Salt Marshes of Port Valdez, Alaska, and Vicinity: A Baseline Study

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Abstract

In 1974 and 1975, 62 baseline locations were selected for intensive study in the salt marshes of Port Valdez and vicintiy. The sites are intended to reflect the impact of oil transport activities. Vegetation and soil characteristics were emphasized. The sites were selected as representative of a wide variety of major communities and were widely distributed over the region to enhance the likelihood of oil spill documentation. Seventeen Community Complexes were identified and correspondence was found between the Community Complexes and habitat characteristics. This may prove to be useful in identification of areas elsewhere that are highly susceptible to oil spill damage; it was useful during the course of this study. In addition, the Community Complexes may be used in salt marsh mapping. Gold Creek and Sawmill Creek, both in Port Valdez, appear to be the marshes most susceptible to major oil spill damage, but all the marshes studied are threatened to some degree. An oil spill associated with seasonal high tides or during the winter when fresh water outflow is minimal would increase the potential hazard to the less vulnerable marsh areas. In order to differentiate between natural successional trends and oil spill effects it will be necessary to systematically restudy selected baseline sites over the coming years.

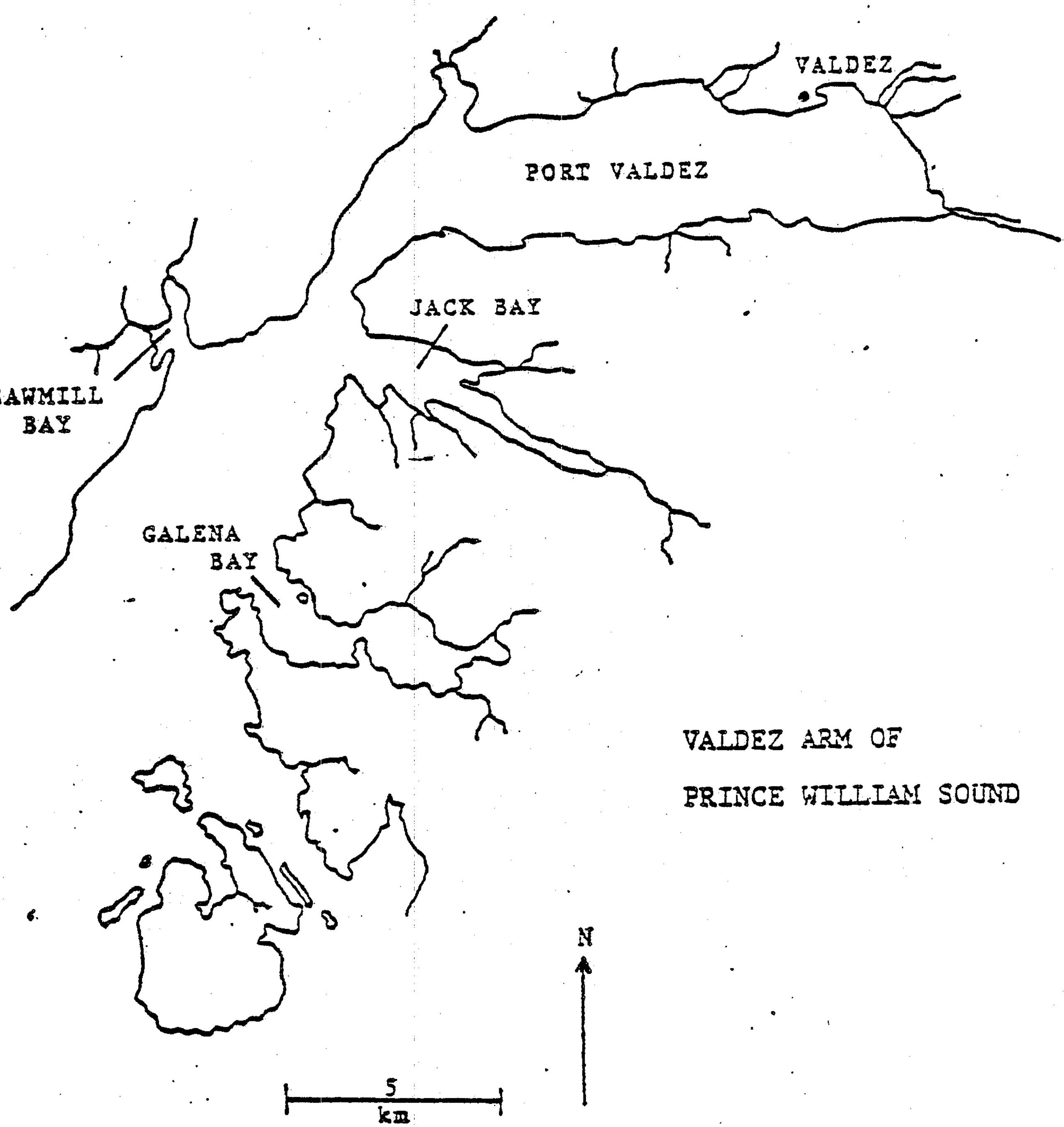
Introduction

Many persons have focused their interests on the activities associated with the Trans-Alaska Pipeline. When Pipeline and Terminus construction was begun, like most salt marshes of the Alaska Pacific Coast, very little was known about the salt marshes of Port Valdez and vicinity (Crow, in press). The need for baseline data was clearly understood by the Department of the Interior. In late July of 1974, research began to establish a collection of baseline data pertaining to the salt marshes of Port Valdez and vicinity (Fig. 1).

This report summarizes the overwhelming bulk of the baseline study. The original expectation had been for the establishment of approximately 40 baseline sites. Excellent weather in 1974 allowed greater production than anticipated. The number of sites ultimately selected came to 62. This number provides a baseline data set with significantly greater community diversity. Naturally it has taken more time to complete the laboratory and computer work.

The value of this research can be enhanced if a follow-up study of relatively small magnitude is undertaken. To begin with, without revisitation of a select number of sites over the next couple of years, it may not be possible to quantitatively separate natural changes from man-related perturbations. After successional trends have been established, revisitation once every 5 to 8 years should be sufficient. At such times the plot markers can be repaired or replaced if necessary.

Fig. 1. Principal study areas of Port Valdez and vicinity.



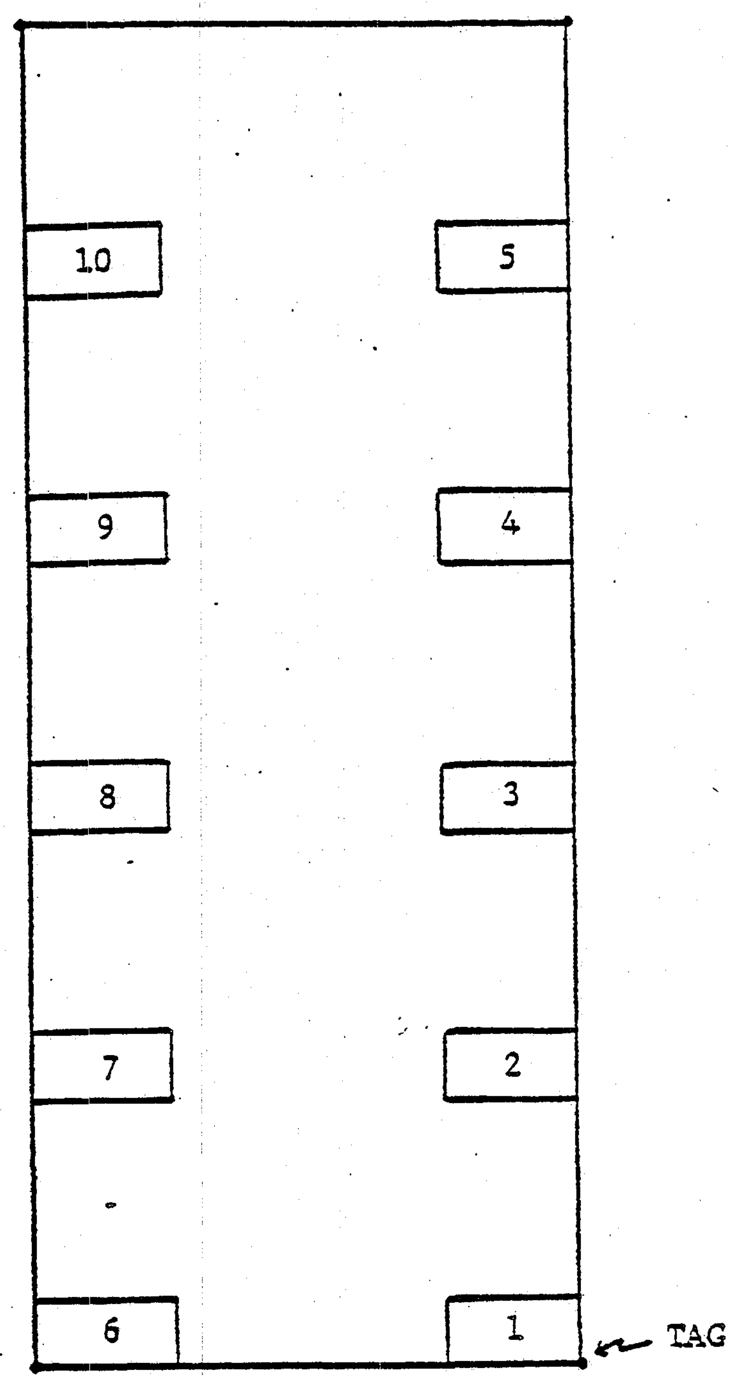
Methods

In 1974 the major emphasis was placed upon reconnaissance. This was done in order to become familiar with the study area, to select representative sites for further study, and for economy of time. Vegetation reconnaissance data were gathered by means of a canopy-coverage technique (Crow 1971, Daubenmire 1959). Habitat features such as local physiography and soils were noted. This approach is compatible with the general approach of the U. S. Forest Service in the western United States (Franklin and Dyrness 1969) as well as with other salt marsh studies by this investigator. Some reconnaissance work was necessary in 1975.

Intensive work in 1974 and 1975 followed the methodology of Daubenmire (1959) as employed by Crow (1971). A rectangular macroplot, ordinarily measuring 2 x 5 m, was marked with stakes at all four corners and labeled (Fig.2). Within the macroplot, a series of 2 x 5 dm microplots was used to obtain coverage and frequency data. The number of microplots need only exceed the minimum sampling area requirements, ordinarily 1 to 3 microplots for the Port Valdez salt marsh communities, but 10 was the standard number used. Soil samples were taken adjacent to the macroplots.

In selected locations a series of 2 x 5 dm microplots were placed along a meter tape for use in transect studies. Such studies are sometimes useful to document the nature of shifts in vegetation that correspond to changes in space.

Fig. 2. Layout of a macroplot including ten microplots.



Soils were routinely analyzed for pH and conductivity, which is a standard salinity measurement. Most soil samples were analyzed for two or more of the following ions: calcium, magnesium, potassium, and sodium. In a few instances, tests for chloride, sulfate, or phosphorus were made.

Nomenclature is according to Welsh (1974), except for *Puccinellia* and *Atriplex*, which follow Hulten (1968).

Results

The principal salt marshes of Port Valdez and vicinity include five marshes in Port Valdez proper, four in Jack Bay, three in Sawmill Bay, and one marsh in Galena Bay (the remainder of this Bay has not been studied). Every one of these marshes was studied and baseline data gathered in nearly all of them. The following is a list of the principal salt marshes by name or location:

- Port Valdez
  - Valdez - East Marsh and Terminus
  - Valdez - West Marsh
  - Mineral Creek
  - Gold Creek
  - Sawmill Creek
- Jack Bay
  - Head - large
  - Head - south side, lateral
  - First Cove, South Side
  - First Cove, North Side
- Sawmill Bay
  - Head
  - Stellar Creek
  - Mouth - west side, very small
- Galena Bay
  - Mouth - north side

Baseline sites were chosen to represent a diverse sample of the salt marsh vegetation. The locations of the marshes and baseline sites are presented in Figures 3 to 6.

The salt marshes of the region are complex and relatively diverse in terms of frequently occurring species (Table 1). The bulk of the plant species were graminoids and succulent forbs; the former are grass-like species and the latter are the remaining fleshy herbaceous flowering plants.

Each plant community on the marsh consists of a collection of species. Without some organization of these communities into a hierarchy it is very difficult to simplify the results into something meaningful. Many kinds of communities were identified and these were organized into Community Complexes. Each Community Complex may include one or more kinds of communities having important taxonomic similarities. Ultimately it may be possible to develop a reliable taxonomy below the level of the Community Complex, but it was not practical for the purposes of this research.

