MOWITCH & SQUALLY BEACH ADAPTIVE MANAGEMENT 2004

Methods and Results

Under Commencement Bay Natural Resource Trustee's (CB-NRT) resolution 2003-18 up to $17,000 in costs were approved to complete adaptive management actions at Mowitch and Squally Beach sites. Unallocated EarthCorps resources from the NOAA RC/EarthCorps Community-based Restoration Partnership provided labor for installation. Salt marsh plants were donated by CB-NRT Funds provided materials as described below:

60 yards hog fuel blown	$	1,659.00
Plants and shipping	$	438.33
Chicken wire and cord	$	331.99
Fence posts and zip-ties	$	156.78
Irrigation and controllers	$	746.07
Chicken wire and zip-ties	$	28.00
Batteries and elec. tape	$	35.94
Irrigation Parts	$	25.14
TOTAL COSTS	$	3,421.25

The following tasks described in the scope of work have been completed:

- Installation of 12-16 goose exclusion devices.
  18 – 12x12 foot fences were installed. If future expansion of goose exclusion was desired, existing fencing can be extended between plots to nearly double the area protected. Half of the exclosures included nylon cord strung over the top of the exclosure. After price comparison chicken wire was used for exclosure fencing. only 3-4 mating pair of geese were observed on site, a reduction from previous years (Adams, pers. obs.). Herbivory was not observed in either netted or un-netted plots. Herbivory was observed between planting and fence installation.
- Replacement of irrigation controllers on whole site and connection of drip line to risers, testing and programming if irrigation.
  Irrigation controllers were replaced and tested. Irrigation was reduced to once per week over the growing season. Site inspection that this irrigation regime maintained soil moisture while preventing anaerobic soil conditions from developing after the end of the rainy season. Soils were anaerobic in some areas during the early growing season from rainfall.
- Planting of 4-6 goose exclusion devices with mixed salt marsh species
  195 1-gallon pots were planted between 6 plots. (150 Carex, 45 Triglochin), Distichlis and Deschampsia were planted in two locations at and below MHHW. No herbivory was observed in any plotsCarex growth has not been substantial in outplantings.
- Seeding of 4-6 goose exclusion devices with seed collected on site
  35 grams of seed (primarily Triglochin and Plantago collected from established populations on site) were spread in each of six plots. Half of each seeded plot was covered by a thin straw based erosion control barrier intended to reduce seed movement. The seedbed surface was roughened with a three tine cultivator before planting to improve seed soil contact. Six plots were left empty to observe natural recruitment in the absence of goose disturbance. No significant difference in recruitment has been observed between seeded and unseeded plots. Increased seedling recruitment has occurred within exclosures as compared to neighboring surfaces (primarily Cotula). Recruitment is higher in micro-depressions and with increased proximity to seed sources (particularly in the case of Plantago).
- Importation of 60 yards of medium hog fuel mulch over 10,000 square feet
  60 yards of hog fuel was imported and spread in upland plantings. No substantial difference in growthor survival was observed between mulched and unmulched areas. mulched areas produced less competition for plantings.
- Retrofit of 3 irrigation zones with in-line drip emitters
  Drip irrigation has been installed for two irrigation zones. Due to reduction of conifer area only two irrigation zones were used to compare plant response between drip and overhead irrigation.

Installation was rapid. Layout of tubing over 8000 square feet required less than 6 labor hours. In mid-summer emitters provided soil moisture in an 18 inch radius, after 4 hours of irrigation, with soil moisture decreasing from 12-18 inches. Planting on emitters made relocating transplants for maintenance easier. Growth of competing vegetation appeared to be less in areas irrigated by drip irrigation alone. One site where the irrigation system failed in 2003 and was supplied by drip only in 2004, had much less weed growth and was dominated by yarrow and lupine. Location of conifer transplants was easy, and most seedlings were above surrounding vegetation.

- Planting of 100-250 conifer stems to provide conifer canopy over no more than 50% of the site in no more than 4 clumps

  A total of 186 2-year bare root conifer seedlings were planted in four clumps across the site. Locations and counts were recorded for monitoring. Plants were installed beginning February 5th while dormant. Treatment of all stock during planting was identical. Transplants were relocated, terminal shoot growth was measured and health visually assessed on a three point scale (poor-ok-good). 19-42 conifer stems (mean 30) are now located in four clumps.
  Picea sitchensis (sitka spruce): 67 transplants were reported planted in four zones. Surveys located 69 surviving transplants (it is likely that some additional stems were accidentally planted). Spruce had a mean growth of 2.6 inches (some individuals with 9 inches growth) and 79% were in OK condition or better. Growth was not substantially different between treatements, and appeared to be strongly controlled by topography, with individuals planted in standing water having <2 inches of growth. Spruce survived in sun or shade.
  Pinus contorta (shore pine): 26 of 38 transplants were found alive (68%). 75% were in OK condition or better. Mean growth was 7 inches with a maximum of 11 inches, and was the greatest of the three species. Standing water reduced shoot elongation. Competition for light caused needle drop – pine is less shade tolerant than spruce.
  Pseudotsuga menziesii (Douglas fir): 28 of 76 transplants were located alive (38%) with a mean growth increment of 3.8 inches, and more than 50% of individuals described as in poor condition. No transplant survived in poorly drained areas. Growth was strong on slopes where drainage was sufficient.

Additional site maintenance was completed: a majority of stakes from failed tree plantings were removed. Garbage was consolidated near the fence line for hauling. Additional Himalayan blackberry control at both was deferred due to low crew availability.

Discussion and Recommendations

Salt Marsh

Seeding experiments did not yield any benefits. Seeding with fresh seed should be attempted to increase seed viability -- the late harvest and dry storage in this trial may have reduced seed viability. At this point natural recruitment from seed is primarily *Cotula*, and will not deliver the potential marsh productivity desired.

