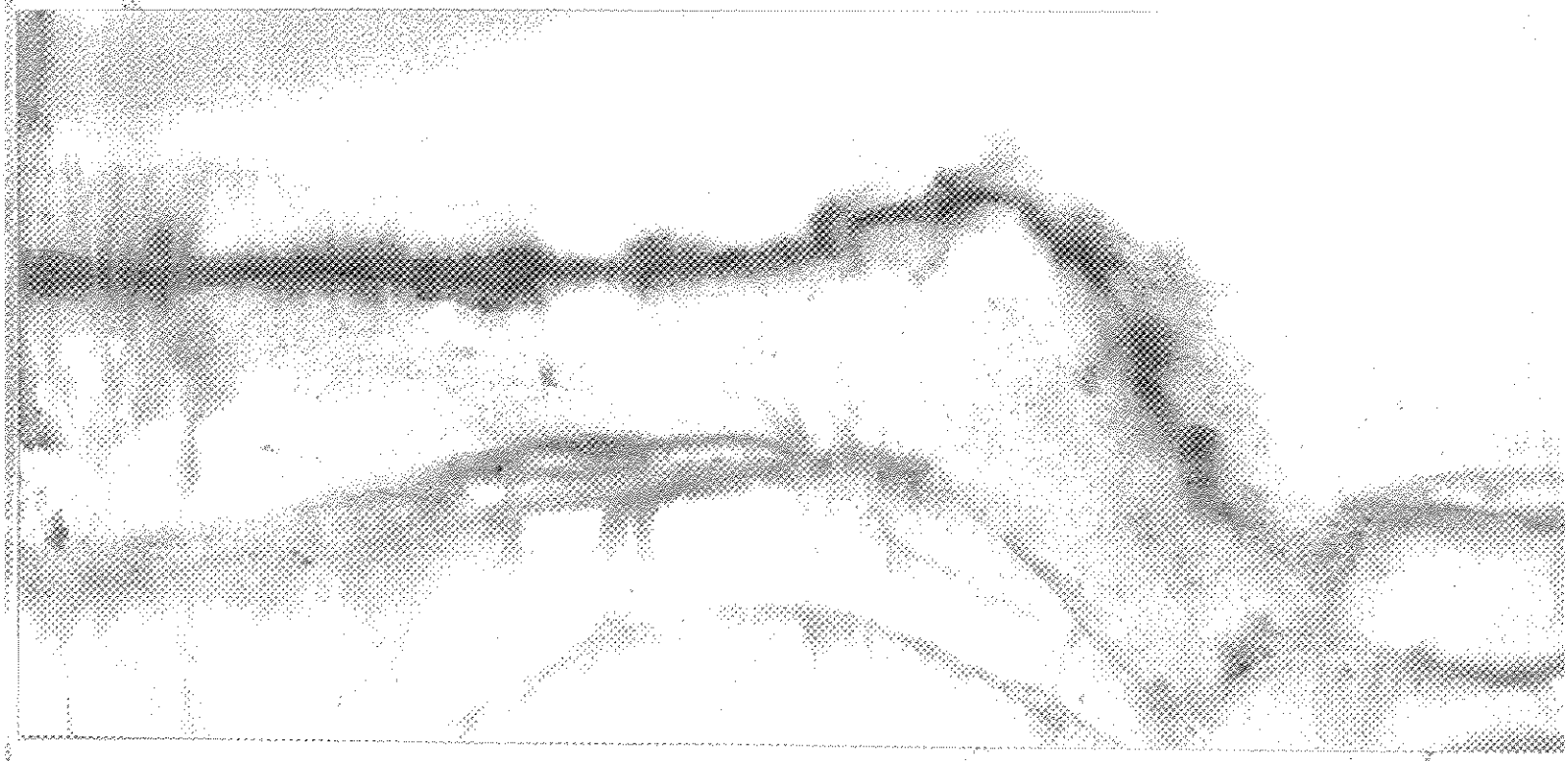
# Sand Dunes on the Queen Charlotte Islands



