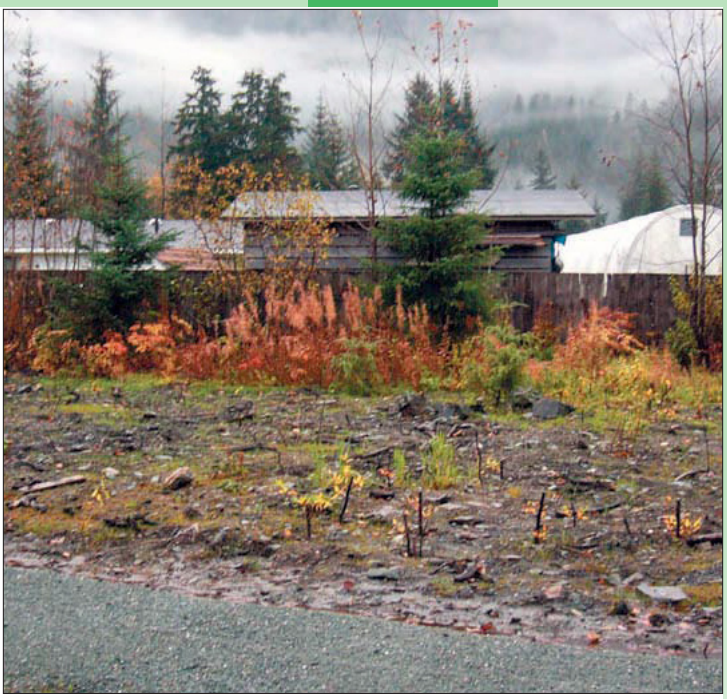
Planting willow & cottonwood cuttings - June, 2006

Leaves emerge from cuttings - August, 2006

Sedges being extracted from nearby wetland - 2006

Volunteers planting wet meadow grasses - 2006

Alders transplanted along stream channel - 2006



Transplanted cuttings bordering trail - October, 2006

Low marsh & high marsh sedges, bulrushes - 2006

Created fingers, view to the south - October, 2006

Wetland vegetation establishment - October, 2006

Finished observation deck & gathering area - 2006

Photos: Michele Elfers (CBJ)

Government Creek Relocation, Gravina Island

Introduction / Objective:

In 2007, the Alaska Department of Transportation and Public Facilities (DOT) began construction at the Ketchikan International Airport (KTN) to meet Federal Aviation Administration (FAA) design and safety standards. These improvements included expanding the Runway Safety Area (RSA) approximately 2000 feet to the southeast; which required the relocation of Government Creek. The creek was rerouted into a created stream channel, 1,250 feet in length, which enters the Tongass narrows along the previous alignment of Boulder Creek (modified to handle additional flow volume). Flow was diverted into the newly constructed channel on August 15, 2007.

The North Tributary to Government Creek was also impacted by the RSA improvements, and was subsequently rerouted into an 800-foot-long new channel that flows into the Government Creek channel at the upper limit of construction disturbance. Flow was diverted into the constructed North Tributary channel of Government Creek on June 1, 2008. Previously, flow from the North Tributary was delivered to the main creek via a pipe.

Additionally, the existing 0.7 acres of estuarine wetlands at the mouth of Boulder Creek was expanded to 1.6 acres, to replace the estuarine habitat lost due to the placement of fill for the RSA in the historical Government Creek estuary and to provide protection of marine resources including marshes and eelgrass.

Project goals included the following requirements:

- At least two pioneering species of trees or shrubs established within cut slopes and overbank areas by 2010, and at least four species of native trees or shrubs established by 2012.
- Stability of upper intertidal areas, such that these areas are not subject to wave erosion.
- Cut slopes will not display excessive gullying or erosion.
- The new estuarine area will have at least 4,000 square feet (0.1 acre) of salt-marsh area with at least 25 percent coverage by salt-marsh species by 2010.
- Monitor construction impacts on eelgrass adjacent to the project.

Coastline Type:

This area of Alaska, bordering the Tongass national forest, is characterized as temperate coastal rainforest. The estuary area is typified by salt marsh vegetation and eelgrass. The tidal area is rich in aquatic resources, including clam beds and fish habitat.

Methods of Revegetation:

During construction of the estuary, sod-like clumps of existing salt marsh vegetation were spread throughout each of three distinct areas, at different densities. Vegetation, applied as sod, was also placed on the cut slopes of the North Tributary during channel construction.

As part of the adaptive management associated with the creek reroute, seven vegetation islands were constructed in the Government Creek floodplain during the summer of 2008. The vegetation islands consisted of soil and large clumps of native vegetation placed within an armored protective barrier of logs and/or boulders, or placed in areas where erosive forces were not a concern.

Additional work was conducted in August 2008 to place pockets of topsoil in the floodplain. Topsoil placement took advantage of higher elevation locations and included some light armoring, such as anchored trees, to allow vegetation to establish. After construction, hydroseeding occurred, followed by erosion control blanket placement on the majority of cut slopes.

Species Used:

Salt Marsh Vegetation (Estuary):

Pacific Silverweed, *Argentina egedii*
Tufted Hairgrass, *Deschampsia caespitosa*
Lyngbye's Sedge, *Carex lyngbyei*
Rushes, including *Juncus effuses, J. balticus*

Constructed Vegetation Islands:

The clumps of vegetation used in construction of the islands were taken from nearby stockpiles of undisturbed vegetation left after initial clearing.

Alder, *Alnus sp.*
Hemlock, *Tsuga sp.*
Salmonberry, *Rubus spectabilis*
Labrador tea, *Ledum sp.*
Huckleberry, *Vaccinium sp.*

Results:

In general, the rerouted Government Creek and the associated expanded estuary appeared to be performing as designed and expected immediately after construction, and in September 2009.

The sod clumps of vegetation continued to appear healthy and were exhibiting signs of spreading, particularly Pacific Silverweed, which continued to send off very long runners, often greater than 5 feet. The original sod species likely have played a key role spreading seed and rhizomes for desired salt-marsh species, including Tufted Hairgrass, Lyngbye's Sedge, and the two dominant Rushes.

Estuary:

Vegetation in the recently expanded estuary has become substantially established. A number of colonizing species have become widespread, particularly alder. Several of the salt-marsh species transplanted during construction have expanded into the bare ground between the original sod placements.

The inner estuary and the upper portion of the outer bench exhibited similar vegetative characteristics, with species generally associated with freshwater riparian conditions interspersed with the transplanted salt marsh sod and expanding salt-marsh vegetation.

The upper portion of the inner estuary is the highest in elevation, and hence is inundated with saltwater less frequently than other portions of the estuary. This portion of the estuary also received the fewest salt marsh plants during construction. The area supported Tufted Hairgrass, Lyngby Sedge, and other native grasses, as noted during 2009 monitoring.

The lower portion of the inner estuary has an increased density of plants spreading from the initial sod transplants, compared to the upper portion. The vegetation consisted of 8- to 12-inch diameter plugs of sod (at approximately 5-foot spacing) of Tufted Hairgrass, Lyngbye's Sedge, Pacific Silverweed, and Rushes. Plant vigor, as observed in 2009, was generally good in this portion of the estuary.

The outer bench not immediately adjacent to the low tide portion of the rerouted channel had the greatest density of transplanted sod. The vegetation in this area also appeared the healthiest at least along the lower half of the outer bench area. The vegetation consisted of Sedges and Hairgrass at 1- to 2-foot spacing with woody debris and a few shrubs interspersed between.

During the 2009 monitoring, it was apparent from the presence of recent algal deposition, that the lower portions of this area are routinely inundated with salt water. At higher elevation sections of the estuary, some upland or riparian vegetation was beginning to colonize, such as salmonberry and horsetails.

Constructed Vegetation Islands:

Vegetation on these islands generally consisted of individual trees and/or shrubs and associated soil and ground cover species. Observed plant species included: trees, such as alder, hemlock, and Sitka Spruce (*Picea sitchensis*); a variety of shrubs, such as willows (*Salix sp.*), Salmonberry, Labrador tea, Red Huckleberry (*Vaccinium parvifolium*), and Salal (*Gaultheria shallon*); and numerous ground cover species, such as fireweed (*Epilobium spp.*), horsetails (*Equisetum sp.*), clubmoss (*Lycopodium sp.*), and several fern species.

The hydroseeded grass seed had become well established in locations where suitable topsoil existed. Stability of the vegetation islands appeared to be good, with all but one island maintaining their original soil, with minimal erosion, as observed in September 2009.

In 2009, no significant vegetation growth or establishment was observed in the Government Creek floodplain. The floodplain consisted of bare glacial till soils and bedrock. As such, soil is lacking, and the mineral nature of the soils that do exist is not conducive to vegetation growth. A few plants have been observed in rocky portions of the floodplain, growing from soil trapped in crevices in the bedrock. An additional concern is the water height during large storm events, which inundates almost the entire floodplain and can scour away any topsoil or seedlings.

The hydroseeding and erosion control blankets worked well. Some erosion and gully formation on cut slopes was noted during initial monitoring in 2008. During subsequent site visits, additional locations of erosion were noted along the slopes, though erosion was minimal. Side channel slopes of the North Tributary, cut into bedrock, did not experience any significant erosion or accretion.

The majority of the eelgrass observed in 2006, where the low tide channel of Boulder Creek

entered Tongass Narrows, is no longer present. Of the nearly 8,000 square feet of eelgrass, only about 600 square feet remained in 2008, and this had diminished to only 350 square feet by 2009.

Conclusions / Lessons Learned:

The hydroseeding and erosion control blankets placed on cut slopes performed well. Hydro seeded areas exhibit a nearly continuous grass cover. Vegetation islands appear to be an adequate solution for the lack of vegetation in the floodplain, and have the potential to become a seed source for adjacent areas.

As of September 2009, the lower intertidal zone did not meet the project goals in two areas: existing eelgrass resources were negatively impacted, and significant erosion had occurred. The extent of erosion and the overall area of impact are greater than initially estimated. It is expected that the low tide channel will stabilize over time and eelgrass beds will colonize the new delta. Loss of eelgrass in this area was anticipated prior to construction and is reflected in the Monitoring Plan and success criteria.

The loss of the eelgrass patches has resulted from a combination of channel erosion and new sediment deposition. Uniformly sandy substrate in the delta area suggests that eelgrass will become re-established in this area once the low tide portion of the creek and delta become more stable.

The transplanted salt marsh vegetation in the estuary appeared to be in good health shortly after construction. Some areas had greater coverage of transplanted vegetation than others, but it is assumed that the remaining areas will become colonized over time. The constructed elevation of some of the intended salt marsh areas may be too high to allow regular inundation by saltwater. It is likely that upland or riparian vegetation may establish over portions of the intended salt marsh.

Low Tide Channel Alignment: Changes in the alignment of the new Government Creek channel exposed during low tide caused erosion of adjacent intertidal areas and the deposition of channel sediments on the adjacent eelgrass beds. Erosion and deposition have impacted eelgrass that was previously in the footprint of the low-tide delta, although the situation is improving.

Salt-marsh vegetation has become more established since monitoring began in 2008, however riparian vegetation has flourished in areas originally intended to provide salt-marsh cover. Future monitoring will determine which of these two somewhat competing interests will dominate.

Substantial portions of the floodplain continue to receive routine overbank flows that scour many areas and hinder the formation of topsoil. The placement of additional boulders and large logs in selected overbank areas has improved the situation, but riparian vegetation cover adjacent to the creek remains sparse. Over time, perennials like alder or willows that can withstand the overbank flows may become rooted in the fractured rock and begin to accumulate soil so other plants can grow.

