Case Studies

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

Section 4:

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   - *Vegetation Study, Sagavanirktok River*
   - *Project Chariot Site, Ogotoruk Valley*
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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)

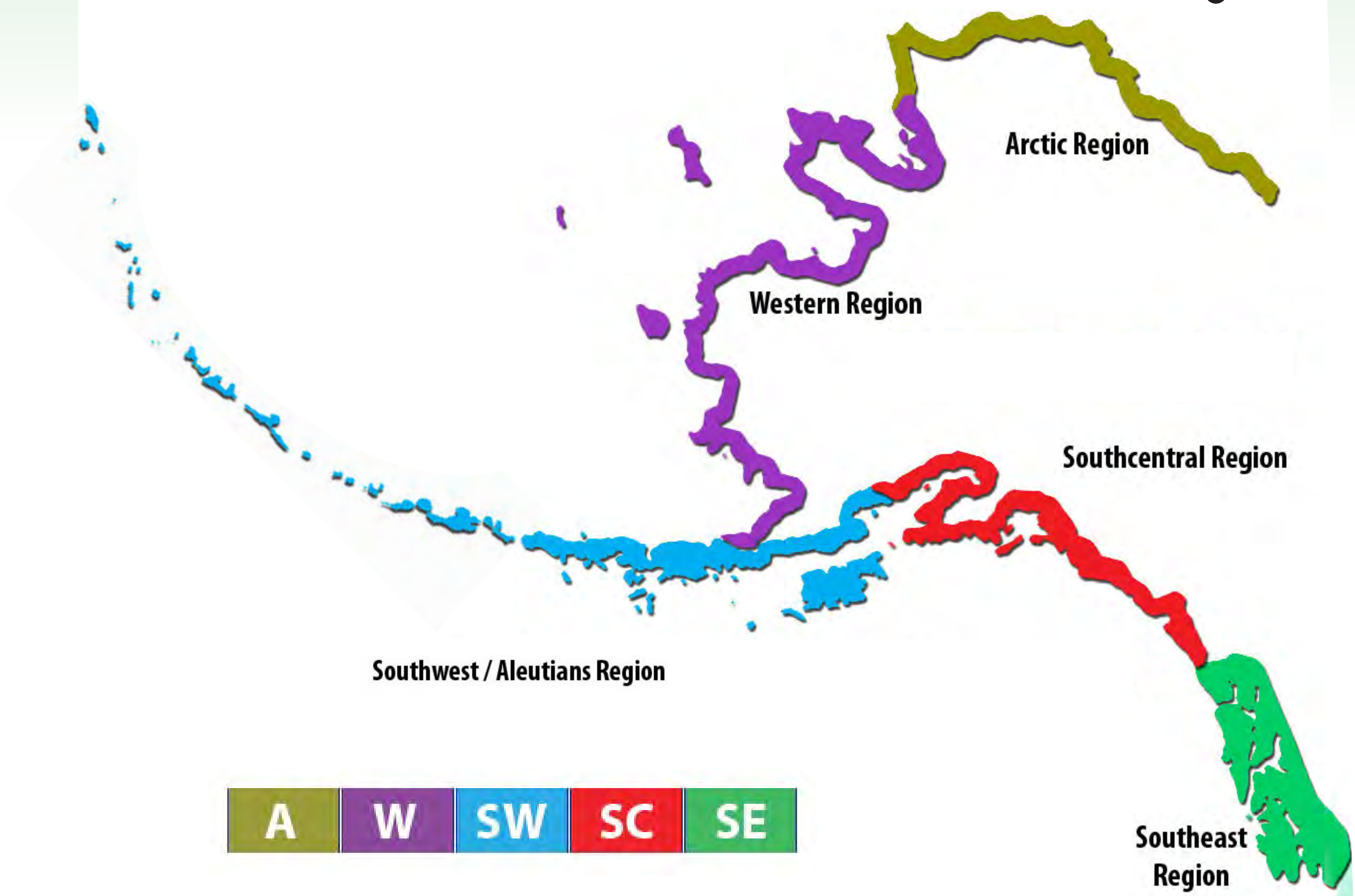
Kongiganak airport apron vegetation growth, six weeks after seeding with *Puccinellia nutkaensis*

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.

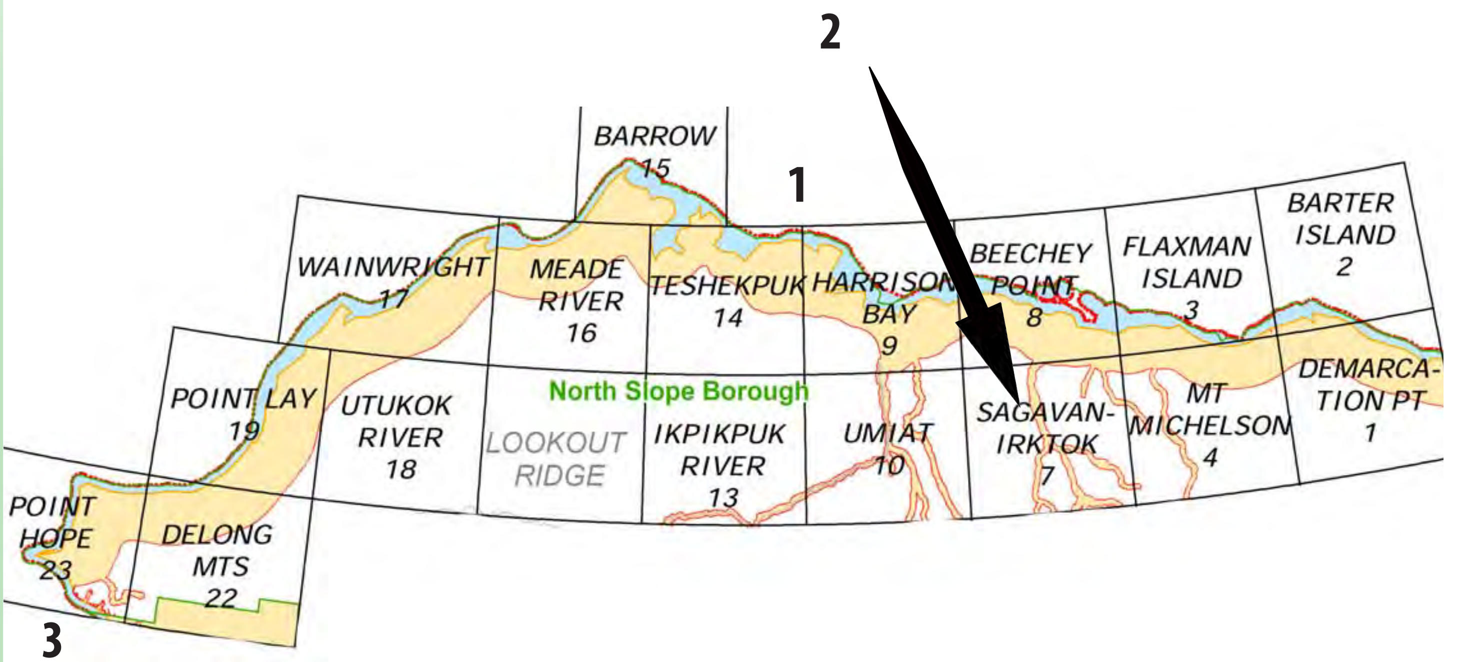


Arctic Coastal Plain

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.