Trudy Carson

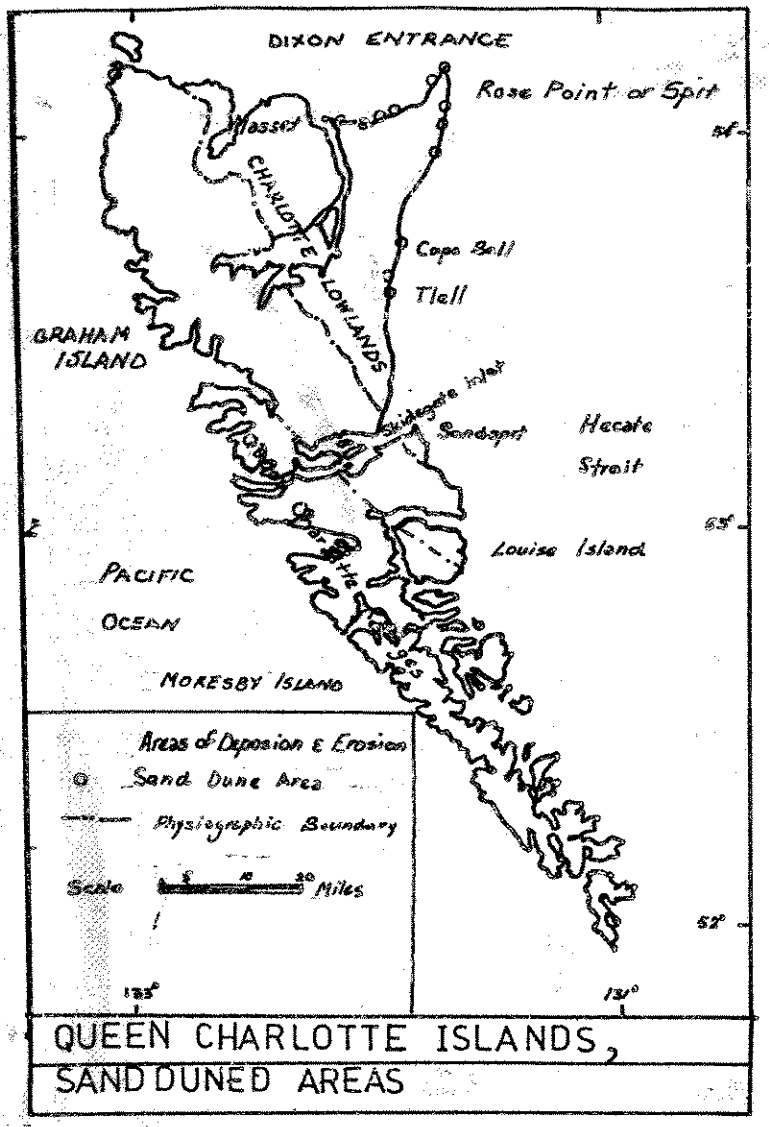

DIXON ENTRANCE
Rose Point or Spit
Massey
CHARLOTTE LOWLANDS
Cape Ball
Tlell
GRAHAM ISLAND
Skidegate Inlet
Sandspit
Hecate Strait
Louise Island
PACIFIC OCEAN
MORESBY ISLAND
Areas of Deposion & Erosion
Sand Dune Area
Physiographic Boundary
Scale
Miles
135°
131°
52°
53°
QUEEN CHARLOTTE ISLANDS,
SAND DUNED AREAS

fig 1.