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Pentec Environmental / Hart Crowser, Inc., 2010. Ketchikan Airport Runway Upgrade and Safety Area Upgrade Government Creek Relocation Year 2 Monitoring Report. Prepared for Alaska Department of Transportation and Public Facilities. 62pp + Appendices

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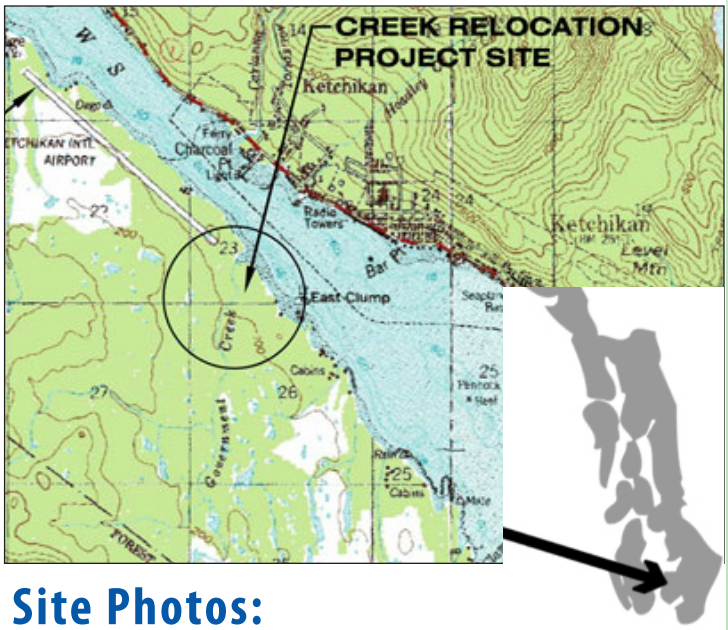
Project Location:

Ketchikan International Airport, Gravina Island, AK

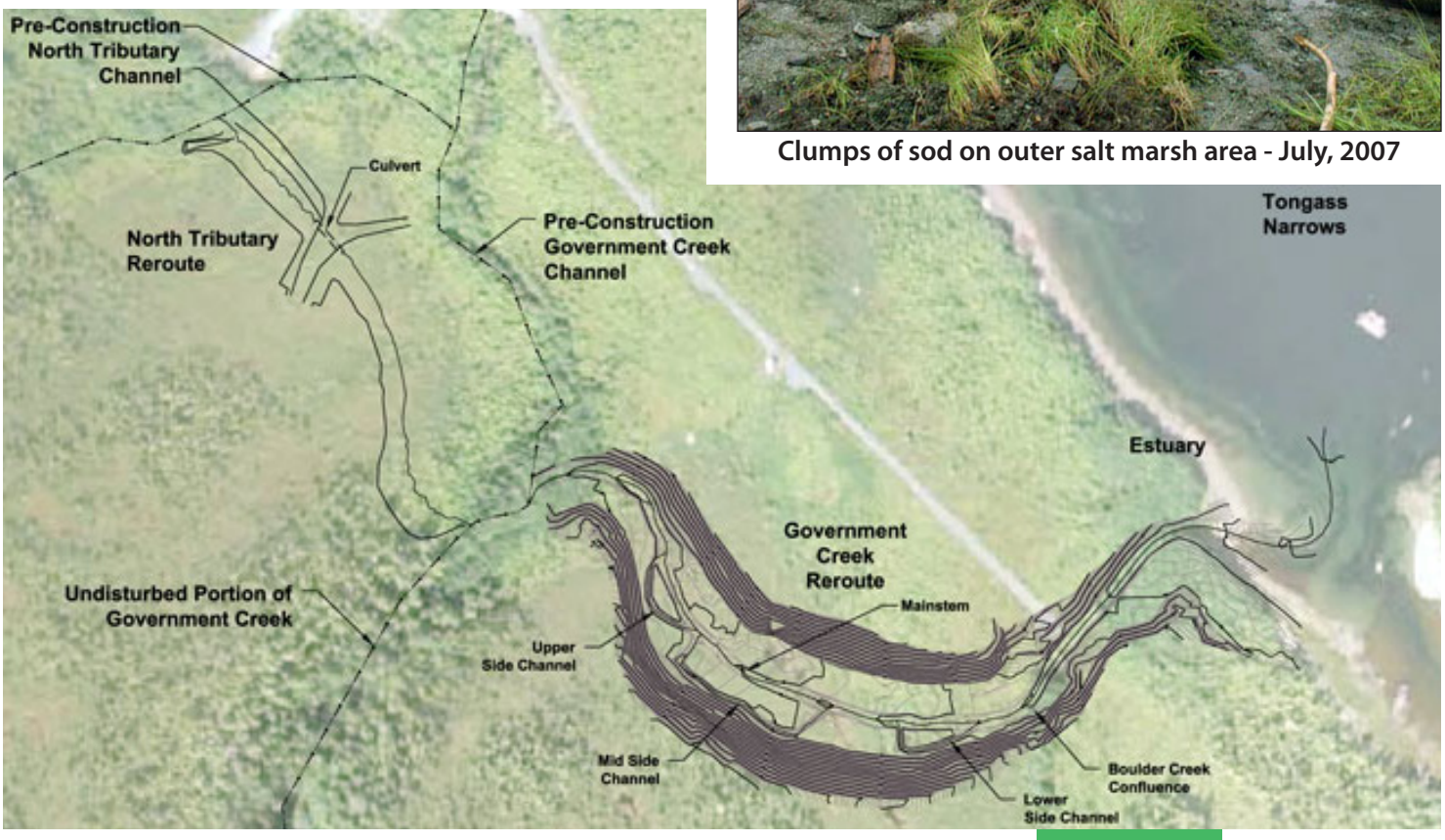


Site Photos:

Aerial view of site in pre-disturbance condition

Aerial view of site showing runway expansion, rerouted Government Creek Channel (foreground)

Clumps of sod on outer salt marsh area - July, 2007



Photos: Pentec Environmental / Hart Crowser Inc.

Cut slopes across from photo point 2 - August, 2008

Cut slopes across from photo point 2; Vegetation island, installed in summer '08 - September, 2009

Photo point N4 (North Tributary) - August, 2008

Photo point N4 (North Tributary) - September, 2009

Photo point 4, view downstream - September, 2007

Photo point 4, view downstream - August, 2008

Photo point 4. Note performance of vegetation island, installed in summer '08 - September, 2009

Photos: Pentec Environmental / Hart Crowser Inc.

Photo point 5, view downstream - August, 2007

Constructed channel, looking upstream - July, 2007

Photo point 5, view downstream - September, 2009

View of estuary from photo point 8 - August, 2007

Across from photo point 8 - August, 2007

View of estuary from photo point 8 - August, 2008

Across from photo point 8 - September, 2009

View of estuary from photo point 8 -September, 2009

Photos: Pentec Environmental / Hart Crowser Inc.

Further Information

Photo: Stoney Wright (AK PMC)

A lagoon on the Baldwin Peninsula, south of Kotzebue, bordered by a gravel bar supporting stands of Beach Wildrye (*Leymus mollis*) and Seaside Sandplant (*Honckenya peploides*)

Section 5:

1. Works Cited
2. Partner Agencies

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Partner Agencies

in Coastal Revegetation & Erosion Control

Seldom does a revegetation or restoration project occur in a vacuum. The following list includes state and federal agencies that may need to be consulted. Academic and private organizations are also listed.

Alaska Department of Fish & Game

http://adfg.alaska.gov/

The mission of the Alaska Department of Fish & Game (ADF&G) is to protect, maintain, and improve the fish, game, and aquatic plant resources of the state, and manage their use and development in the best interest of the economy and the well-being of Alaskans.

Department of Natural Resources

http://dnr.alaska.gov/

The Department of Natural Resources (DNR) has a mission to develop, conserve, and enhance Alaska's natural resources for the benefit of all Alaskans. DNR manages all state-owned land, water and natural resources, except for fish and game, on behalf of the people of Alaska.

Division of Agriculture

http://dnr.alaska.gov/ag/

The Division of Agriculture works with local producers to promote and support Alaska's agricultural industry through financing for farmers and processors, plant material development, conservation education, marketing assistance, inspection and farm product certification. The Division of Agriculture houses the Alaska Plant Materials Center.

Division of Mining, Land, and Water

http://dnr.alaska.gov/mlw/

The Division of Mining, Land, and Water (DMLW) is the primary manager of Alaska's land holdings. Responsibilities include preparing land-use plans and easement atlases; classifying, leasing and permitting state land for recreation, commercial and industrial uses, as well as coordinating and overseeing water rights.

Department of Environmental Conservation

http://dec.alaska.gov/

The Department of Environmental Conservation (DEC) has the mission of conserving, improving and protecting Alaska's natural resources and environment to enhance the health, safety, economic and social well being of Alaskans. The DEC houses the divisions of Air Quality, Environmental Health, Water, and Spill Prevention and Response.

US Army Corps of Engineers, Alaska District

http://www.poa.usace.army.mil/

The US Army Corps of Engineers, Alaska District provides a full spectrum of quality engineering, technical, and construction support services in support of peacetime and contingency operations in Alaska and throughout the Pacific Region. Major programs focus on military construction, civil works and environmental cleanup.

National Climatic Data Center

http://www.ncdc.noaa.gov/oa/ncdc.html

The National Climate Data Center (NCDC) develops both national and global data sets used by both government and the private sector to maximize the resource provided by our climate and minimize the risks of climate variability and weather extremes. The Center has a statutory mission to describe the climate of the United States and the NCDC keeps track of trends and anomalies of weather and climate. The NCDC maintains the world's largest archive of climate data.

National Oceanic and Atmospheric Administration

http://www.noaa.gov/

The National Oceanic and Atmospheric Administration (NOAA) has responsibilities that include daily weather forecasts, severe storm warnings and climate monitoring, as well as fisheries management, coastal restoration and supporting marine commerce.

National Marine Fisheries Service, AK Regional Office

http://www.fakr.noaa.gov/

NOAA's National Marine Fisheries Service (NMFS) is dedicated to the stewardship of living marine resources through science-based conservation and management, and the promotion of healthy ecosystems. The Alaska Region of NOAA Fisheries works to protect and enhance Alaska's marine habitat, and has responsibilities covering 842,000 square nautical miles off Alaska.

NMFS Habitat Conserveration Divison

http://alaskafisheries.noaa.gov/habitat/default.htm

NMFS' Habitat Conservation Division (HCD) works to avoid, minimize, or offset the adverse effects of human activities on Essential Fish Habitat (EFH) and living marine resources in Alaska. This work includes conducting and/or reviewing environmental analyses for activities ranging from commercial fishing to coastal development to large transportation and energy projects. HCD identifies technically and economically feasible alternatives and offers realistic recommendations for the conservation of valuable living marine resources. The Habitat Conservation Division also maintains the ShoreZone mapping system, which combines low-tide oblique angle aerial imagery with geomorphic and biological data.

ShoreZone is located at:
http://alaskafisheries.noaa.gov/habitat/shorezone/szintro.htm

NMFS Habitat Restoration Center

http://alaskafisheries.noaa.gov/habitat/restoration.htm

The NOAA Fisheries (NMFS) Restoration Center restores coastal habitats and provides technical restoration expertise on restoration planning, implementation and monitoring, as well as financial assistance through various grant programs. Since 1996, the NMFS Restoration Center has supported nearly 70 community restoration projects in Alaska, benefiting more than 560 acres of estuarine and riparian habitat.