Recruitment of vegetation increased inside exclosures. Recruitment is dominated by *Cotula coronopifolia* and *Scirpus cernuus*. *Triglochin* and *Plantago* recruited adjacent to existing populations (<10' distance). Additional planting or seeding will be needed to significantly increase the area of high-productivity native marsh. It is unclear if this is due to goose trampling and herbivory, or if monitoring crews contribute to vegetation trampling.

Micro-topography has a strong effect on plant establishment and growth. While *Triglochin* grew well in exclosures, *Carex* did not grow aggressively. Areas with standing water fail between tides fail to recruit any vegetation (except algae) while adjacent drained areas had seedlings establish. Poor drainage between tidal cycles combined with the existing compacted soils reported by planting crews may prevent re-diffusion of oxygen into soils between tides, limiting the number of species which will persist and their productivity.

Research indicates that *Carex* productivity and distribution is reduced under low soil oxygen levels {Ewing}. *Scirpus maritimum* and *Triglochin* are adapted to anaerobic muck and have been observed to colonize more anaerobic environments within reference salt marshes found in the literature, and while Carex has only demonstrated the ability to tolerate long periods of inundation, it only does so where soil pore drainage between tidal cycles is sufficient {Eilers}. At Mowitch *Carex* has proven viable on the slope, but has not yet grown well on the bench.

- Postpone additional plantings of Carex on the bench until growth of existing transplants demonstrates viability
- Expand exclosures and increase planting of *Triglochin* in the marsh
- Test plantings of *Scirpus maritimum* on the bench
- Expand *Carex* plantings along the bottom of the transition slope to expand existing vigorous populations.
- Consider increasing drainage with trenches in a portion of the bench to see if Carex growth increases with increased drainage
- Plant green seed of Triglochin and Plantago in seed treatment plots

Goose grazing pressure is limited by low populations (only 3-4 mating pairs observed in the 2004 season; Adams pers. obs.). Fencing without netting may be sufficient to protect marsh plantings, as long as alternate grazing sources are available in the transition marsh and upland. It was extremely difficult for crews to remove green metal fence posts and rebar from the site. The labor cost of removing fencing systems should be considered as part of the cost of that system.

- Expand minimalist chicken-wire fencing (the Adams system) to protect new plantings – consider using shallowly planted t-posts to stabilize corners.

Upland

Due to soil compaction and flat topography, some upland areas may best suited to shrubland of deciduous species adapted to spring inundation. Very few newly planted Douglas-fir survived on level terrain. Spruce and pine survival was high. Spruce survived and grew modestly despite being overtopped by weeds in some locations. Due to bareroot transplant shock, year two growth will be a better indicator of species competitiveness under site conditions.

Overhead irrigation increased weed growth. This difference was particularly strong where overhead irrigation was discontinued for two years due to a combination of irrigation controller failure and conversion to drip irrigation. Drip irrigation lines made relocation of infill plantings for maintenance easier. Marking the beginning and endings of drip lines, and keeping lines laid straight would make this function more effective. Drip lines were very difficult to relocate where ground vegetation growth was dense and tall.

- Densely plant and maintain red alder in spaces between conifer clumps where it has not established to date
- Maintain existing plantings by reducing competition where necessary.
- Control blackberry on both sides of the fence
- Increase planting of spruce and pine in conifer patches – include Douglas-fir where drainage is very good.
- Further reduce irrigation over next growing season to ~5 applications during mid-late summer depending on weather.
- Experiment with planting wet shrub vegetation into anaerobic zones – determine best timing for survival
- Increase marsh edge vegetation.

Monitoring

Eleven criteria are being measured and evaluated at Mowitch as part of the CB-NRT's monitoring plan. Six criteria evaluate vegetation. A report each December provides a snapshot view of overall site conditions during the previous growing season.

Response of site-wide mean plant cover measurements will lag several years behind restoration actions. There is no ability to compare zones within the site under different management regimes, or evaluate the effectiveness of individual actions with existing monitoring data. To determine the effectiveness of varied management regimes or

observe variation in response among different zones, additional monitoring or modification of the current regime is necessary.

Transect based monitoring does not sample the whole site, only that part of the site along the transect. Daubenmire developed his transect based methods to measure vegetation across an environmental gradient and not to characterization vegetation in discrete polygons. All interpretation of monitoring data as describing the site condition assumes that the transect is representative of overall site conditions. Riparian transect 1.1 is located near the fenceline which is not typical for the site due to: 1) flat topography which is more waterlogged than areas with sloped topography, 2) trampling during maintenance, 3) dispersal of blackberry across the fenceline from the unmanaged land between the fence and asphalt.

The 20x50cm quadrat size is of a scale most appropriate for monitoring grasslands (another one of daubenmire's interests). Idealized quadrat size is determined by species area curve analysis that has not been performed. A larger quadrat size would sample a greater percentage of the site and reduce variance.

Comments of Marsh Data Analysis

BMC1(cover) should be analyzed in the context of **BMC2(composition)**. The marsh plants recruiting at Mowitch are not those you'd find on a productive natural marsh system. Cover and composition targets need to be coupled for evaluation of success. Current increases in cover do not indicate success because the composition of that cover is not moving the site towards a desired target condition. The presence of recruitment in exclosures immediately adjacent to seed sources suggests that marsh development is limited by propagule source and disturbance. Observations of transplant growth suggest that site conditions are variable, and may limit the character and productivity of potential vegetation.

Based on **BMC3(vigor)** measurements and site observation, highly productive *Carex* marsh communities are viable on portions of the site. However low soil redox on flat, poorly drained and poorly colonized areas of the site may prevent broad development of a sedge marsh. BMC3 measures are based on six quadrats all located within a single patch of sedge located on the marsh bench-upland transition. out of a total of 69 marsh quadrats. Although useful, this measurement should not be taken to reflect the potential vigor of the entire potential marsh area – and this measurement should be secondary to establishment of cover, perhaps being used to evaluate productivity once a certain level of cover has been established. Above ground biomass could be used as a more powerful measure if and when we get to this point, however, if no corrective action is available, this measurement is purely academic.

