Salt Marsh Mapping in Cook Inlet: Trading, Redoubt, and Chickaloon Bays

Final Report

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Summary

The flora of salt marshes was mapped from the lowest extent of vascular plants to the highest wrack line on the beach. Salt marshes were outlined using rectified aerial photographs, and oblique low-altitude aerial photographs were obtained at each marsh. Initial delineation of plant communities was done based on aerial photographs. Fieldwork was carried out in each marsh to classify plant communities. During this fieldwork, multiple formal vegetation plots were established, as well as numerous less formal notes. All plots and notes were assigned to specific points on the ground using hand-held GPS. Final delineation of plant communities was based on a combination of overhead aerial photos, oblique aerial photos, and field notes and data. Each polygon was assigned a plant community and vegetative growth form. **This project was initiated by the Cook Inlet Regional Citizens Advisory Council in an effort to obtain information on areas of Cook Inlet that are particularly sensitive to oil.**

Introduction

Salt marshes are highly productive estuarine habitats that support a wide range of animal species, including intertidal invertebrates, fish, birds and mammals. The patterns of vegetation in salt marshes are influenced by small-scale variations in elevation (and thus tidal inundation time, salinity, and soil moisture). They are also dynamic systems, with elevation changes influenced by siltation and erosion, the effects of ice rafting, and any changes in sea level or land elevation. In order to document change in the salt marshes of Cook Inlet, a basic understanding of the current conditions of the salt marshes is needed. In addition to change analysis, this mapping effort has the potential to serve as the basis for understanding the habitat value of these marshes to a wide range of animal species, as well as identifying priority areas for protection in the event of an oil spill.

Methods

Mapping methodology was derived from mapping carried out in the mid-90's in Lake Clarke National Park (Tande 1996), and a similar effort several years ago in Kachemak Bay (Pegau 2005). Vegetation was mapped from the lowest extent of vascular plant communities to the extreme high tide wrack line. Since this upper line coincided with a transition to communities dominated by less salt-tolerant plant species, the presence of such communities was often used to delineate the upper tidal range of our mapping efforts. Berms or levees dominated by communities of these less salt-tolerant species (especially *Leymus mollis*) were included in our mapping efforts when they were isolated within our mapping area within each marsh.

Three Cook Inlet tidal marshes were mapped during this project. These were Trading Bay and Redoubt Bay on the western side of Cook Inlet, and Chickaloon Bay on the eastern side of the Inlet (Figure 1).

To begin mapping, rectified aerial photography was obtained for each marsh. Digital orthophotos were used for Chickaloon Bay. However, such photos were not available for Trading or Reboubt Bays. We purchased overhead aerial photos of these marshes, and rectified them to align with rectified satellite imagery. The rectified imagery was used to delineate total extent of each marsh and plan our field work. We also conducted low-elevation flights to obtain oblique photographs. These flights took place in late summer, when differences in the color of various plant species was most pronounced. We were able to differentiate individual plant communities on these photos by differences in color and texture. Fieldwork was planned to ensure that we were able to place vegetation plots in each different plant community visible in the photographs.

Fieldwork was undertaken in each marsh from late July through August, 2006. Because these marshes are remote and not accessible by road, planes and helicopters were used to access the marshes. As much of each marsh as possible was walked over a three to five day period. Upon encountering a unique vegetation community within each marsh, a formal vegetation plot was established. Each plot was given an identifying code (a combination of an alphabetic code for each marsh and a sequential number for each plot within a marsh), and its location was marked on our field maps with a pinhole, and labeled on the reverse side of the map. GPS waypoints were also recorded at each plot. We characterized the plant community at each plot by recording percent cover of the dominant plant species. These data were recorded using standard codes for each plant species (USDA, NRCS 2007), and an estimate of percent cover, generally to the nearest five percent (although "trace" was used for species well below 5 percent). The percent of the plot covered by bare ground was also recorded. Each plot was allowed to have up to three physiognomic layers (vertical layers). A few minutes were spent at each plot searching for less common plant species, and a digital photograph was taken. Data were entered on field data sheets developed for this mapping project (Figure 2), following the methods used for the Lake Clark Coastal Marsh Mapping (Tande 1996). In addition to observer names, date, and plant species data described above, vegetative growth form and notes were taken at each plot. Notes were also made on printed copies of aerial photographs, especially concerning boundaries between vegetation types.