Natural Resource Conservation Service

http://www.nrcs.usda.gov/

The Natural Resource Conservation Service (NRCS) is a program of the U.S. Department of Agriculture (USDA). NRCS works with landowners through conservation planning and assistance designed to benefit the soil, water, air, plants, and animals that result in productive lands and healthy ecosystems. NRCS works at the local level, maintaining field offices at 12 locations across Alaska. To find the closest service center for your region, refer to the map at: http://www.ak.nrcs.usda.gov/technical/fo.html. The Natural Resource Conservation Service provided the funding to produce this publication.

NRCS Soils Website

http://soils.usda.gov/

This NRCS soils website is part of the National Cooperative Soil Survey, an effort of Federal and State agencies, universities, and professional societies to deliver science-based soil information.

US Forest Service

http://www.fs.fed.us/

The U.S. Forest Service (USFS) is an agency of the U.S. Department of Agriculture. The Forest Service manages public lands in national forests and grasslands. Alaska has two National Forests managed by the USFS; the Chugach, in Southcentral Alaska, and the Tongass, in Southeast Alaska. These forests total nearly 22 million acres, including over 7 million acres of wetlands.

US Fish & Wildlife Service

http://fws.gov/

The U.S. Fish and Wildlife Service works to conserve, protect, and enhance fish, wildlife, plants, and their habitats. The USFWS is the only agency in the federal government whose primary responsibility is management of these important natural resources for the American public. USFWS is responsible for implementing and enforcing some important environmental laws, such as the Endangered Species Act, Migratory Bird Treaty Act, & Marine Mammal Protection.

US Bureau of Land Management

http://blm.gov/

In Alaska, the Bureau of Land Management administers approximately 75 million surface acres of federal public land - an area larger than the State of New Mexico. The Bureau has an active program of soil and watershed management on 86 million acres in Alaska. BLM encourages practices such as revegetation, protective fencing, and water development that are designed to conserve and enhance public land, including soil and watershed resources.

Western Regional Climate Center

http://www.wrcc.dri.edu/

The Western Regional Climate Center (WRCC) consolidates delivery of climate services at national, regional and state levels, working with the National Climatic Data Center, National Weather Service, the American Association of State Climatologists, and NOAA Research Institutes.

Alaska State Climate Center

http://climate.uaa.alaska.edu/

The Alaska State Climate Center, an effort of the University of Alaska, provides climatological information and official weather data to the public. The climate center library contains a wide variety of publications of climatologically interest.

Alaska Climate Research Center

http://climate.gi.alaska.edu/

The Alaska Climate Research Center is a research and service organization at the Geophysical Institute, University of Alaska Fairbanks. The group conducts research focusing on Alaska and polar regions climatology and maintains an archive of climatological data for Alaska.

Juneau Watershed Partnership

http://www.juneauwatersheds.org/

The Juneau Watershed Partnership (JWP) promotes watershed integrity in the City and Borough of Juneau through education, research and communication while encouraging sustainable use and development.

Kenai Watershed Forum

http://www.kenaiwatershed.org/

The Kenai Watershed Forum (KWF) is a 501(c)(3) non-profit organization dedicated to maintaining the health of the watersheds on the Kenai Peninsula. KWF is active in education, restoration, and research.

Colville River Watershed

http://www.colville-watershed.org/

The mission of Colville-Watershed.org is to promote sustainable resource development, and to help increase public understanding of the watershed issues and hydrology of the Colville River. Collection of baseline data is a primary focus of this organization.

Alaska Association of Conservation Districts

http://www.alaskaconservationdistricts.org/

Alaska Association of Conservation Districts' (AACD) mission is to actively support 12 statewide Soil and Water Conservation Districts, while providing other services such as education programs, information, meetings and conferences. The Alaska district works as a community-based organization, serves as a non-regulatory agency, maintains strong partnerships with other agencies and becomes involved only at the land users' request.

Appendix A:

Beach Wildrye Planting Guide

Photo: Stoney Wright (AK PMC)

Abandoned sand quarry on Adak Island, revegetated with Beach Wildrye

Beach Wildrye is a native species that is highly adapted for revegetation and erosion control on sandy and/or gravelly coastal areas, river and lake banks, and unstable dune areas.

This guide is intended to give the user ideas and techniques for using Beach Wildrye through a series of flow charts from which actual need and method of use can be determined. If Beach Wildrye has a place in your revegetation plan and you require additional information, please contact the Alaska Plant Materials Center at (907) 745-4469. Alternatively, visit the Plant Materials Center's website, at plants.alaska.gov/.

BEACH WILDRYE

Planting Guide for Alaska

By Stoney Wright

Originally Published in 1994
Reprinted in 2010

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DIVISION OF AGRICULTURE
PLANT MATERIALS CENTER
PALMER, ALASKA

UNITED STATES NAVY
ENGINEERING FIELD ACTIVITY NORTHWEST
POULSBO, WASHINGTON

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US. ARMY CORPS OF ENGINEERS
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WHAT'S IN A NAME?

Beach Wildrye is an easily identifiable grass species common throughout coastal and insular Alaska. This species (or subspecies) has been called 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 as the scientific name of the species. It has also been called *Elymus mollis, Leymus arenarius* and *Elymus arenarius. Leymus mollis* is the third scientific name the Plant Materials Center has used since starting to work with Beach Wildrye. 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”.

FIGURE a.2: Typical stand of Beach Wildrye on a gravel beach.

WHERE DOES IT GROW?

Beach Wildrye is the North American species or variety of the *Elymus arenarius* 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 land lakes occupying the same relative shoreline areas as in the marine coastal areas (Klebesadel 1985).

FIGURE a.3:
Typical coastal band community of Beach Wildrye

Photos: Stoney Wright (AK PMC)

FIGURE a.4: Rock-based Beach Wildrye community in Prince William Sound

THE FIRST DECISION: DO YOU NEED BEACH WILDRYE?

If you wish to revegetate or control erosion on a coastal site or fore-dune area where drifting sand is a concern, Beach Wildrye may be the preferred species. If a pre-existing stand of Beach Wildrye needs to be recreated, it is the only solution.

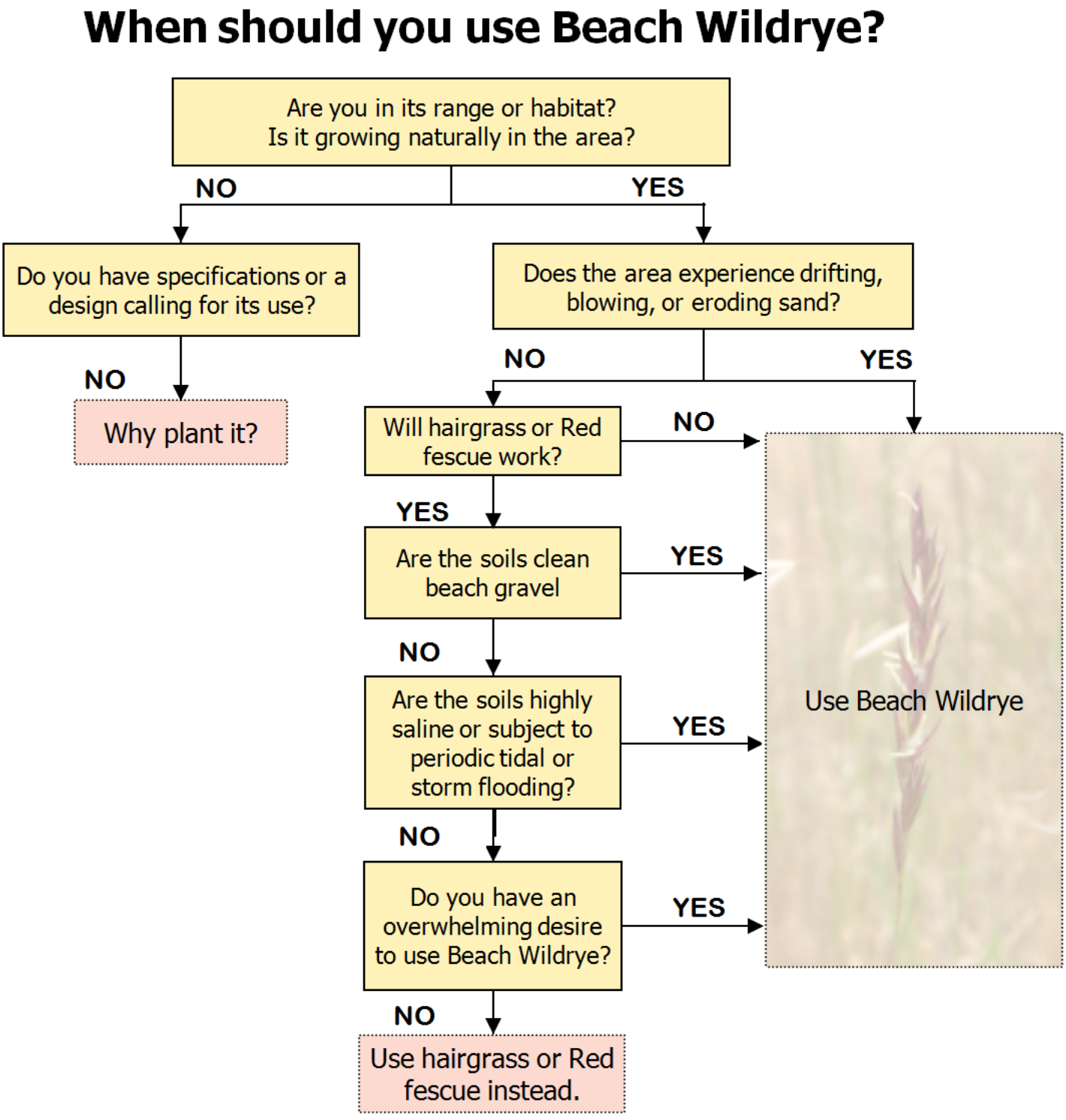


FIGURE a.5: Do you need or want Beach Wildrye?

WHAT TO PLANT: THE SECOND DECISION

Usually when planning a revegetation or erosion control project, seed comes to mind. Beach Wildrye may require a different approach. At the time of this publication's printing, Beach Wildrye seed is not commercially available. However, in 1991, two cultivars of Beach Wildrye were released for commercial production. One was developed for vegetative reproduction or transplanting (sprigging) the other for seed production.

To date, the most common method of using Beach Wildrye has been sprigging. As seed becomes commercially available, more projects will use standard seeding methods.

SEED vs.	SPRIGS
ADVANTAGES	**ADVANTAGES**
Reduced cost	Readily available
Low manpower requirements	Can be used on erosive sites
Standard method can be used	High degree of success
	Allows for layout design
	Can tolerate flooding by high tides or storm surges soon after planting
DISADVANTAGES	**DISADVANTAGES**
Slow growth	Higher manpower requirement
Low vigor	Higher costs
Short supply	
Not adapted for all sites	

Table a.1: Seed/Sprig comparisons

Once it has been determined that Beach Wildrye will be used for a revegetation project, Figure a.6 can guide the process for selecting a planting technique and address additional considerations important for planting the project.