PROPOSAL: Divide the marsh into the transition marsh and the bench marsh for evaluation (already done to some degree). Use a baseline approach to sampling and offset quadrats from the transect for the marsh bench survey. Stratify quadrat between the three lobes sampled.

If it serves a concrete management need, consider vigor measurements as a post-installation academic evaluation of productivity once sufficient vegetation has been established. If the Carex is not the dominant vegetation you may need to use above-ground biomass sampling to get at primary productivity, or include a height measurement. Identify target vegetation using observation of growth in experimental plantings.

Comments on Upland Data Analysis

BMC5(composition) and BMC6(cover) is the key driver of management activities. Whole site mean canopy cover by species is a useful measure of the effectiveness of these activities, but data response may lag several years behind management actions that involve planting. The bias in the transect method makes the data not representative of the whole riparian polygon. Future analysis should consider summarizing mean site coverage of functional groups (shrubs layer, conifer canopy, deciduous canopy). Native cover is increasing, but from an extremely low level. High heterogeneity of cover has created large areas where native plant development is insufficient to create a sustainable native cover – a pattern not reflected in the data. Invasive species recruitment is inversely related to development of vigorous native vegetation, and so is part of the cost of waiting for the increase in native cover. The combination of patchy sparse cover and constant invasive recruitment makes a trend toward persistent dominance by native vegetation unsustainable without continued management.

BMC6(survival) has not provided useful information. Evidence of dead plants Ongoing planting efforts will be recorded zone by zone, so that the development of coverage can be compared to total planting efforts to achieve a more accurate measure of BMC6. There will be a lag time between planting effort and statistically significant response in cover measures.

PROPOSAL: Stratify samples between management zones. Use a baseline-offset method to sample entire polygon. Lump species of low concern into functional groups to reduce sampling time. Increase quadrat size to reduce variance and reliability of results. Select a quadrat size appropriate to scale of vegetation patterns to reduce variance. Discontinue survival measurement, rather track management actions by zone and compare plant input to cover output. Summarize cover by functional groups, and calculate variance and 0.05 margin of error.

Introduction

This vegetation management plan intends to, 1) orient stewards to the Mowitch Restoration Site, 2) define objectives shared by Citizen's for a Healthy Bay (CHB) and the Commencement Bay Natural Resource Trustees (CB-NRT), and in doing so, 3) allow CHB increased autonomy in responding to site needs under the authorization of the CB-NRT. It contains a main section, and four appendices:

The main section defines the goals objectives and terms and conditions for CHB involvement in the site, primarily vegetation management. Appendix A describes tasks that are pre-authorized by the CB-NRT, and presents a subset of these tasks to be completed as part of continued funding. The remaining appendices provide additional supporting documentation and materials. The management plan is intended to be a living document, updated and readopted as site conditions dictate.

Site Management Plan

To date, management actions on the Mowitch Site have been primarily stimulated by site observations by CB-NRT or NOAA RC staff. Local stewardship is necessary for long term site viability. The goal of this management plan is to increase community-based monitoring and stewardship at the Mowitch site by Citizens for a Healthy Bay's (CHB's) Adopt-A-Wildlife-Area program (AAWA) as a pilot project. CHB acts as a subcontractor of Ridolfi Engineers.

This management plan describes the organization of the site, target vegetation, and conditions for site access. As pilot, this management regime is intended to be adopted for one year increments, with review and modifications being made based on management experiences. The following measures should be considered in evaluation of the program effectiveness.

- Volunteer individuals, hours, and value logged during site management
- Stock installed and surviving
- Results from site specific monitoring efforts

Contact Information

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Terms and Conditions

The following general terms and conditions will guide site work:

SAFETY AND STEWARDSHIP

- CHB will carry liability insurance for their staff and volunteers.
- The site will be left in orderly condition (bagging or stacking waste, safely organizing materials)
- Materials will not be stored below the extreme high tide line

COMMUNICATIONS PROTOCOL

- CHB will contact the restoration project manager (RPM) and the Trustee Steward when making site visits. This is a requirement imposed by a legal obligation of the CB-NRT to the property owner.
- Follow all CHB site visit safety procedures:
  - Carry a cell phone
  - Wear appropriate clothing and footwear
  - Notify CHB staff when you will be on site

- Call CHB staff when you have completed site work and left the site

- CHB stewards will immediately report any site conditions that are in any way unusual, dangerous or otherwise of concern to the RPM and the Trustee Steward.
- Fax copies of work reports to the RPM at the end of a days work (206-526-6665)

SITE PROTECTION

- CHB will not modify monitoring markers left on the site by other contractors.
- CHB will not intentionally damage or remove existing native vegetation without permission from the RPM or Trustee Steward.
- Traffic on the site will be minimized to prevent damage to soils. Maintenance access will be focused on a access corridor maintained along the north fence line.

RESTORATION CONTINUITY

- **Specific treatments will be reviewed by the RPM before implementation.** Treatments will be consistent with the scope of work proposed in Appendix A. Actions will be conducted as constrained by task specifications listed below. CHB will consult regularly with the RPM in good faith regarding any concerns, confusion, or need for guidance.
- Planting composition will be limited to those communities and species discussed below. Modifications to this list based on additional research or observations should be resolved with the RPM prior to acquisition or planting.
- All site work will be quantified and recorded by management zone. Include the number of workers, the time spent on the work, the extent of work done, including the area affected and/or the number of plants added, and any observations that may help future visitors understand the motive, or interpret the outcome of the work. A sample work report is found in Appendix D.
- A summary report of all work performed on the site over a calendar year will be presented in January following each calendar year. This report will be incorporated into the Site Management History in Appendix C, and delivered along with any proposed modifications of this management plan for approval of future work.

Management Zones

The site is divided into three ecological management zones: Forest (Above extreme high water), Transition marsh (Between extreme high water and MHHW) and Marsh (between MLHW and MHHW). Each zone is further divided into work management zones for the purposes of record keeping. For the marsh these sub-zones are divided by geographic separation (three lobes and an island). In the upland buffer the site is divided by irrigation control into seven zones. A map of management zones is found in appendix D.