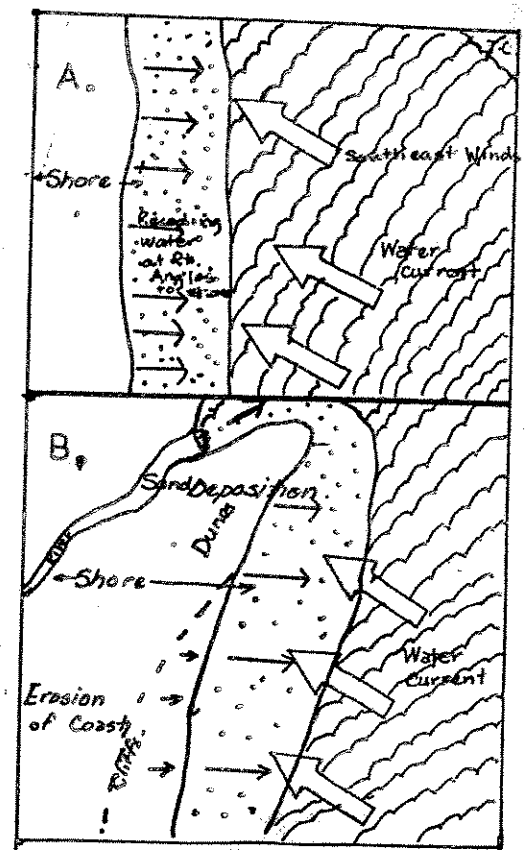

A.
Shore
Breaking water at Rt. Angles to
Southeast Winds
Water Current
B.
Sand Deposition
Dunes
Cliffs
Shore
Water Current
Erosion of Coast
Cliffs
A Littoral Drift
B. Resulting Erosion & Deposition

fig 2

The east coast of Graham Island from Skidegate Inlet north to Rose Spit is noted for its continuous sand beaches. The beach and the Queen Charlotte Lowland area (see fig. 1) was formerly part of Hecate Strait. The Lowland area is comprised of glacial sands and silts. When the last glacier (Pleistocene) melted, the shoreline, relieved of the glacial weight, rose up to form the sand and gravel cliffs found along the east coast. Today, this coast is still being changed and formed by an ongoing process of sand erosion and deposition.

Change of Coastline

Southeast winds, storm waves and ocean currents move sands from eroding cliffs and deposit it in areas of gently sloping beaches. The coastal profile is constantly changing. Waves approach the east coast generally from the southeast direction. The water then runs over the sand and retreats to the sea at a right angle to the shore. As a result of current, and wind, sand is deposited northwards of its origin (see fig. 2). This littoral drift is responsible for the prominent spit formation at Rose Point and the Tlell River Mouth which are continually moving northwards towards Dixon Entrance. At low water sand is exposed to the air, and as it dries, the sand is blown off the beach to form a series of dune ridges. Sand dunes will only form when the ground behind the beach is low-lying. The dunes have a characteristic shape that resembles

an air foil cut in half.  At the same time as the dune ridges are being formed by the forces of wind and sea, another part of the coastline is being eroded away by the same forces. This dynamic equilibrium of the shore profile exists in a delicate state of balance, and may easily be disturbed, so that an excess of erosion caused by disturbance of sand, replaces a former excess of deposition.

Growth of Sand Dunes

Seaward growth of dunes and spits is restricted by high storm tides which undercut the dunes to form a steeper wind-ward (sea-ward) face. As this condition develops in areas of strong onshore winds, the wind-ward side continues to erode. Sand accumulates on the grass covered lee-ward slope of the dune. The dune moves back from the shoreline and continues to build up higher. Whole coastal ridges move landwards in this way. Partially buried spruce trees in the back dunes near Tlell are evidence of the landward movement of dunes. The steeply sloping wind-ward slope of a sand dune is not usually completely vegetated and therefore inherently the dune is unstable and continually in a state of change.

The variety of dunes is great. Each type of dune is affected by strength and direction of wind, local topography, and vegetation. The main types of dunes are listed as follows (adapted from Smith, 1954). (See fig. 2b)