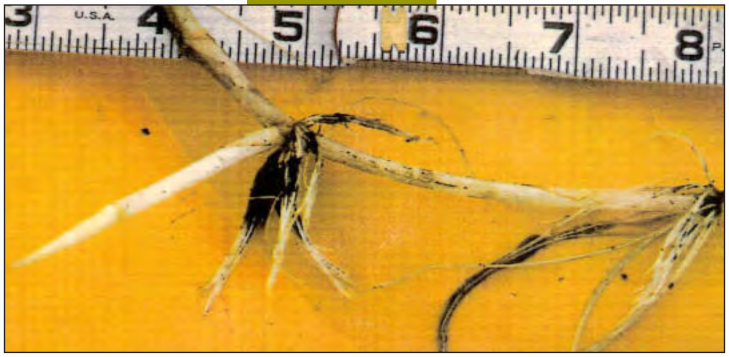
Project Location :

Mouth of the Kuparuk River.
North slope of Alaska

Clumps of *Arctophila fulva*

Transect 2, Nest Lake - July 1, 1985

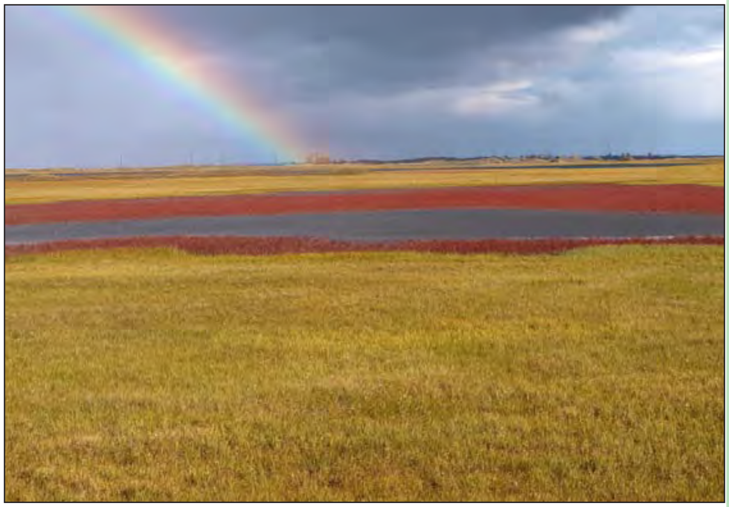
Transect 2, Nest Lake - Mid August, 1985



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

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

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

Plot 1 (scarified only) - September, 1996

Plot 1 (scarified only) - August, 2000

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

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.

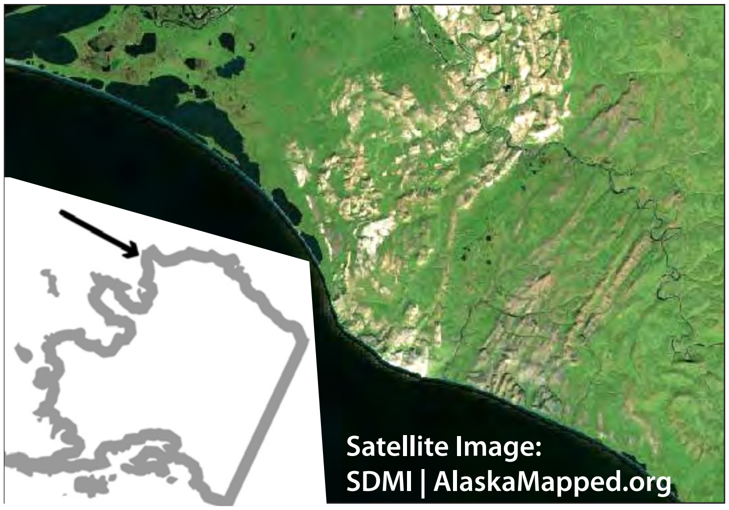
O'Neill, D. 1994 The Firecracker Boys St. Martin's Press, New York. 418 pp.

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.

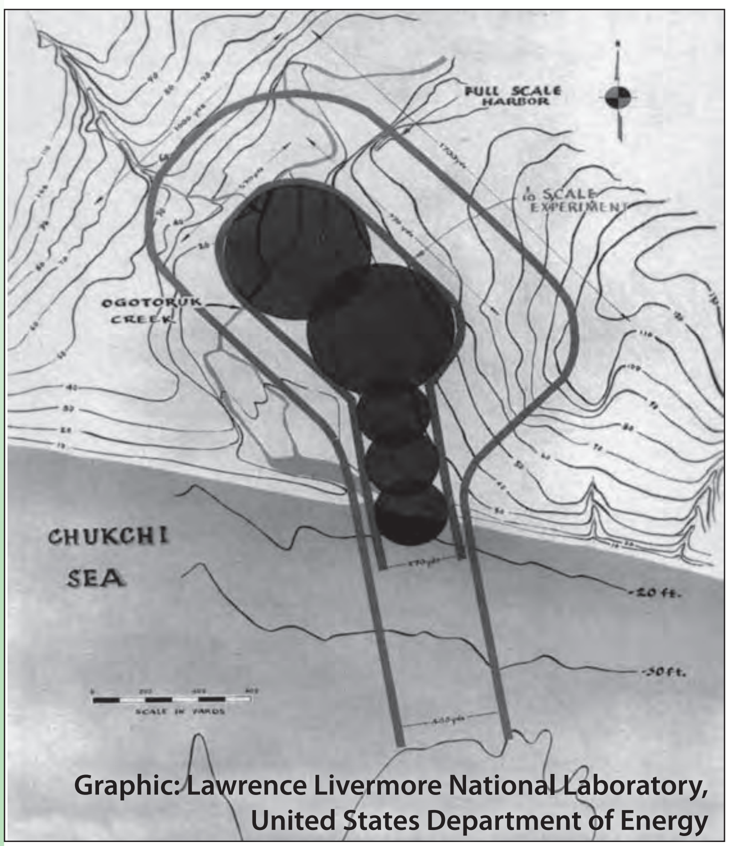
Project Location:

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.