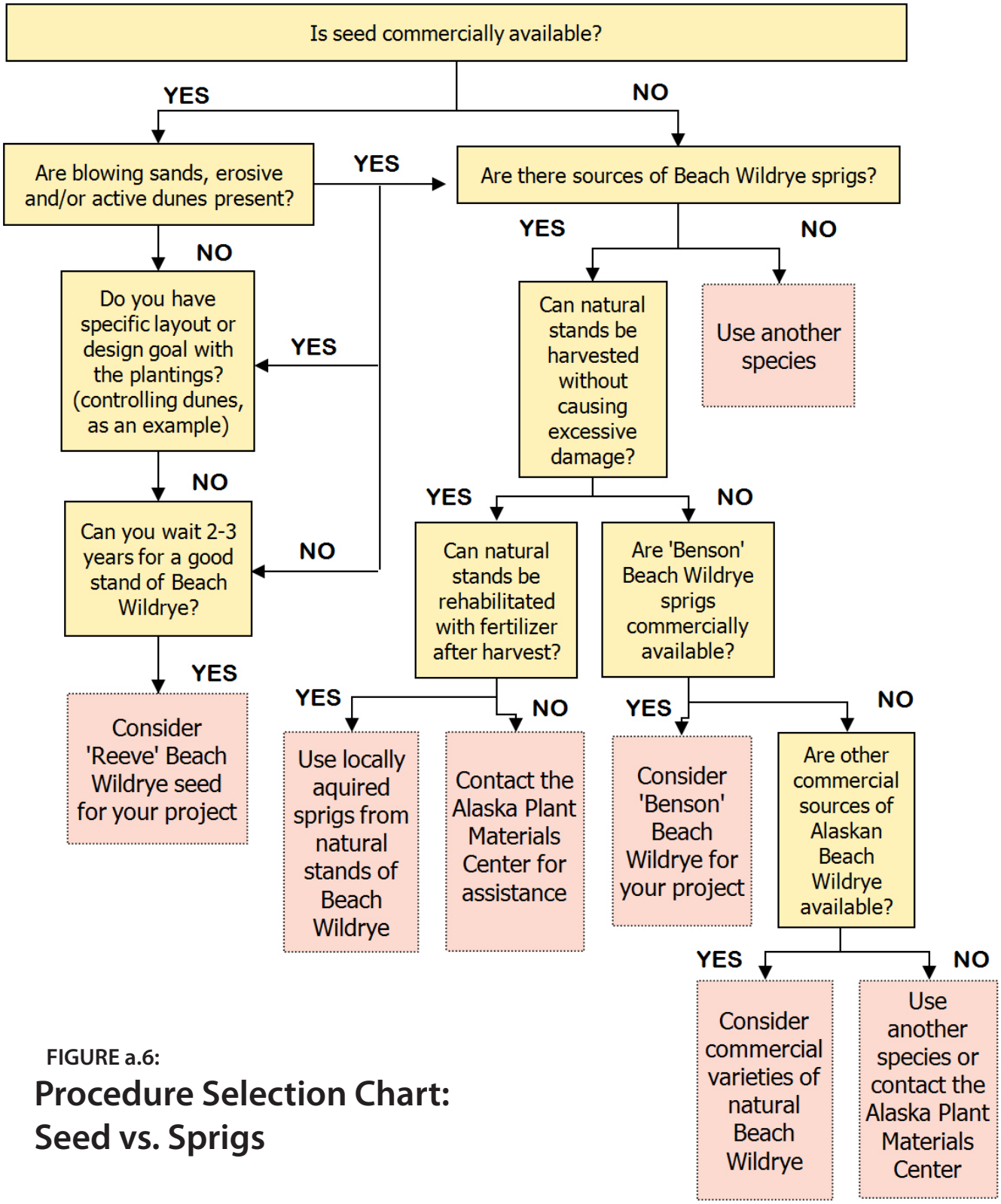


FIGURE a.6:

Procedure Selection Chart: Seed vs. Sprigs

SPRIGGING: A.K.A. TRANSPLANTING

What is a sprig?

Basically, a sprig of Beach Wildrye is the smallest division taken from a live Beach Wildrye plant that can be used to grow a new plant.

FIGURE a.7: Clump of Beach Wildrye, prior to division

Does the sprig need to have well developed roots attached?

No. A Beach Wildrye sprig will rapidly regenerate new roots.

Does the sprig need to have green leaves?

No. The above ground portion of the sprig may be dormant when transplanted. Also, if the leaves are green when transplanted, they die back after transplanting. This is not reason for concern. New growth will start from the below ground portion.

Is it necessary to trim either the leaves or the below ground portion of a sprig?

No. Simply transplant the entire sprig.

How many times can a clump of Beach Wildrye be divided?

A clump can be divided to a point where only a portion of the below ground crown and above ground leaf mass exists.

SPRIGGING: A.K.A. TRANSPLANTING

Photo: Brennan Veith Low (AK PMC)

FIGURE a.8:
Sprigs of Beach Wildrye, one year after planting at the mouth of the Kenai River

FIGURE a.9: Excavator used to harvest Beach Wildrye

FIGURE a.10: Loader used to harvest sprigs

Photos: Stoney Wright (AK PMC)

HOW ARE SPRIGS HARVESTED?

Several tools can be used to harvest Beach Wildrye sprigs. Shovels are an appropriate tool for harvesting small quantities of sprigs or for harvest in sensitive areas.

When possible, a backhoe, excavator, or front-end loader (Figures a.9 - a.11) provides a very efficient harvesting tool. With this equipment, sod blocks are dug and moved to a site where workers can easily remove sprigs by hand. The vibration and force exerted by the equipment on the sod loosens the soils, usually sand, and allows large undamaged clumps to be removed easily by hand. These are then further divided into individual sprigs for planting.

At the Alaska Plant Materials Center, Beach Wildrye is harvested with a potato digger (Figure a.12). This specialized tool is fragile and is more appropriate for use in the commercial production of Beach Wildrye than for wild harvested plants.

FIGURE a.11:
Loader preparing to lift a natural stand of Beach Wildrye for sprig harvest

Photos: Stoney Wright (AK PMC)

FIGURE a.12: A potato digger used to harvest Beach Wildrye at the Alaska Plant Materials Center

Planting can be accomplished with shovels or construction equipment. If a shovel or spade is used, simply drive the point four to six inches in the soil. Push the handle forward and slip the sprig into the slit behind the shovel. Note this is done without withdrawing the shovel or spade (Figure a.15).

It is more efficient to use machinery to open trenches, as shown in figures a.13 and a.14.

FIGURE a.13: Modified dozer blade with 'tiger teeth'

Photos: Stoney Wright (AK PMC)

FIGURE a.14: A site prepared with tiger teeth

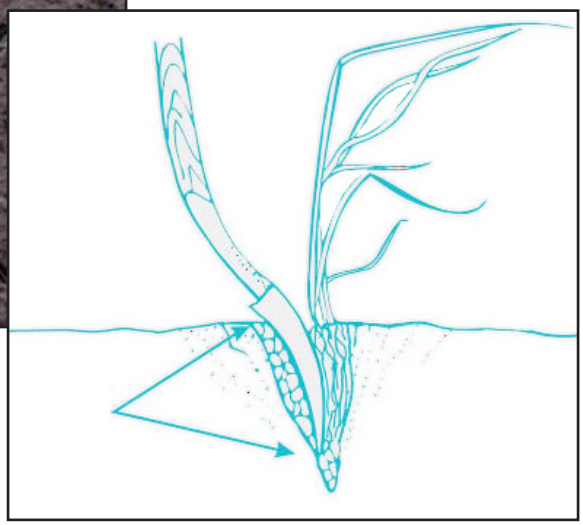


FIGURE a.15: Shovel method of planting

PLANTING

The actual planting technique is referred to as the "drop and stomp method". This technique is not described in any landscape or horticulture text, however, the technique has been proven at both Shemya AFB and Adak NAF.

The use of mechanical tree planters (Figure a.18) can be used on production ground with good results. It is unlikely that a contractor will use this type of equipment. Instead, they will rely on standard construction equipment or manual methods.

FIGURES a.16 AND a.17:
Drop (above) & stomp (below) planting method

Photos: Stoney Wright (AK PMC)

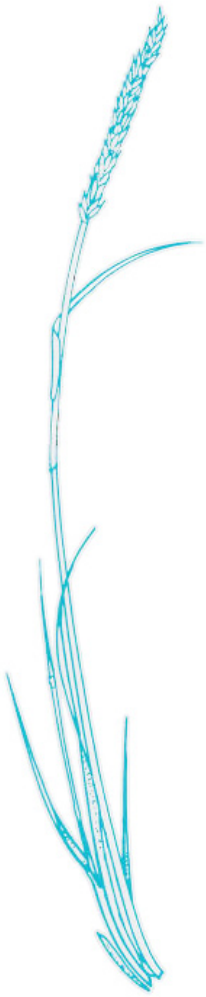
FIGURE a.18:
Mechanical tree planters can be used to plant Beach Wildrye

Do the sprigs need to be planted vertically?

No. Beach Wildrye sprigs can be placed in any position and will resume growth, thereby eliminating the need for careful upright planting (Wright 1990a). Negative geotropic growth resumes quickly from inverted seed blocks (Amundsen 1986) indicating haphazard and rough treatment of the sprigs is acceptable. This was verified on Shemya.

When can the sprigs be transplanted?

One major drawback usually pointed out for this species is that the window or time period for successful planting is very limited. Carlson (1991) states "American dunegrass (Beach Wildrye) must be planted when dormant". This point has been dismissed in Alaska. Table a.2 lists various planting times attempted by the Plant Materials Center. High success rates have been reported at all sites from mid May to mid September. This may be in part due to the relatively cool temperatures and cloudy conditions typical of all of the planting sites in Alaska. As a general rule in Alaska, try to complete all transplanting prior to September 1 south of the Arctic Circle, and prior to August 1 north of the Arctic Circle.



LOCATION	PLANTING DATE	SUCCESS RATE after 1 year
Shemya	5/15	98% [1]
Red Dog	6/15	99% [2]
Adak	6/23	93% [3]
Shemya	7/12	98% [1]
Adak	7/18	99% [3]
Port Clarence	7/20	70% [2]
Kuparuk	8/16	96% [4]
Adak	8/17	98% [3]
Fish Creek (Anchorage)	8/23	60% [5]
Adak	9/15	99% [3]

[1] Based on 3 replications of 300 sprigs

[2] Based on 2 replications of 50 sprigs

[3] Based on 3 replications of 100 sprigs

[4] Based on 25 sprigs, no replication

[5] Based on 50 sprigs, no replication

TABLE a.2.
Percent survival of locally collected Beach Wildrye sprigs related to time of planting (Wright et al 1987, Wright 1980a, 1990b).

Photos: Stoney Wright (AK PMC)

FIGURE a.19: A site on Shemya sprigged in May 1987

FIGURE a.20: Same Shemya site in September 1989

What spacing should be used for transplants?

In general, a 3-4 foot on center spacing is adequate. If the site is subject to severe erosion, 18 inches may be needed.