Monitoring and Reporting

A bay-wide monitoring regime and success criteria are defined in a Restoration Monitoring Plan (Commencement Bay Natural Resources Trustees (CB-NRT) 2000). Vegetation monitoring is completed under sub-contract by Adolfson Associates as a subcontractor of Ridolfi Engineers. The vegetation protocol was developed to detect change in cover and composition along fixed transects. The results of these efforts are used to identify if performance measures are being reached. As the protocol does not sample the spatial extent of the site, existing monitoring efforts do not necessarily provide information on the condition of vegetation across the site, and may not capture response of vegetation to management measures. CHB activities will integrate with existing monitoring plans and protocols, until potential modifications to the monitoring program are developed, proposed, and approved.

Data on restoration effort will be tracked by CHB in cooperation with the RPM. Each calendar year, daily work reports will be compiled into an annual work report that will be presented to the CB-NRT along with any proposed changes to the Management Plan.

Scope of Work

There are two types of tasks described in this scope as detailed in the Scope of Work in Appendix A:

1. Work currently planned for completion within the specified calendar year based on existing available resources – high priority tasks.
2. Work that is pre-approved by the CB-NRT as appropriate management activity, but that will be completed depending on development of resources and priorities – lower priority tasks.

The purpose of advance authorization of type two tasks on older sites like Mowitch is to allow CHB and the RPM the flexibility to take advantage of volunteer interest, respond quickly to opportunities for collaboration, and otherwise be responsive to the needs of the site and the community in a way that maximizes their effectiveness and ability to develop resources. Secondarily, advance authorization provides a broad framework through which site stewards can become more responsible and personally engaged in site management, promoting the long-term stewardship relationships that are critical to successful management of vegetation in severely disturbed environments.

Specific work plans proposed by CHB and their associates will be reviewed by the RPM before implementation, to insure they are consistant with CB-NRT goals and objectives, and to maintain continnity of the restoraiton effort over time. When CHB has demonstrated the techincal capacity to develop work plans a less supervised approach may be considered.

Discussion and Specifications for Approved Tasks

Work will be completed in accordance with the following specifications based on type of task.

TASKS	DISCUSSION AND SPECIFICATIONS
Plant high marsh species	Materials will be grown from seed collected within 20 miles of the Mowitch site. Quantity, species and stock type will be recorded for each management zone.
Expand exclosures	Fence stakes will be removable with hand held tools. Exclosure fencing shall integrate with existing fencing, and non-functional fencing removed or repaired as part of expansion. Risks of entangling wildlife shall be minimized and monitored. Remnant erosion control netting shall be removed before expanding exclosures.
Weed and mulch existing native plants	Avoid damage to existing plant species. Methods may include cutting, shallow gruhbing, spot mulching, sheet mulching, or temporary weed control fabric. Additional methods will be reviewed by the RPM.
Monitor seedling recruitment	Monitoring may be quantitative or qualitative. Results of experimental plantings will be monitored and results included in the annual report.
Control target weeds	Invasive species will be disposed of so as to control spread of seed and prevent re-rooting of stems. Target Species include Scot's broom, Himalayan blackberry, English Ivy (not currently present), black locust, tansy ragwort, and any other class A or class B designate noxious weeds. Non-native species may be removed as deemed necessary to enhance growth of target vegetation. No herbicides will be used for weed control. Methods may include cutting, grubbing, or covering as determined to be BMP for the species in question.
Till areas in preparation for infill planting	Identify irrigation before tillage. Prepare to repair and test irrigation following tillage. Locate and preserve desired plants before and during tillage. The extent and nature of tillage will be coordinated with the RPM before starting work.
Plant shrub and canopy species	Species will be selected from the associations described or will be reviewed by the RPM. Species will be adapted to micro-site conditions. Quantity, species and stock type will be recorded for each management zone.
Plant bare-root plants and stakes across upland-marsh ecotone in test patches	Results of experimental plantings will be monitored and results included in the annual report. The objective of this activity is to test response of species and stock to environmental gradients to improve the efficiency of larger scale planting efforts.
Test and program irrigation	Irrigation programming must be coordinated with the RPM. Irrigation will be maintained at a minimum level to prevent summer mortality of newly planted stock. The party responsibility for monitoring irrigation function must be specified and reported to the RPM. That duty is currently assigned to the site steward.
Monitor irrigation function	The party responsibility for monitoring irrigation function must be

Perennial pepperweed (Lepidium latifolium)

	specified and reported to the RPM. That duty is currently assigned to the site steward.
Realign irrigation system in preparation for plantings	Modification of the irrigation system should be reversible at no additional cost, and will be coordinated with the RPM before starting work.
Remove exclosures	Where plant materials are well established, or where exclosures are determined to not provide functional plant protection, exclosures may be considered for removal. All exclosure removal proposals should consider whole site management, seasonal and yearly fluctuation in goose populations, human traffic, and will be coordinated with the RPM.

Vegetation Objectives

Vegetation objectives at this site have been defined in association with monitoring criteria developed for riparian and marsh vegetation. Current cover is and will continue to fall short of these objectives:

Target cover in monitoring plan	Cover on upland transect in year 3 (2004)
▪ Riparian Shrubs – 30% by year 3, 50% by year 5, 80% by year 10	▪ Riparian Shrubs – 4.2% primarily rose, snowberry, ocean spray and salal
▪ Riparian Trees – 25% by year 3, 40% by year 5, 70% by year 10	▪ Riparian Trees – 0.4% primarily red alder
▪ Riparian "invasive" vegetation – <5% year 5 through 10	▪ Riparian non-native – 1.5% primarily blackberry and Scot's broom
▪ Marsh Vegetation – Vegetation showing an increasing trend, 50% cover with "target vegetation", <5% invasive cover, plants "thriving"	▪ Marsh Vegetation on transect 1-2 – 19% (with 16% coming from a diminutive 1" tall spikerush) – 13.3% non-native.

