VEGETATION OF THE TSITIKA RIVER ESTUARY

prepared for

ECOLOGICAL RESERVES UNIT

MINISTRY OF LANDS, PARKS AND HOUSING

PROVINCE OF BRITISH COLUMBIA

by

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1. INTRODUCTION

The Tsitika River watershed is the last unlogged watershed on the eastern side of Vancouver Island. Attempts to preserve this watershed in its entirety have failed, and the original proposal for preserving the whole watershed as an ecological reserve(1) hase been replaced by a proposal which would establish seven small ecological reserves, each of which would preserve some important features of the watershed. One of the proposed ecological reserves(2) consists of the Tsitika River estuary and nearby forest.

The objective of our study was to describe and map the vegetation within this proposed ecological reserve, to establish plots for measuring of biomass, and to provide lists of species of vascular plants and bryophytes found in the area.

2. METHODS

Two field trips were made to the Tsitika River estuary, one from August 8 - 10, 1979, and another on October 6 and 7, 1979. The objective of the first trip was the botanical investigation of the marsh vegetation, taking productivity samples, and sampling the forest surrounding the delta. The objective of the second trip was the completion of forest

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(1) Proposal no. 111. Rosevelt elk area in Tsitika River drainage. Proposed by the Fish & Wildlife Branch, Nanaimo, Vancouver Island in 1972, with additional informations prepared by H.L. Roemer in 1973.

(2) Proposal no. 111/1.

sampling. The field crew consisted of Adolf Ceska and Oldriska Ceska. We were accompanied by Lindsey Jones (on the first trip) and Ken Summers (on the second trip), both of whom are with the Terrestrial Studies Branch.

Preliminary mapping of the non-forest vegetation of the delta was done prior to the first field trip. Large scale colour air photos(3), colour air photo enlargements, and infra-red air photos(4) were used for air photo interpretation. The preliminary map was checked and boundaries were refined on the first field trip.

The vegetation was documented using relevés, i.e. lists of species accompanied by the species' cover estimates. The plot size used for this was about 30 m in the non-forested vegetation and about 400 m in the forests. A species' cover was estimated as a percentage of the plot area. The center of each non-forested estuary plot was marked by a wooden stake and the above ground biomass was harvested from an area of 1 m^2 for the productivity estimate. The total number of relevés was 15 from the non-forested areas and 19 from the forests. Considering the size and the variety of the area, this number seems sufficient for the description of the vegetation of the area.

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(3) BCC209, approx.scale 1:5,000, June 13, 1979.

(4) BCIR24, approx scale 1:5,000, June 14, 1979.

Productivity samples were air dried and the above ground biomass was expressed in g/m^2 of the air dried weight.

3. LOCATION AND THE NATURAL ENVIRONMENT OF THE AREA

The Tsitika River estuary is located between 126° 34' and 126° 36' W and 50° 28.5' and 50° 29.1' N. The slopes of the Vancouver Island Ranges drop steeply into Johnstone Strait. In the lower part of its watershed the Tsitika River runs in a sloping valley between Mt. Derby to the east and Mt. Tsitika to the west. The mouth of the Tsitika River is in a small sheltered bay named Robson Bight. The river forms a small delta with three main channels. The outer margin of the delta drops to a depth of 240 fathoms (ca. 430 m).

The sides of the valley are formed of basaltic rock. Road cuts between the Eve River valley and the Naka Creek valley, south of the Tsitika River, reveal mighty layers of pillow lava. Similar features are expected to be found in the lower parts of the Tsitika River valley. The whole area was glaciated during the last glacial period. The peculiar pillars of basalt found in the Mt. Derby area, however, cast some doubt on the extent of glaciation in this area. The deposits in the valley bottom were deposited after the retreat of the glacier. The formation of the delta also began with the retreat of the glacier.

The climate of the area can be classified as Marine West Coast Climate (Cfb according to Köppen/Trewartha's classification). The climatic diagram of the nearest climatological station in Alert Bay, is shown in Figure 1.