Satellite Image:
SDMI | AlaskaMapped.org

Site Photos:



Graphic: Lawrence Livermore National Laboratory, United States Department of Energy

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)

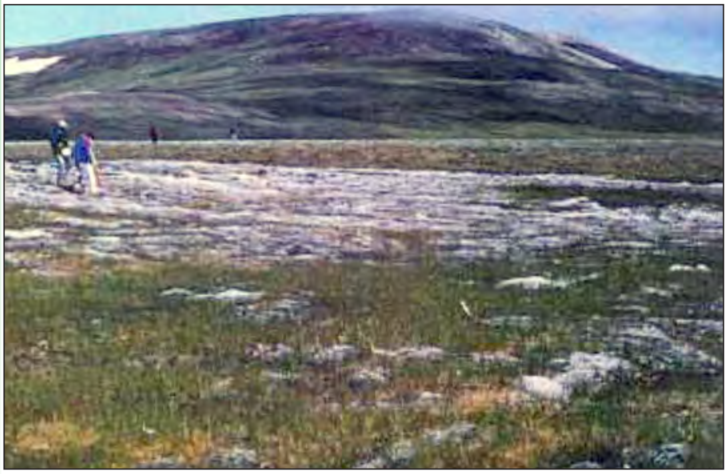
Single species evaluation plot - August, 1993

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

Photos: Stoney Wright (AK PMC)


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

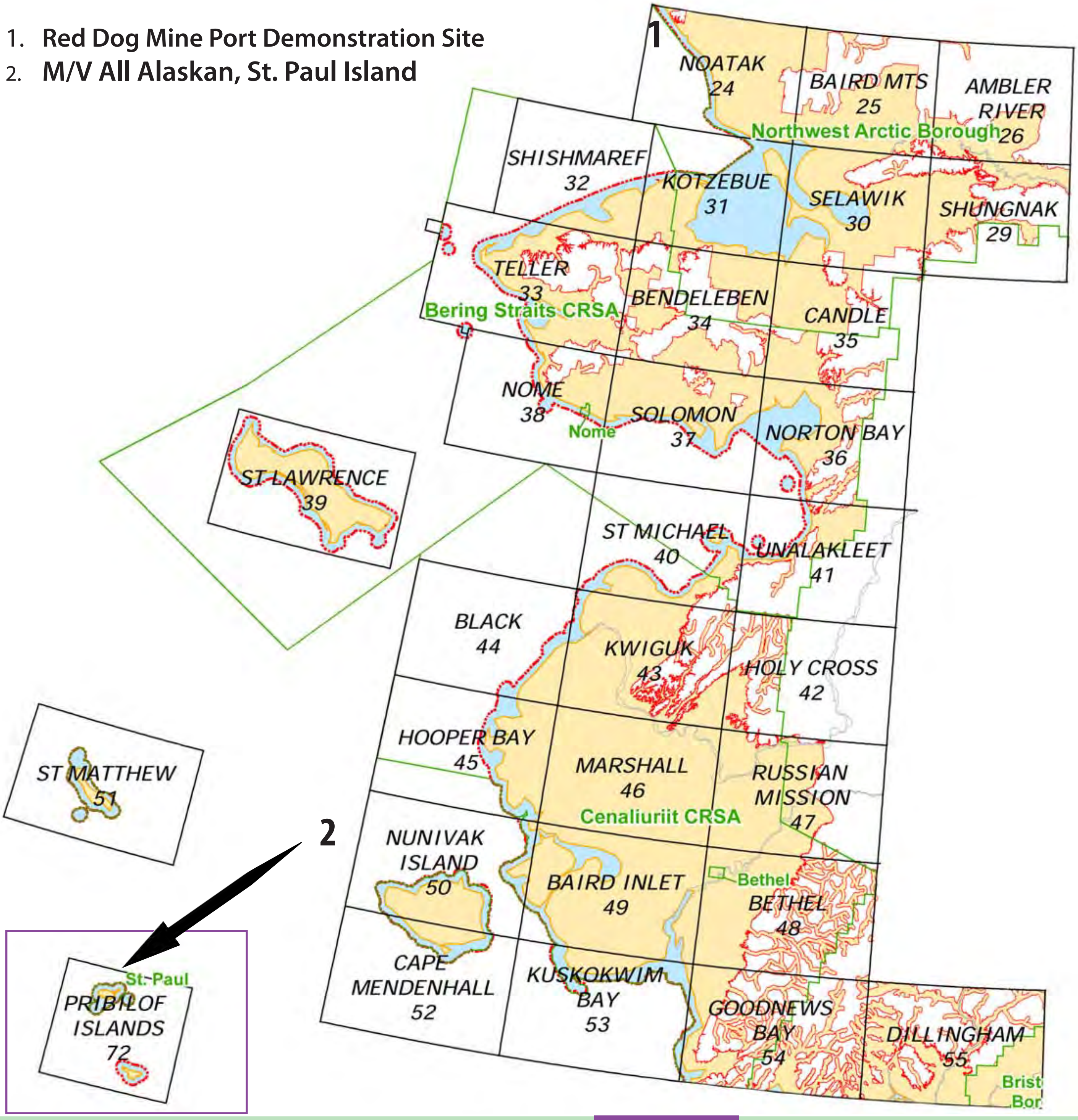
Case Studies of Revegetation Projects

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.

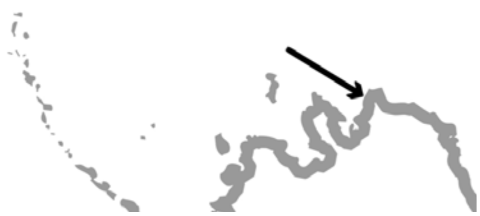
The rate of re-colonization by the surrounding sedge community was observed to be more rapid than similar areas where non-native species were used in revegetation efforts. The use of species not specifically native to the site did not prevent native species from reclaiming the disturbance. It can only 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:

Photo: Stoney Wright (AK PMC)

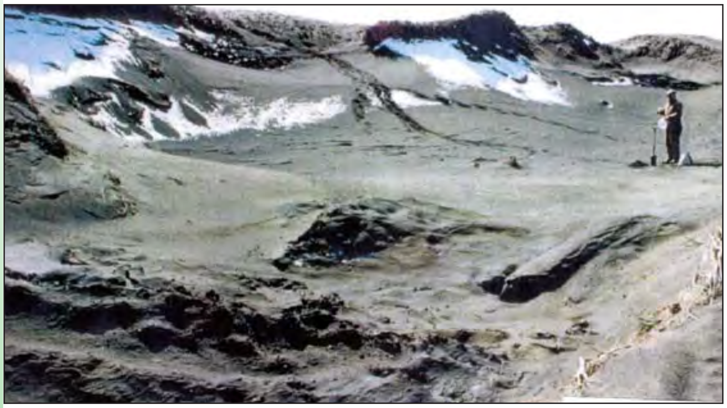
The M/V All Alaskan, shipwrecked on St. Paul Island

Photo: Art Sowls (US FWS)

Grounded M/V All Alaskan, Beach Wildrye community

Hairgrass and dunegrass community on St. Paul

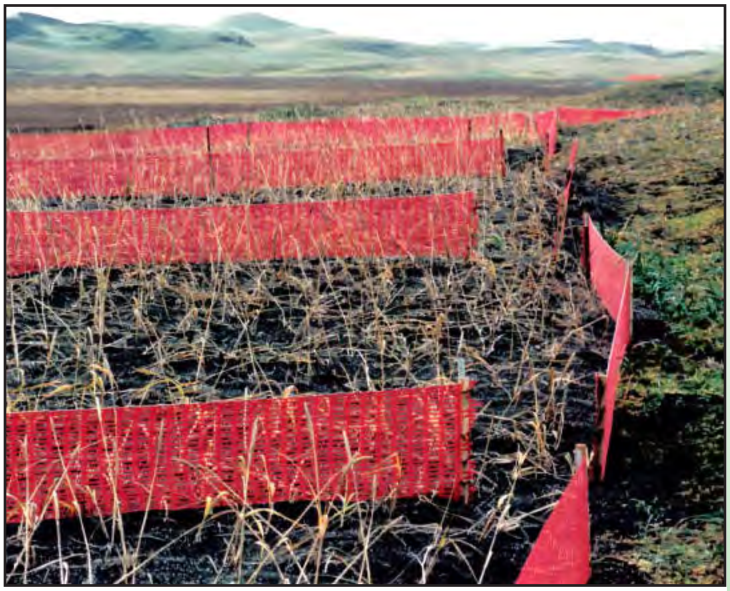
Areas damaged in the initial shipwreck response



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.)