Target plant community composition was defined by default by in the planting plan. An as-built plan is not available to document the initial revegetation effort, but some of this can be inferred from plant species cover as calculated in the year 1 monitoring report, and the as-designed planting plans.

In negotiating a framework for management actions in 2003, the Commencement Bay Technical Committee agreed to the goal of complete forest cover where possible, with conifer canopy limited to 50% of the upland site, in no more than 4 discrete patches (Resolution 2003-18).

Ultimately the end state of vegetation will be defined by a subjective cost-benefit analysis of whether continued expenditure of resources on this site will significantly benefit habitat function. That determination will be made cooperatively by CHB and the CB-NRT, and will reflect economic, social and ecological considerations.

Working Plant Association Targets

The following plant associations are proposed to guide future planting at this site. Overall the site will support vegetation adapted to moist to saturated soils in spring with the potential for significant drought in summer. Given the damage to soils, development of competitive native vegetation will be experimental, iterative, and synthetic.

Uplands will be dominated by alder forest with patchy but dense conifer regeneration. Patches of dense shrubs dominate where tree growth is limited by perched wetlands soils. Understory is typical of forest edge, dominated by shrub species. The site transitions abruptly from forest to a narrow band of sedge-hairgrass-aster high marsh, and then to a low marsh dominated by seaside arrowgrass interspersed with pooly drained pans.

Association	Distribution and Discussion
Spruce-Pine Forest (Large Patches)	**(F1, F3, F5, & F7)** Dense conifer canopy is planned in four clumps within a matrix of alder forest. Sitka spruce (*Picea stichensis*) and shore pine (*Pinus contorta*) survived and grew most in an experimental bare root conifer planting in winter 2003-04. Both species are tolerant of saturated soil conditions in early spring. In areas where drainage is good, Douglas-fir (*Pseudotsuga menzeisii*) may thrive.
Red Alder Forest (Matrix)	**(F2, F4, F6)** Alder forest is the dominant target vegetation on the site. Red alder (*Alnus rubra*) has been far more successful than Oregon ash (*Fraxinus latifolia*), and has established in all but the most poorly drained soils. A mixture of dense canopy plantings intermixed with more open canopy with a shrub dominated understory is desired to compete with Himalayan blackberry. An underplanting of spruce, or perhaps western redcedar (*Thuja plicata*) or hemlock (*Tsuga heterophylla*) can be established in gaps in the alder canopy, to replace alder over the long term. A mosaic of species adapted to micro-site drainage conditions will need to be placed based on observed soil conditions. Understory species listed for this association should transition to shade tolerant species from the shrub vegetation where drainage is poor.
Willow-Dogwood Shrubland (Patches)	**(Patches throughout forest zones based on hydrology)** Due to low oxygen soil conditions some soil patches may not support canopy species. Hooker's willow (*Salix hookeriana*) and Sitka willow (*Salix sitchensis*) are commonly associated with estuarine buffer wetland soils. Red-twig dogwood (*Cornus sericea*) will tolerate these conditions and thrive under canopy. Snowberry (*Symphoricarpos albus*), Western crabapple (*Malus fusca*), black hawthorne (*Crataegus douglasii*), twinberry (*Lonicera involucrata*), and ninebark (*Physocarpus capitatus*), Nootka rose (*Rosa nutkana*) can be used to supplement willow and dogwood thickets. Shrubs should be planted as low as possible into the transition marsh, and density should increase

	along and beyond the edges of forest canopy.
Hairgrass-Aster Salt Meadow (Band)	**(T1, T2, and T3)** Douglas aster (*Aster subspicatus*) and Sucksdorf's mugwort (*Artemesia sucksdorfii*) has established from seed. Hairgrass (*Deschampsia caespitosa*) has established from plantings in infrequently inundated high marsh and some seedling recruitment is evident. These species commonly coexist past the lower edge of woody plant salt tolerance. Lygnby's sedge (*Carex lyngbyei*) has established well in planted sections of high marsh, however may have been encouraged by past irrigation's dilution of soil pore salinity, and may be limited by high salinity on the marsh bench. Saltgrass (*Distichlis spicata*) may dominate in patches.
Triglochin marsh (Matrix)	**(M1, M2, M3)** Seaside arrowgrass (*Triglochin maritimum*) and seaside plantain (*Plantago maritima*) has proven most able to colonize the marsh bench. Carex is unproven on the bench, but may supplement the Hairgrass-Aster association in the high marsh. Pickleweed (*Salicorna virginica*) has begun to establish in modest amounts and may dominate the marsh over time if soil conditions allow. Scirpus maritimus should be considered, as it is adapted to poorly drained conditions and does co-occur with Triglochin in some systems. Poor drainage due to topography may limit even arrowgrass. Saltgrass (*Distichlis spicata*) may dominate in patches.

Species Lists

The following plant lists identify the species and relative abundances targeted for each Association. Plantings should be designed based on the resources available for site preparation and maintenance, and prioritization of work goals. This plant list is preliminary and focused on dominant species. More extensive analysis of the varied conditions on the site, and performance of existing plantings may indicate the need to modify these lists. Due to the localized effects of compaction and micro-topography, successful planting may involve careful matching of species to micro-sites.