Seventeen Community Complexes have been identified and named (Table 2). A detailed summary for the baseline sites is provided in Appendix I. Each Complex consists of closely related salt marsh communities. Within any one Complex the presence, absence, or abundance of species may have significance that can be interpreted or correlated with environmental parameters. For example, the Puccinellia hultenii/Glaux maritima Community Complex tends to be correlated with saline conditions; i.e., conductivity values near or exceeding 4.0 mmhos/cm. Within the Puccinellia/Glaux Complex, however, the presence of Deschampsia beringensis corresponds to a

Fig. 3. The salt marshes and baseline study sites of Port Valdez; one inch equals one mile (U.S.G.S. map).

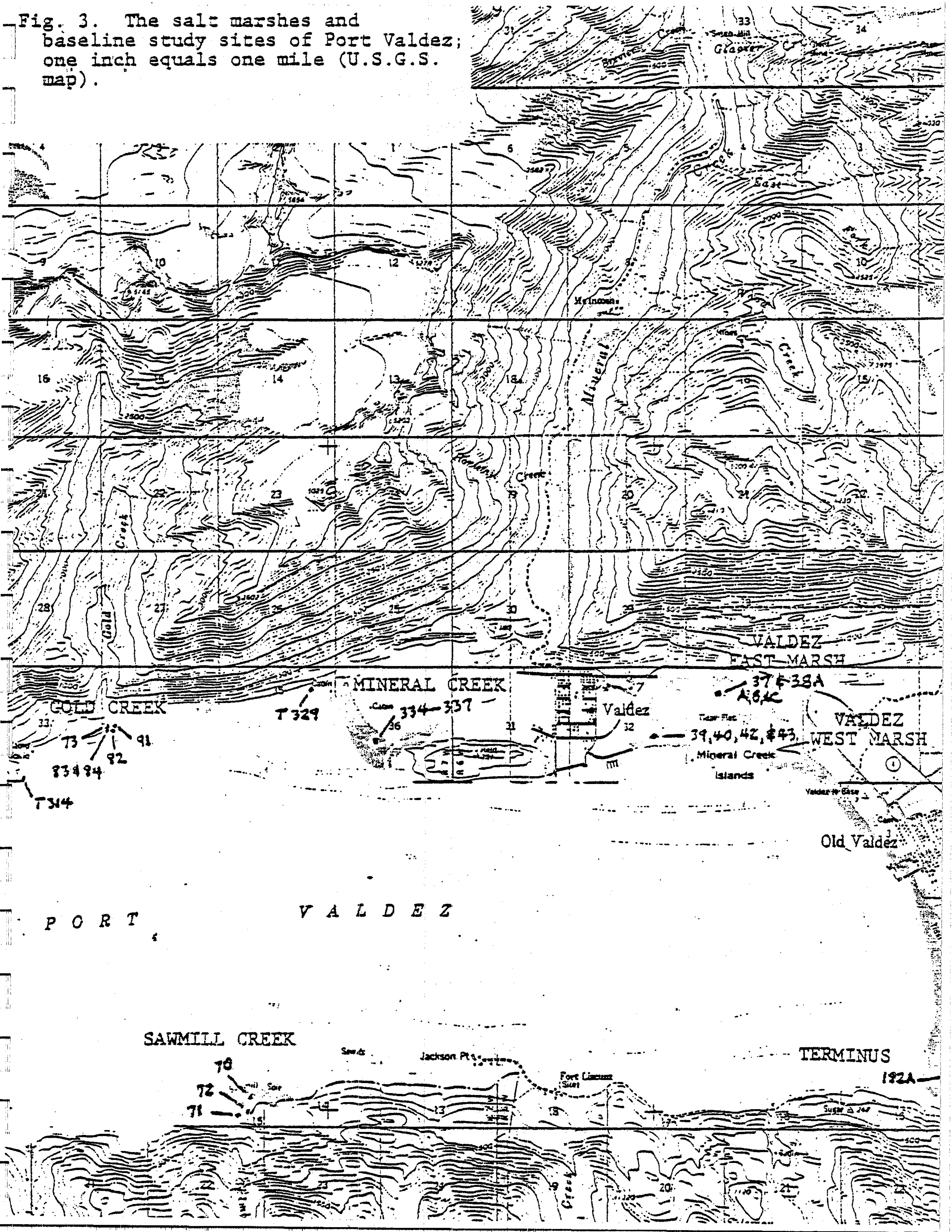


Fig. 4. The salt marshes and baseline study sites of Sawmill Bay; one inch equals one mile (U.S.G.S. map).

Fig. 5. The salt marshes and baseline study sites of Jack Bay; one inch equals one mile (U.S.G.S. map composite).

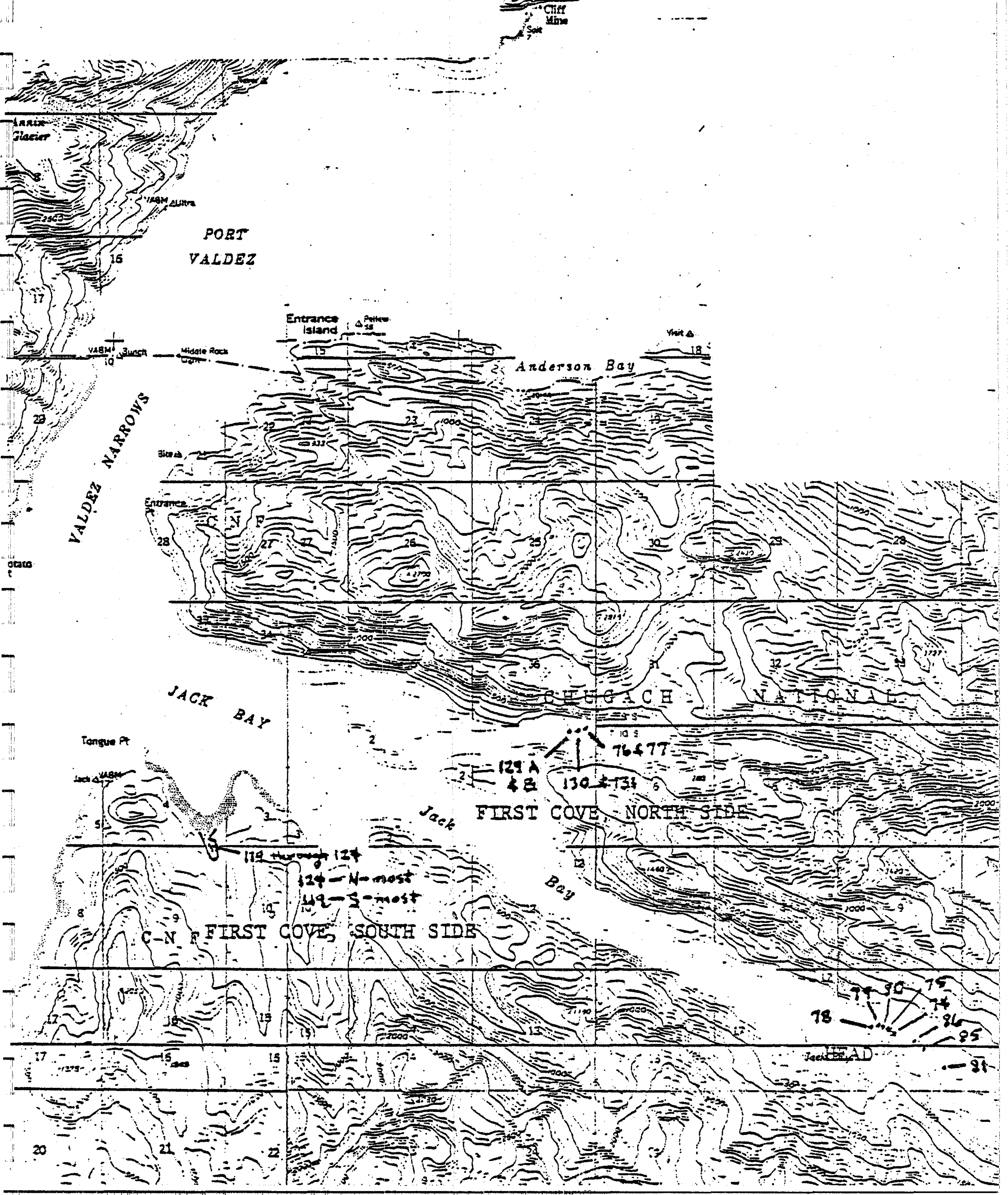


Fig. 6. The salt marshes and baseline study sites of Galena Bay; one inch equals one mile (U.S.G.S. map).

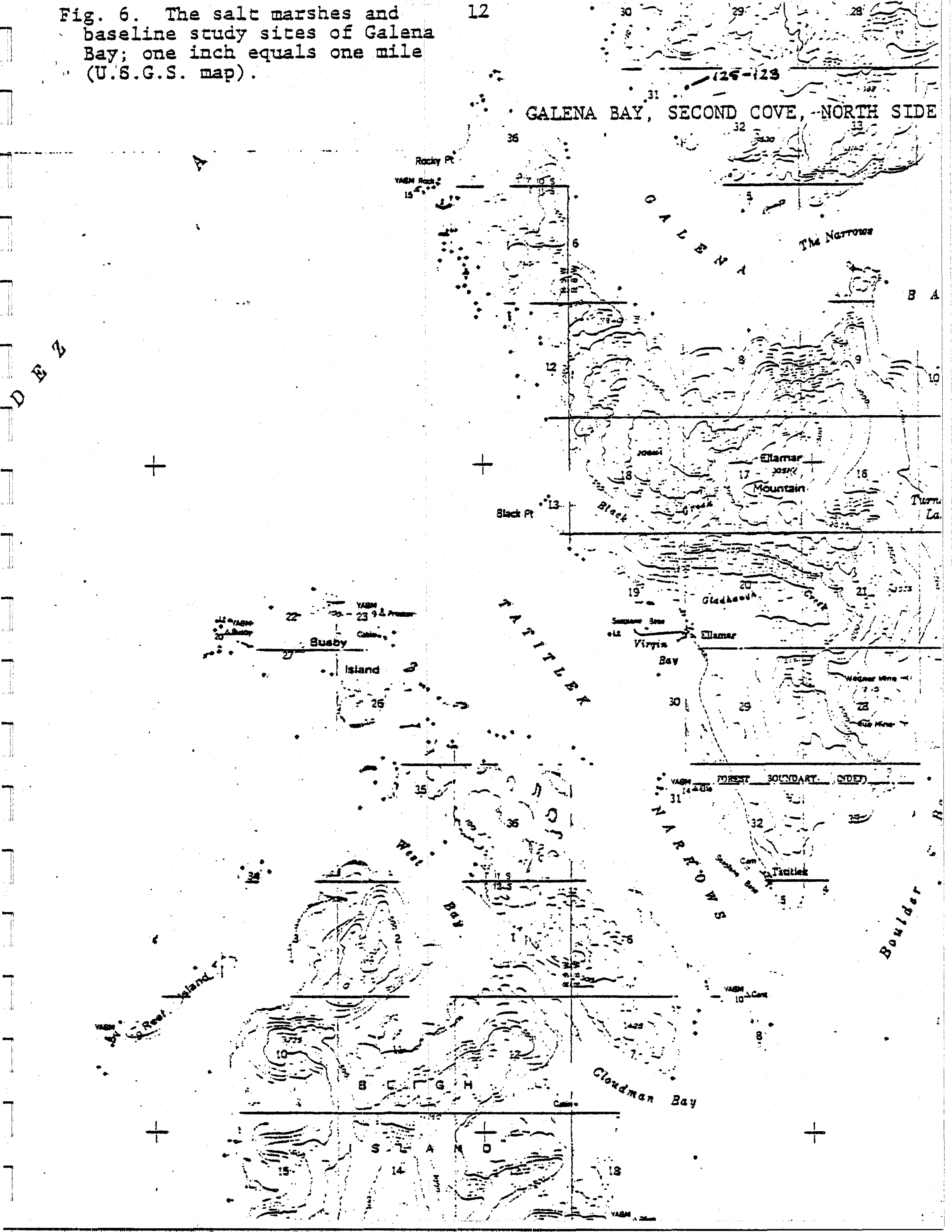


Table 1. Scientific and common names of frequently occurring salt marsh species in Port Valdez and vicinity.