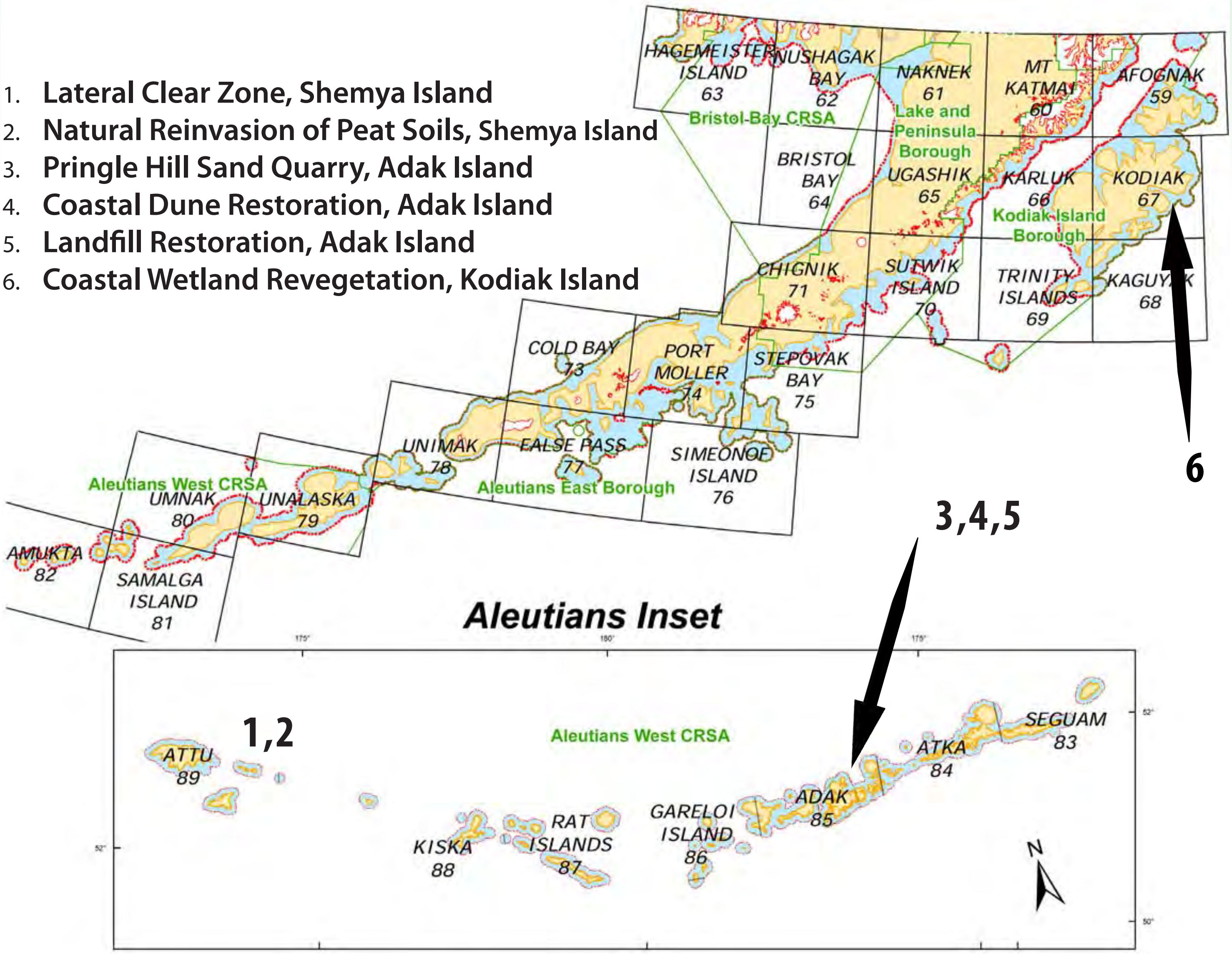
Case Studies of Revegetation Projects

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**



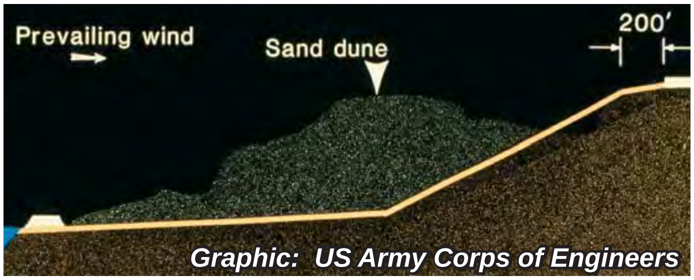
Lateral Clear Zone (LCZ) , Shemya Island

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.

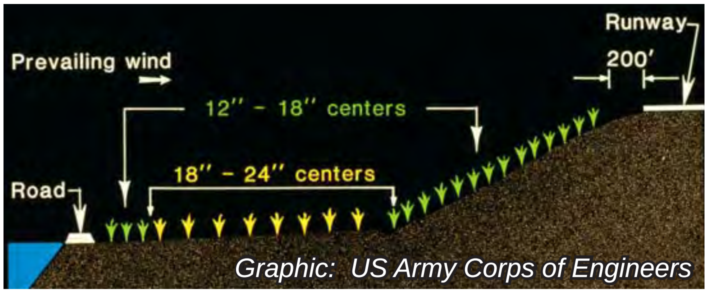
Methods of Revegetation:

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.

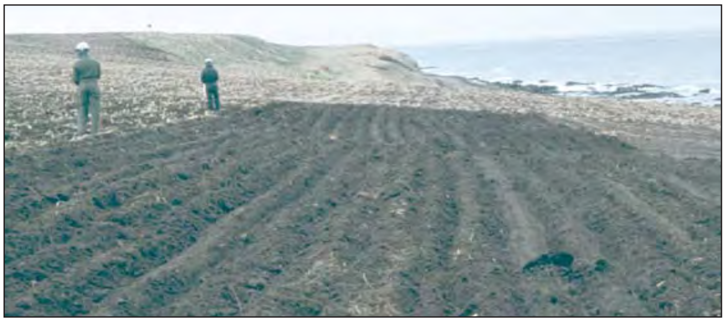
Wright, S. J., Fanter, L. H. & Ikeda, J. M., 1987. Sand Stabilization Within the Lateral Clear Zone at Shemya Air Force Base, Alaska Using Beach Wildrye, (Elymus arenarius). State of Alaska, Division of Agriculture, Plant Materials Center and U. S. Army Corps of Engineers, Alaska District. 16 pp.