Association	Species composition	Abundance
Spruce-Pine Forest	Sitka spruce (*Picea stichensis*)	++
	shore pine (*Pinus contorta*)	+
	Douglas-fir (*Pseudotsuga menzeisii*)	-
	(additional species as appropriate from lists below)	
Red Alder Forest	red alder (*Alnus rubra*)	++
	red-twig dogwood (*Cornus sericea*)	++
	snowberry (*Symphoricarpos albus*)	++
	redcedar (*Thuja plicata*)	-

	hemlock (*Tsuga heterophylla*)	-
	sword fern (*Polystichum munitum*)	+
	lady Fern (*Athyrium felix-femina*)	+
	trailing blackberry (*Rubus ursinus*)	++
	red elderberry (Sambucus racemosa)	+
	beaked hazelnut (Corylus cornuta)	+
Willow-Dogwood Shrubland	Hooker's willow (*Salix hookeriana*)	++
	Sitka willow (*Salix sitchensis*)	++
	red-twig dogwood (*Cornus sericea*)	+
	snowberry (*Symphoricarpos albus*)	-
	western crabapple (*Malus fusca*)	-
	black hawthorne (*Crataegus douglasii*)	-
	twinberry (*Lonicera involucrata*)	+
	ninebark (*Physocarpus capitatus*)	+
	Nootka rose (*Rosa nutkana*)	++
Hairgrass-Aster Salt Meadow	Douglas aster (*Aster subspicatus*)	+
	hairgrass (*Deschampsia caespitosa*)	++
	Lygnby's sedge (*Carex lyngbyei*)	+
	Sucksdorf's mugwort (*Artemesia sucksdorfii*)	-
	gumweed (*Grindella integrifolia*)	-
	silverweed (Potentilla anserina ssp. pacificia)	-
	saltgrass (*Distichlis spicata*)	-
Triglochin marsh	seaside saltgrass (*Triglochin maritimum*)	++
	seaside plantain (*Plantago maritima*)	+
	pickleweed (*Salicorna virginica*)	+
	saltgrass (*Distichlis spicata*)	-
	Scirpus maritimus	-

"++" = dominant, "+" = common, "-" = minor

Appendix A -- Scope of Work 2005

This work plan outlines approved activity types at the Mowitch Site over the calendar year 2005. Earthcorps has been retained as a contractor for completing work outside of the capacity of CHB. Earthcorps will work within the scope as described. Work on the site by crews other than Earthcorps and CHB staff and volunteers will be arranged with the RPM before committing to that work.

Management Goals

Given existing site conditions, a wide range of goals are unmet at Mowtich. Work will achieve one or more of the following goals,

1. Reduce weed competition with new plantings
2. Reduce invasive species cover
3. Increase native tree stems
4. Increase native shrub stems
5. ~~Increase marsh area~~
6. Learn about restoration practice

Work planned for completion in 2005-06

TASKS	GOAL	SPR	SUM	FAL	WIN
Plant high marsh species	Increase marsh	X			
Control target weeds	Reduce invasive		X		
Plant canopy trees	Increase trees			X	X

Pre-authorized work for 2005-06

TASKS	GOAL	SPR	SUM	FAL	WIN
Weed and spot mulch existing native plants	Reduce competition	X	X		
Monitor seedling recruitment	Test practices		X		
Till weedy areas in preparation for infill planting	Reduce competition		X	X	
Plant shrub species	Increase shrubs			X	X
Plant bare-root plants and stakes across upland-marsh ecotone in test patches	Test practices			X	X
Test and program irrigation	Increase trees and shrubs	X			
Monitor irrigation function	Increase trees and shrubs		X		
Realign irrigation system in preparation for plantings	Increase trees and shrubs			X	
Install additional chicken-wire fencing to existing exclosures.	Increase marsh	X	X	X	X

Appendix B - Site Overview

Location and Project Overview

The Mowitch site also known as the Wasser/Winter site, or Hylebos Estuary Site, is owned by the Port of Tacoma. It was constructed under the management of NOAA Fisheries Restoration Center and Ridolfi Engineers under a consent decree between Commencement Bay Natural Resource Trustees and the Port of Tacoma. It is located in the City of Tacoma Northwest of where Marine View Drive bridge crosses Hylebos Creek before it enters the Hylebos Waterway.

The site covers approximately 2.3 acres and includes a portion of Hylebos creek and the adjacent riparian buffer (site map in appendix C). The site was re-graded in summer of 2000 to create two benches adjacent to the creek channel. The top bench, approximately 25 feet wide along the NE edge of the property, remained upland buffer. A parallel bench between the upland and the creek was created at an elevation between 10 and 12 feet above MLLW, to support salt marsh vegetation. Three 'backwater' fingers were carved out of the marsh bench to increase the area and frequency of fish access. A second 'creek mouth' was constructed where Hylebos creek enters the Hylebos Waterway. Construction occurred during the summer and fall of 2000.

Project Goals

Mowitch Estuary is an example of an engineered habitat enhancement in a severely degraded landscape. Mowitch was designed to create a maximum of habitat function for marine fisheries, including anadromous fish, within a limited area. Given the narrow site, a stepped bench design was used that would maximize the area of salt marsh while retaining buffer functions. A bay-wide monitoring program to quantify performance criteria measures vegetation characteristics, fish density, insect density, bird presence, and stability of topography.

Physical Environment

All **surface soils** were imported during construction. Soils are loamy, and drained except where compacted during construction. There appears to be a gradient, from extremely high levels of compaction in the SE to lower levels of compaction in the NW. This is assumed to result from higher levels of vehicle traffic near the entrance of the site.

Subsurface water movement has not been studied on this site. The degree to which groundwater discharge affects soil moisture in the upland or soil pore water salinity in the marsh is unknown. Soil pore salinity can strongly affect the plant association which can develop in a marsh.

Water level fluctuation in the marsh is primarily driven by tidal flux in Commencement Bay. Hylebos creek does not strongly influence water levels in a way that is likely to affect vegetation. For the purposes of site management, water levels at the head of Hylebos Waterway are assumed to be equal to NOAA tidal observations in Commencement Bay. Summary statistics were generated from 5 years of observed data from August 1999 to August 2004 (Table ##). Elevations are relative to mean lower low water (MLLW) at the Commencement Bay tidal observation station.