Additional GPS waypoints were taken to identify vegetation types that were the same as one of the plots within each marsh. For instance, after we had established a plot designated "RAB14" in the Redoubt Bay marsh, any points comprised of the same plant community would simply be labeled "Same as RAB14" on the field map. No attempt was made to produce comprehensive lists of all plant species occurring in each marsh, but the most common plant species in each marsh are included in our data.

Due to the size of these marshes, and the barriers to foot travel caused by large rivers, not all areas of the marshes were walked. Smaller rivers and tidal guts were crossed with the aid of an inflatable raft carried with us. On being picked up by helicopter in each marsh, we flew low over the unwalked portion, ensuring that we could see no entirely new vegetation communities, and making notes on field maps. In the largest of the marshes visited (Chickaloon Bay), several brief landings were made to establish vegetation plots in areas we did not access by foot. The routes walked and all GPS waypoints were recorded and imported into the final GIS project for each marsh. Upon returning to the office, we made preliminary outlines of plant communities within each marsh on printed aerial photos before beginning fieldwork in the next marsh.

Field notes, maps, data sheets, and photographs were used to produce final polygon boundaries in the GIS project. The low-altitude oblique aerials were invaluable in delineating these boundaries, some of which were difficult or impossible to detect in the rectified vertical photography. Tidal gut and river patterns were used as reference points to place boundaries on the maps with a high degree of accuracy. We used 30 meters as a minimum mapping unit, and polygons were digitized on-screen at a scale of 1:3,750. Plant community designations from the area we walked within each marsh were applied to unwalked areas based on color and texture observed in the various photos of each marsh, as well as notes we took while flying over those areas.

To arrive at plant community descriptions, percent cover data were reclassified into plant cover classes, as listed in Table 1 (Pegau 2005, Tande 1996, Mueller-Dombois and Ellenberg 1974). Field data sheets were then sorted into groups based on the single species with the highest percent cover. These groups were again sorted into associations based on other plant species with relatively high plant cover class values. Groups with similar plant species assemblages were then compared to determine whether it was appropriate to combine them. Finally, all photos from plots within each grouping were compared to ensure that they were consistent with the group. The final two steps were repeated until we were satisfied that no further combination was appropriate.

Plant community codes were assigned to each plot. These were a combination of an arbitrary letter designating the primary plant species or assemblage, and then a number for each unique community within that group. Scientific names were used to develop descriptive names for each plant community type. Table 2 lists our final plant community types and the plant cover classes of the plant species found in each community for each marsh.

Plant community designations and vegetative growth form were entered into the database table associated with the polygon shapefile, and vegetation plots were entered into the table associated with a point shapefile representing the location of all vegetation plots.

Results & Discussion

Data were taken at 91 sample plots across the three marshes. Additional field notes and photos were taken at many additional locations. The total salt marsh area mapped was approximately 7,640 hectares (18,880 acres).

The main results for this study are included in a GIS project. This includes two shape files: 1) a point file representing the center of all vegetation plots; and 2) a polygon file representing final plant community delineations within each marsh. A database file associated with the polygons identifies the plant communities at two different resolutions: a very general community type defined by the dominant plant morphology (ie- grass, sedge, forb, etc), and detailed plant community designations, as well as the percent cover class values for the dominant plant species within each community. The rectified aerial photographs for each marsh are included in the GIS projects as well. Copies of all field data sheets and photos will be presented to CIRCAC.

The three coastal marshes mapped during this project include a wide range of plant community types, although they tend to be dominated by relatively few species. Both marshes on the western side of Cook Inlet (Trading Bay and Redoubt Bay) show evidence of ongoing erosion- there was often a sudden several-foot change in elevation at the upper limit of normal wave activity. This resulted in a relatively small low-marsh area transitioning into an extensive high-marsh, with little to no mid-marsh. Our helicopter pilot indicated that these marshes underwent extensive change following the most recent eruption of Redoubt volcano (1989), and the character of these marshes may be a result of heavy siltation following that eruption. However, other factors, such as a change in elevation following a large earthquake, could also be responsible. The Chickaloon Bay marsh was a more classic salt marsh, with no sudden breaks in elevation except at tidal guts and rivers. The plant species composition of this marsh was also different from the other two (for instance, *Carex mackenziei* was common at the western Cook Inlet marshes, but absent from Chickaloon), and more similar to the Kachemak Bay salt marshes, which are also on the eastern side of Cook Inlet.