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


Barst lane, view to the north - 1992


Barst lane, view to the north - 1994


Terminal way, vegetation cover - 1996


Barst lane, view to the north - 1996


Area east of Hanger 4 - September, 1992


Barst lane, vegetation cover - 1996


Area east of Hanger 4 - 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.

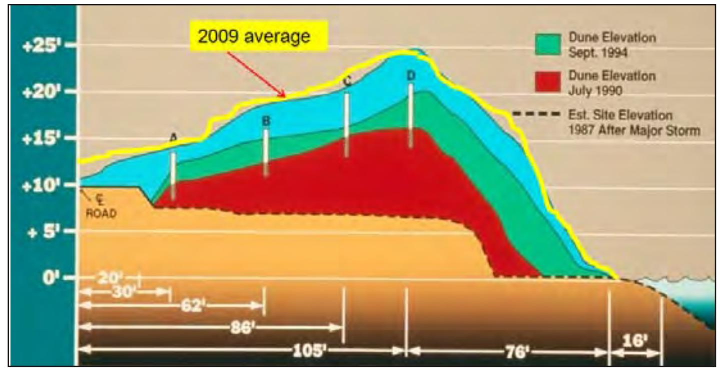
Species Used:

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:

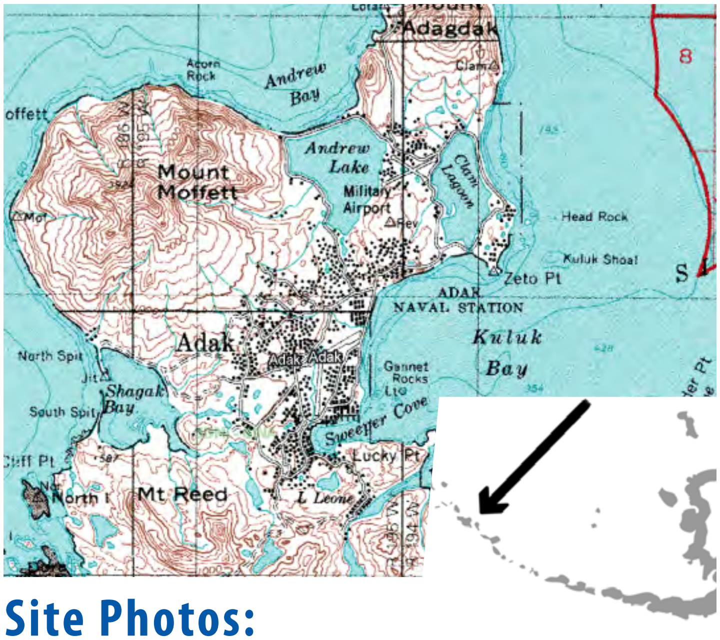
Wright, S. J. 2009. Long-Term Monitoring of Dune Re-Establishment and Sand Quarry Restoration Utilizing Beach Wildrye, On the Former Adak Naval Air Station On Adak Island, Alaska. Proceedings for the 2009 Annual Meeting of the American Society of Agronomy, Pittsburgh, PA. (Abstract).

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.

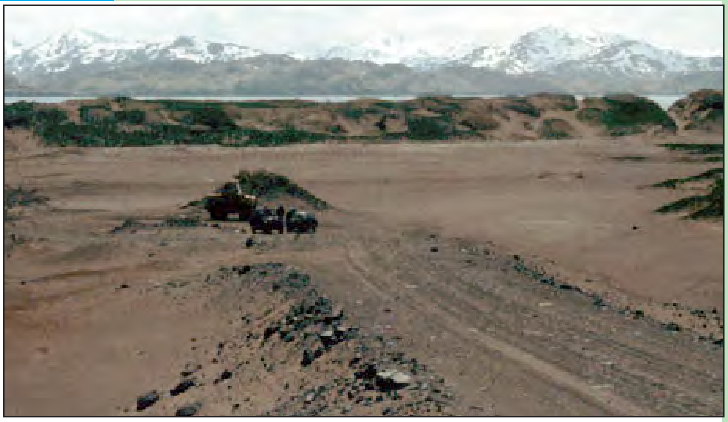
Project Location:

Adak Island, Aleutians west region



Site Photos:

Photos: Stoney Wright (AK PMC)


Pringle Hill sand quarry prior to revegetation - 1993


Quarry area preparation and sprigging - May, 1994


Sprigging the quarry area by hand - May, 1994

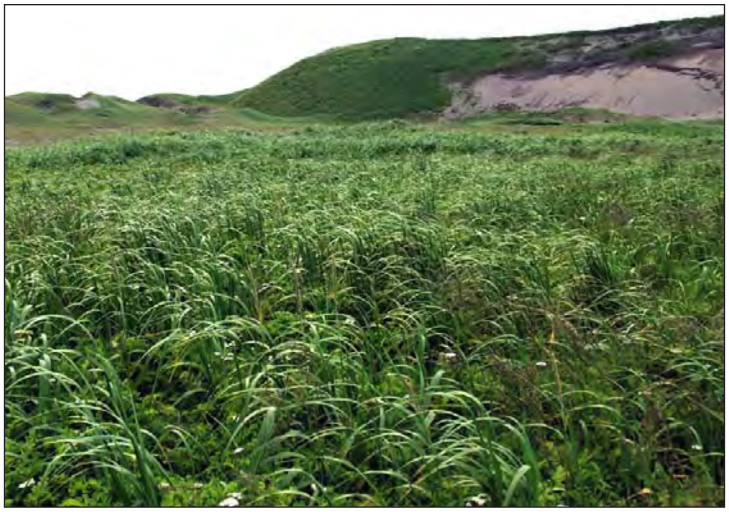

Beach Wildrye after one seasons growth - May, 1995

Area over-seeded with seed mix - September, 1995

September, 1999

Photos: Stoney Wright (AK PMC)

One year after seed mix applied - September, 1996



Seeded grass presence nearly zero - August, 2009

September, 1997

September, 1998

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

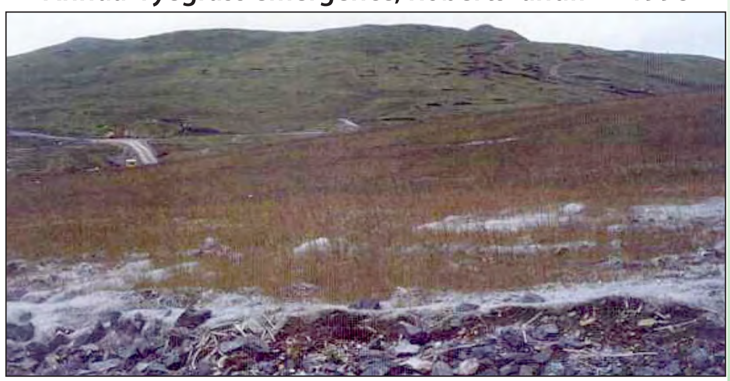
Unraveling excelsior at White Alice landfill - 1998

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.