Table 1 – Tidal inundation regime based on 5 years of observed data, 1999-2004

TIDAL STATISTICS (in feet)	
MLLW (as compared to Mean lower low water for period of record)	- 0.08 MLLW
MHLW (Mean higher low water)	+ 5.72 MLLW
MLHW (Mean lower high water)	+ 10.01 MLLW
MHHW (Mean higher high water)	+ 11.83 MLLW
MEAN TIDAL RANGE	11.91
MAXIMUM TIDE	+ 14.58 MLLW
MINIMUM TIDE	+ 4.31 MLLW
EXTREME RANGE	18.89

Soil pore oxygen level fluctuation in marsh sediments is likely controlled by compaction and topography. In depressions or compact soils, water is retained in soil pores between tidal cycles. Oxygen is depleted by soil micro-organisms, and the low rate of oxygen diffusion water prevents re-oxygenation between tidal cycles. Soil pore oxygen levels can strongly affect the plant associations which can develop in a marsh.

Fresh water dilution of Hylebos Waterway **salinity** is limited to a shallow lens of freshwater. Salinity/depth curves were observed at six times in late summer of 1999 (Figure 1). At 6 inches depth, salinity ranged from 18-27 ppt. These measurements were taken at the road crossing of Hylebos Creek. Surface water salinity may increases toward the NW end of the site, where the proportion of bay water to creek water increases and mixing is more complex.

In upland areas, standing water is common in patches throughout the site due to compacted surface soils and flat topography, creating **low-oxygen soils** during rainy periods. Redoximorphic features (mottling, low chroma soils) have formed in these poorly drained areas since construction. Variation in the plant communities on the site are strongly affected by variable soil drainage. Douglas-fir (Pseudotsuga menziesii) has only survived on slopes with drainage. Wetland indicating species like Soft Rush (Juncus effusus) and Watson's willowherb (Epilobium watsonii) are common in water retaining areas.

Next to the mouth of Hylebos creek, Approximately 2-3 cm of **sediment** has accumulated over four flood seasons (gauged by the depth at which erosion control materials had been buried) Next to the Hylebos Turning Basin no sediment has been deposited. It is assumed that the creek discharge velocity decreases rapidly after entering the site, causing the majority of sediment to be deposited at the SE end of the site. Alternately, higher wave energy near the turning basin could be transporting sediment deposited on the NW end of the site into deeper water.

Biotic Environment

- There are very limited sources of native seed available for **natural dispersal to uplands**. The majority of unmanaged vegetation in the vicinity is found on derelict industrial sites and dominated by invasive shrub lands of Scot's broom (*Cytisus scoparius*) and Himalayan blackberry (*Rubus discolor*). Blackberry and Canada Thistle has been spreading vegetatively from unmanaged land, north of the fenced property line.
- The non-native species, Brass-buttons (*Cotula coronopifolia*) and saltmarsh sandspury (*Spergularia marina*) dominate **natural recruitment to the marsh**. Some pickleweed has

begun to recruit naturally. Lower density of seaside arrow-grass (*Triglochin maritimum*) and seaside plantain (*Plantago maritima*) recruit next to established populations.

- A number of native **wind-dispersed forbs** have established on the site including Goldenrod (*Solidago canadensis*) and Sucksdorf's mugwort (*Artemesia sucksdorfii*)
- The combination of low soil oxygen levels in spring and summer aridity creates a difficult environment for plant establishment, limiting the variety of native species that will be competitive with invasive species on this site. [discuss observed mortality]
- When NOAA RC increased active management of this site in summer 2003, **irrigation** was running daily, and because of compaction, low oxygen soils could be found during the middle of the dry season. In areas where this irrigation regime had failed due to dead controller batteries, vegetation composition was substantially different with increased dominance by lupine (*Lupinus sp.*) and yarrow (*Achillea millefolium*). The current management strategy intends to minimize irrigation to that required for planting establishment. Ground vegetation composition may change over time because of this change in soil moisture regime.

Disturbance Stressors

- **Canada goose** (*Branta canadensis*) herbivory is a limiting factor on salt marsh establishment. Goose exclusion can be accomplished with modest investment in fencing. Pressure from goose herbivory is related to breeding population on the site which fluctuates from year to year. Goose populations have decreased from very high levels during initial establishment (2001-2002) and much lower levels in recent years (2003-2004). Only 2-4 mating pairs were observed in spring 2004.
- **Human traffic** through the site has created distinct pathways through the site. In Spring of 2004 work crews were directed to use a access trail established along the fence line to reduce through-site trampling. Given the poor condition of soils, excessive foot traffic, particularly on saturated soils, will likely have a gradual cumulative effect on soil health.

Landscape Restrictions

- Plantings should not conflict with the existing railroad **right-of-way**. A zone within 20' of the railroad fence should be limited to shrub plantings.
- **Site access** for staging and storage of materials is limited to a fenced entry on the railroad right of way. Planting in this area should be delayed to allow for staging materials entering or exiting the site and for free movement of the gate.
- A 3' wide **maintenance corridor** should be maintained along the NE fence line. Use of this corridor for transit will limit the extent of compaction from foot traffic, allow access to irrigation controllers, and increase awareness of the spread of blackberry from the fence line.

Appendix C - Site Management History

Treatment Summaries

Year*	Date	Treatment
1	2000 June-October	♦ excavation, regrading and soil reconstruction
1	2000 Fall	♦ hydroseed upland
1	Fall 2000- Spring 2001	♦ initial volunteer planting (count unknown) ♦ goose protection installed.
1	2001 November	♦ Supplemental volunteer planting and ♦ spot mulch with compost
2	2003 Spring	♦ hog fuel mulch application, ♦ large goose exclosure installed in Marsh zone 3, ♦ large stock conifer planting (mostly failed) ♦ supplemental willow planting (mostly failed)
3	2004 Jan-Mar	♦ Site zonation established ♦ additional hog fuel mulch application ♦ 18 goose exclosure plots installed in marsh zones 2,3, and 4. ♦ experimental seeding and planting in 12 of 18 plots ♦ upland zones 3 and 5 retrofitted to drip ♦ 250 conifers/250 shrubs planted in upland primarily in zones3, 5, and 7 and a patch in zone 1.