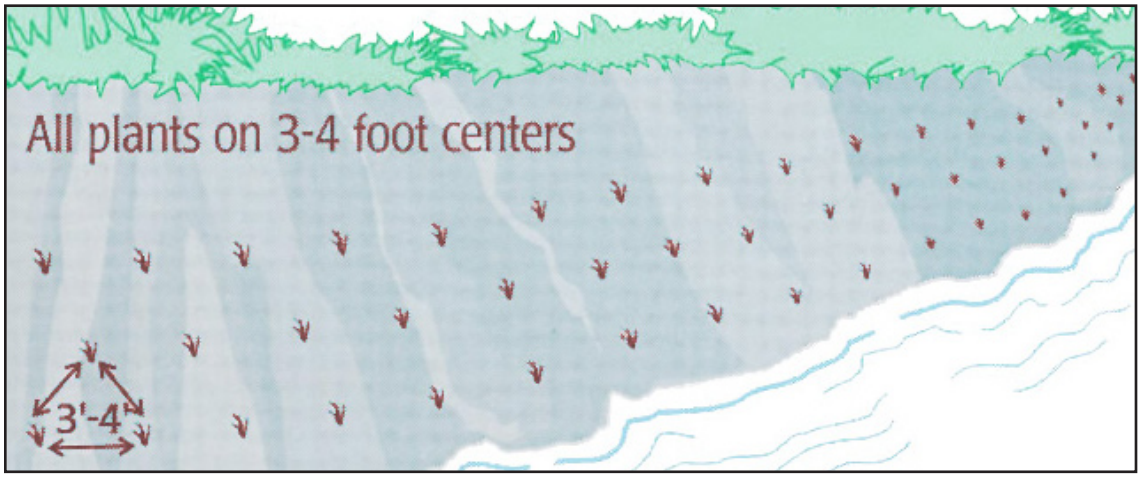


FIGURE a.21: Typical planting layout

Photos: Stoney Wright (AK PMC)

FIGURE a.22:
A planting site on Adak in June 1989

FIGURE a.23: The Adak planting site in August 1991

How long will it take to plant an acre?

The time required depends on the spacing between sprigs and how many are planted per acre.

Projects at Shemya, Port Clarence, Kasilof and Adak indicated that 400 sprigs could be dug and prepared per man-hour relatively easily and that 350 sprigs could be planted per man-hour using the drop and stomp method.

What should I expect for survival?

A well planned project planted with reasonable care can be expected to have a sprig survival rate of 90%. Figures a.19 - a.20, and a.22 - a.25 show successful plantings at three sites in Alaska.

Photos: Stoney Wright (AK PMC)

FIGURE a.24:
Adak dune restoration project in 1989, 3 months after sprigging

FIGURE a.25: Same Adak dune area in 1994, 5 years after sprigging

USING SEED TO ESTABLISH BEACH WILDRYE

Beach Wildrye as a species is notorious for not producing seed. The Plant Materials Center has expended a great deal of effort in finding a collection of Beach Wildrye that would produce commercially viable amounts of seed. By 1991 these efforts resulted in the release of 'Reeve' Beach Wildrye, a collection from Norway. This release is classified as *Leymus arenarius.* The demand for seed should be strong if it becomes commercially available, and *Leymus arenarius* can be substituted for *Leymus mollis.*

What is Beach Wildrye seed like?

Beach Wildrye seed is very large when compared to other grasses. There are 33,000 seeds per pound. For comparison, Kentucky bluegrass averages 1,500,000 seeds per pound and Red fescue averages 365,000 seeds per pound.

How is the germination & vigor?

Beach Wildrye is not known for being a species with either high seedling vigor or exceptional germination percentages for its seed. Fifty percent germination for the seed should be considered acceptable.

How about a seeding rate?

Based on the seed size and evaluation of plantings throughout Alaska, a seeding rate of 60 pounds per acre should provide an adequate stand. Remember that this is a large-seeded species, so the rate per acre may appear excessive. It is not.

When should I sow the seed?

In general, use the standard seeding recommendations as presented in Table a.3.

REGION	SOWING DATES
Southwest Alaska	May 1 - September 30
Southeast Alaska	May 1 - September 30
Southcentral Alaska	May 15 - September 1
Western Alaska	June 1 - August 15
Arctic Alaska	July 1 - August 1

TABLE a.3: Standard seeding dates in Alaska

ADDITIONAL FACTS ABOUT BEACH WILDRYE

Beach Wildrye responds to high nitrogen fertilizers. When planting sprigs or seed, rates of 500 to 600 pounds of 20% nitrogen, 20% phosphorus, and 10% potassium fertilizer give good results.

No other soil amendments are necessary.

This species will not tolerate excessive traffic (Wright 1990c). This includes foot traffic. Both natural and artificially established stands can be severely damaged by traffic that causes soil compaction.

Beach Wildrye works best in sandy or gravelly soils. Performance in organic, silt and clay soils tends to be poor.

Planting patterns must be planned. Irregular spacing can result in dunes. Uniform spacing tends to promote uniform sand deposition and therefore uniform build-up of sand.

This species does not tolerate strong competition from other grasses. Avoid using strongly rhizomatous species with Beach Wildrye sprigs. Avoid any other grass when using Beach Wildrye seed. If a grass species is used with Beach Wildrye, use light rates of Hairgrass *(Deschampsia* sp.) (less than ten pounds per acre). Broadleaf material such as Tilesy sagebrush *(Artemisia tilesii)* can be used with either seed or sprigged Beach Wildrye.

A one-acre natural stand can produce enough sprigs to establish a seven-acre site with sprigs on two - to three-foot centers.

Photo: Stoney Wright (AK PMC)

FIGURE a.26: Beach Wildrye roots and rhizomes stabilize sandy soils

COMMERCIAL AVAILABILITY OF SPRIGS & SEED

Two cultivars, 'Reeve' and 'Benson', have been released by the Alaska Plant Materials Center (Wright 1991a, 1991b). Reeve is a seed producing cultivar of *L. arenarius,* while Benson, *L. mollis,* is intended to be sold as sprigs. Presently, availability of both is limited. Contact the Plant Materials Center if you are interested in commercially producing either cultivar. If you are searching for seed for plants to use on projects, contact your local Co-operative Extension Service Office or the Alaska Plant Materials Center.

Figure a.27: Beach Wildrye along the Kenai Peninsula

CLOSING STATEMENT ABOUT USING BEACH WILDRYE & WHERE TO GET MORE INFORMATION

Beach Wildrye is an extremely effective species for use in coastal revegetation, restoration and erosion control. Due to the dynamic nature of most shorelines, prior planning is needed if planting efforts using Beach Wildrye are to succeed. Before undertaking a Beach Wildrye planting program, a call to the Alaska Plant Materials Center may prevent unnecessary surprises, (907) 745-4469.

Photo: Brennan Veith Low (AK PMC)

Figure a.28:

Beach Wildrye is very susceptible to damage by uncontrolled foot traffic. In this photograph, an eroded coastal dune has been used for a fire-pit. Protective fencing and access controls can help limit human causes of erosion.

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Appendix B:

State of Alaska Seed Regulations

Alaska Administrative Code:
Title 11, Chapter 34

Title 11, Alaska Administrative Code,
Chapter 34: ***Plant Health and Quarantine***

Article 1:

10. Labeling

20. Prohibited and restricted noxious weeds

30. Weed seed as agricultural seed

40. Sampling procedure for purity and germination tests

45. Duties and authority of the director

50. Germination and purity tests

60. Laboratory fees and schedule

70. Code of Federal Regulations

75. Prohibited acts

77. Weed seeds in shipment

80. Penalties

85. When penalties not applicable

90. Records

100. Expense of treatments

Article 2:

105. Quarantine officers

110. Pest certificate fees

115. Appeals from director's decision

120. Federal-state cooperation

125. Inspection stations

130. Quarantine regulations; inspections

135. Form of certain regulations

140. New pests

145. Permits for pest shipment

150. Notification of quarantined articles

155. Release from inspection

160. Right to inspect

165. Labeling and certificates

170. Destruction or treatment of pests

180. Treatment of appliances

Article 4:

400. Definitions

SEED REGULATIONS: 11 AAC 34.010

11 AAC 34.010.

Labeling

(a) Each lot or package of agricultural seed sold or offered for sale within the state must bear on it or have attached to it in a conspicuous place, a legibly written or printed label or tag, in English, providing the following information:

(1) the commonly accepted name of the kind and variety of the seed;

(2) the country or state where the seed was grown;

(3) the total percentage by weight of pure seed;

(4) the total percentage by weight of all weed seed;

(5) the total percentage by weight of inert matter;

(6) the total percentage by weight of other crop seed;

(7) the name and approximate number per pound of each kind of restricted noxious weed seed, as listed in 11 AAC 34.020;

(8) the percentage of germination of the agricultural seed, together with the month and year the seed was tested;

(9) the percentage of hard seed, if any is present;

(10) the name and address of the person labeling the seed or selling, offering, or exposing the seed for sale within the state; and

(11) the lot number or other lot identification.

(b) Each lot of mixed agricultural seed sold or offered for sale within the state must bear on it or have attached to it in a conspicuous place, a legibly written or printed label or tag, in English, providing the following information:

(1) that the seed is a mixture;

(2) the name and variety and total percentage by weight of each kind of agricultural seed present in order of predominance;

(3) the total percentage by weight of other crop seed less than five percent of the mixture; and

(4) the information listed in (a)(4), (a)(5), (a)(7), (a)(8), (a)(10), and (a)(11) of this section.

(c) Vegetable seed in a container of one-half pound or more sold or offered for sale within the state must bear on the container or have attached to the container in a conspicuous place, a legibly written or printed label or tag, in English, providing the following information:

(1) the name of the kind and the variety and total percentage by weight; and

(2) the information listed in (a)(4) - (a)(8), (a)(10), and (a)(11) of this section.

(d) Vegetable seed in a container of less than one-half pound sold or offered for sale within the state and which meets the germination standards and tolerances in 7 U.S.C. 1551 - 1611 (Federal Seed Act) must bear on the container or have attached to the container in a conspicuous place, a legibly written or printed label or tag, in English, providing the following information:

(1) the name of the kind and variety of the seed;

(2) the name and address of the person or firm labeling the seed, or selling, offering, or exposing the seed for sale within the state;

(3) the year the seed was packed; and

(4) the lot number or other identification.

(e) Vegetable seed in a container of less than one-half pound sold or offered for sale within the state and which does not meet the germination standards and tolerances in 7 U.S.C. 1551 - 1611 (Federal Seed Act) must be labeled, in English,

to provide the information required by (d) of this section and the following:

(1) percentage of germination;

(2) percentage of hard seed, if applicable; and

(3) the phrase “substandard germination” in not less than eight-point type.

(f) Any agricultural or vegetable seed treated with toxic substances must be labeled to provide the information required by (a) - (e) of this section and the following:

(1) a word or statement, in type no less than eight points, that the seed has been treated;

(2) the commonly accepted coined or chemical name of the applied substances; and

(3) a caution statement and appropriate poison symbol if the applied substance presents a hazard to human or animal health.

(g) Seed packed in hermetically sealed containers must be labeled to provide the information required by (a) - (f) of this section and the following:

(1) that the container is hermetically sealed;

(2) that the seed has been preconditioned as to moisture content;

(3) that the germination test is valid for a period of not more than 24 months from the date of germination test for seed offered for sale on a wholesale basis, and for a period of not more than 36 months for seed offered for sale at retail; and

(4) that the germination of seeds at the time of packaging was equal to or above standards and tolerances prescribed in the 7 U.S.C. 1551 - 1611 (Federal Seed Act).

(h) Agricultural seeds, mixed agricultural seeds, or bulk vegetable seeds, are exempt from the provisions of this section when

(1) the seeds are grown in or sold within the state to be recleaned before being sold, exposed, or offered for sale for seeding purposes;

(2) the seeds are held for purposes of recleaning; or

(3) the seeds are held or sold for milling for food or for feeding purposes only.

(i) Tetrazolium viability test results are not considered valid germination tests for the purposes of labeling as required by this section.

(j) Hybrid seed, as defined in 7 C.F.R. 201.2(y), must be labeled in accordance with provisions of 7 C.F.R. 201.11(a).