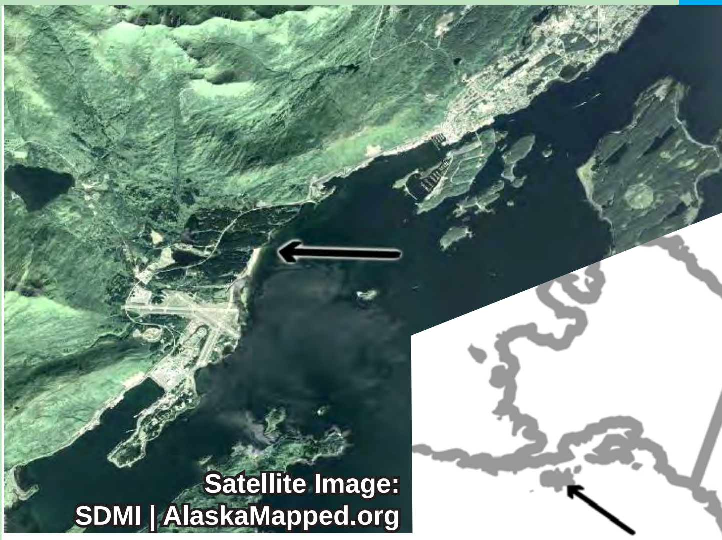
References:

Crayton, W., D.B. Ward, E. Campellone, and M. TeVrucht., 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

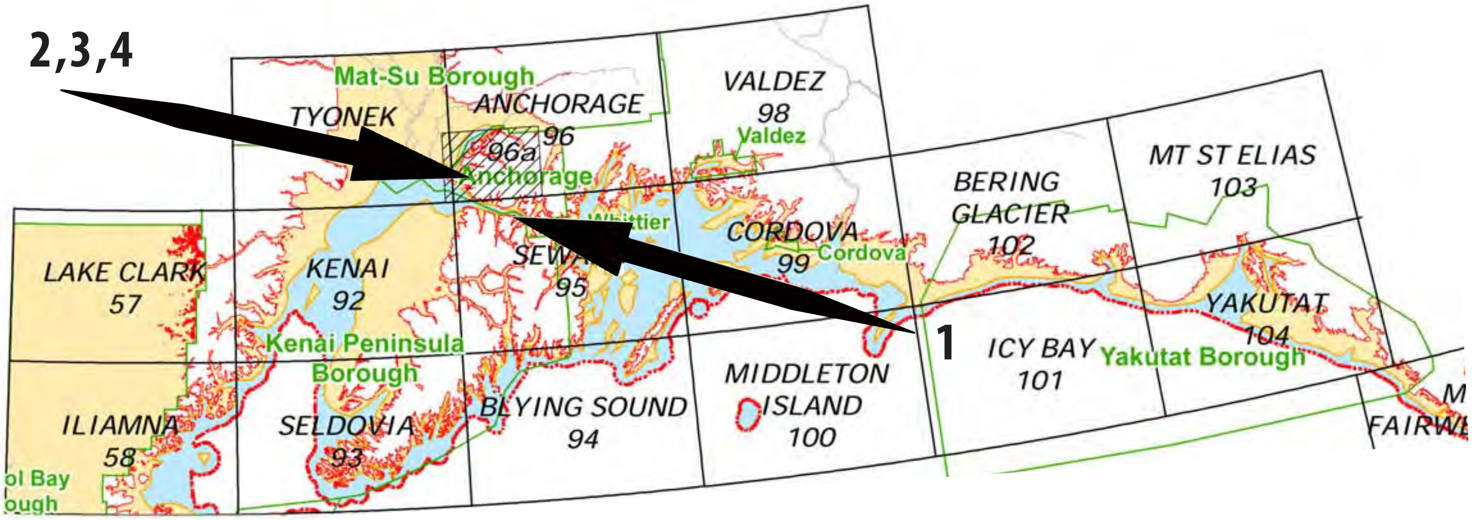
Photos: Jacobs Engineering

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.

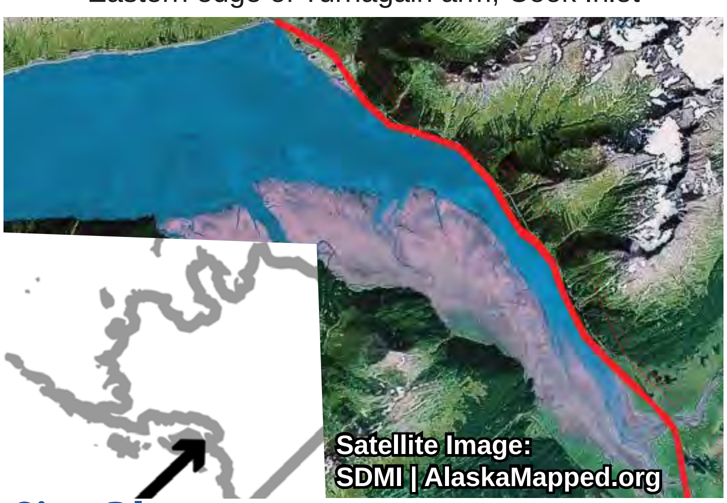
References:

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


Photo: Stacie Havron (APU)

Transplanted vegetation along bank - July, 2009


Photo: Phil Czapla (AK PMC)

Transplanted vegetation performance - September, 2010


Photo: Phil Czapla (AK PMC)

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


Photo: Stacie Havron (APU)

Flooding of spillway during high tide - July, 2009


Photo: Stacie Havron (APU)

Grass cover established along stream outfall - July, 2009


Photo: Phil Czapla (AK PMC)

Stream outfall vegetation performance - May, 2010


Photo: Stacie Havron (APU)

Steep vegetated grade, erosion matting - July, 2009


Photo: Phil Czapla (AK PMC)

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

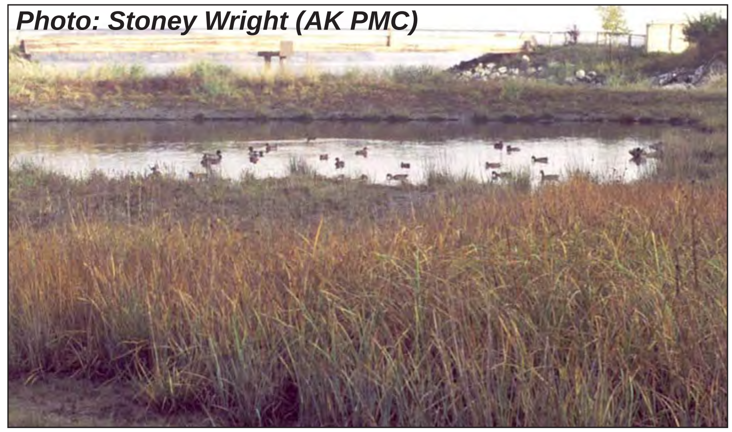
Photos: Stoney Wright (AK PMC)

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.