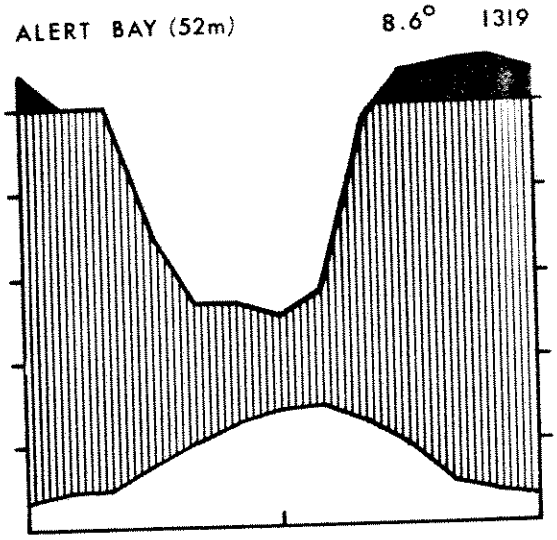

Figure 1. Climatic diagram of Alert Bay

With regard to vegetation the area belongs to the Coastal Western Hemlock biogeoclimatic zone. Floristically the area exhibits an affinity with the northern part of Vancouver Island and the northern coast of British Columbia. Cochlearia officinalis and Stellaria humifusa can be cited as characteristic examples of this distribution type.

Human disturbance in the area is slight. A small shack on the easternmost point of Robson Bight serves as accomodation for occasional hikers. The Sitka spruce forest at the edge of the estuary also serves as a camping spot for hikers but shows only few signs of disturbance. A telegraph line was constructed on the western side of the Tsitika River valley but today decayed telegraph poles are the only remnants of this line, which has been overgrown. A few stumps on the western side of Robson Bight indicate attempts made some time ago to carry out selective logging in this area.

4. DESCRIPTION OF THE VEGETATION

4.1 NON-FOREST VEGETATION

Four vegetation types formed by vascular plants were identified and sampled (see Table 1). These were:

the *Elymus mollis* community;

the *Deschampsia beringensis* community;

the *Plantago maritima* community; and

the *Carex lyngbyei* community.

In addition to these communities, algal communities occur in backwater channels and on the seaward margin of the delta.

Table 1. Non-forest vegetation of the Tsitika River estuary

Community:	e	d								p		c			
Releve number:	4	11	12	1	6	15	7	2	13	10	9	3	5	8	14
Elymus mollis	60	5	1												
Holcus lanatus	5														
Vicia gigantea	10														
Galium aparine	1														
Bromus sitchensis	1														
Deschampsia beringensis		30	40	20	50	10	5	5	60	50	1	5	5		1
Hordeum brachyantherum		30	30	10	10	15	10								
Festuca rubra	5	40	20	20	10	40	40								20
Achillea millefolium			2	3											
Agrostis stolonifera	10		15	5											
Potentilla pacifica		10	5	15	20	35	60	1		20	5				2
Triglochin maritima			5	1								1			
Trifolium wormskjoldii			5	15	1	1									
Carex lyngbyei		1	10		1	1				5	5	60	40	60	90
Fucus distichus								30	70	5	1	80	60	40	
Plantago maritima		5		1	10					15	35				
Glaux maritima		1			5				1	5	5				

Communities: e - Elymus mollis community, d - Deschampsia beringensis community,
p - Plantago maritima community, c - Carex lyngbyei community.
Cover estimates in %

4.1.1 The Elymus mollis community

In the Tsitika River estuary this community is developed only fragmentarily. A single larger stand occurs at the western side of the estuary. It is dominated by Elymus mollis and the co-dominant is Vicia americana. It hosts a number of species which are found in the nearby forest, such as Galium aparine and Bromus sitchensis. We also found a single plant of Cochlearia officinalis at the margin of the sampled stand.

Elymus mollis also grows in the middle portion of the estuary at the edge of the spruce forest. Here it does not form a continuous stand but grows scattered in the driest variant of the Deschampsia beringensis community.