<u>Succulent Forbs</u>	
Arenaria peploides	Beach Sandwort
Atriplex patula var. obtusa	Spearscale
Chrysanthemum arcticum	Arctic Daisy
Cochlearia officinalis	Scurvy Grass
Dodecatheon pulchellum	Pretty Shooting Star
Glaux maritima	Sea Milkwort
Ligusticum scoticum	Hulten's Sea Lovage
Plantago maritima	Goose Tongue
Sagina crassicaulis	Beach Pearlwort
Spergularia canadensis	Canada Sand Spurry
Stellaria humifusa	Low Chickweed
Triglochin maritima	Seaside Arrowgrass
Triglochin palustris	Marsh Arrowgrass
<u>Non-Succulent Forbs</u>	
Achillea millefolium ssp. borealis	Boreal Yarrow
Conioselinum chinense	Western Hemlock Parsley
Cornus canadensis	Bunchberry
Fritillaria camchatcensis	Indian Rice
Polygonum viviparum	Bulblet Bistort
Potentilla anserina	Pacific Silverweed
Ranunculus cymbalaria	Marsh Crowfoot

Table 1 (Cont.)

<u>Graminoids</u>	
Calamagrostis canadensis	Bluejoint
C. deschampsioides	Small Reedgrass
Carex glareosa	Clustered Sedge
C. lyngbyei	Lyngbye Sedge
Eleocharis kamtschatica	Kamtschatka Spikerush
Elymus mollis	Dunegrass or Beach Rye
Festuca rubra	Red Fescue
Poa eminens	Large-flower Bluegrass
Puccinellia hultenii	Hulten's Mudgrass or Alkaligrass
<u>Fucoids</u>	
Fucus spp.	Rockweed

Table 2. Salt marsh community complexes of Port Valdez and vicinity.

Puccinellia hultenii/Spergularia canadensis
Puccinellia hultenii/Fucus spp.
Puccinellia hultenii/Arenaria peploides
Puccinellia hultenii/Glaux maritima
Potentilla anserina/Poa eminens
Carex pluriflora/Deschampsia beringensis
Carex lyngbyei/Calamagrostis canadensis
Calamagrostis canadensis/Galium trifidum
pure Carex lyngbyei
Carex lyngbyei/Eleocharis kamtschatica
Eleocharis kamtschatica dominant
Carex lyngbyei/Potentilla anserina
Potentilla anserina/Dodecatheon pulchellum
pure Arenaria peploides
Elymus mollis/Arenaria peploides
Elymus mollis/Festuca rubra
Elymus mollis/Cornus canadensis

distinctly non-saline habitat. In addition, the more saline *Puccinellia*/*Glaux* habitats correlate with relatively high species diversity (seven or more) and greater than 50% coverage of *Puccinellia hultenii*.

The Community Complex names should be very useful in the development of maps from aerial photographs and as an economical means of describing salt marshes. The following marsh-by-marsh discussion summarizes the most important characteristics and should help in an assessment of the region's salt marsh resources. The vegetation portfolio previously submitted (Crow, 1976) may be useful as a visual aid.

Valdez East and West Marshes

The marshes of Valdez proper have been divided into two parts, the West Marsh and the East Marsh, on the basis of slight geographic separation. These marsh areas share a number of characteristics. The soils are characterized by fine silts and clays and the inter-channel landscape is quite flat. It follows that drainage is poor and a mosaic of plant communities has developed in response to varying wetness at any particular tidal level. The habitat-plant community interaction is such that there is a marked trend to saline conditions and at the same time acid pH. In such cases there is a tendency for high sulfate to correspond wtih low pH (Crow, in press).

The two marshes differ in several respects. The West Marsh is small and mostly above the tidal levels of the East Marsh. In addition, the West Marsh is characterized by communities having high total coverage and frequency and ordinarily having a diversity of seven or more species; the communities sampled belonged to the *Puccinellia hultenii*/*Glaux maritima* Community Complex (Table 3). On the other hand, the majority of the East Marsh is covered by communities having a species diversity of only one to three species; 'pure' *Carex lyngbyei* and *Carex lyngbyei*/*Eleocharis kamtschatica* and *Eleocharis kamtschatica* dominated Complexes (Table 3).

In both cases the uppermost zones of the marshes have been severely disturbed. The East Marsh is cut by a highway and the West Marsh has been affected by sewage development, direct

Table 3 . Dominance of plant species found in the Community Complexes at the Valdez East, West, and Terminus locations.

Taxa	Community Complex		
	Pu/Gl	Cl	Cl/Ek
Puccinellia hultenii	+++		
Carex lyngbyei	+++	+++	P
Glaux maritima	++		
Potentilla anserina	++		
Triglochin maritima	++		
Stellaria humifusa	+		
Plantago maritima	+		
Eleocharis kamtschatica	P		+++
Chrysanthemum arcticum	P		
Ranunculus cymbalaria	P		
Zannichellia palustris			P
Potamogeton pectinatus			P

Pu/Gl = Puccinellia hultenii/Glaux maritima

Cl = 'pure' Carex lyngbyei

Cl/Ek = Carex lyngbyei/Eleocharis kamtschatica and Eleocharis kamtschatica dominated vegetation.

(+++) signifies dominant or co-dominant species, ordinarily high coverage/frequency values; (++) common, important; (+) minor, coverage is low, present in most locations; (P) present in some communities, may have high or low coverage/frequency values.

disturbance, etc. The proximity of the Valdez marsh areas to disturbance makes them less useful as short term baseline sites than sites selected elsewhere. For example, the development of an artificial spit in the East Marsh area resulted in silt and clay particulates covering the plants of the East and West Marshes. Damage was apparent in 1974. By 1975, the effect had lessened as the sea further reclaimed the artificial spit. Because of disturbances such as those described one cannot expect these marshes to have the value as baseline sites as has the majority of the other marsh locations.

In 1970, baseline sites 39, 40, 42, and 43 were established on the Valdez West Marsh by this investigator. By the time this work was begun in 1974, local disturbances from town runoff, garbage, sewage, human traffic, and an attempt to develop an artificial spit resulted in obvious degradation of the Valdez West and East marshes. In 1974 it seemed that the use of these marshes to monitor the effects of Terminus construction and oil transport would introduce an unacceptable bias. At that time, Mr. L. Sowl of the Department of the Interior walked and examined the West marsh with this investigator. Mr. Sowl participated in the successful relocation of the 1970 sites. It was agreed that emphasis of the Valdez East and West marshes would probably jeopardize the value of the baseline study. Nevertheless, a few baseline sites were developed and the 1970 sites restudied in 1974 and 1975. The data are presented in Appendix II. The vegetation changed erratically in terms of coverage and frequency as well as the presence of plant species. This appears to have confirmed the judgements made by Mr. Sowl and myself. At some later date it may be important to make comparisons with other marshes of Port Valdez and vicinity. Furthermore, the possibility does exist that the Valdez marshes may stabilize and become more useful.

Valdez Terminus

This is a small marsh area characterized by *Carex lyngbyei*-dominated vegetation. Only one stand was studied in detail and this belonged to the 'pure' *Carex lyngbyei* Community Complex. The soils, primarily clay with silt, had acid pH values of about 5.4 and were non-saline but evidently washed with brackish tides (conductivity about 2.6 mmhos/cm). The level of sodium was moderate, 431 ppm.

This monospecific *Carex lyngbyei* vegetation had coverage and frequency values of 100 per cent or nearly that high in most locations. Table 3 includes the data for the Terminus study area.

Sawmill Creek

Sawmill Creek can be best described as a fan-like gravel marsh. In contrast to most salt marshes, the soils of this one are characterized by gravels at the surface. Moderately high pH values (7.0 to 8.0) and rather low salinity (conductivity values less than 1.0 mmhos/cm) are characteristic of this marsh. In places such as this, where the soils are coarse and drainage is good to excellent, the salts leach away easily between successive inundations. The net result is that the soils associated with the prominent vegetation at Sawmill Creek are not saline; i.e., less than 4.0 mmhos/cm. It should be noted, however, that highly saline tidal waters do cover this marsh frequently.

At the time of the field work this area was free of apparent disturbance or damage to the vegetation. Since its location is adjacent to that of the TAPS Terminus it should be an excellent baseline area.

Exclusive of the strand vegetation, the vegetation is dominated by two plant Community Complexes, *Puccinellia hultenii*/*Fucus* spp. and *Puccinellia hultenii*/*Glaux maritima* (Table 4). In both cases, the vegetation has a conspicuously succulent character and *Arenaria peploides* is a noticeable element even though it does not attain high coverage/frequency values. It should be noted that three species are highly constant in the communities studied: *Puccinellia hultenii*, *Glaux maritima*, and *Arenaria peploides* (Table 4).

Stands of the *Puccinellia*/*Fucus* Complex dominate this marsh and vary modestly from spot to spot. In the lowest zones, *Fucus*

Table 4. Dominance of plant species found in the Community Complexes at Sawmill Creek.

Taxa	Community Complexes Pu/Fu	Pu/Gl
Puccinellia hultenii	+++	+
Fucus spp.	++	
Glaux maritima	+++	+
Arenaria peploides	++	+
Potentilla anserina	++	
Plantago maritima	+	

Pu/Fu = Puccinellia hultenii/Fucus spp.

Pu/Gl = Puccinellia hultenii/Glaux maritima

(+++) signifies dominant or co-dominant species, ordinarily high coverage/frequency values; (++) common, important; (+) minor, coverage is low, present in most locations; (P) present in some communities, may have high or low coverage/frequency values.

spp. frequency is highest, up to 90%, but it remains an important element nearly everywhere. _Puccinellia hultenii_ and _Glaux maritima_ are in evidence nearly everywhere and in typical stands their coverage varied from 38 to 41% for the former and 15 to 19% for the latter; _Puccinellia_ coverage ran as low as 1% in the limited _Puccinellia/Glaux_ sites. Frequency values for both species were around 100% nearly everywhere. Other species had lower coverage and frequency values, including _Potentilla anserina_, the sole non-succulent forb present, and _Arenaria peploides_, which was relatively conspicuous.

The localized representatives of the _Puccinellia/Glaux_ Complex are essentially confined to the habitats adjacent to the fresh-water streams. This is very sparse vegetation with only three species, all with scant coverage and low frequency of occurrence (Table 4).

Gold Creek

The marshes of Gold Creek are protected from the sea by a natural gravel spit. The marsh portion of this area is dominated by gravels covered with a layer of silt and clay; gravels being more evident in selected lower habitats and on the margin of the spit itself. Like the Sawmill Creek Marsh habitat, the soils are not saline but the pH values are somewhat higher in places, up to 8.0. It would seem that the pH elevation corresponds with slightly higher conductivity figures than those associated with Sawmill Creek; refer to the Appendix for details pertaining to the soils. As might be expected there is a tendency for lower pH values, to 6.7 in the highest areas tested.

Three salt marsh plant community complexes were sampled which were well represented at Gold Creek: Puccinellia hultenii/ Fucus spp., Puccinellia hultenii/Arenaria peploides, and Puccinellia hultenii/ Glaux maritima (Table 5). Species diversity is fairly good, from 5 to 9 species per stand, with coverage and/or frequency high for several of these species, notably Puccinellia hultenii, Plantago maritima, Fucus spp., and Glaux maritima (Table 5). In addition to Puccinellia hultenii, which had 100% frequency in all stands studied, a few species deserve mention. Plantago maritima, a succulent forb, was a major species in all stands studied at Gold Creek. This species is common in the community complexes characterized by Puccinellia hultenii but drops out entirely from all the stands at Port Valdez and vicinity where Puccinellia hultenii is lacking. The presence of Carex lyngbyei

Table 5. Dominance of plant species found in the Community Complexes at Gold Creek.

Taxa	Community Complex Pu/Fu	Pu/Ar	Pu/Gl
Puccinellia hultenii	+++	+++	+++
Fucus spp.	+++		
Arenaria peploides		+	+
Glaux maritima	+	+	+++
Plantago maritima	+++	+++	++
Potentilla anserina	+	P	+++
Stellaria humifusa	+	P	+
Spergularia canadensis	++	P	
Cochlearia officinalis	+	+	
Atriplex gmelini	+		
Triglochin maritima			++
Carex lyngbyei			++

Pu/Fu = <u>Puccinellia hultenii/Fucus</u> spp.