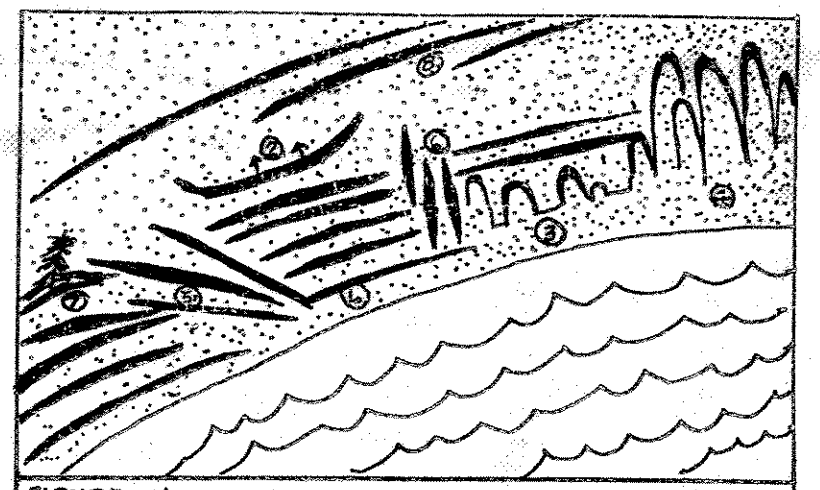


FIGURE 2b

AERIAL VIEW OF DUNE TYPES

1. Parallel fore dunes
2. Crescentic dunes
3. Blow-outs developing to
4. V-Shaped dunes
5. Transverse dunes
6. Longitudinal dunes
7. Attached dunes
8. Back-dunes

figure 2b.

1. Foredunes: mounds of sand up to 10 feet in height adjacent to the beach. Also known as primary dunes. Foredunes are built at the crest of the beach ridge where dune grasses colonize and start to trap blown sand.

2. Back-dunes: are the secondary dunes formed behind the foredunes. These are separated from the foredunes by a trough.

3. Blow-outs: Hollows or troughs of bare sand, cutting into already formed dunes. Blow-outs develop where the vegetation cover on dunes is destroyed or removed so the sand is no longer held in position. Blow-outs can lead to the formation of U-shaped dunes.

4. U-Shaped dunes: Arc-shaped ridges with open ends towards the beach.

5. Crescentric dunes: Dunes with steep faces on the lee-slope, facing away from the beach.

6. Transverse dune ridges: These dunes tend to trend perpendicular to the shore and are elongated parallel to the wind direction.

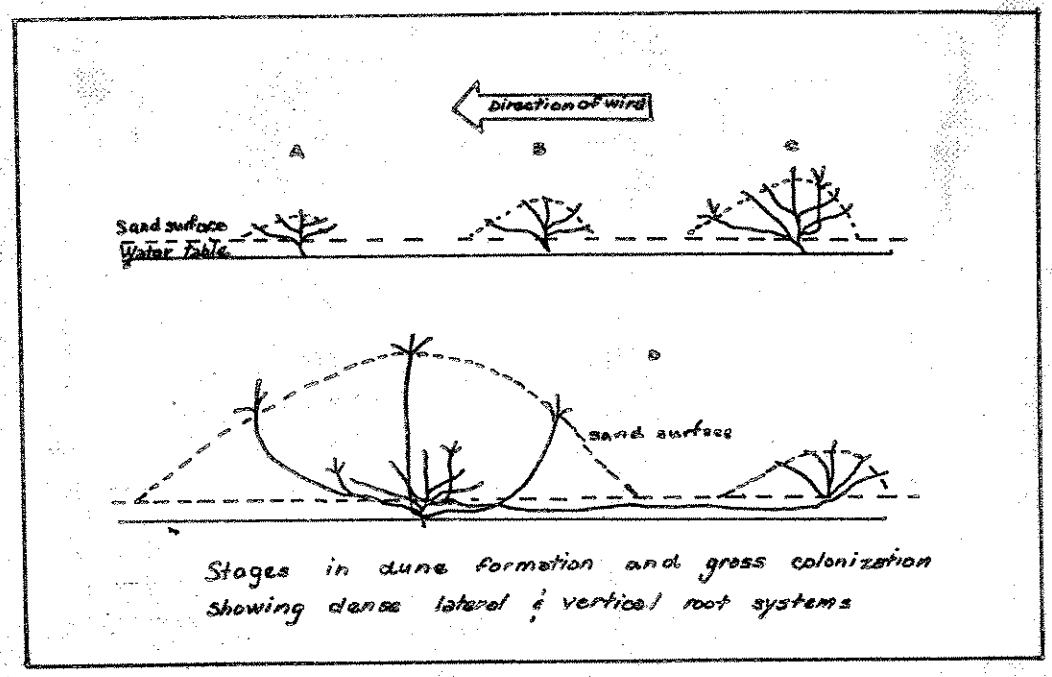
7. Longitudinal dunes: These dunes extend perpendicular to the shore and are elongated parallel to the wind direction.