References

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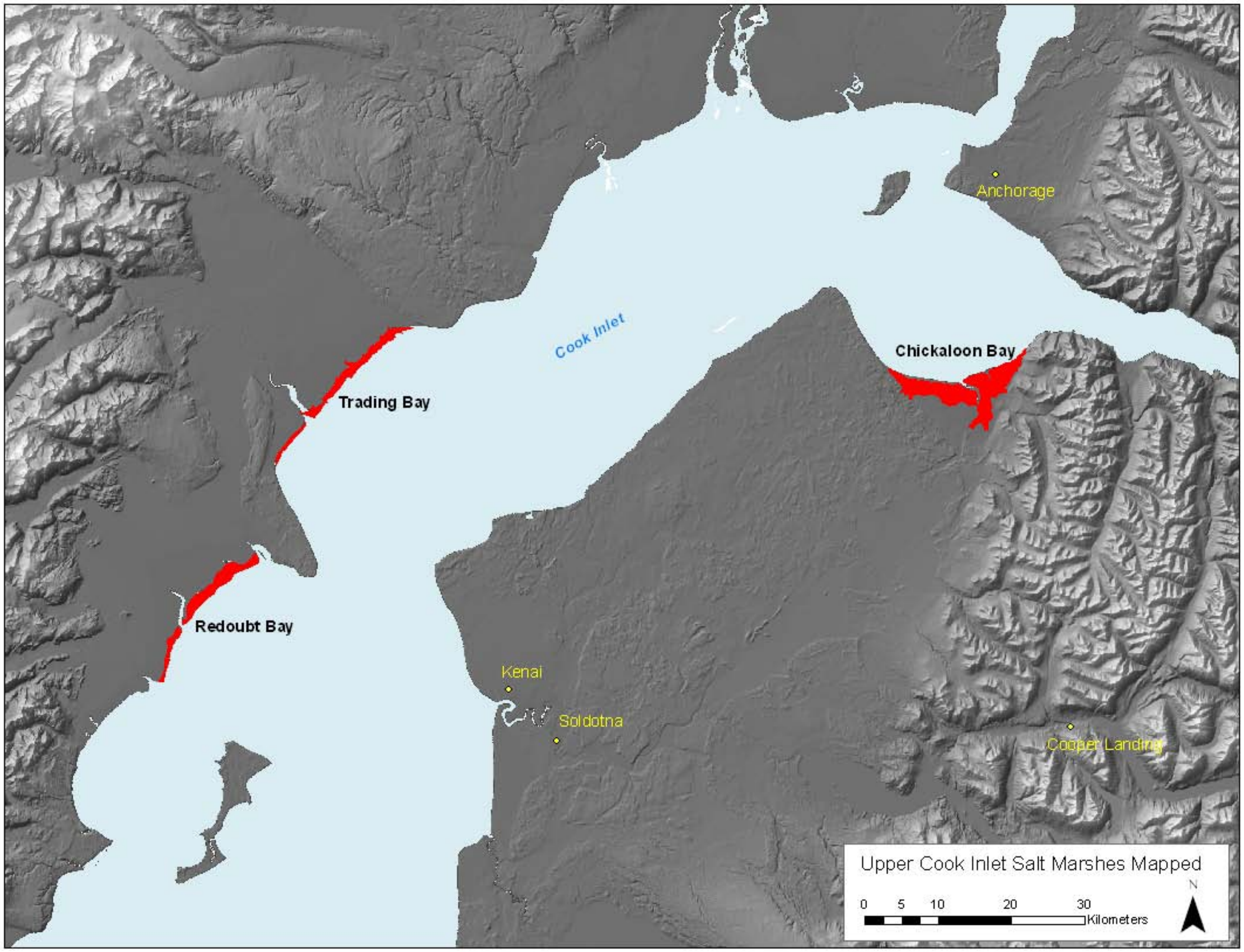

Figure 1: Marshes mapped in Cook Inlet for this project.

KBRR Salt Marsh Mapping

Observers:			Date:	

Location	Stop	Site Moisture	Land Description	Veg. Growth Form	Human/ Animal Use

Plant Name	% Cover	Plant Name	% Cover

Flooding Condition:	

Notes:
Photos:

Figure 2: Salt marsh data sheet.