Pu/Ar = <u>Puccinellia hultenii/Arenaria peploides</u>

Pu/Gl = <u>Puccinellia hultenii/Glaux maritima</u>

(+++) signifies dominant or co-dominant species, ordinarily high coverage/frequency values; (++) common, important; (+) minor, coverage is low, present in most locations; (P) present in some communities, may have high or low coverage/frequency values.

in the uppermost zone sampled, a rather complex stand of Puccinellia/Glaux, is most likely related to the presence of fresh water as a significant factor in portions of the marsh; the pH in this zone was 6.7 and the soils not saline.

Mineral Creek

Near Valdez, this marsh is characterized by a few hectares of the _Potentilla anserina_/_Poa eminens_ and _Potentilla anserina_/_Dodecatheon pulchellum_ Community Complexes, the former occupying the lower ground. The soils are dominated by the fine separates, silt and clay. All sites were slightly acid and nearly all sites non-saline, although clearly influenced by brackish tidal waters ; most soils had conductivity values between 1.7 and 3.0 mmhos/cm with one stand of the _Potentilla_/_Poa_ Complex as high as 5.7 mmhos/cm, clearly saline.

Species diversity provided strong contrasts between the stands of vegetation at Mineral Creek (Table 6). Some _Potentilla_/_Poa_ localities had as few as three species while many examples of the _Potentilla_/_Dodecatheon_ Complex had up to ten species. _Potentilla anserina_, _Poa eminens_, and _Carex lyngbyei_ were found at all sites studied and the vegetation clearly lacks the fleshy character of the marshes such as Gold Creek and Sawmill Creek.

Among the sites representing the _Potentilla_/_Dodecatheon_ Complex, eight species were present in all sites considered in the reconnaissance and in the two chosen for intensive study (Table 6). The coverage and/or frequency values are rather high for several of these, namely _Potentilla anserina_, _Poa eminens_, _Carex lyngbyei_, _Stellaria humifusa_, and _Triglochin maritima_. Lesser but significant amounts of the remaining species was usual. In short, these stands are diverse, dense, with high species frequency a reliable character;

Table 6. Dominance of plant species found in the Community Complexes at Mineral Creek

Taxa	Community Complex Pa/Pe	Pa/Dp
Potentilla anserina	++	+++
Poa eminens	+++	+++
Dodecatheon pulchellum		++
Carex lyngbyei	+++	+++
Stellaria humifusa	P	++
Festuca rubra	P	P
Triglochin maritima	P	++
Triglochin palustris	P	
Calamagrostis deschampsioides		++
Chrysanthemum arcticum		++
Conioselinum chinense		P

Pa/Pe = <u>Potentilla anserina/Poa eminens</u>

Pa/Dp = <u>Potentilla anserina/Dodecatheon pulchellum</u>

(+++) signifies dominant or co-dominant species, ordinarily high coverage/frequency values; (++) common, important; (+) minor, coverage is low, present in most locations; (P) present in some communities, may have high or low coverage/frequency values.

e.g., in baseline site 335, the two most infrequent species, *Festuca rubra* and *Conioselinum chinense*, had frequency values of 50 per cent.

Head

This is a very interesting marsh including many hectares of salt marsh. Most of this marsh has soils in which the silt and clay separates dominate but limited portions are influenced by gravels at the surface. The latter are ordinarily covered by stands of the Puccinellia hultenii/Fucus spp. Complex. Selected stream-side levee habitats also have coarse soils ranging from sandy to gravelly in nature. These nearly always correspond with Elymus mollis-dominated Complexes. In the reconnaissance three such Elymus mollis-dominated Complexes were represented but only one was selected for intensive study, the lowest one, believed to be more likely to be affected by oil spillage.

The soils tended to be slightly to distinctly acid and the influences of brackish tidal waters were evident with conductivity values averaging about 0.8 mmhos/cm in the Potentilla anserina/Poa eminens Community Complex. The Carex lyngbyei/Potentilla anserina Community Complex, which is very well represented, tends to be slightly acid, saline, and has over 700 ppm of sodium. The 'pure' Carex lyngbyei Community Complex was similar but somewhat more acid and had far less sodium, 88 ppm. In the slightly higher zones of the marsh the conductivity tended to drop below the saline levels and the pH rose. The low gravelly areas, characterized by Puccinellia hultenii/Fucus spp., are apparently covered by brackish tides but drainage is good and the conductivity 1.02 mmhos/cm; the pH is slightly acid and sodium evident, but only 115 ppm.

This marsh is relatively diverse in terms of species and Community Complexes present; 15 species were found in the five Community Complexes that were sampled (Table 7). Community Complex differences are marked. The zonation of Complexes is represented in Fig. 7 . In most cases there are sharp, identifiable transition zones between the various kinds of vegetation present.

Frequency values of the dominants tend to be nearly 100 per cent and coverage values of dominants rather variable depending upon the Community Complex. Carex lyngbyei is perhaps the most conspicuous plant on the marsh. In most stands where it appears the coverage is 95 per cent or higher. Other species with high coverage in some localities include Poa eminens, Potentilla anserina, and Calamagrostis deschampsioides. These are all found together in a number of representatives of the Potentilla anserina/ Poa eminens Community Complex. Potentilla anserina coverage exceeds 60 per cent in many Carex lyngbyei/Potentilla anserina Community Complex stands.

It should be noted that there is quite a lot of bare ground in representatives of the Puccinellia hultenii/Fucus spp. Community Complex, often about 70 per cent bare ground. In Sawmill Bay, Cochlearia officinalis is dominant in this Complex and very conspicuous; coverage/frequency values of 24/100 are representative.

In most Elymus mollis-dominated vegetation, the Elymus may attain virtually 100 per cent coverage and 100 per cent frequency values. As a rule, the high diversity types correspond with lower Elymus coverage values.

Table 7. Dominance of plant species found in the Community Complexes at Sawmill Bay, Head.

Taxa	Community Complex				
	Pu/Fu	Pa/Pe	Cl	Cl/Pa	Em/Fe
Puccinellia hultenii	++			+	
Fucus spp.	+				
Carex lyngbyei		+++	+++	+++	
Potentilla anserina		+++		+++	++
Poa eminens		+++			
Festuca rubra		++		P	+++
Elymus mollis					+++
Stellaria humifusa		++		++	
Spergularia canadensis	+				
Cochlearia officinalis	+++				
Sagina crassicaulis	+				
Carex glareosa		P			
Calamagrostis deschampsioides		P			
Galium trifidum		P			
Triglochin palustris				P	

(Continued)

Table 7 (Cont.)

Pu/Fu = _Puccinellia hultenii/Fucus_ spp.

Pa/Pe = _Potentilla anserina/Poa eminens_

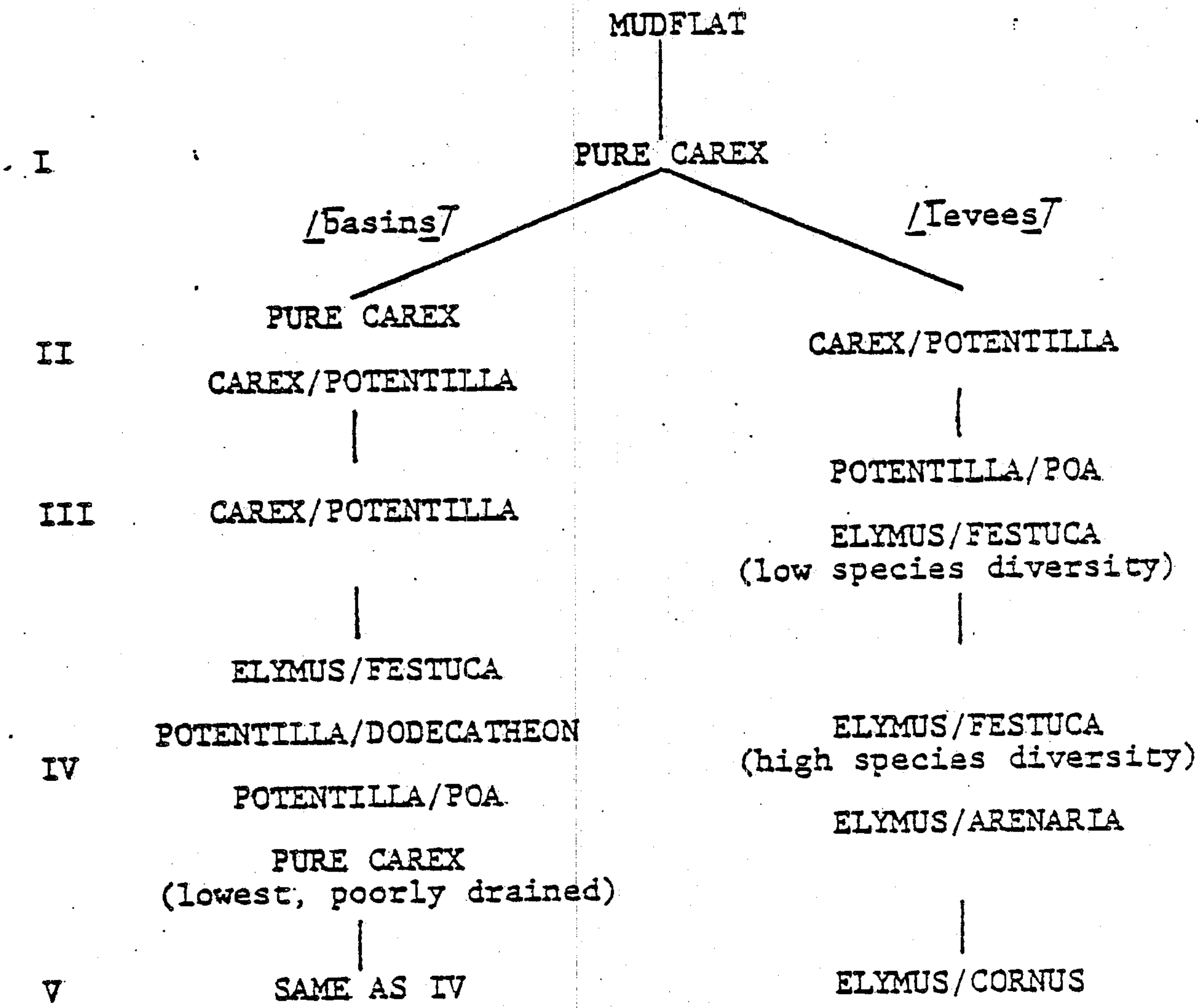
Cl = 'pure' _Carex lyngbyei_

Cl/Pa = _Carex lyngbyei/Potentilla anserina_

Em/Fe = _Elymus mollis/Festuca rubra_

(+++) signifies dominant or co-dominant species, ordinarily high coverage/frequency values; (++) common, important; (+) minor, coverage is low, present in most locations; (P) present in some communities, may have high or low coverage/frequency values.

Fig. 7. Marsh at the head of Sawmill Bay. I to V are low to high zones respectively.



Stellar Creek

This very small marsh area was sampled in order to document the nature of three stands belonging to two high species diversity Community Complexes in which fresh water influences were dominant. In addition, the adjacent stream was filled with Pink Salmon and was said to be the richest stream in Prince William Sound (Larry Haddock, on-site communication, 1974).

The three stands studied form a catena that runs from the bank of the marsh up to the woods. Actually three plant communities are easily identifiable, with the two nearest the forest belonging to the Carex pluriflora/Deschampsia beringensis Community Complex and the stream-side vegetation belonging to the Carex lyngbyei/ Calamagrostis canadensis Community Complex. The former Complex has a distinctly acid pH, as low as 4.0 in places, and conductivity values between 0.2 and 0.4 mmhos/cm. The latter Complex has higher pH and conductivity values. The soils are fine textured, with lots of organic matter and apparently high exchangeable base potential. All contained moderate levels of sodium, 500 to 2000 ppm, and other basic cations in moderate to high levels. This is a somewhat unusual combination.

The species diversity is rather high for the Port Valdez region. Selected stands of the Carex pluriflora/Deschampsia beringensis Community Complex had as many as 12 species. Carex pluriflora had virtually 100 per cent coverage and 100 per cent frequency with high values for Deschampsia beringensis and Calamagrostis deschampsioides in some stands. Calamagrostis canadensis, Cornus canadensis, and *Rubus stellatus* are high in the other locations - adjacent to the forest. The remaining species had low coverage values but most had a high frequency of occurrence.