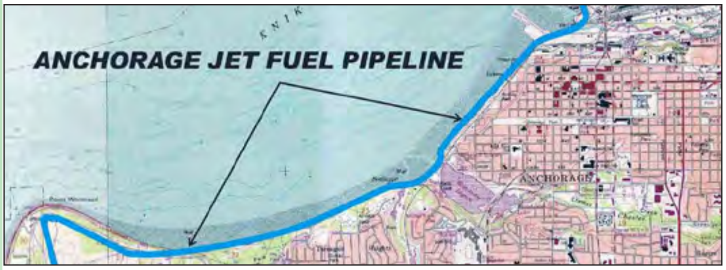
Revegetation efforts were very successful. Natural reinvasion is occurring through growth of seeded and transplanted material, as well as through colonization in all areas of the corridor. Ponding of water has limited the area available for plant colonization, although these effects are minimized through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

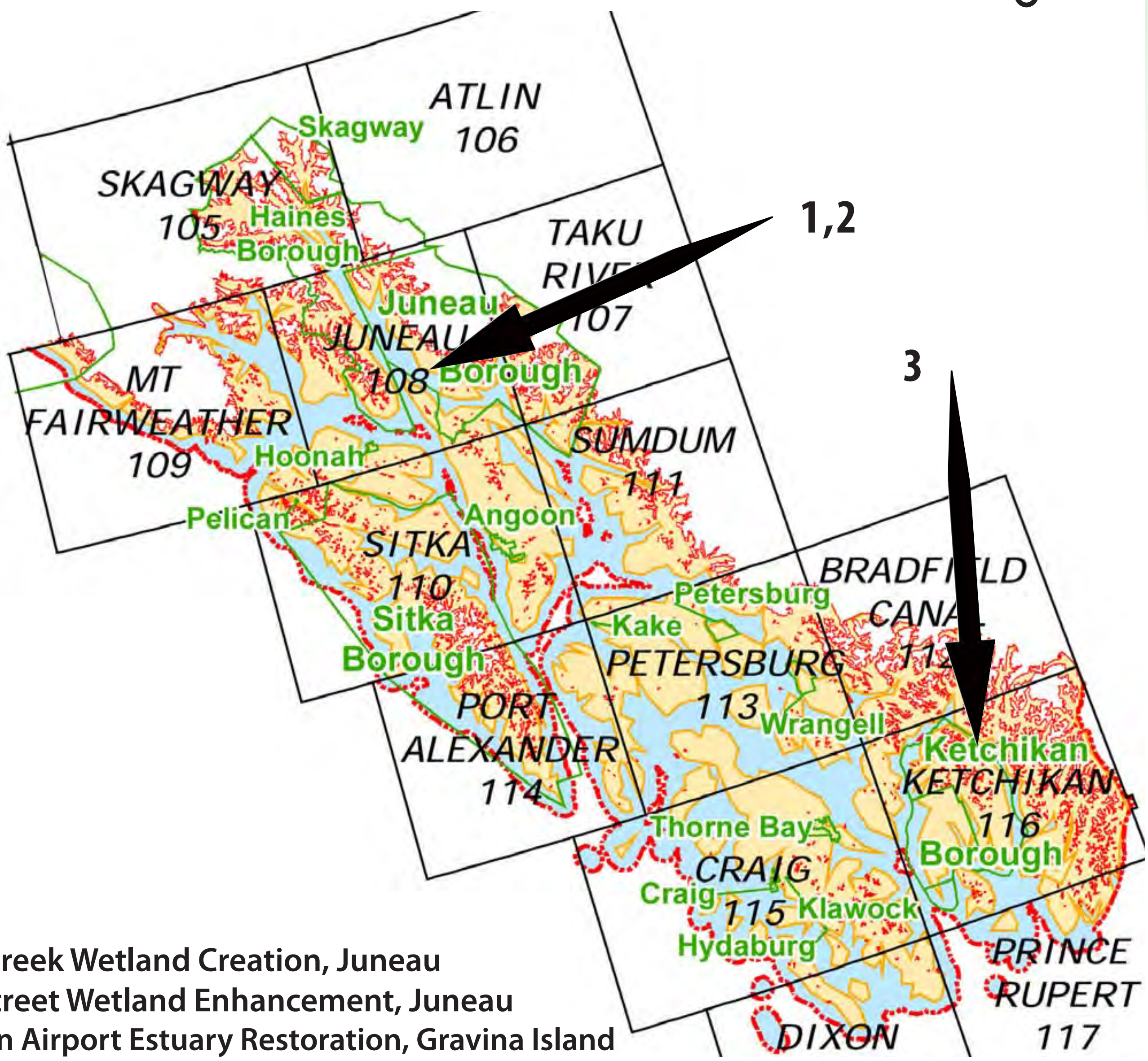
Case Studies of Revegetation Projects

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

Photos: John Hudson (USFWS)

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

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.

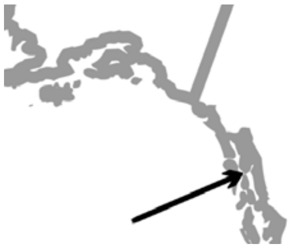
Lack of proper gear & equipment for the crew made harvesting and planting more difficult. Waterproof gloves, waders, rubber boots, and bigger buckets for transporting plants would have allowed the revegetation effort to progress more efficiently.

References:

Michele Elfers, 2006, Nancy Street Wetland Enhancement: Assessment of Design and Construction. City and Borough of Juneau, Engineering Department, 69pp.

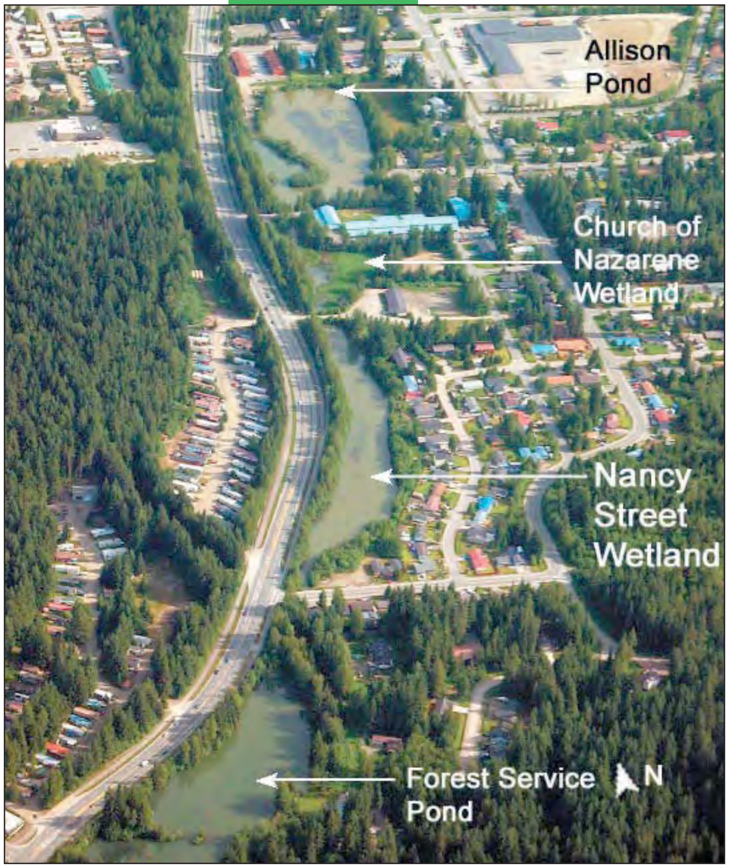
Project Location:

The Nancy Street wetland is located in the Mendenhall Valley, in the city and borough of Juneau, Alaska.