Table 1. Plant cover classes (Tande 1996; Meuller-Dombois and Ellenberg 1974)

1	Individual or trace
2	<5 percent (few, seldom)
3	<5 percent (many individuals)
4	6-25%
5	26-50%
6	51-75%
7	76-100%

Table 2. Salt marsh plant communities identified in this project. Each row includes a plant community by name, followed by the composition of the community, listing plant species and their associated plant cover class. See Table 1 for an explanation of the plant cover classes. Since there are up to three vertical layers the total coverage may exceed 100%. Species in the same physiognomic layer are separated by dashes, while slashes are used for species in separate vegetation layers (Mueller-Dombois and Ellenberg 1974)

Table 2a: Trading Bay plant communities

Community Name	Compostion			
Poa eminens / Argentina egedii High-marsh Meadow	*Poa eminens*	6	*Carex mackenziei*	4
	Argentina egedii	5	*Calamagrostis deschampsioides*	3
	Triglochin maritimum	4	*Triglochin palustre*	2
	Dendranthema arcticum	4		
Puccinellia nutkaensis Community	*Puccinellia nutkaensis*	5	*Salicornia depressa*	3
	Bare mud	4	*Puccinellia phryganodes*	1
	Triglochin maritimum	3	*Suaeda calceoliformis*	1
	Plantago maritima	3	*Atriplex gmelinii*	1
Puccinellia phryganodes Community	*Puccinellia phryganodes*	6	*Triglochin maritimum*	4
	Carex ramenskii	4	Bare mud	3
Puccinellia phryganodes-Puccinellia nutkaensis Community	*Puccinellia phryganodes*	5	*Salicornia depressa*	3
	Bare mud	5	*Suaeda calceoliformis*	2
	Puccinellia nutkaensis	4	*Atriplex gmelinii*	1
	Triglochin maritimum	4		
Carex lyngbyei Community	*Carex lyngbyei*	6	*Carex mackenziei*	3
	Argentina egedii	5	*Juncus arcticus*	3
	Eleocharis pauciflora	4	*Dendranthema arcticum*	3
	Carex ramenskii	4	*Poa eminens*	3
	Triglochin maritimum	4	*Calamagrostis deschampsioides*	2
Carex lyngbyei-Poa eminens Community	*Carex lyngbyei*	6	*Triglochin maritimum*	2
	Poa eminens	5	*Juncus arcticus*	1
	Argentina egedii	5	*Cicuta virosa*	1
	Plantago maritima	4		
Carex lyngbyei-Carex ramenskii Community	*Carex lyngbyei*	5	*Triglochin maritimum*	4
	Carex ramenskii	4	*Eleocharis kamtschatica*	4
	Argentina egedii	4	*Glaux maritima*	3

Triglochin maritimum-Triglochin palustre Community	*Triglochin maritimum*	4	*Carex mackenziei*	4
	Triglochin palustre	4	*Puccinellia nutkaensis*	3
	Eleocharis kamtschatica	4	*Dendranthema arcticum*	2
	Carex ramenskii	4		
Triglochin maritimum Community	Bare mud	6	*Puccinellia nutkaensis*	4
	Triglochin maritimum	4	*Salicornia depressa*	3
	Plantago maritima	4	*Atriplex gmelinii*	1
Leymus mollis Community	*Leymus mollis*	6	*Lathyrus japonicus*	4
	Angelica lucida	4	*Poa eminens*	4
	Senecio pseudoarnica	4	*Ligusticum scoticum*	3
	Calamagrostis canadensis	4	*Achillea millefolium*	3
	Lathyrus palustris	4		
Leymus mollis-Carex lyngbyei Community	*Leymus mollis*	6	*Dendranthema arcticum*	4
	Carex lyngbyei	5	*Festuca rubra*	4
	Argentina egedii	5	*Lathyrus palustris*	4
	Plantago maritima	5	*Parnassia palustris*	4
	Lathyrus japonicus	5	*Honckenya peploides*	4
Leymus mollis Levee	*Leymus mollis*	6	*Triglochin maritimum*	4
	Argentina egedii	4	*Puccinellia nutkaensis*	2
	Plantago maritima	4		
Carex mackenziei-Triglochin maritimum Community	*Carex mackenziei*	5	*Poa eminens*	2
	Triglochin maritimum	4	Bare mud	2
	Argentina egedii	4	*Triglochin palustre*	1
	Puccinellia phryganodes	4	*Dendranthema arcticum*	1
	Spergularia canadensis	4		
Carex mackenziei / Plantago maritima Community	*Carex mackenziei*	6	*Puccinellia nutkaensis*	4
	Plantago maritima	4	*Dendranthema arcticum*	2
	Triglochin maritimum	4	Bare mud	2
	Argentina egedii	4		
Carex mackenziei-Carex ramenskii Community	*Carex mackenziei*	4	*Triglochin maritimum*	5
	Carex ramenskii	6	*Dendranthema arcticum*	3
	Argentina egedii	5		
Plantago maritima Community	*Plantago maritima*	5	*Triglochin maritimum*	4
	Bare mud	5	*Salicornia depressa*	2
	Puccinellia nutkaensis	4	*Stellaria humifusa*	1
Carex ramenskii Community	*Carex ramenskii*	6	*Puccinellia phryganodes*	4
	Triglochin maritimum	5	Bare mud	4