History: In effect before 7/28/59;
am 3/2/78, Register 65;
am 10/28/83, Register 88

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.020.

Prohibited and restricted noxious weeds

(a) The following are prohibited noxious weeds:

(1) **Bindweed, field** (*Convolvulus arvensis*);
(2) **Fieldcress, Austrian** (*Rorippa austriaca*);
(3) **Galensoga** (*Galensoga parviflora*);
(4) **Hempnettle** (*Galeopsis tetrahit*);
(5) **Horsenettle** (*Solanum carolinense*);
(6) **Knapweed, Russian** (*Centaurea repens*);
(7) **Lettuce, blue-flowering** (*Lactuca puichella*);
(8) **Orange Hawkweed** (*Hieracium aurantiacum*);
(9) **Purple Loosestrife** (*Lythrum salicaria*);
(10) **Quackgrass** (Ag*ropyron repens*);
(11) **Sowthistle**, perennial (*Sonchus arvensis*);
(12) **Spurge, leafy** (*Euphorbia esula*);
(13) **Thistle, Canada** (*Cirsium arvense*);
(14) **Whitetops** and its varieties (*Cardaria drabe*, *C. pubescens*, *Lepidium latifolium*).

(b) The following are restricted noxious weeds, with their maximum allowable tolerances:

(1) **Annual bluegrass** (*Poa annua*), 90 seeds per pound;
(2) **Blue burr** (*Lappula echinatat*), 18 seeds per pound;
(3) **Mustard** (*Brassica kaber, juncea*), 36 seeds per pound;
(4) **Oats wild** (*Avena fatua*), seven seeds per pound;
(5) **Plantain, buckhorn** (*Plantago sp.*), 90 seeds per pound;
(6) **Radish** (*Raphanus raphanistrum*), 27 seeds per pound;
(7) **Toadflax, yellow** (*Linaria vulgaris*), one seed per pound;
(8) **Vetch, tufted** (*Vicia cracca*), two seeds per pound;
(9) **Wild Buckwheat** (*Polygonum convovulus*), two seeds per pound.

History: In effect before 7/28/59;
am 3/2/78, Register 65;
am 10/28/83, Register 88;
am 7/28/2007, Register 183

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.030.

Weed seed as agricultural seed

The following seeds, when occurring incidentally in agricultural and vegetable seeds, are classed as weed seeds, except when sold alone or as a specific constituent of a definite seed mixture:

- Black Medic (Medicago lupulina);
- Cardoon (Cynara cardunculus);
- Dandelion (Taraxacum species);
- Lupine (Lupinus species);
- Pigweed (Amaranthus species);
- Radish (Raphanus sativus);
- Rape (Brassica campestris and napus);
- Sunflower (Helianthus annuus);
- Yarrow (Achillea millefolium); and
- Tufted Vetch (Vicia cracca).

History: In effect before 7/28/59;
am 3/2/78, Register 65;
am 10/28/83, Register 88

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.040.

Sampling procedure for purity and germination tests

(a) A sample of seed chosen by an authorized agent of the division of agriculture for the purpose of determining whether or not the seed meets the requirements of this chapter is known as an “official sample,” and must be drawn in a manner to represent as nearly as possible the entire lot from which it is taken.

(b) Official samples of seed shall be taken according to procedures which conform as nearly as practicable to those used by the United States Department of Agriculture pursuant to 7 C.F.R. 201.39 - 201.44.

History: In effect before 7/28/59;
am 3/2/78, Register 65

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.045.

Duties and authority of the director

(a) The duty of enforcing this chapter and of carrying out its provisions and requirements is vested in the director. The duties and authority of the director include the following:

(1) to sample, inspect, make analyses of, and test any agricultural or vegetable seed held, transported, sold, offered, or exposed for sale within the state for planting purposes, at the time, place, and to the extent the director finds necessary to determine whether the seed is in compliance with this chapter;

(2) to sample, inspect, make analyses of any tree, shrub, or flower seed held, transported, sold, offered, or exposed for sale within the state for planting purposes, at the time, place, and the extent as the director may find necessary to determine whether the seed is in compliance with this chapter;

(3) to issue and enforce a written stop sale order or to issue a violation notice, whichever the director determines applicable, to the possessor or owner of any lot of agricultural, vegetable, tree, shrub, or flower seed which is found to be in violation of this chapter; and

(4) to prohibit the further sale, processing, or movement of seed, except on approval of the director, until evidence is obtained that shows that the requirements of this chapter have been complied with and a release from the stop sale order has been issued for the seed.

(b) When seed is denied further sale, processing, or movement under (a)(3) and (a)(4) of this section, the owner or processor of the seed has the right to appeal to a court of competent jurisdiction in the locality in which the seeds were found in violation, asking for a judgment as to the justification of the order and for the discharge of the seed from the order prohibiting the sale, processing, or movement, in accordance with the findings of the court.

(c) The provisions of (a)(3) and (a)(4) of this section do not limit the right of the director to proceed as authorized by other sections of this chapter.

(d) For the purpose of carrying out the provisions of this chapter, the director or his authorized agents, may

(1) enter upon any public or private premises during regular business hours in order to access seeds and associated records maintained under this chapter, and any truck or other conveyer by land, water, or air at any time when the conveyer is accessible, for the same purposes; and

(2) either alone or in the presence of a representative or employee of the person whose premises are entered, examine and inspect any agricultural, vegetable, tree, shrub, or flower seed in possession, offered, or exposed for sale for planting purposes in this state, for compliance with this chapter.

(e) A sample taken under this section, and the report showing the results of the official test made on a sample, is prima facie evidence of the true condition of the entire lot from which the sample was taken.

(f) A copy of the results of any seed test from a sample taken under this section may be mailed to any person or his authorized representative, known to own, possess, or hold the seed from which the sample was taken.

History: Eff. 10/28/83, Register 88

Authority:
AS 03.05.010 , AS 03.05.030 , AS 03.05.040 , AS 03.05.050 , AS 44.37.030

11 AAC 34.050.

Germination and purity tests

Germination and purity tests of seeds must be conducted according to procedures which conform as nearly as practicable to those used by the United States Department of Agriculture pursuant to 7 C.F.R. 201.59 - 201.66.

Authority: AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.060.

Laboratory fees and schedule

(a) Germination and purity tests are performed at the Alaska Seed Testing Laboratory.

(b) State residents may submit seed samples for routine testing free of charge if the samples are limited to three per year per person and are submitted before April 15 of the year.

(c) Samples submitted by residents in excess of three per year or after April 15, or submitted by nonresidents will be charged a service fee as determined by the director.

(d) Samples submitted by residents and nonresidents for germination tests requiring tetrazolium procedures will be charged a service fee to be determined by the director according to a fee schedule based upon the difficulty of the species being tested.

History: Eff. 3/2/78, Register 65

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.070.

Code of Federal Regulations

Except where in conflict with specific provisions of this chapter, the rules, regulations and recommendations pertaining to sampling procedures and germination and purity testing procedures and standards contained in 7 C.F.R. 201.39 - 201.44 and 201.59 - 201.66 are adopted by reference and made part of this chapter. Copies of these provisions may be obtained from the U.S. Government Printing Office, Washington, D.C. 20250. Any reference in these provisions to U.S. Government officials and agencies shall be construed to refer to the corresponding officials and agencies of the State of Alaska.

History: Eff. 3/2/78, Register 65

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

Editor's note: *These regulations are adopted by reference. The official Rules and Regulations under the Federal Seed Act are published by the U.S. Department of Agriculture and are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20250*

11 AAC 34.075.

Prohibited acts

(a) No person may sell, offer for sale, expose for sale, or transport for use in planting in the state any agricultural or vegetable seed that

(1) unless exempt under 11 AAC 34.010(h) , has not been labeled as required by 11 AAC 34.010;

(2) bears a false or misleading label;

(3) contains any prohibited noxious weed seed, except as allowed in (g) of this section;

(4) contains any restricted noxious weed seed in excess of the permissible tolerance per pound established under 11 AAC 34.020(b) , except as allowed in (g) of this section; or

(5) has not been tested within the 18 months preceding the sale, offering, or exposure for sale, or transportation, not including the calendar month in which the test was completed, except for hermetically sealed containers under 11 AAC 34.010(g) (3), and except that

(A) the director will, in his discretion, allow a shorter period for kinds of seed which he finds, under ordinary conditions of handling, will not maintain a germination within the established limits of tolerance during the prescribed time period, or a longer period for kinds of seed which are packaged in a container and under conditions the director determines will, during the longer period, maintain the viability of the seed under ordinary conditions of handling;

(B) a person in possession of seed shall keep on file, available for department inspection, the original or duplicate copy of the latest test made of the seed which must show, in addition to the information required by this chapter, the date and name of the person making the test.

(b) No person may substitute uncertified seed for certified seed.

(c) No person may use tags or seals indicating certification other than as prescribed by the authorized certification agency unless the tuber, horticultural, vegetable, tree, shrub, flower, or cereal grain seed has been produced, tested, examined, and labeled in accordance with this chapter or the official certification agency of another state, territory, or country. No person may

(1) sell, offer for sale, expose for sale, advertise, or transport any tuber, plant, or seed, falsely representing it to be certified; or

(2) use in connection with a tuber, plant, or seed any tags or seals similar to

those used in official certification as established by this chapter.

(d) No person may hinder or obstruct in any way, any authorized person in the performance of his duties under this chapter.

(e) No person may sell, offer, or expose for sale, plant, transport or process any seed that is under a stop sale order issued under 11 AAC 34.045(a) (3) or that is in violation of this chapter, without express approval of the director.

(f) No person may plant in this state any agricultural, vegetable, tree, shrub, or flower seed containing any prohibited noxious weeds listed in 11 AAC 34.020(a) or any restricted noxious weeds in excess of the maximum allowable tolerances listed in 11 AAC 34.020(b) , except as provided in 11 AAC 34.030, without express written approval of the director, or as provided in (g) of this section.

(g) No person may use, sell, offer, expose for sale, give away, or transport for feeding, seeding, or mulching purposes any seed or grain screenings containing any prohibited noxious weed seed listed in 11 AAC 34.020(a) or any restricted noxious weeds in excess of the maximum allowable tolerances listed in 11 AAC 34.020(b), except as provided in 11 AAC 34.030, and except that the director may allow sale or transport of screenings for

(1) complete destruction;

(2) removal outside of the boundaries of the state;

(3) recleaning to the point of being in compliance with 11 AAC 34.020(a) and (b); or

(4) processing to make the weed seed nonviable.

(h) No person may sell, offer, or expose for sale for seeding purposes, seed containing more than one and one-half percent by weight of all weed seed.

(i) No person may sell, offer, expose for sale or transportation, or transport a container or package of seed within this state unless the container or package of seed is labeled with a net contents statement, expressed by either weight, volume, or numerical count, except for seed being transported from an owner's field to a warehouse for storage, cleaning, or processing.

(j) No person may sell, offer for sale, or represent potatoes as seed potatoes unless the potatoes have been certified by the official seed certifying agency of the state or country of origin.

History: Eff. 10/28/83, Register 88;
am 10/28/87, Register 104

Authority:
AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.077.

Weed seeds in shipment

Whenever anything brought into a part of the state from another part of the state

or from any other state or foreign country is found to be infested with the seed of any prohibited noxious weed, the director will notify the owner or bailee of the shipment to return it to the point of shipment within 48 hours, and the owner or bailee of the shipment shall return it. If the director determines that the seeds can be destroyed by treatment, the shipment may, at the option and expense of the owner or bailee, be treated under the supervision of the director, and may be released after treatment.