Nearest the stream, *Carex lyngbyei* is dominant averaging nearly 90 and 100 per cent values for coverage and frequency respectively. In the *Carex lyngbyei*/*Calamagrostis canadensis* Complex, the *Carex pluriflora* is absent but other species attain up to 100 per cent frequency values. These are *Calamagrostis canadensis*, *Festuca rubra*, and *Poa eminens*. Measured coverage values were substantial, at 88, 69, and 24 per cent for the three species respectively. Most locations observed had all the seven species listed in Table 8.

Table 8. Dominance of plant species found in the Community Complexes at Stellar Creek, Sawmill Bay.

Taxa	Community Complex Cl/Cc	Cp/Db
Carex lyngbyei	+++	P
Carex pluriflora		+++
Deschampsia beringensis	+	++
Calamagrostis canadensis	+++	P[a]
Festuca rubra	+++	++
Poa eminens	+++	P
Calamagrostis deschampsioides	++	P[a]
Galium trifidum	+	P
Stellaria humifusa		+
Trientalis europaea		+
Carex glareosa		P
Epilobium palustre		P
Conioselinum chinense		P
Cornus canadensis		P[a]
Rubus stellatus		P[a]
Achillea millefolium borealis		P
Sphagnum sp.		P

(Continued)

Table 8 (Cont.)

[a]Major species in some communities.

Cl/Cc = *Carex lyngbyei/Calamagrostis canadensis*

Cp/Db = *Carex pluriflora/Deschampsia beringensis*

(+++) signifies dominant or co-dominant species, ordinarily high coverage/frequency values; (++) common, important; (+) minor, coverage is low, present in most locations; (P) present in some communities, may have high or low coverage/frequency values.

Jack Bay

First Cove, South Side

Community Complex diversity was relatively high in this salt marsh of only a few hectares and the stream contained large numbers of Pink Salmon during the spawning period. The soils were dominated by silt and clay, at least near the surface. In special habitats associated with gravel spit locations, the soils were dominated by gravels; these coarse soil habitats were characterized by *Arenaria peploides* or *Elymus mollis*. The soil pH tended to be in the range of 6.4 to 7.5 and none were found to be saline. The only stand to show extremely high sodium belonged to the *Elymus mollis*/*Festuca rubra* Community Complex and was on the order of 2300 ppm. Other sites ranged from 54 to 560 ppm, as would be expected from the influence of brackish tides.

Although Community Complex diversity is high, species diversity is rather low in the Complexes represented. Species diversity ranged from one to five. The dominants had very high coverage and frequency values and the subordinants very low values. The character of the vegetation is determined almost entirely by only one or two species in each of the Community Complexes present (Table 9). *Puccinellia hultenii*, *Potentilla anserina*, *Poa eminens*, *Arenaria peploides*, *Elymus mollis*, and *Calamagrostis canadensis* are the most important plant species on this marsh, giving it a simple grass-forb character.

Table 9. Dominance of plant species found in the Community Complexes of the first cove on the south side of Jack Bay.

Taxa	Community Complex					
	Pu/Gl	Pa/Pe	Cc/Gt	Ar	Em/Ar	Em/Fe
Puccinellia hultenii	+++					
Glaux maritima	+					
Potentilla anserina	+++	+++				+
Poa eminens		+++				
Arenaria peploides	+			+++	+++	
Stellaria humifusa	+	+				
Elymus mollis					+++	+++
Galium aparine					+	
Festuca rubra						+
Carex lyngbyei		+				
Calamagrostis canadensis			+++			
Galium trifidum			+			

Pu/Gl = *Puccinellia hultenii/Glaux maritima*

Pa/Pe = *Potentilla anserina/Poa eminens*

Cc/Gt = *Calamagrostis canadensis/Galium trifidum*

Ar = 'pure' *Arenaria peploides*

Em/Ar = *Elymus mollis/Arenaria peploides*

Em/Fe = *Elymus mollis/Festuca rubra*

(+++) signifies dominant or co-dominant species, ordinarily high coverage/frequency values; (++) common, important; (+) minor, coverage is low, present in most locations; (P) present in some communities, may have high or low coverage/frequency values.

First Cove, North Side

Several hectares of marsh are characterized by three Community Complexes in this Jack Bay location. The soils examined were all clay and silt dominated. They were all circumneutral to acid, as low as pH 5.0. There was a downward trend in conductivity from about 3 to less than 1 mmhos/cm that corresponded with the Puccinellia hultenii/Spergularia canadensis, Puccinellia hultenii/Arenaria peploides, and Potentilla anserina/Poa eminens Complexes in that order. Sodium was measured as high as 1000 ppm in the Puccinellia/Spergularia Complex and as low as 126 ppm in one of the Potentilla/Poa stands.

Where Puccinellia hultenii characterized the vegetation, species diversity varied from four to six. Community Complex differences were distinct and transition areas between communities sharp (Table 10). Much higher species diversity was found in the Potentilla/Poa Complex, about 10 species per stand. The density of the vegetation is noticeably greater and the frequency of assorted grasses and sedges very high; namely Poa eminens, Festuca rubra, Carex lyngbyei, and Carex glareosa, which were as high as 100 per cent in places. These same species tended to have quite variable coverage values. Only Festuca rubra was over 50 per cent in all Potentilla/Poa localities in this marsh. Potentilla ansèrina and Parnassia palustris attained frequency values as high as 100 per cent. Coverage values nevertheless tended to be quite low, however, with most below 4 per cent.

Table 10. Dominance of plant species found in the Community Complexes of the first cove on the north side of Jack Bay.

Taxa	Community Complex		
	Pu/Sp	Pu/Ar	Pa/Pe
Puccinellia hultenii	++	+++	
Potentilla anserina		+	++
Spergularia canadensis	++	P	
Fucus spp.	+		
Triglochin palustris	+		
Carex lyngbyei	P[a]		++
Arenaria peploides		+	P
Stellaria humifusa		P	P
Sagina		+	
Poa eminens			++
Festuca rubra			+++
Carex glareosa			++
Parnassia palustris			+
Calamagrostis deschampsioides			+
Juncus arcticus var. balticus			P
Epilobium palustre			P
Galium trifidum			P
Deschampsia beringensis			P

(Continued)

Table 10 (Cont.)

[a]In some locations very high coverage and frequency values, absent in other locations.

Pu/Sp = Puccinellia hultenii/Spergularia canadensis

Pu/Ar = Puccinellia hultenii/Arenaria peploides

Pa/Pe = Potentilla anserina/Poa eminens

(+++) signifies dominant or co-dominant species, ordinarily high coverage/frequency values; (++) common, important; (+) minor, coverage is low, present in most locations; (P) present in some communities, may have high or low coverage/frequency values.

Head

The marsh at the head of Jack Bay covers many hectares and was characterized by clay and silt dominated soils with a few locally sandy sites. There was narrow variation in soil pH characteristics among complexes; all the sites were acid, pH 5.6 to 6.2. Wide variation was found for other soil chemical characteristics. Although no site had extremely high sodium concentration, most locations measured between about 400 to 530 ppm. Salinity ranged from very low values of about 0.4 mmhos/cm in the higher portions in the back of the marsh to nearly 9.0 mmhos/cm in the 'pure' Carex lyngbyei vegetation in the lowest zone of the marsh. It should be noted that large numbers of salmon were observed spawning in 1974 and 1975 in the streams that are a part of this marsh.

There are five Community Complexes that are well represented in this marsh. The lowest zone is dominated by 'pure' Carex lyngbyei. In the middle zone, Carex lyngbyei/Potentilla anserina predominates in the wetter habitats, but the Potentilla anserina/Poa eminens and Potentilla anserina/Dodecatheon pulchellum Complexes, occupying progressively better drained sites, are conspicuous and important. The Potentilla/Dodecatheon Complex is very well represented in the upper portion of the middle zone and usually covers the crests of the channel banks. The uppermost vegetation sampled, Elymus mollis/Cornus canadensis Complex, would seem to be at or very near the upper limit of tidal waters.

Species diversity is 6 to 10 per stand over most of the salt marsh, with exceptions in the monospecific 'pure' Carex lyngbyei and the Elymus/Cornus Complex which had 15 species (Table 11). Over the entire marsh, Carex lyngbyei is the most frequently occurring plant. Where it is important, the frequency is nearly always 100 per cent and the coverage comparably high, 77 to 100 per cent. In most stands, Potentilla anserina had very high coverage/frequency values, as did Festuca rubra. Where Poa eminens grows it is a dominant or co-dominant but its distribution is less widespread than the preceding species. Stellaria humifusa also deserves mention; it is not a dominant but was found, even if in very small amounts, in every stand studied except those belonging to the 'pure' Carex lyngbyei. Species such as Calamagrostis canadensis, Elymus mollis, Cornus canadensis, and Achillea millefolium borealis are of no consequence outside of the Elymus/Cornus Community Complex, where they are major species.

Table 11. Dominance of plant species found in the Community Complexes at the head of Jack Bay.

Taxa	Community Complex				
	Cl	Cl/Pa	Pa/Pe	Pa/Dp	Em/Co
Carex lyngbyei	+++	+++	+++	P	++
Potentilla anserina		++	+++	+++	
Festuca rubra		++	++	+++	
Stellaria humifusa		++	+	+	+
Poa eminens			+++	+++	
Dodecatheon pulchellum				+	
Calamagrostis deschampsioides			+	++	
Deschampsia beringensis		P		P	+++
Conioselinum chinense			+	P	+
Triglochin palustris		P			
Eleocharis kamtschatica		P			
Chrysanthemum arcticum				P	
Arenaria peploides				P	
Elymus mollis					+++
Cornus canadensis					++
Calamagrostis canadensis					+++

(Continued)

Table 11 (Cont.)

	Cl	Cl/Pa	Pa/Pe	Pa/Dp	Em/Co
Achillea millefolium borealis					+++
Galium trifidum					++
Ligusticum scoticum					++
Fritillaria camchatcensis					+
Sanguisorba sitchensis					+
Hordeum brachyantherum					+
Trientalis europaea					+
Polygonum viviparum					+

Cl = 'pure' Carex lyngbyei

Cl/Pa = Carex lyngbyei/Potentilla anserina

Pa/Pe = Potentilla anserina/Poa eminens

Pa/Dp = Potentilla anserina/Dodecatheon pulchellum

Em/Co - Elymus mollis/Cornus canadensis

(+++) signifies dominant or co-dominant species, ordinarily high coverage/frequency values; (++) common, important; (+) minor, coverage is low, present in most locations; (P) present in some communities, may have high or low coverage/frequency values.

Galena Bay

Only one small marsh area in Galena Bay was sampled. Gravel was evident in the lowest zone of this marsh which was covered with representatives of the Puccinellia hultenii/Fucus spp. Community Complex. In the higher zones the soils were dominated by the clay and silt separates. The middle zone was characterized by Puccinellia hultenii/Glaux maritima. Stands of the Potentilla anserina/Poa eminens Complex grew on the highest ground. The soils were circumneutral to alkaline, pH 7.0 to 8.0. Some locations in the Puccinellia/Fucus Complex were highly saline, 7.80 mmhos/cm, with the lowest values in the Puccinellia/Glaux vegetation, 0.53 mmhos/cm. It is most interesting that the soil salinity transitions are very abrupt. Extremes like those just presented routinely occurred within a spatial change of a meter or two. All the soils showed substantial quantities of sodium, up to 14,940 ppm.

Puccinellia hultenii was of significance in all the stands studied but had very high coverage/frequency values in the Puccinellia/Fucus Community Complex (Table 12). Potentilla anserina had 100 per cent frequency and medium to high coverage in every location except the lowest portion of the Puccinellia/Fucus habitat. Plantago maritima had very high coverage/frequency values in the low and middle zones. Glaux maritima had high to very high frequency but modest coverage in the low and middle zones. It is absent from the upper zone. Deschampsia berinensis and Potentilla anserina dominate the upper zone with 98/100 and 60/100 coverage/frequency values respectively. In the upper zone Triglochin maritima and Poa eminens are also important species.

Table 12. Dominance of plant species found in the Community Complexes at Galena Bay.

Taxa	Community Complex		
	Pu/Fu	Pu/Gl	Pa/Pe
Puccinellia hultenii	+++	++	++
Potentilla anserina	P	+++	+++
Fucus spp.	+++		
Glaux maritima	++	++	
Plantago maritima	+++	+++	
Poa eminens			++
Deschampsia beringensis		+	+++
Atriplex gmelini			+
Triglochin maritima			++
Festuca rubra			+
Stellaria humifusa	P		+
Carex lyngbyei			+
Spergularia canadensis	++		

Pu/Fu = Puccinellia hultenii/Fucus spp.