4.1.2 The Deschampsia beringensis community

This community covers the largest area of the estuary. Deschampsia beringensis is accompanied by Festuca rubra, Potentilla pacifica and Hordeum brachyantherum. Each of the latter can attain a higher cover. In the central part of the estuary patchy stands with Potentilla pacifica as the dominant species are especially conspicuous in the Deschampsia beringensis-community. These stands can be considered to be a facies of the typical Deschampsia beringensis community and they apparently reflect a larger amount of nutrients in the soil. At the upper margin of the Deschampsia

stands, close to the forest, a drier variant of the Deschampsia beringensis community can be found. This variant is characterized by a higher cover of Festuca rubra and the presence of Achillea millefolium.

Depauperate stands of the Deschampsia beringensis community occur in areas which have a shallow layer of fine deposits and in the gravelly parts of the delta. Deschampsia beringensis forms large tussocks without any other accompanying vascular plant. Fucus distichus usually covers the soil surface between the Deschampia tussocks. This depauperate form of the Deschampsia beringensis community occurs in the lower parts of the delta and may represent the initial stages of colonization of the delta. The releves numbered 2 and 13 can be cited as examples of this depauperate form.

4.1.3 The Plantago maritima community

This plant community is developed on higher gravelly ridges which are being formed along the main river channels. It is characterized by Plantago maritima and Glaux maritima, which have a low total cover. Relevé no. 9 is a good example of this community. Relevé no. 10 represents a transition between this community and the Deschampsia beringensis community. Sporadic occurrence of Plantago maritima and Glaux maritima in the lower parts of the delta may indicate the initial stages of this community.

4.1.4 The Carex lyngbyei community

This community occupies the second largest area of the vegetated part of the estuary. It replaces the Deschampsia beringensis community in the lower parts of the delta, i.e. those which are subject to more frequent and longer tide flooding. Stands of this community are dominated by Carex lyngbyei and there are almost no other vascular plants present. Fucus distichus usually densely covers the soil surface in this community.

An exeptional variant of the Carex lyngbyei community occurs in the central part of the delta (relevé no. 14). Festuca rubra is a co-dominant species in these stands. The lush growth of all the plants present here and the high productivity measured indicate that this variant reflects a great amount of nutrients in the soil. This higher nutrient status may be the result of detritus accumulation in the central part of the delta, which may in turn be caused by a prevailing wave action.

4.1.5 Algal communities

Fucus distichus is a common species which occurs in the Carex lyngbyei stands and in the depauperate stands of Deschampsia beringensis. It is often found with Enteromorpha intestinalis. In the dead water channels at the western margin of the delta Fucus distichus forms stands mixed with Spongomorpha coalita, a green filamentous alga.

Shallow pools in the lower intertidal zone of the delta host sporadic algal vegetation with different species of Gigartina and with Ulva fenestrata. Fucus distichus and Spongomorpha coalita are still abundant in this part of the delta.

The lowest margin of the Tsitika River delta belongs to the upper subtidal zone and is exposed only in extremely low tides. Porphyra perforata, Rhodymenia pertusa, Iridaea sp., Alaria marginata, A. nana, and Hedophyllum sessile are the dominant species in this zone. They are accompanied by Desmarestia latifrons, Prionitis lyallii, Rhodomela larix, and Aghardiella tenera. The vascular plant Zostera marina occurs in this zone. Several small patches of this species occur at the mouth of the river's eastern channel.

In the lower subtidal zone stands of Nereocystis luetkeana are conspicuous along the rocky shores at the eastern margin of the estuary.

4.2 FOREST VEGETATION

The mature forests in the area studied consist of four dominant tree species. These are: Sitka spruce (Picea sitchensis); western hemlock (Tsuga heterophylla); amabilis fir (Abies amabilis); and Douglas fir (Pseudotsuga menziesii). In addition to these species, lodgepole pine (Pinus contorta) forms a stand on a rocky bluff at the eastern side

of the estuary, and red alder (Alnus rubra) forms shrubby stands on gravel bars along the river.

4.2.1 Sitka spruce forests

Sitka spruce forms large stands at the mouth of the Tsitika River. These stands border on the Deschampsia beringensis community. Upstream Sitka spruce forests occupy well-drained areas along the river, especially on islands between the river's channels.