* Site year indicates the monitoring year in which the work might first impact vegetation measurements.

Treatment details

[data for year 3 available but not included in this draft]

Appendix D - Site Management Resources

Sample Work Report

WORK REPORT

Site:	MOWITCH	Notification:	
Date:		Time Arrived:	Time Left:
Work leader:		# workers:	person hours:
Contractor:		# workers:	person hours:

Planting Summary:

Zone	Species	Stock	Count	Notes

Work Summary:

Zone	Task	Person hours	Notes

Figures

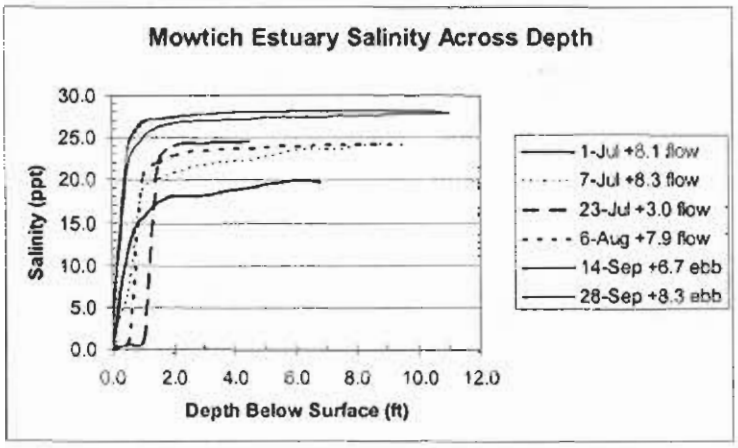
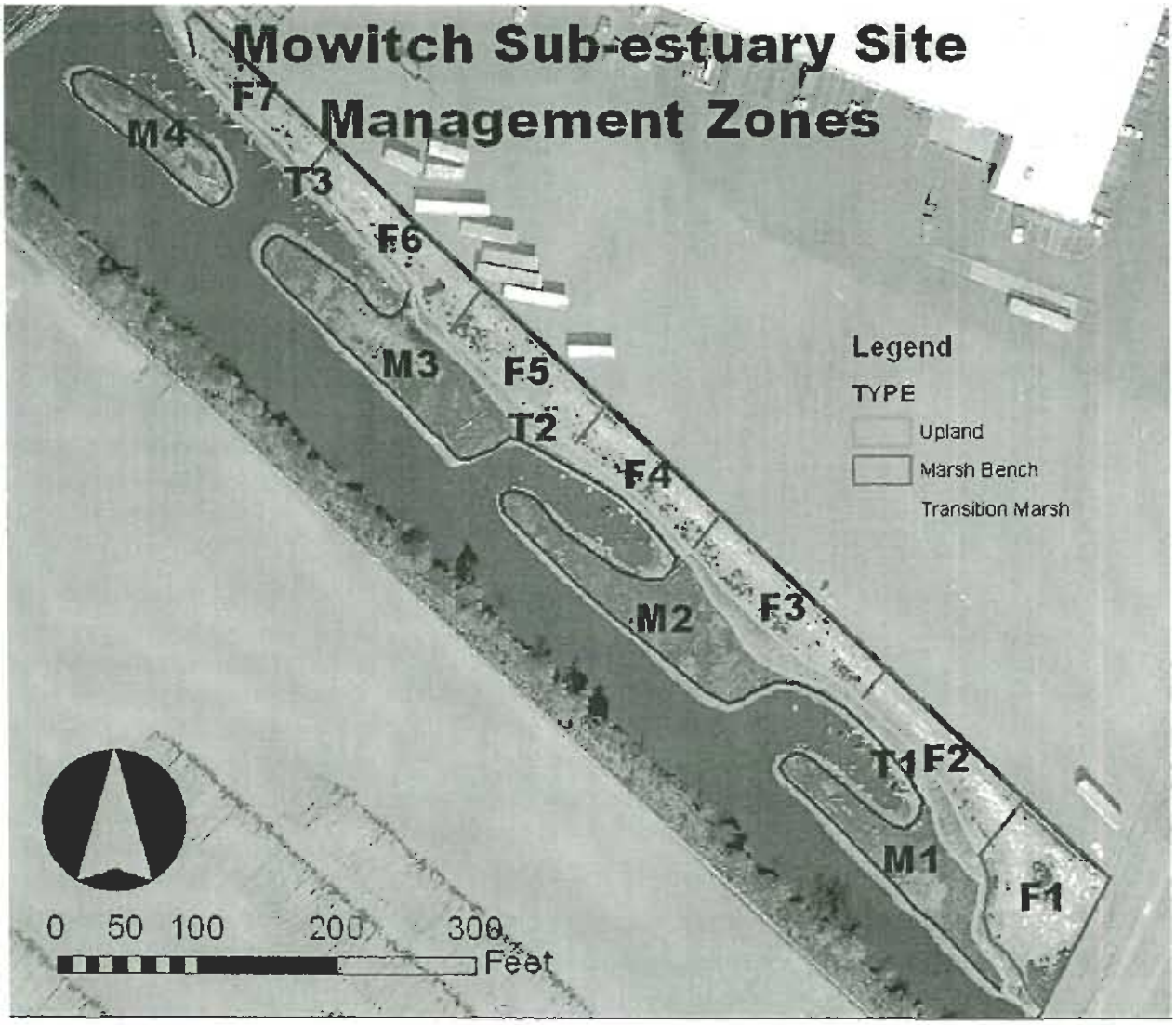


Figure 1 – Salinity was measured at the Marine View Drive Bridge at six times. Tidal stage during measurement in indicated after the date in elevation relative to MLLW and whether the tide was flowing or ebbing.


Mowitch Sub-estuary Site
Management Zones
F7
M4
T3
F6
M3
F5
T2
F4
M2
F3
T1
F2
M1
F1
Legend
TYPE
Upland
Marsh Bench
Transition Marsh
0 50 100 200 300
Feet