Site Photos:


Photo: Michele Elfers (CBJ)
Nancy Street Pond 2005, prior to reclamation



Aerial view of Nancy Street wetland area.

Planting willow & cottonwood cuttings - June, 2006

Leaves emerge from cuttings - August, 2006

Early stages of filling - November, 2005

Sedges being extracted from nearby wetland - 2006

Digging outlet stream channel - July, 2006

Volunteers planting wet meadow grasses - 2006

Alders transplanted along stream channel - 2006

Low marsh & high marsh sedges, bulrushes - 2006

Wetland vegetation establishment - October, 2006

Photos: Michele Elfers (CBJ)

Transplanted cuttings bordering trail - October, 2006

Created fingers, view to the south - October, 2006

Finished observation deck & gathering area - 2006

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.

References:

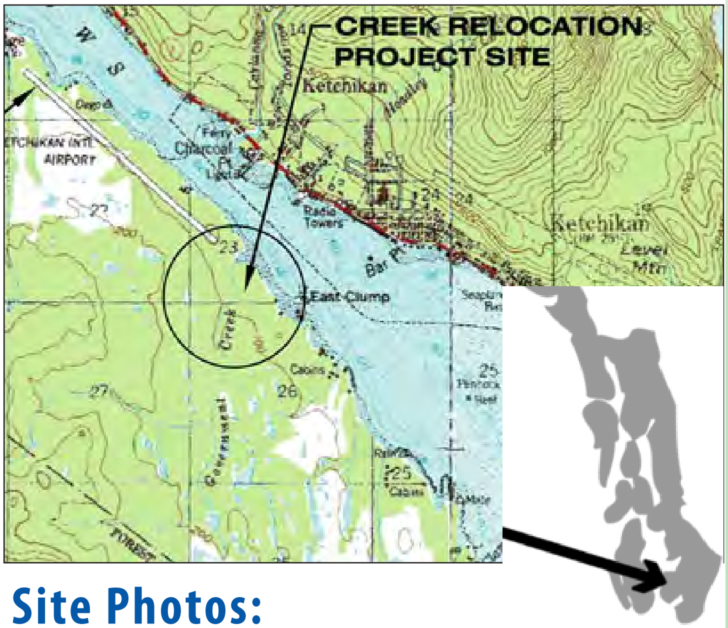
Pentec Environmental / Hart Crowser Inc., 2009. Ketchikan International Airport Runway Overlay and Safety Area Upgrade Government Creek Relocation Year 0 and Post-High Flow Mitigation Monitoring Report. Prepared for Alaska Department of Transportation and Public Facilities. 78pp.

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

Houghton, J., Cherry, S., Ormerod, D., Mearig, L., 2010. Re-inventing Government Creek - lessons from a successful salmon stream and estuary relocation on Gravina Island. Abstract of Oral Presentation at 2010 Alaska Marine Science Symposium, Anchorage AK.

Project Location:

Ketchikan International Airport, Gravina Island, AK

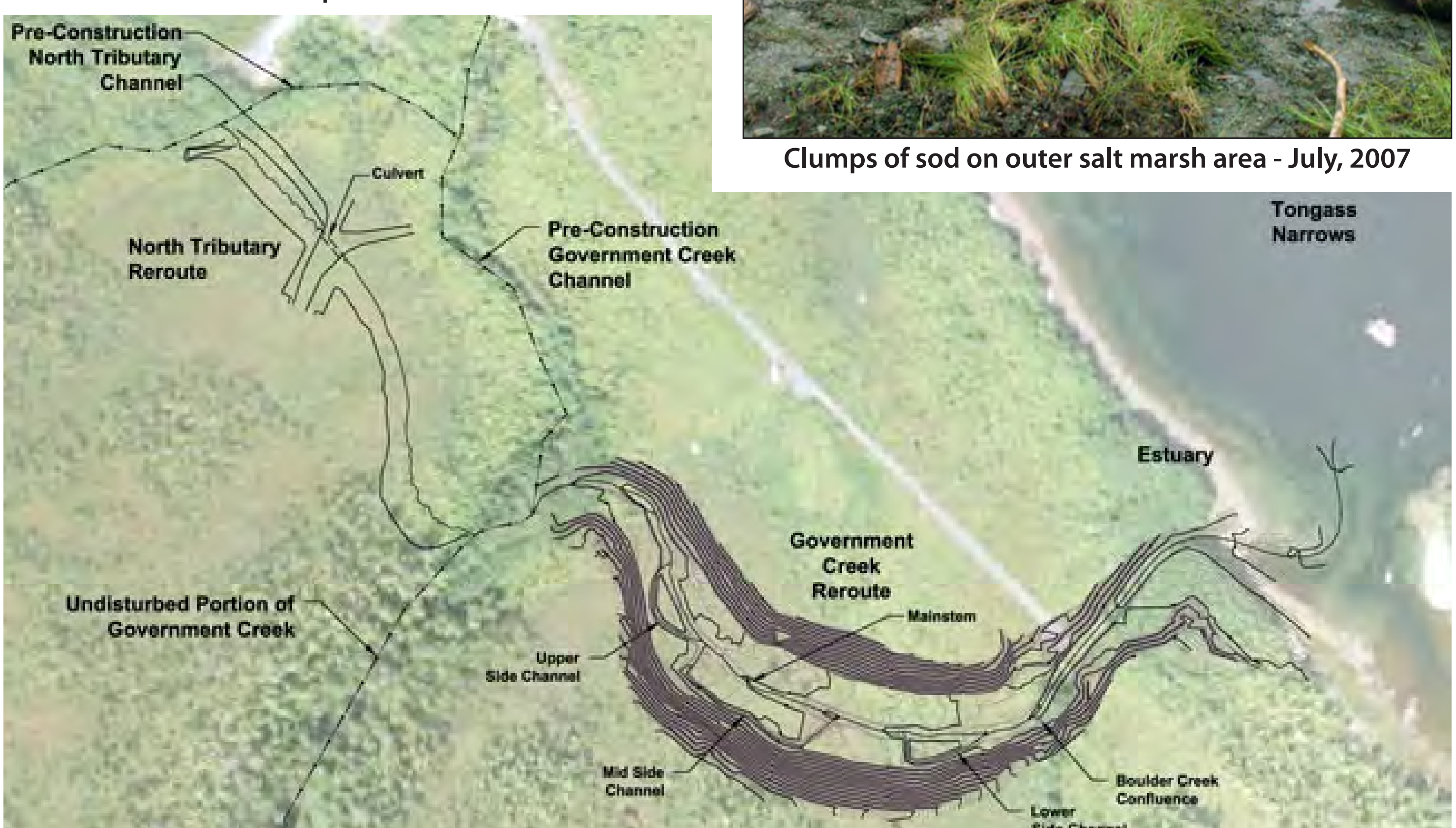


Site Photos:

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.