The tree layer is dominated by Sitka spruce, western hemlock and western red cedar (Thuja plicata) are the subdominant species. The shrub layer is usually poorly developed and consists mainly of red huckleberry (Vaccinium parvifolium). The herb layer is lush with a great variety of herbs and grasses. Polystichum munitum and Dryopteris expansa are the dominant species and are accompanied by the grasses Festuca subulata, Bromus carinatus, Melica subulata, Calamagrostis canadensis, Cinna latifolia and Trisetum cernuum. Herbs such as Ranunculus uncinalis and Galium triflorum are also common species in the herb layer. Hylocomium splendens, Stokesiella oregana and Rhytidiadelphus loreus are the dominant mosses in the moss layer.

4.2.2 Western hemlock forests

Forests dominated by Western hemlock occur on the valley bottom and on the slopes of a hill on the eastern side of the estuary.

The tree layer is formed almost exclusively by the western hemlock. Several species, such as Vaccinium ovalifolium, V. parvifolium, Menziesia ferruginea and Gaultheria shallon occur in the shrub layer. Juvenile western hemlock is also a constant component of the shrub layer. The herb layer is usually poorly developed. Blechnum spicant, Polystichum munitum, Dryopteris expansa and Moneses uniflora are constant species in the herb layer. The moss layer of western hemlock forests consists of Hylocomium splendens, Plagiothecium undulatum, Rhytidiadelphus loreus and numerous liverworts, such as Scapania bolanderi, Calypogeja trichomanis, Plagiochila asplenioides, Diplophyllum albicans, Lophozia incisa, etc.

Western hemlock forms a pygmy forest on a dry rocky knoll at the eastern side of the estuary. Its trees are stunted, relatively low and form open stands. Alnus sinuata is an interesting species in the shrub layer. Diplophyllum albicans, Scapania bolanderi, Claopodium bolanderi, Sphagnum girgensohnii and Dicranum fuscescens are the most conspicuous species in the rich moss layer. They grow there together with Hylocomium splendens and Rhytidiadelphus loreus.

4.2.3 Amabilis fir forests

Amabilis fir replaces western hemlock as the dominant tree species in the colluvial parts of the valley and on the lower slopes. The floristic composition of amabilis fir

forests is similar to that of western hemlock forests. Rubus pedatus and Cornus unalaschenis are additional species in the herb layer.

4.2.4 Douglas fir stands

Douglas fir is scattered among all the forest types of the area. It usually occurs as a veteran or in the upper tree layer. Near the southern boundary of the area larger stands occur on the islands in the river. Douglas fir is a dominant tree species in these stands with the co-dominants Sitka spruce and western hemlock. Vaccinium parvifolium occurs in the shrub layer, which is usually poorly developed. The herb layer of Douglas fir stands is floristically similar to the herb layer of Sitka spruce forests. Linnaea borealis, Tiarella laciniata, and Corallorhiza sp. are additional species.

4.2.5 The lodgepole pine stand

A small lodgepole pine stand occurs on a rocky knoll at the eastern side of the estuary. Stunted pine is accompanied by western red cedar and western hemlock. A dense shrub layer is formed of Gaultheria shallon and Vaccinium parvifolium. Hylocomium splendens, Rhytidiadelphus loreus and Pleurozium schreberi occur in the moss layer.

4.2.6 Alder stands

Alder stands occur on gravel bars along the Tsitika River. They are formed of young shrubby red alder and they have almost no understorey. A small stand of more mature alder, which we sampled, hosts several interesting plants such as Cinna latifolia, Luzula parviflora, Trientalis latifolia, Circaea alpina, Boykinia elata, and Festuca occidentalis. Atrichum selwynii and Sphagnum girgensohnii occur in the moss layer.

5. EVALUATION OF THE PRODUCTIVITY ESTIMATES

It was assumed that if a harvest is undertaken at the peak of the vegetation period the weight of the biomass is a good estimate of the net annual productivity of the above ground vegetation. This assumption is supported by Burg et al.(5), who made measurements of the above ground biomass at a salt marsh in Puget Sound and found that in the majority of investigated communities the peak of the biomass was reached in August.

The weight of the above ground biomass ranges from 134 g/m^2 to 843 g/m^2 (see Table 2). The lowest productivity was found in plot no. 3, the highest in plot no. 14.