Pu/Gl = Puccinellia hultenii/Glaux maritima

Pa/Pe = Potentilla anserina/Poa eminens

(+++) signifies dominant or co-dominant species, ordinarily high coverage/frequency values; (++) common, important; (+) minor, coverage is low, present in most locations; (P) present in some communities, may have high or low coverage/frequency values.

Both have frequency values of 80 per cent and nearly identical coverage, 19 and 18 per cent respectively.

Diatom studies were peripheral to the major thrust of this investigation. Nevertheless, samples were taken to expand the baseline data as it was little trouble to collect them from the soil surface. Table 13 lists the major diatom taxa identified. Diatoms were identified by Dr. J. D. Koppen, Department of Botany, Newark College of Arts and Sciences, Rutgers University.

Strand vegetation is a variant of salt marshes that may inhabit the sea-land interface. In Port Valdez, this vegetation grows on beaches and spits composed of gravels or cobble-sized rocks. Most of the strand is characterized by Elymus mollis. This grass is prominent in at least one zone of nearly every development of strand vegetation. Other important species are listed in Table 14.

In spite of the fact that strand was not central to this research, baseline transects were established for this kind of vegetation and are summarized in Appendix III.

Table 13. Major diatom taxa from Port Valdez marsh communities.

CENTRALES	
	Biddulphia aurita
	Melosira nimmuloides
PINNALES	
Araphidineae	
	Synedra tabulata var. fasciculata
	S. tabulata var. tabulata
	Tabellaria flocculosa var. flocculosa
Monoraphidineae	
	Achnanthes breviceps var. intermedia
	A. haukiana var. hauchiana
	Cocconeis costata var. costata
	C. scutellum var. scutellum
Biraphidineae	
	Amphipleura rutilans var. obtusa
	A. rutilans var. rutilans
	Amphora caffeaeformis var. acutiuscula
	Caloneis bacillium var. inconstantissima
	Diploneis ovalis var. ovalis
	Frustula vitrea var. vitrea
	Gyrosigma eximium var. eximium
	G. fasciola var. fasciola
	Mastigloia elliptica var. elliptica

Table 13. Continued

Navicula cryptocephala var. cryptocephala

N. peregrina

N. pygmea var. pygmea

N. sp.

Nitzschia frustulum

N. panduriformis

N. sigma

N. sigma var. clausii

Pleurosigma salinarum var. salinarum

Table 14. Scientific and common names of frequently occurring strand species in Port Valdez and vicinity.

Succulent Forbs	
Arenaria peploides	Beach Sandwort
Atriplex patula	Spearscale
Ligusticum scoticum	Hulten's Sea Lovage
Mertensia maritima	Beach Bluebell or Oysterleaf
Senecio pseudo-arnica	False Beach Arnica
Stellaria humifusa	Low Chickweed
Non-Succulent Forbs	
Angelica genuflexa	Angelica
Conioselinum chinense	Western Hemlock Parsley
Epilobium angustifolium	Fireweed
Galium aparine	Cleavers
G. trifidum	Small Bedstraw
Heracleum lanatum	Cow Parsnip
Lathyrus maritima	Beach Pea
Potentilla anserina	Pacific Silverweed
Sanguisorba sitchensis[a] (Sanguisorba stipulata)	Sitka Burnet

[a]Not Sorbus sitchensis as indicated in the original table.

Table 14 (Cont.)

<u>Graminoids</u>	
Calamagrostis canadensis	Bluejoint
Carex lyngbyei	Lyngbye Sedge
Deschampsia beringensis	Bering Hairgrass
Elymus mollis	Dunegrass or Beach Rye
Festuca rubra	Red Fescue
Hordeum brachyantherum	Meadow Barley
Poa eminens	Large-flower Bluegrass
Puccinellia hultenii	Hulten's Mudgrass or Alkaligrass
<u>Fucoids</u>	
Fucus spp.	Rockweed

Discussion and Recommendations

The diversity of plant species and their abundance in assorted kinds of vegetation were documented. In addition to a sizeable number of frequently occurring species, about 28 to 30, the diversity of common Community Complexes was rather high (17). For the most part, the marshes show a fresh to brackish water character and there is much less development of the Puccinellia/ succulent species Community Complexes that are abundant in places like Kachemak Bay. Nevertheless, evidence of saline influences was present at all sites.

This is important for several reasons, since in the event of an oil spill, the degree of salt marsh damage is expected to vary with factors such as degree of tidal influx, tide level, location, season, and, of course, extent and duration of a spill. The factors that seem to be primary in an assessment of potential oil spill hazard are location and degree of tidal influx. For example, a site with tremendous fresh water outflow tends to be less likely to have oil carried over it than one in which the saline tidal waters that may carry oil dwarf the amount of fresh water outflow. In other words, exposure of the vegetation and soils to spilled oil is most probable and of primary concern in circumstances where the sea water is not greatly diluted with fresh water.

The following marshes seem to be of greatest concern:

Sawmill Creek - Port Valdez;

Gold Creek - Port Valdez;

nearly all the strand of Port Valdez, the Narrows, and the main shores of adjacent areas within Prince William Sound.

These marsh areas are characterized by Puccinellia/succulent vegetation and are near the Terminus or transport route.

Some caution should be observed in an assessment of other areas, especially in the winter when fresh water outflow may be minimal and oil in a tide could flow over areas that would not be subject to such hazards in the summer months. With this reservation, the remaining marsh areas would seem to be less worrisome. Possible exceptions are the Valdez East, West, and Terminus marsh sites; these marshes do have substantial salt water influences from time to time and are rather close to the Trans-Alaska Pipeline Terminus.

At this time it would seem that the greatest concern should be for spills occurring simultaneously with monthly or seasonal high tides.

The marshes of Jack Bay are probably the safest in terms of potential oil spill hazards of those in the vicinity of Port Valdez. These marshes are characterized by vegetation that corresponds with a decided net outflux of fresh water. In addition, the largest and most important marshes are well back into the Bay, thereby reducing the probability of impact. In the event that oil is spilled into Jack Bay, a greater time (several days) should be available for a thorough clean-up operation.

One exception is the small marsh in the first cove on the south side of Jack Bay. Although there is a substantial outflow of fresh water, this marsh is at the head of the Bay and is much closer to the Narrows and possible spill locations. Let me point out that this marsh was the site of rather dense Pink Salmon spawning when checked in 1974.

The marshes of Sawmill Bay are of an intermediate degree of concern with respect to oil spill damage. Although fresh water influences prevail, the principal marsh (at the head of the Bay) is not far from the Narrows and the main bay of the Valdez Arm. Seasonal high tides and winter monthly high tides would seem to be times when the likelihood of oil encroachment on the vegetation is greatest.

It should be noted that Hell's Hole, Prince William Sound, was visited briefly in 1974 and found to have an abundance of Puccinellia/succulent vegetation. Although not in Port Valdez, it is possible that Hell's Hole and similar areas elsewhere along the route of oil vessels may be equally susceptible to oil spill damage. Hell's Hole is reported to be important to sea birds and other animal species (L. Sowl, vive voce).

Two primary recommendations seem essential if the impact of oil transport and related activities is to be documented. First, a systematic revisitation of selected plots is necessary. Without such continuing research it is likely that the separation of oil impact from normal successional changes will be impossible.

Second, baseline plots should be placed in many additional locations within Prince William Sound and in selected locations along the entire coast of Alaska.

In addition, oil damage vegetation tests should be performed in the marshes to aid in the evaluation of oil spill damage and to further quantify oil spill hazards.

Reclamation-oriented research is also advocated. Tests on germination, growth, vegetative reproduction, and the like may some day be valuable in the reestablishment of vegetation damaged by oil.

Summary

The salt marsh resources of Port Valdez and vicinity were found to be substantial and 62 locations were selected as baseline sites. The sites were spread widely over the region and include 17 distinct plant Community Complexes that may serve to document the regional impact of oil transport from Port Valdez. Identification of the Community Complexes should be useful in salt marsh mapping. Most of the areas revealed major fresh water influences, a factor that seems to lessen the vulnerability of the marshes to oil spill damage.

The marshes appearing to be most vulnerable to oil spillage were found in Port Valdez. These two marshes, Gold Creek and Sawmill Creek, are characterized by Puccinellia hultenii/succulent vegetation and are regularly inundated by saline or brackish waters.

A selection of the baseline sites must be revisited from time to time in order to characterize natural successional trends. In the absence of such continuing research, it may be impossible to separate natural from oil spill related changes.

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APPENDIX I

For each set of Complexes, it is suggested that they be laid on a table top as a set to facilitate examination. The position of each page is indicated by the numbers in the upper right hand corner. The first number indicates the row and the second number the column. For example, the layout for set A is:

A-1,1 A-1,2 A-1,3 A-1,4

A-2,1 A-2,2 A-2,3 A-2,4

Note that the order of plant species is the same for any given set.

<u>Symbols</u>

** = To be determined

+/ = 0.5% coverage or less

+ = Not found in any of the microplots but present within the macroplot.

Set A 1,1

	Puccinellia hultenii/ Spergularia canadensis Complex		
Stand number	129A	129B	132B
Soil			
pH, paste	5.0	6.5	7.5
pH, extract	6.5	5.6	7.9
Conductivity, mmhos/cm	3.60	2.40	3.30
Ca, ppm	300	450	1175
Mg, ppm	212	276	300
K, ppm	29	38	80
Na, ppm	800	1000	1160
Species	Coverage/Frequency		
Glaux maritima	-	-	-
Potentilla anserina	-	-	-
Plantago maritima	-	-	+/20
Puccinellia hultenii	50/100	2/50	88/100
Fucus spp.	4/90	6/80	-
Spergularia canadensis	16/100	2/40	1/40
Arenaria peploides	-	-	-
Cochlearia officinalis	-	-	-
Sagina crassicaulis	-	-	-
Stellaria humifusa	-	-	-
Atriplex gmelinii	-	-	-

Puccinellia hultenii/Fucus spp. Complex

133	87	125	84	126	70	72
7.5	6.7	7.5	7.1	7.7	7.0f	7.7
7.4	6.7	7.3	7.8	7.0	7.28	7.9
2.70	1.02	3.70	3.10	7.80	0.81	0.75
350	59	975	67	1275	150	30
287	645	1070	600	1200	450	415
73	12	178	60	190	18	10
880	115	1760	569	2600	590	1173
Coverage/Frequency						
+/20	-	3/60	+/10	14/100	19/100	15/100
-	-	-	+	55/100	14/60	16/30
13/90	-	43/100	40/100	86/100	2/30	2/10
88/100	2/100	92/100	20/100	73/100	41/100	38/100
+/10	2/70	14/100	57/100	2/30	7/90	2/20
1/40	+/20	8/100	6/100	-	-	-
-	-	-	-	-	8/30	9/40
-	24/100	-	+/20	-	-	-
-	+/10	-	-	-	-	-
-	-	-	3/30	-	-	-
-	-	+/10	+	-	-	-

f = Field Determination

Set A 1,3

Puccinellia hultenii/Arenaria peploides Complex

Stand number	82	83
Soil		
pH, paste	7.0	7.6
pH, extract	7.5	8.0
Conductivity, mmhos/cm	3.10	2.70
Ca, ppm	98	160
Mg, ppm	630	460
K, ppm	42	26
Na, ppm	552	451
Species	**Coverage/Frequency**	
Glaux maritima	1/40	1/50
Potentilla anserina	10/80	2/30
Plantago maritima	77/100	48/100
Puccinellia hultenii	86/100	74/100
Fucus spp.	-	-
Spergularia canadensis	-	+/30
Arenaria peploides	16/50	2/10
Cochlearia officinalis	-	+
Sagina	-	-
Stellaria humifusa	+/10	+/20
Atriplex gmelinii	-	-

<u>Puccinellia</u> <u>hultenii</u>/<u>Arenaria</u> <u>peploides</u> Complex

76	77	73
6.0	6.3	7.1
6.8	7.0	7.4
1.45	1.21	1.15
75	37	41
760	550	490
4	4	21
230	230	166
Coverage/Frequency		
-	-	2/60
+/10	+/20	-
-	-	48/100
12/100	24/100	42/100
-	-	-
-	+/20	9/100
2/30	10/70	4/10
38/100	18/100	-
2/80	2/90	-
-	2/20	-
-	-	-