History: Eff. 10/28/83, Register 88

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.080.

Penalties

Penalties for violation of this chapter are as provided in AS 03.05.090.

Authority: AS 03.05.010 , AS 03.05.030 , AS 03.05.090

11 AAC 34.085.

When penalties not applicable

No person may be subjected to the penalties of AS 03.05.090 for selling, offering, exposing for sale, or transporting in this state any agricultural or vegetable seed that;

(1) is incorrectly labeled or represented as to kind and variety or origin, and which cannot be identified except by a field test, when that person

(A) obtains an invoice or grower's declaration stating the kind, or kind and variety, and origin, if required;

(B) takes the invoice or grower's declaration in good faith; and

(C) takes other precautions as are reasonable to insure the identity of the seeds to be as stated;

(2) does not conform to the label on the container, but is within the tolerances authorized by the director under this chapter; or

(3) is in violation of this chapter, but is allowed sale or movement under specific written permission of the director.

History: Eff. 10/28/83, Register 88

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.090.

Records

Each person whose name appears on the label as handling agricultural or vegetable seed subject to this chapter shall keep for two years a complete record of each lot of agricultural or vegetable seed handled, and shall keep for two years a file sample of each lot of seed after final disposition of the lot. All records and samples pertaining to the shipment or shipments involved must be accessible for inspections by the director or his designated agent during customary business hours.

History: Eff. 10/28/83, Register 88

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.100.

Expense of treatments

Any treatment which may be required under the provisions of this chapter shall be at the risk and at the expense of the owner or persons in charge or in possession thereof at the time of treatment unless otherwise provided.

History: In effect before 7/28/59

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

ARTICLE 2

11 AAC 34.105.

Quarantine officers

(a) The director is an enforcing officer of all laws, rules and regulations relative to the prevention of the introduction into, or the spread within the state of pests.

(b) The director and such inspectors as he may appoint, holding valid certificates of eligibility for the office to which they have been appointed, are hereby designated State Plant Quarantine officers for the purpose of certifying to the pest condition or pest treatment of shipments, when certification as a condition of movement is officially required, and for the purpose of enforcing of laws, rules and regulations, relative to plant quarantine.

History: In effect before 7/28/59

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.110.

Pest certificate fees

The director may establish a schedule of fees for any or all classes of certificates to be paid by shippers requesting such certificates. Upon receipt of such scheduled fee, or in the event no schedule has been established, then upon request of the shipper it is the duty of the director to make such inspection as may be necessary to determine the facts required by the state or country of intended destination and to issue a certificate stating the facts determined; provided, that no fee shall be charged for certification required by any law, regulation, or requirement of the United States or of this state. The schedule of fees established for such certificates shall be based upon the approximate cost of the inspection made therefor.

History: In effect before 7/28/59

Authority:
AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.115.

Appeals from director's decision

(a) In cases relative to the prevention of the introduction into, or the dissemination within the state of pests, any interested person aggrieved by any action or order of the director may appeal in writing to the office of the director within five days after notice of action or order where there is no time limit upon such action or order, and in cases where a time limit is fixed, within such time limit. In cases where the director is empowered to, and does take summary action, no appeal may be taken.

(b) Appeals will be heard by the director within 10 days after receipt thereof upon notice to all interested parties and his decision shall be final.

History: In effect before 7/28/59

Authority:
AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.120.

Federal-state cooperation

Whenever quarantine regulations are established under this chapter, if there are any authorities or officers of the United States having authority to act in such matter, or any part thereof, the director shall notify such authorities or officers and seek their cooperation as far as possible. When any article is found to have been transported into this state from any other state, or district of the United States, in violation of the provisions of a quarantine established by the Secretary of Agriculture of the United States, such article shall be subject to seizure, destruction or other disposition to the same extent and in the same manner as if such article had originated in this state and was in violation of a provision of this chapter.

History: In effect before 7/28/59

Authority:
AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.125.

Inspection stations

To prevent the introduction into, or the spread within this state, of pests, the director may maintain at such places within this state as he deems necessary quarantine inspection stations for the purpose of inspecting all conveyances which might carry plants or other things which are or are liable to be infested or infected with pests.

History: In effect before 7/28/59

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.130.

Quarantine regulations; inspections

(a) The director may establish, maintain and enforce such quarantine regulations as he deems necessary to protect the agricultural industry of this state from pests, by establishing quarantine at the boundaries of this state or elsewhere within the state. He may make and enforce such rules and regulations as are necessary to prevent any plant or thing which is or is liable to be infested or infected by or which might act as a carrier of any pest, from passing over any quarantine line established and proclaimed pursuant to this chapter. The person conducting the inspection shall not permit any such plant or thing to pass over the quarantine line during quarantine, except upon a certificate of inspection and release signed by him.

(b) No person shall conceal from plant quarantine officers any plant or fail to present the same or any quarantined article for inspection at the request of such officer.

History: In effect before 7/28/59

Authority:
AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.135.

Form of certain regulations

All quarantine regulations involving another state, district, or foreign country will be adopted by the commissioner and will be approved and proclaimed by the

governor. A proclamation will be signed in duplicate. The original proclamation will be filed in the office of the lieutenant governor and a copy in the office of the director before it takes effect.

History: In effect before 7/28/59; am 10/28/83, Register 88

Authority:
AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.140.

New pests

Upon information received by the director of the existence of any pest not generally distributed within this state he shall thoroughly investigate the existence and probability of the spread thereof. He may also establish, maintain and enforce quarantine and such other regulations as are in his opinion necessary to circumscribe and exterminate or prevent the spread of such pest. The director may disinfect, or take such other action with reference to, any plants or things infested or infected with, or which in his opinion may have been exposed to infection or infestation by, any such pest, as in his discretion shall seem necessary.

History: In effect before 7/28/59

Authority:
AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.145.

Permits for pest shipment

No pest, live insect or disease may be imported into or shipped or transported within the state except for the purpose of identification, unless such shipment or transportation is authorized under written permit and the regulations of the director or the United States Department of Agriculture. Any unauthorized shipment shall be returned to the point or origin, shipped out of the state, or destroyed within 48 hours at the expense of the owner or bailee.

History: In effect before 7/28/59

Authority:
AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.150.

Notification of quarantined articles

Any person who transports, receives or imports into the state any things, or any

plants against which quarantine has been established and who fails immediately after the arrival thereof to notify the director of their arrival, and to hold them for immediate inspection by the director, without unnecessarily moving them, or placing them where they may be harmful, is in violation of this section.

History: In effect before 7/28/59

Authority: AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.155.

Release from inspection

The director may designate certain plants arriving from certain areas not for planting, propagation or ornamental purposes within this State which may be released without inspection, if he finds upon investigation that such plants from such areas are not liable to cause the introduction of pests into the state.

History: In effect before 7/28/59

Authority: AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.160.

Right to inspect

The officer making the inspection may enter at any time into any conveyance or place within the state where the said plants or things are located, to ascertain whether they are or are liable to be infested or infected with any pest.

History: In effect before 7/28/59

Authority: AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.165.

Labeling and certificates

Each shipment of plants, brought into this state, shall have legibly marked thereon in a conspicuous manner and place the name and address of the shipper or owner, the name of the person to whom the same is forwarded or shipped, or his agents, the name of the country or state where the contents were grown, and a statement of the contents therein. Also each shipment of plants, grown in a country or state which maintains inspection of plants, shall be accompanied by a copy of a current inspection certificate from such country or state.

History: In effect before 7/28/59

Authority: AS 03.05.010, AS 03.05.030, AS 44.37.030

11 AAC 34.170.

Destruction or treatment of pests

When any shipment of plants brought into this state is found infested or infected or there is reasonable cause to presume that it may be so infested or infected with any pest, the shipment shall be immediately destroyed by, or under the such pest may be exterminated by treatment or processing prescribed by the director, and it is determined by the inspecting officer that the nature of the pest is such that no damage can be caused to agriculture in this state through such treatment or processing, or procedure incidental thereto. In such case, the shipment may be so treated or processed at the expense of the owner or bailee in the manner, and within the time specified by the inspecting officer, under his supervision, and if so treated or processed, upon determination by the enforcing officer that the pest has been exterminated, the shipment may be released.

History: In effect before 7/28/59

Authority: AS 03.05.010 , AS 03.05.030 , AS 44.37.030

11 AAC 34.180.

Treatment of appliances

(a) To prevent the dissemination of pests through the agency of appliances, the director will, in his discretion, publish a list of pests that can be carried that way and designating the appropriate treatment for appliances.

(b) No person may ship or move any used appliances unless he furnishes to the director proof satisfactory to the director that the appliances have not been exposed to infestation or infection by any pests, or that the appliances have been treated immediately before shipment or movement in the manner designated by the director.

History: In effect before 7/28/59;
am 10/28/83, Register 88

Authority: AS 03.05.010, AS 03.05.030, AS 44.37.030

Definitions

11 AAC 34.400.

Definitions

The terms used in this chapter are construed to conform insofar as possible with the terms used in the Federal Seed Act (7 U.S.C. 1551 et seq.) and the regulations issued under that Act. Unless the context indicates otherwise, in this chapter

(1) "*advertisement*" means representation other than on labels, disseminated in

any manner or by any means relating to seed within the scope of these regulations;

(2) "*agricultural seeds*" means the seeds of all domesticated grasses and cereals, and of all legumes and other plants grown as turf, cover crops, forage crops, fiber crops or field crops and mixtures of the seeds;

(3) "*appliance*" means box, tray, container, ladder, tent, vehicle, implement, or any other article which is or may be used in connection with the planting, growing, harvesting, handling, or transportation of an agricultural commodity;

(4) "*bailee*" means a person who, by warehouse receipt, bill of lading, or other document of title, acknowledges possession of goods and contracts to deliver them;

(5) "*certified*," as applied to bulblets, tuber, or horticultural plants or to agricultural, vegetable, tree, shrub, flower, or cereal grain seed, means inspected and labeled by and in accordance with the standards and rules and regulations of the official certification agency or in accordance with similar standards established by a similar authority in another state, country, or territory;

(6) "*certified seed potatoes*" means potatoes used for planting a crop, that have been officially certified as "foundation seed" or "certified seed" by an authorized inspector, in a manner approved by the director, or, in the case of seed imported into the state, meets the certification standards of the Association of Official Seed Certifying Agencies;

(7) "*commercial production*" means products not grown exclusively for use or consumption by the producer;

(8) "*director*" means the director of the division of agriculture, Department of Natural Resources, or the director's authorized agent;

(9) "*flower seed*" includes seed of herbaceous plants grown for their blooms, ornamental foliage, or other ornamental parts which is commonly sold under the name of flower seed in the state;

(10) "*labeling*" means all labels and other written, printed, or graphic representations in any form whatsoever, whether attached to, or accompanying and pertaining to any seed, whether in bulk or in containers and includes invoices;

(11) "*lot*" means a definite quantity of seed identified by a lot number or other mark, every portion of which is uniform within the recognized tolerances for the factors which appear in the labeling;

(12) "*mixed agricultural seeds*" means any lot of seeds that contains five percent or more by weight of each of two or more kinds of agricultural seeds;

(13) "*noxious weed*" means any species of plants, either annual, biennial, or perennial, reproduced by seed, root, underground stem, or bulblet, which when established is or may become destructive and difficult to control by ordinary means of cultivation or other farm practices; or seed of such weeds that is considered commercially inseparable from agricultural or vegetable seed;