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(5) Burg, M.E., D.R. Tripp & E.S. Rosenberg. 1980. Plant associations and primary poductivity of the Nisqually salt marsh on southern Puget Sound, Washington, U.S. Northwest Science 54(3):222-236.

Table 2. Tsitika River estuary - above ground biomass $[g/m^2]$

Elymus mollis community		
	plot no. 4	368
Deschampsia beringensis community		
	plot no. 11	418
	plot no. 12	342
	plot no. 1	445
	plot no. 6	639
	plot no. 15	448
	plot no. 7	464
depauperate stands		
	plot no. 2	548
	plot no. 13	326
Plantago maritima community		
	plot no. 10*	389
	plot no. 9	266
Carex lyngbyei community		
	plot no. 3	134
	plot no. 5	278
	plot no. 8	282
	plot no. 14**	843

* Transition to the *Deschampsia beringensis* community.

** Nutrient rich site with *Festuca rubra* as a co-dominant species.

It is interesting to note that both the lowest and the highest biomass values were found in the Carex lyngbyei community. The extremely high productivity of plot no. 14 can be explained by the accumulation of nutrients in the central part of the delta. Festuca rubra, the co-dominant species in this plot contributes significantly to its higher productivity.

The Deschampsia beringensis community has biomass productions ranging from 326 g/m^2 to 639 g/m^2 . It is probable that these numbers are actually lower than the potential net annual production, since Deschampsia reaches the peak of its biomass later in the vegetation season (cf. Burg et al.) The depauperate form of the Deschamspia beringensis community has a yield comparable to that of the typical form.

The Elymus mollis community was sampled in only one plot. Its biomass (368 g/m^2) was lower than the average biomass of the Deschampsia beringensis community but higher than the biomass of the less productive stands of the Carex lynbyei community. The biomass of the Plantago maritima community is surprisingly high (266 g/m^2) considering this type's low total cover. The data on the biomass of the Elymus mollis community and the Plantago maritima community will be used for the comparing biomass production in future studies rather than for comparison with other communities in the area.

It is unfortunate that our data cannot be directly compared with those obtained by Burg et al., but our communities differ from those described by them. Not even the pure stands of Carex lyngbyei can be compared. In the Pacific Northwest Carex lyngbyei occurs in two different growth forms, a tall one and a shorter one. The Tsitika River population belongs to the latter and consequently has a lower productivity.

6. CONCLUSIONS

The non-forest vegetation of the Tsitika River estuary consists of four vascular plant communities. Of these, the Deschampsia beringensis and the Carex lyngbyei communities cover the greatest part of the vegetated area of the estuary. The other two communities, i.e. the Elymus mollis community and the Plantago maritima community, are developed in considerably smaller areas. The vegetation pattern of the delta is thus relatively simple. Several algal communities occur in the lower part of the delta. The forest communities of the area exhibit greater variation than the non-forest vegetation. Sitka spruce forests at the mouth of the river and stands of the coastal variety of Douglas fir, which occur here close to this variety's northern limit of distribution, are valuable examples of plant communities and deserve protection.

The rocky knoll at the eastern side of the estuary should be included within the boundaries of the proposed ecological reserve. This area is interesting because its pygmy forest which is formed by western hemlock and also it is a locality of several species such as Selaginella wallacei and Holodiscus discolor, which are close to their northern limit of distribution.

The most significant function of this ecological reserve would be to provide a buffer zone between the logging operations in the Tsitika River watershed and Robson Bight, which is an area especially important to large populations of killer whales. The logging of the Tsitika River watershed will result in drastic changes in the Tsitika River estuary and Robson Bight proper. Considering the size of the proposed reserve there is still a question as to whether or not this reserve will be able to fulfill this buffering function. It may be advisable to include a large portion of the Tsitika River valley in this reserve. In any case, monitoring the effects of logging on the estuary is highly recommended.