Suaeda calceoliformis Mudflat	Bare mud	6	*Triglochin maritimum*	3
	Suaeda calceoliformis	4	*Puccinellia phryganodes*	3
Atriplex gmelinii Mudflat	*Atriplex gmelinii*	5	*Triglochin maritimum*	4
	Bare mud	4	*Salicornia depressa*	3
	Puccinellia nutkaensis	4		
Salicornia depressa Mudflat	Bare mud	5	*Triglochin maritimum*	4
	Salicornia depressa	4	*Atriplex gmelinii*	3

Table 2b: Chickaloon Bay plant communities.

Community Name	Compostion			
Low Marsh *Puccinellia phryganodes*	*Puccinellia phryganodes*	5	*Salicornia depressa*	1
	Bare mud	5	*Triglochin maritimum*	1
	Puccinellia nutkaensis	2		
Puccinellia phryganodes-Suaeda calceoliformis Community	*Puccinellia phryganodes*	5	*Suaeda calceoliformis*	2
	Bare mud	7	*Salicornia depressa*	2
	Puccinellia nutkaensis	2		
Sparse *Puccinellia phryganodes*	Bare mud	7		
	Puccinellia phryganodes	4		
Triglochin maritimum-Puccinellia phryganodes Community	*Triglochin maritimum*	4	*Puccinellia nutkaensis*	4
	Puccinellia phryganodes	4	Bare mud	4
Plantago maritima-Puccinellia nutkaensis Community	*Plantago maritima*	6	*Triglochin maritimum*	4
	Pucinellia nutkaensis	4	Bare mud	4
Plantago maritima-Triglochin maritimum Community	*Plantago maritima*	6	*Leymus mollis*	2
	Triglochin maritimum	4	*Hordeum brachyantherum*	2
	Puccinellia nutkaensis	3	*Dendranthema arcticum*	2
	Bare mud	3		
Puccinellia nutkaensis-Plantago maritima Community	*Puccinellia nutkaensis*	5	Bare mud	4
	Plantago maritima	4	*Atriplex alaskensis*	2
	Triglochin maritimum	4	*Salicornia depressa*	1
Carex lyngbyei Community	*Carex lyngbyei*	7	*Poa eminens*	4
	Carex ramenskii	3	*Triglochin maritimum*	3
	Scirpus maritimus	3	*Cicuta virosa*	1
	Argentina egedii	4	*Triglochin palustre*	1

Carex ramenskii Community	*Carex ramenskii*	5	*Argentina egedii*	3
	Triglochin maritimum	4	*Scirpus maritimus*	3
	Carex lyngbyei	3		
Scirpus maritimus Community	*Scirpus maritimus*	5	*Carex ramenskii*	3
	Carex lyngbyei	4	*Triglochin palustre*	2
	Triglochin maritimum	4	*Puccinellia nutkaensis*	1
Leymus mollis Community	*Leymus mollis*	4	*Argentina egedii*	4
	Hordeum brachyantherum	4	*Lomatogonium rotatum*	1
	Dendranthema arcticum	4		
Panne	Bare mud	6	*Puccinellia nutkaensis*	4
	Salicornia depressa	5	*Atriplex gmelinii*	4
	Plantago maritima	5	*Atriplex alaskensis*	1

********* Still need to add table for Redoubt Bay***********