	Puccinellia hultenii/ Spergularia canadensis Complex		
Stand number	129A	129B	132B
Atriplex drymarioides	-	-	-
Carex lyngbyei	-	93/100	-
Triglochin palustris	9/100	+/10	-

<u>Puccinellia</u> <u>hultenii</u>/<u>Fucus</u> spp. Complex

133	87	125	84	126	70	72
+/10	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

Set A 2,3

Puccinellia hultenii/Arenaria peploides Complex

Stand number	82	83
Atriplex drymarioides	-	-
Carex lyngbyei	-	-
Triglochin palustris	-	-

Puccinellia hultenii/Arenaria peploides Complex

76	77	73
-	-	-
-	-	-
-	-	-

Puccinellia hultenii/Glaux maritima Complex

Stand number	132A	71	122
Soil			
pH, paste	7.5	7.5	7.5
pH, extract	8.0	7.7	7.6
Conductivity, mmhos/cm	3.70	0.69	1.23
Ca, ppm	425	30	1250
Mg, ppm	222	295	380
K, ppm	71	4	79
Na, ppm	1520	69	560

Species	Coverage/Frequency		
Glaux maritima	38/100	+/20	+/10
Puccinellia hultenii	4/90	1/40	42/100
Triglochin maritima	-	-	-
Potentilla anserina	-	-	98/100
Carex lyngbyei	-	-	-
Stellaria humifusa	-	-	+/10
Plantago maritima	-	-	-
Eleocharis kamtschatica	-	-	-
Chrysanthemum arcticum	-	-	-
Ranunculus cymbalaria	-	-	-
Arenaria peploides	-	2/30	10/20

Set B 1,2

Puccinellia hultenii/Glaux maritima Complex

134	127	91	39-74	40-74	42-74	43-74
8.0	8.0	6.7	6.2	5.5	3.9	5.0
8.4	7.9	-	7.0	5.6	4.0	5.0
2.60	0.53	2.45	3.3	12.0	15.1	14.0
575	250	59	36	126	153	258
353	440	690	85	370	675	650
78	166	64	24	122	130	238
720	840	360	685	3215	3470	4605
Coverage/Frequency						
+/10	5/90	26/100	4/100	2/90	2/50	+/10
76/100	6/70	14/100	13/70	74/100	66/100	82/100
-	-	24/100	17/100	12/100	26/100	34/90
-	33/100	74/100	18/90	42/100	55/100	+/20
-	-	16/90	93/100	98/100	98/100	33/80
-	-	+/10	+/20	4/90	14/100	2/10
69/100	84/100	15/100	3/100	5/60	9/70	-
-	-	-	-	-	21/100	2/30
-	-	-	-	-	8/80	-
-	-	-	-	-	5/50	-
-	-	2/10	-	-	-	-

Set B 1,3

Potentilla anserina/Poa eminens Complex

Stand number	347	121	118
Soil			
pH, paste	6.2	6.4	6.5f
pH, extract	6.3	6.7	Destroyed in shipment
Conductivity, mmhos/cm	3.00	0.84	
Ca, ppm	71	300	
Mg, ppm	1200	241	
K, ppm	90	63	
Na, ppm	598	232	
Species	**Coverage/Frequency**		
Glaux maritima	-	-	-
Puccinellia hultenii	-	-	-
Triglochin maritima	-	-	-
Potentilla anserina	7/40	90/100	82/100
Carex lyngbyei	98/100	2/10	29/70
Stellaria humifusa	-	+	3/70
Plantago maritima	-	-	-
Eleocharis kamtschatica	-	-	-
Chrysanthemum arcticum	-	-	-
Ranunculus cymbalaria	-	-	-
Arenaria peploides	-	-	-

f = Field Determination

Set B 1,4

Potentilla anserina/Poa eminens Complex

130	131	115	79	346	128
7.0	7.0	6.5	5.9	6.0	7.0
6.5	6.5	5.7	6.4	6.5	7.0
0.14	0.82	0.83	3.25	5.40	3.85
250	600	500	82	100	3900
131	390	305	760	2800	5560
27	36	100	58	92	1620
126	880	102	529	667	14940
Coverage/Frequency					
-	-	-	-	-	-
-	-	-	-	-	12/40
-	-	-	-	11/60	19/80
2/50	33/100	58/100	82/100	16/90	60/100
3/30	90/100	95/100	77/100	84/100	+
-	2/80	2/80	+/20	29/100	+/10
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
32/90	-	-	-	-	-
-					

Set B

	Carex pluriflora/ Deschampsia beringensis Complex	
Stand number	1114B	114A
Soil		
pH, paste	4.5	4.0
pH, extract	5.5	4.7
Conductivity, mmhos/cm	0.38	0.22
Ca, ppm	2000	2250
Mg, ppm	1575	1713
K, ppm	923	1075
Na, ppm	1836	510
Species	**Coverage/Frequency**	
Glaux maritima	-	-
Puccinellia hultenii	-	-
Triglochin maritima	-	-
Potentilla anserina	-	-
Carex lyngbyei	10/40	-
Stellaria humifusa	1/40	4/40
Plantago maritima	-	-
Eleocharis kamtschatica	-	-
Chrysanthemum arcticum	-	-
Ranunculus cymbalaria	-	-
Arenaria peploides	-	-

Carex lyngbyei/Calamagrostis canadensis & Calamagrostis canadensis/Galium trifidum Complex	
114C	119
6.2	7.0
6.0	6.2
0.86	0.42
2213	2032
1040	230
273	55
1000	480
Coverage/Frequency	
-	-
-	-
-	-
-	-
88/100	-
-	-
-	-
-	-
-	-
-	-
-	-

Set B 2,1

Puccinellia hultenii/Glaux maritima Complex

Stand number	132A	71	122
Deschampsia beringensis	-	-	-
Poa eminens	-	-	-
Festuca rubra	-	-	-
Carex glareosa	-	-	-
Parnassia palustris	-	-	-
Calamagrostis deschampsioides	-	-	-
Juncus arcticus var. balticus	-	-	-
Epilobium palustre	-	-	-
Galium trifidum	-	-	-
Atriplex gmelinii	-	-	-
Carex pluriflora	-	-	-
Trientalis europaea	-	-	-
Conioselinum chinense	-	-	-
Calamagrostis canadensis	-	-	-
Cornus canadensis	-	-	-
Rubus stellatus	-	-	-
Achillea millefolium borealis	-	-	-
Sphagnum spp.	-	-	-
Triglochin palustris	-	-	-

Set B 2,2

Puccinellia hultenii-Glaux maritima Complex

134	127	91	39-74	40-74	42-74	43-74
-	2/10	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

Potentilla anserina/Poa eminens Complex

Stand number	347	121	118
Deschampsia beringensis	-	-	-
Poa eminens	30/100	98/100	91/100
Festuca rubra	-	-	27/90
Carex glareosa	-	-	-
Parnassia palustris	-	-	-
Calamagrostis deschampsioides	-	-	-
Juncus arcticus var. balticus	-	-	-
Epilobium palustre	-	-	-
Galium trifidum	-	-	-
Atriplex gmelinii	-	-	-
Carex pluriflora	-	-	-
Trientalis europaea	-	-	-
Conioselinum chinense	-	-	-
Calamagrostis canadensis	-	-	-
Cornus canadensis	-	-	-
Rubus stellatus	-	-	-
Achillea millefolium borealis	-	-	-
Sphagnum spp.	-	-	-
Triglochin palustris	-	-	-

Set B 2,4

Potentilla anserina/Poa eminens Complex

130	131	115	79	346	128
-	3/20	-	-	-	98/100
4/90	48/100	28/100	88/100	19/90	18/80
56/100	92/100	7/40	32/70	12/40	6/40
60/100	6/40	16/70	-	-	-
4/100	2/70	-	-	-	-
+/10	28/90	98/100	+/10	-	-
22/90	-	-	-	-	-
1/30	-	-	-	-	-
-	5/100	1/40	-	-	-
-	-	-	-	-	+/20
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	6/40	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	18/100	-

Set B 2.5

	Carex pluriflora/ Deschampsia beringensis Complex	
Stand number	114B	114A
Deschampsia beringensis	36/100	2/40
Poa eminens	8/40	-
Festuca rubra	14/80	+/20
Carex glareosa	+/20	-
Parnassia palustris	-	-
Calamagrostis deschampsioides	88/100	-
Juncus arcticus var. balticus	-	-
Epilobium palustre	2/60	-
Galium trifidum	2/80	-
Atriplex gmelinii	-	-
Carex pluriflora	98/100	98/100
Trientalis europaea	2/80	2/60
Conioselinum chinense	+/20	-
Calamagrostis canadensis	-	57/100
Cornus canadensis	-	42/100
Rubus stellatus	-	52/100
Achillea millefolium borealis	-	8/20
Sphagnum spp.	-	17/20
Triglochin palustris	-	-

Set B

Carex lyngbyei/Calamagrostis canadensis & Calamagrostis canadensis/Galium trifidum Complex	
114C	119
17/20	-
24/100	-
69/100	-
-	-
-	-
10/40	-
-	-
-	-
+/20	+/20
-	-
-	-
-	-
-	-
31/100	98/100
-	-
-	-
-	-
-	-
-	-

Set C

1,1

	Pure *Carex lyngbyei* Complex	
Stand number	38A	78
Soil		
pH, paste	5.0	6.2
pH, extract	5.1	6.8
Conductivity, mmhos/cm	9.2	8.90
Ca, ppm	108.5	220
Mg, ppm	630	865
K, ppm	36	70
Na, ppm	2710	1553
Species	**Coverage/Frequency**	
Carex lyngbyei	98/100	98/100
Potentilla anserina	-	-
Stellaria humifusa	-	-
Festuca rubra	-	-
Puccinellia hultenii	-	-
Triglochin palustris	-	-
Conioselinum chinense	-	-
Poa eminens	-	-
Dodecatheon pulchellum	-	-
Calamagrostis deschampsioides	-	-
Deschampsia beringensis	-	-

Pure *Carex lyngbyei* Complex		*Carex lyngbyei*/*Eleocharis kamtschatica* & *Eleocharis kamtschatica* dominant Complex		
182A	117	37A	37B	37C
5.4	5.5	4.4	4.3	4.5
5.8	5.4	4.4	4.3	4.6
2.58	5.1	10.2	10.6	10.4
640	700	236	206	238
205	235	475	495	410
10	95	75	73	90
431	88	2325	2580	2460
Coverage/Frequency				
98/100	98/100	45/80	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Set C 1,3

	Carex lyngbyei/ Potentilla anserina Complex		
Stand number	89	90	86
Soil			
pH, paste	6.9	6.1	5.9
pH, extract	6.9	6.8	6.7
Conductivity, mmhos/cm	5.02	5.70	4.02
Ca, ppm	110	150	130
Mg, ppm	780	795	645
K, ppm	80	117	69
Na, ppm	746	759	529
Species	Coverage/Frequency		
Carex lyngbyei	98/100	98/100	98/100
Potentilla anserina	6/40	64/100	1/40
Stellaria humifusa	4/80	7/90	32/100
Festuca rubra	-	+	4/20
Puccinellia hultenii	3/70	1/30	-
Triglochin palustris	-	2/30	15/80
Conioselinum chinense	-	-	-
Poa eminens	-	-	-
Dodecatheon pulchellum	-	-	-
Calamagrostis deschampsioides	-	-	-
Deschampsia beringensis	-	-	-

Set C 1,4

Carex lyngbyei/ Potentilla anserina Complex	Potentilla anserina/ Dodecatheon pulchellum Complex				
85	334	335	80	75	74
5.7	6.2	6.29	5.6	6.0	5.6
6.5	6.6	6.6	5.7	6.7	6.2
2.28	2.00	1.70	2.40	2.50	3.55
88	53	30	35	67	82
490	1500	710	550	445	490
42	78	47	13	26	27
393	540	472	540	414	520
Coverage/Frequency					
98/100	84/100	78/100	8/20	2/20	-
95/100	64/100	52/100	83/100	76/100	76/100
3/60	6/100	13/100	10/100	1/30	+/20
8/70	-	2/50	94/100	94/100	98/100
-	-	-	-	-	-
-	-	-	-	-	-
-	-	7/50	25/100	+/20	-
-	55/100	23/100	76/100	45/100	64/100
-	3/30	20/90	2/60	2/20	+/10
-	5/40	48/100	7/60	6/60	34/100
8/20	-	-	-	10/40	3/20