Appendix A

TSITIKA RIVER ESTUARY - LIST OF SPECIES

A.1 INTRODUCTION

A.1.1 Nomenclature

The nomenclature of vascular plants follows Taylor, R.L. & B. MacBryde (1977): Vascular plants of British Columbia: A descriptive resource inventory, Technical Bull. no. 4, Botanical Gardens, UBC, Vancouver, 754 p. (with several exceptions). The abbreviations of authorities follow Flora Europaea: Volume 5, pp. 353-374, Cambridge 1980. Few additional abbreviations, such as Fern. for M.L. Fernald and Hult. for E. Hulten, were used for several American authors following Hulten, E. (1968): Flora of Alaska and neighboring territories, pp. 969-983, Stanford.

The nomenclature of mosses follows Crum, H.A. et al. (1973): A new list of mosses of North America north of Mexico. Bryologist 76:85-130. The nomenclature of liverworts follows Stotler, R. & B. Crandall-Stotler (1977): A checklist of the liverworts and hornworts of North America. Bryologist 80:405-428.

A.1.2 Species rareness

Several categories of plant rareness in British Columbia were established for vascular plants by the Rare and Endangered Species Committee. These are:

R1 - Species occurring in B.C. in single or few populations

R2 - Species occurring in several populations, locally common

R3 - Widespread or scattered distribution, small populations

R4 - Restricted distribution, large populations

R? - Species rare, but its distribution is poorly known

The list of species compiled by the Rare and Endangered Species Committee (October 20, 1978) was used for the species rarity rating in the list of species and is printed at the end of the line.