(14) "*nursery stock*" means any plant for planting, propagation or ornamental use;

(15) "*other crop seed*" means that part of a lot or sample of seed that consists of the seed of cereal grain and agricultural and vegetable seeds other than those named on the label;

(16) "*packer*" means the person or firm putting the seed into its final container in preparation for sale as seed;

(17) "*person*" means a individual, partnership, corporation, company, society, association, or cooperative;

(18) "*pest*" means a form of animal life, plant life, or infectious, transmissible, or contagious disease of plants, that is or is liable to be dangerous or detrimental to the agricultural industry of the state;

(19) "*plant*" means a whole or part of a plant, tree, shrub, vine, fruit, vegetable, seed, bulb, stolon, tuber, corm, pip, cutting, scion, bud, graft, or fruit pip, and includes an article made from a plant;

(20) "*pure seed*," "*germination*," and other seed labeling and testing terms in common use are defined as the terms are defined in the Rules for Seed Testing (Volume 6, #2, 1981) published by the Association of Official Seed Analysts, Stone Printing Company, Lansing, Michigan, and in the Federal Seed Act (7 U.S.C. 1551 et seq.) and the regulations promulgated under it (7 C.F.R. 201 et seq.);

(21) "*restricted noxious weed seed*" means the seed of weeds which are very objectionable in fields, lawns, and gardens of this state, but which can be controlled by good cultural practices;

(22) "*shipment*" means an article or thing, which may be, is being, or has been transported from one place to another place;

(23) "*tree and shrub seed*" means seed of woody plants commonly known and sold as tree and shrub seeds in this state;

(24) "*vegetable seeds*" means the seeds of all crops which are being grown or which may be grown in gardens, privately or commercially, and which are generally known and sold under the name of vegetable seeds; and

(25) "*weed seed*" means a restricted noxious weed seed and any seed not included in the definition of agricultural seed when it occurs incidentally in agricultural or vegetable seeds.

History:
In effect before 7/28/59;
am 3/2/78, Register 65;
am 10/28/83, Register 88

Authority: AS 03.05.010, AS 03.05.030, AS 44.37.030

Appendix C:

Other Publications of Interest

Gathering information from a variety of reference materials can be helpful when approaching a revegetation or erosion control project. The publications listed in this section are included because the authors feel that they are particularly relevant to the topics covered in the Alaska Coastal Revegetation and Erosion Control Guide.

Interior Alaska Revegetation & Erosion Control Guide

Phil K. Czapla and Stoney J. Wright

The Interior Alaska Revegetation & Erosion Control Guide is the complement to the Alaska Coastal Revegetation & Erosion Control Guide, focusing on the unique concerns of professionals involved in construction or cleanup activities in Interior Alaska. The guide includes information on planting techniques, the protection of wetlands and permafrost, and the mitigation of negative human and natural impacts to the environment.

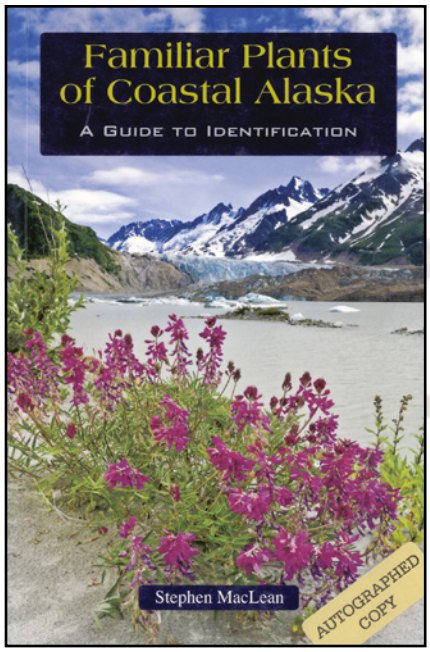
This publication contains species suggestions and a step-by-step guide to planning a revegetation project. Several case-studies examine past reclamation and restoration projects in the region, serving as a useful reference for future revegetation activities.

The Interior Alaska Revegetation & Erosion Control Guide is funded in part by a grant from the USDA Natural Resource Conservation Service, and will be published in late 2011 by the Alaska Department of Natural Resources. The guide will be available from the Alaska Plant Materials Center, at plants.alaska.gov/reveg/.

Familiar Plants of Coastal Alaska

A Guide to Identification

by Stephen MacLean



This full color plant guide features the most common and familiar plants of Alaska's coastal environments as well as the ferns, mosses, lichens and trees. The book explains how the temperate rainforest "works" with detailed descriptions of the climate and major habitats such as the forest, forest edge, coastal meadows, and muskeg bog.

Designed for both the beginner and advanced learner, this book features large oversize photos to aid identification and handy tables that let you quickly find your plant by looking at habitat, color, counting the number of petals and other shortcuts.

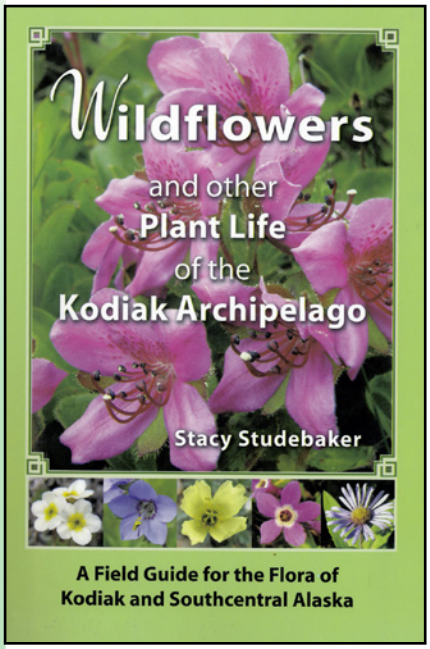
Author Stephen MacLean is a retired professor from the University of Alaska and works as a naturalist on board cruise ships in the Inside Passage during the summer.

6 x 9 inches, 224 pages.
ISBN 978-0-9821896-7-2 $19.95
Published by: Greatland Graphics, Anchorage, AK. alaskacalendars.com

Wildflowers and other Plant Life of the Kodiak Archipelago

A Field Guide for the Flora of Kodiak and Southcentral Alaska

by Stacy Studebaker



The first comprehensive field guide to cover the flora of this unique region of Alaska. This book contains illustrations and descriptions of 365 species of vascular plants, with over 650 full color photographs.

The plants are organized by flower color in an easy-to-use format and is full of information on habitats, uses, folklore, and other natural history information. In addition to wildflowers, the book also includes ferns, horsetails, clubmosses, shrubs, trees, grasses, sedges, rushes and aquatic plants that are found throughout Southcentral AK.

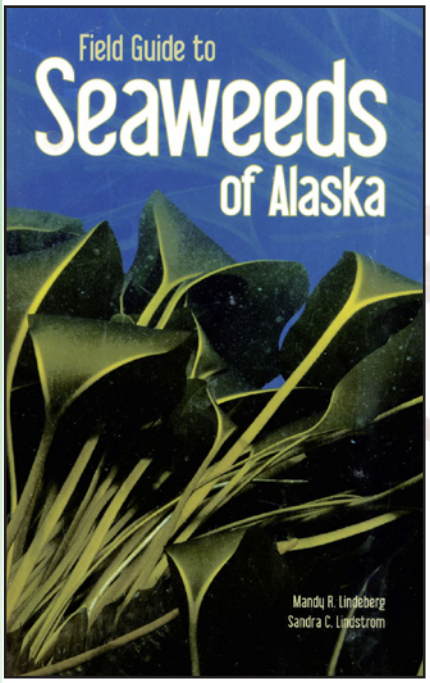
The book contains information about geology, glacial history, soils, the Kodiak glacial refugium, the recovery of plant life after the ice age, and notable Alaskan botanists.

The author has researched, documented, and photographed the flora of coastal Alaska since 1973 and lived in Kodiak since 1980.

6" x 9" format. 224 pages. $25.00
Published by: Sense of Place Press, Kodiak AK. kodiakwildflowers.com

Field Guide to Seaweeds of Alaska

Mandy R. Lindeberg and Sandra C. Lindstrom



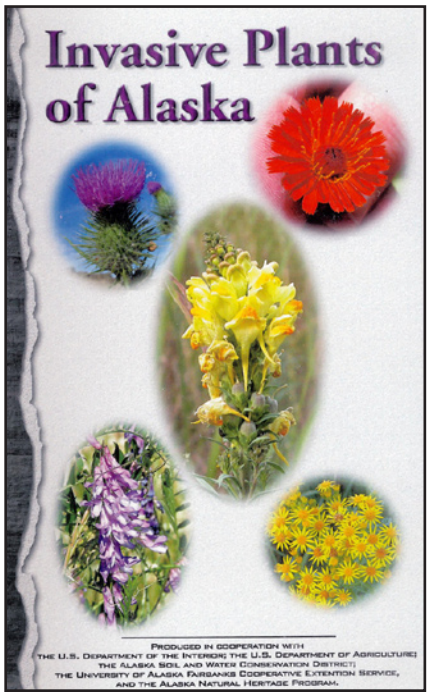
This book is the first and only field guide to more than 100 common seaweeds, seagrasses, and marine lichens of Alaska. Filled with color photos and clearly written descriptions, and printed on water-resistant paper, it is a must-have addition to the reference collections of any scientist, coastal monitor, naturalist, educator, student, or beachcomber interested in Alaska's coastal ecosystems.

Author Mandy Lindeberg is a biologist with the National Oceanic and Atmospheric Administration in Juneau, Alaska. In 2006 she discovered a new genus of kelp, golden V (depicted on the cover), in the Aleutian Islands. Coauthor Sandra Lindstrom is a professor at the University of British Columbia and has published many journal articles and books on algae.

Size: 6.5 x 9 inches, 192 pages.
ISBN: 978-1-56612-156-9; $30.00
Published by: Alaska Sea Grant Program. seaweedsofalaska.com

Invasive Plants of Alaska

Edited by Matt Carlson, Jeff Heys, Michael Shepard and Jamie Snyder



In recent years, biologists, ecologists, and land managers have become acutely aware of the global threats posed by invasive species. Invasive species can include plants, animals, fungi, insects, and other organisms that have overcome previously limiting geographical barriers through deliberate or inadvertent human activity.

This guide is intended for use by anyone interested in learning more about the invasive non-native plants moving into Alaska. Some of the plants described have been here for many years; some are common, others are rare and just now spreading, and still others have not yet shown up here but are likely to arrive soon. Some species in this guide are known to be serious problems in Alaska and elsewhere, while others are quite ubiquitous except in remote places.

Size: 5.5 x 8.5 inches, 294 pages.
Produced by: U.S. Department of the Interior, the U.S. Department of Agriculture, The Alaska Soil and Water Conservation District, the University of Alaska Fairbanks Cooperative Extension Service, and the Alaska Natural Heritage Program.
www.fs.fed.us/r10/spf/fhp/invasiveplants.htm

The Alaska Coastal Revegetation & Erosion Control Guide was released by the Alaska Plant Materials Center, a part of the Department of Natural Resources, Division of Agriculture. This publication is intended for use by the general public and environmental professionals in the protection of coastal Alaska. It was produced at a cost of $24.49 per copy, and printed in Anchorage, Alaska. This publication is also available online, at plants.alaska.gov/reveg/.

Beach Wildrye covers a sandy beach in Southeast Alaska

Back Cover: *Honckenya peploides* and *Leymus mollis* community on a beach in Safety Sound
Photo: Stoney Wright (AK PMC)