	Pure *Carex lyngbyei* Complex	
Stand number	38A	78
Arenaria peploides	-	-
Chrysanthemum arcticum	-	-
Eleocharis kamtschatica	-	-
Zannichellia palustris	-	-
Potamogeton pectinatus	-	-
Triglochin maritima	-	-

Set C 2,2

Pure *Carex lyngbyei* Complex		*Carex lyngbyei*/*Eleocharis kamtschatica* & *Eleocharis kamtschatica* dominant Complex		
182A	117	37A	37B	37C
-	-	-	-	-
-	-	-	-	-
-	-	92/100	98/100	66/100
-	-	1/30	-	-
-	-	-	2/20	-
-	-	-	-	-

Set C 2,3

	Carex lyngbyei/ Potentilla anserina Complex		
Stand number	89	90	86
Arenaria peploides	-	-	-
Chrysanthemum arcticum	-	-	-
Eleocharis kamtschatica	-	-	2/20
Zannichellia palustris	-	-	-
Potamogeton pectinatus	-	-	-
Triglochin maritima	-	-	-

Carex lyngbyei/ Potentilla anserina Complex	Potentilla anserina/ Dodecatheon pulchellum Complex				
85	334	335	80	75	74
-	-	-	-	15/100	1/30
-	11/80	10/80	4/10	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	22/100	18/100	-	-	-

	Pure *Arenaria peploides* Complex
Stand number	123
Soil	
pH, paste	7.5
pH, extract	7.4
Conductivity, mmhos/cm	1.32
Ca, ppm	975
Mg, ppm	141
K, ppm	46
Na, ppm	212
Species	**Coverage/Frequency**
Arenaria peploides	98/100
Elymus mollis	-
Galium aparine	-
Festuca rubra	-
Potentilla anserina	-
Calamagrostis canadensis	-
Cornus canadensis	-
Achillea millefolium ssp. borealis	-
Deschampsia beringensis	-
Galium trifidum	-
Ligusticum scoticum	-

Set D 1,2

Elymus mollis/ Arenaria peploides Complex	Elymus mollis/ Festuca rubra Complex		Elymus mollis/ Cornus canadensis Complex
124	116	120	81
7.0	7.2	7.5	5.6
7.4	6.0	6.5	6.3
.44	.57	0.57	0.41
1500	635	4860	41
108	375	2268	490
55	45	630	23
54	130	2320	49
Coverage/Frequency			
65/90	-	-	-
90/100	98/100	98/100	60/100
2/10	-	-	-
-	48/60	4/10	-
-	5/90	+/20	-
-	-	-	70/100
-	-	-	26/100
-	-	-	55/100
-	-	-	49/100
-	-	-	6/90
-	-	-	5/90

	Pure *Arenaria peploides* Complex
Stand number	123
Carex lyngbyei	-
Fritillaria camtchatcensis	-
Sanguisorba sitchensis	-
Stellaria humifusa	-
Hordeum brachyantherum	-
Trientalis europaea	-
Conioselinum chinense	-
Polygonum viviparum	-

Set D

2,2

Elymus mollis/ Arenaria peploides Complex	Elymus mollis/ Festuca rubra Complex		Elymus mollis/ Cornus canadensis Complex
124	116	120	81
-	-	-	22/90
-	-	-	8/60
-	-	-	13/50
-	-	-	1/40
-	-	-	7/30
-	-	-	1/30
-	-	-	+/20
-	-	-	+/10

APPENDIX II

Valdez West Marsh: Comparisons for 1970, 1974, and 1975

West Marsh: Comparisons for 1970, 1974, & 1975			
Stand-Year	39-70	39-74	39-75
Soil			
pH, paste	5.9	6.2	5.85
pH, extract	6.0	7.0	6.60
Conductivity, mmhos/cm	14.4	3.3	7.32
Ca, ppm	198	36	160
Mg, ppm	440	85	900
K, ppm	217	24	64
Na, ppm	4210	685	360
Species	Coverage/Frequency		
Glaux maritima	6/100	4/100	6/100
Puccinellia hultenii	-	13/70	14/90
Triglochin maritima	20/100	17/100	6/70
Potentilla anserina	+/20	18/90	18/100
Carex lyngbyei	98/100	93/100	94/100
Stellaria humifusa	-	+/20	2/80
Plantago maritima	3/20	3/100	3/30
Eleocharis kamtschatica	-	-	-
Chrysanthemum arcticum	-	-	-
Ranunculus cymbalaria	-	-	-
Calamagrostis inexpansa	-	-	-
Triglochin palustris	-	-	2/30
Festuca rubra	-	-	-

West Marsh: Comparisons for 1970, 1974, & 1975

40-70	40-74	40-75	42-70	42-74	42-75
5.2	5.5	5.5	5.4	3.9	5.3
5.2	5.6	6.0	5.7	4.0	5.7
13.2	12.0	8.85	7.6	15.1	5.30
154	126	98	126	153	75
295	370	2500	220	675	4500
142	122	102	104	130	107
3360	3215	1495	1830	3470	799
Coverage/Frequency					
2/100	2/90	1/40	3/60	2/50	2/40
13/90	74/100	8/100	3/100	66/100	6/70
38/100	12/100	22/100	52/100	26/100	33/100
43/100	42/100	50/100	62/100	55/100	47/100
98/100	98/100	98/100	95/100	98/100	94/100
2/60	4/90	5/90	10/90	14/100	22/100
4/70	5/60	4/50	26/100	9/70	8/70
-	-	-	85/100	21/100	27/100
-	-	-	7/70	8/100	3/70
-	-	-	7/50	5/50	-
-	-	-	2/20	-	-
-	-	-	-	-	4/80
-	-	-	-	-	1/40

West Marsh: Comparisons for 1970, 1974, & 1975		
43-70	43-74	43-75
5.3	5.0	6.3
5.0	5.0	6.7
9.6	14.0	12.3
158	258	220
340	650	660
113	238	164
2520	4605	2220
Coverage/Frequency		
-	+/10	+
98/100	82/100	91/100
23/100	34/90	40/100
+/20	+/20	+/10
4/30	33/80	44/100
+/20	2/10	3/60
-	-	-
-	2/30	2/100
-	-	-
-	-	-
-	-	-
-	-	+/20
-	-	-

APPENDIX III

The numbers that correspond with each species are coverage class values (Daubenmire 1959).

blank = not present

1 = 0 to 5 per cent cover

2 = 5 to 25 per cent cover

3 = 25 to 50 per cent cover

4 = 50 to 75 per cent cover

5 = 75 to 95 per cent cover

6 = 95 to 100 per cent cover

T329 - Northwest of Mineral Creek

Elymus mollis	6	6	6	6	6	6	6	6
density	29	38	30	27	34	25	14	24
height	190	180	175	160	160	169	133	180
Galium aparine			1	3	5	6	6	6
Ligusticum hultenii								
Alnus fruticosa								
Urtica lyallii								
Angelica genuflexa								
Sorbus sitkensis								

Microplots every 2 dm to 9.0 m (see Strand Locations)

T329 - Northwest of Mineral Creek

6	6	6	6	6	6	4
22	12	16	9	18	5	7
160	150	183	180	191	185	170
6	6	6	6	5	2	
			1	1	1	1
						3
						4
				1		2
			2	6	2	

T314 - Southernmost Area of Bowie Camp

Elymus mollis				5	5	2
density				0	0	1
height						97
Arenaria peploides	2				1	3
Atriplex alaskensis		+	2	3	5	5
Crucifer sp.			1	1		
Galium aparine					2	5
Mertensia maritima					2	1
Ligusticum hultenii		—				
Calamagrostis canadensis						
Trientalis europaea						
Heracleum lanatum						
Epilobium angustifolium						

Microplots every 2 dm

T314 - Southernmost Area of Bowie Camp

5	6	6	6	6	6	6	6	6	6	6	6	6
5	22	31	30	26	25	17	16	19	20	23	24	21
132	136	165	158	154	157	169	181	152	151	145	182	169
3	2											
5	5	4	2									
5	3	6	6	6	6	6	6	6	6	6	5	5
3												
										2	4	4
											2	3

T314 - Southernmost Area of Bowie Camp

6	6	6	5	2	4	3	3	5	6	6	6	6
13	18	11	5					3	3	9	6	5
173	170	183	152					150	168	170	165	140
3	1	3		2								
3			+		1		1					
2	4	6	5	6	6	6	6	6	6	6	6	6
	2	2	2									
	1	6	6	6	6	6	6	6	6	63		
					6		3	3	3	3	3	+

T314 - Southernmost Area of Bowie Camp

6	6	6	6	6	6
10	9	15	4	10	16
163	132	137	138	118	125
6	6	6	6	6	
					1
1	1		3		

T331 - Sawmill Bay

Elymus mollis						
density						
height						
Puccinellia nutkaensis	3	1				2
Arenaria peploides	1	3		1	1	
Fucus	2	2	2	2		
Carex lyngbyei			5		3	6
Stellaria humifusa					1	
Deschampsia caespitosa						
Festuca rubra						
Poa eminens						
Galium trifidum						
Hordeum brachyantherum						
Potentilla anserina						

Microplots every 0.5 m

T331 - Sawmill Bay

	2	3	5	5			6	6	5	2	2	
	2	5	8	10			17	12	11	3	3	
	10	110	100	120			94	83	113	85	80	
1	1											
	1											
6	4	2										
		1							1			
			2		DRIFT LOG	DRIFT LOG			2	4	4	6
							1	2	2	3	5	6
									2	4	4	2
												1
												2
			1				1					1

APPENDIX IV

Site Versus Location Cross-Reference Aid for Use with Appendix I

Set A

Puccinellia hultenii/Spergularia canadensis Complex

129 A	Jack Bay - First Cove, North Side
129 B	Jack Bay - First Cove, North Side
132 B	Hell's Hole

Puccinellia hultenii/Fucus spp. Complex

133	Hell's Hole
87	Sawmill Bay - Head
125	Galena Bay
84	Gold Creek
126	Galena Bay
70	Sawmill Creek
72	Sawmill Creek

Puccinellia hultenii/Arenaria peploides Complex

82	Gold Creek
83	Gold Creek
76	Jack Bay - First Cove, North Side
77	Jack Bay - First Cove, North Side
73	Gold Creek

Set B

Puccinellia hultenii/Glaux maritima Complex

132 A	Hell's Hole
71	Sawmill Creek
122	Jack Bay - First Cove, South Side
134	Hell's Hole
127	Galena Bay
91	Gold Creek
39	Valdez - West Marsh
40	Valdez - West Marsh
42	Valdez - West Marsh
43	Valdez - West Marsh

Potentilla anserina/Poa eminens Complex

347	Mineral Creek
121	Jack Bay - First Cove, South Side
118	Sawmill Bay - Head
130	Jack Bay - First Cove, North Side
131	Jack Bay - First Cove, North Side
115	Sawmill Bay - Head
79	Jack Bay - Head
346	Mineral Creek
128	Galena Bay

Carex pluriflora/Deschampsia beringensis Complex

114 B	Sawmill Bay, Stellar Creek
114 A	Sawmill Bay, Stellar Creek

Carex lyngbyei/Calamagrostis canadensis and
Calamagrostis canadensis/Galium trifidum Complexes

114 C	Sawmill Bay
119	Jack Bay - First Cove, South Side

Set C

pure Carex lyngbyei Complex

38 A	Valdez - East Marsh
78	Jack Bay - Head
182 A	Terminus, Valdez
117	Sawmill Bay - Head

Carex lyngbyei/Eleocharis kamtschatica and Eleocharis kamtschatica dominant Complexes

37 A	Valdez - East Marsh
37 B	Valdez - East Marsh
37 C	Valdez - East Marsh

Carex lyngbyei/Potentilla anserina Complex

89	Sawmill Bay - Head
90	Sawmill Bay - Head
86	Jack Bay - Head
85	Jack Bay - Head

Potentilla anserina/Dodecatheon pulchellum Complex

334	Mineral Creek
335	Mineral Creek
80	Jack Bay - Head
75	Jack Bay - Head
74	Jack Bay - Head

Set D

pure Arenaria peploides Complex

123	Jack Bay - First Cove, South Side

Elymus mollis/Arenaria peploides Complex

124	Jack Bay - First Cove, South Side

Elymus mollis/Festuca rubra Complex

116	Sawmill Bay - Head
120	Jack Bay - First Cove, South Side

Elymus mollis/Cornus canadensis Complex

81	Jack Bay - Head