A.2 VASCULAR PLANTS

Abies amabilis (Douglas) Forbes - Pacific Silver Fir

Achillea millefolium L. - Yarrow

Adianthum pedatum L. - Northern Maidenhair Fern

Agrostis exarata Trin. - Spike Bent Grass

Agrostis oregonensis Vassey - Oregon Bent Grass

Agrostis scabra Willd. - Hair Bent Grass

Agrostis stolonifera L. - Creeping Bent Grass

Aira caryophyllea L. - Silver Hair Grass

Aira praecox L. - Early Hair Grass

Allium cernuum Roth - Nodding Onion

Alnus rubra Bong. - Red Alder

Alnus sinuata (Regel) Rydb. - Sitka Mountain Alder

Aquilegia formosa Fischer - Sitka Columbine

Aruncus dioicus (Walter) Fern. - Sylvan Goat's-beard

Aster sp. - Aster

Athyrium filix-femina (L.) Roth - Common Lady Fern

Atriplex patula L. - Common Orach

Blechnum spicant (L.) Roth - Deer Fern

Boykinia elata (Nutt.) Greene - Coast Boykinia R4

Bromus carinatus Hooker & Arnott - California Brome Grass

Bromus sitchensis Trin. - Alaska Brome Grass

Calamagrostis canadensis (Michx) Beauv. - Bluejoint Small Reed Grass

Carex bolanderi Olney - Bolander's Sedge

Carex kelloggii W. Boot - Kellogg' Sedge

Carex laeviculmis Meinsh. - Smooth-stemmed Sedge

Carex mertensii Prescott - Merten's Sedge

Cinna latifolia (Triv.) Griseb. - Wood Reed Grass

Cirsium arvense L. - Canada Thistle

Cochlearia officinalis L. - Common Scurvy Grass R4

Conioselinum pacificum (S.Watson) Coulter & Rose - Pacific Hemlock Parsley

Corallorhiza sp. - Coralroot

Cornus unalaschensis Ledeb. - Western Cordilleran Bunchberry

Deschampsia beringensis Hult. - Bering's Hair Grass

Dryopteris expansa (C.Presl) Fraser-Jenkins & Jermy - Spiny Shield Fern

Elymus glaucus Buckley - Blue Wild Rye Grass

Elymus hirsutus C.Presl - Hairy Wild Rye Grass

Elymus mollis Trin. - Dune Wild Rye Grass

Empetrum nigrum L. - Black Crowberry

Equisetum arvense L. - Common Horsetail

Festuca occidentalis Hooker - Western Fescue

Festuca rubra L. - Red Fescue

Festuca subulata Trin. - Bearded Fescue

Galium aparine L. - Common Cleavers

Galium triflorum Michx - Sweet-scented Bedstraw

Gaultheria shallon Pursh - Salal

Glaux maritima L. - Sea-milkwort

Gymnocarpium dryopteris (L.) Newman - Oak Fern

Heracleum lanatum Michx - Common Caw-parsnip

Heuchera micrantha Douglas - Small-flowered Alumwort

Hieracium albiflorum Hooker - White Hawkweed

Hierochloe hirta (Schrank) Borbas - Hairy Sweet Grass

Holcus lanatus L. - Yorkshire Fog

Holodiscus discolor (Pursh) Maxim. - Oceanspray

Hordeum brachyantherum Nevski - Meadow Barley

Huperzia selago (L.) Bernh. ex Schrank & Mart. - Fir Club-moss

Juncus effusus L. - Soft Rush

Juncus ensifolius Wikstrom - Sword-leaved Rush

Linnaea borealis L. - Northern Twinflower

Lonicera involucrata (Richardson) Banks - Twinflower Honeysuckle

Luzula multiflora (Retz) Lej. - Many-flowered Wood-rush

Luzula parviflora (Ehrh.) Desv. - Small-flowered Wood-rush

Luzula spicata (L.) DC. - Spiked Wood-rush

Lysichiton americanum Hult. & St.John - American Skunk-cabbage

Maianthemum dilatatum (A.Wood) A.Nelson & McBride - Two-leaved False Solomon's-seal

Melica subulata (Griseb.) Scribner - Alaska Onion Grass

Menziesia ferruginea Sm. - Pacific Menziesia

Moneses uniflora (L.) A.Gray - One-flowered Wintergreen

Montia sibirica L. - Siberian Spring Beauty

Mycelis muralis (L.) Dum. - Wall-lettuce

Oenanthe sarmentosa C.Presl - Pacific Oenanthe

Picea sitchensis (Bong.) Carriere - Sitka Spruce

Pinus contorta Douglas - Lodgepole Pine

Plantago maritima L. - Sea Plantain

Poa angustifolia L. - Narrow-leaved Blue Grass

Polypodium glycyrrhiza D.E.Eaton - Licorice Fern

Polystichum munitum (Kaulfuss) C.Presl - Western Sword Fern

Potentilla pacifica Howell - Pacific Silverweed

Prenanthes alata (Hooker) D.N.F.Dietrich - Western Rattlesnakeroot

Prunella vulgaris L. - Common Self-heal

Pseudotsuga menziesii (Mirbel) Franco - Douglas Fir

Puccinellia nutkaensis (C.Presl) Fern. - Nootka Alkali Grass

Ranunculus uncinatus D.Don - Little-flowered Buttercup

Ribes bracteosum Douglas - Stink Currant

Ribes lacustre (Pers.) Poir. - Blue Swamp Gooseberry

Rubus parviflorus Nutt. - Western Thimbleberry

Rubus pedatus Sm. - Five-leaved Creeping Raspberry

Rubus spectabilis Pursh - Salmonberry

Rumex occidentalis S.Watson - Western Dock

Sagina maxima A.Gray - Sticky-stemmed Pearlwort

Salicornia sp. - Glasswort

Salix hookeriana Barratt - Hooker's Willow

Sambucus racemosa L. - Coastal American Red Elder

Selaginella wallacei Hieron. - Wallace's Selaginella

Spergularia marina (L.) Griseb. - Salt Marsh Sand Spurrey

Stellaria calycantha (Ledeb.) Bong. - Northern Starwort

Stellaria crispa Cham. & Schlecht. - Crisp Starwort

Stellaria humifusa Rottb. - Salt Marsh Starwort

Taraxacum officinale Weber in Wiggers - Common Dandelion

Thuja plicata Donn ex D.Don in Lamb. - Western Red Cedar

Tiarella laciniata Hooker - Cut-leaved Foamflower R4

Tiarella trifoliata L. - Trifoliate Foamflower

Trautvetteria caroliniensis (Walter) Vail - False Bugbane

Trientalis latifolia Hooker - Broad-leaved Starflower

Trifolium wormskioldii Lehm. - Springbank Clover

Triglochin maritima L. - Sea-side Arrow-grass

Trisetum cernuum Trin. - Nodding Trisetum

Tsuga heterophylla (Raf.) Sargent - Western Hemlock

Vaccinium ovalifolium Sm. - Oval-leaved Blueberry

Vaccinium parvifolium Sm. - Red Huckleberry

Veronica americana Schweinitz - American Speedwell

Vicia americana Muhlenb. - American Vetch

Vicia gigantea Hooker - Giant Vetch

Viola glabella Nutt. - Yellow Wood Violet

Viola sempervirens Greene - Trailing Evergreen Yellow Violet

A.3 BRYOPHYTES

Andreaea rupestris Hedw.

Aneura latifrons Lindb.

Atrichum selwynii Aust.

Blepharostoma trichophyllum (L.) Dum.

Brachythecium sp.

Calypogeja muelleriana (Schiftn.) K.Müll.

Calypogeja neesiana (Caerst. & Massal) K.Müll.

Calypogeja trichomanis (L.) Corda

Cephalozia ambigua Massal.

Cephalozia bicuspidata (L.) Dum.

Cephalozia connivens (Dicks.) Lindb.

Cephaloziella sp.

Claopodium bolanderi Best.

Conocephalum conicum (L.) Lindb.

Dicranella schreberiana (Hedw.) Schimp..

Dicranodontium denudatum (Brid.) Britt. ex Williams

Dicranum fuscescens Turn.

Dicranum howellii Ren.& Card.

Diplophyllum albicans (L.) Dum.

Diplophyllum plicatum Lindb.

Fontinalis antipyretica Hedw.

Gymnomitrion obtusum (Lindb.) Pears.

Homalothecium nuttallii (Wils.) Jaeg. & Sauerb.

Hookeria lucens (Hedw.) Sm.

Hylocomium splendens (Hedw.) B.S.G.

Hypnum circinale Hook.

Hypnum cupressiforme Hedw.

Isothecium spiculiferum (Mitt.) Ren. & Card.

Jungermannia sp.

Kurzia sp.

Lepidozia reptans (L.) Dum.

Leucolepis menziesii (Hook.) Steere ex L.Koch

Lophozia sp.

Lophozia incisa (Schrad.) Dum.

Lophozia ventricosa (Dicks.) Dum.

Marsupella alpina (Mass. & Caerst.) H.Bern.

Mnium glabrescens Kindb.

Mnium insigne Mitt.

Pellia endiviifolia (Dicks.) Dum.

Plagiochila asplenioides (L.) Dum.

Plagiothecium piliferum (Sw. ex C.J. Hartm.) B.S.G.

Plagiothecium undulatum (Hedw.) B.S.G.

Pleurozium schreberi (Brid.) Mitt.

Pogonatum alpinum (Hedw.) Roehl. var. sylvaticum (Hoppe) Law.

Pogonatum urnigerum (Hedw.) P.-Beav.

Polytrichum commune Hedw.

Porella navicularis (Lehm.& Lindenb.) Lindb.

Rhacomitrium canescens (Hedw.) Brid.

Rhacomitrium heterostichum (Hedw.) Brid.

Rhacomitrium lanuginosum (Hedw.) Brid.

Rhytidiadelphus loreus (Hedw.) Warnst.

Rhytidiadelphus squarrosus (Hedw.) Warnst.

Rhytidiadelphus triquetrus (Hedw.) Warnst.

Scapania bolanderi Aust.

Scapania nemorosa (L.) Dum.

Sphagnum capillaceum (Weiss) Schrank

Sphagnum girgensohnii Russ.

Sphagnum squarrosum Crome

Stokesiella oregana (Sull.) Robins.

Timmia austriaca Hedw.

Ulota obtusiuscula C.Müll. & Kindb. ex Macoun & Kindb.

Appendix B

TSITIKA RIVER ESTUARY - MAP LEGEND

Elymus mollis community	e
Deschampsia beringensis community	d
Plantago maritima community	p
Carex lyngbyei community	c
Algal communities	a
Gravel bars	g
Sitka spurce forests	S
Western hemlock forests	H
Amabilis fir forests	B
Douglas fir stands	F
Lodgepole pine stands	Pl
Red alder stands	D