8. Attached dunes: These are formed when sand accumulates around some obstacle.

The first and second type of sand dune are the most common. By a close examination of the individual dunes, one can find great variety in a seemingly uniform landscape. This landscape has the capacity to change over relatively short periods of time due to the unstable nature of the sand dunes.

## Initial Stabilization of the Dunes By Grasses

What is the force that stabilizes the unstable moving sand dunes? Vegetation plays a most important role in stabilization




Stages in dune formation and gress colonization showing dense lateral & vertical root systems

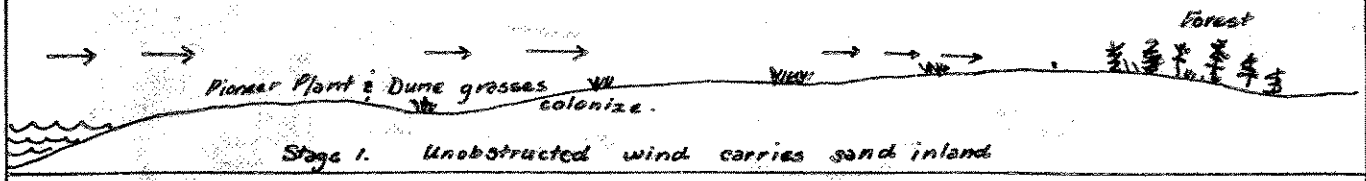
Figure 3

of dunes and promotes growth of dunes by providing a trap for wind-blown sand.

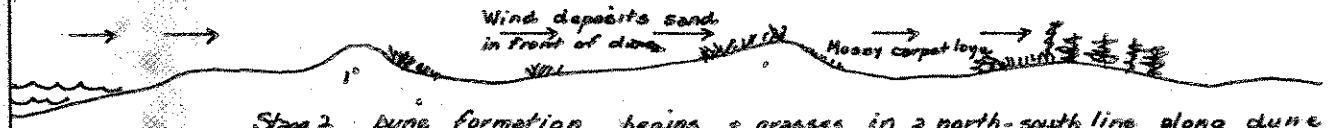
Hardy grasses and sedges pioneer the harsh dune environment where lack of nutrients, lack of soil moisture and instability persists. The sand colonizing grasses are astonishingly tolerant to high winds, high salinity, extreme sunglare, bare mineral soils without humus, and soil moisture extremes. Incredibly enough, they thrive under these conditions, and as sand piles up around the stems of the grasses, they send up more shoots and develop extensive horizontal and vertical root systems (See fig.3). Root systems quickly extend to depths where moisture content is higher than at the surface. Dune grasses have buds along their stems. This adaptation allows the grasses to grow roots (adventitious) along the stem and elongate sideways as well as lengthwise. The dense mat of roots stabilize the dune below and the upright shoots trap sand and anchor the dune above ground level.

Plant & Community Succession on the Dunes

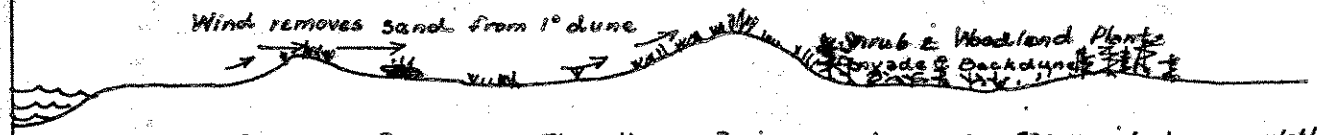
A further more indirect effect of the pioneer plants is to make the dune environment more habitable for the colonization by other plant species. As the grasses stabilize the sand, they die and initiate soil development. Ecological succession is very visible on the sand dunes. Over time, plant community groups replace one another from the sea edge to the forest.



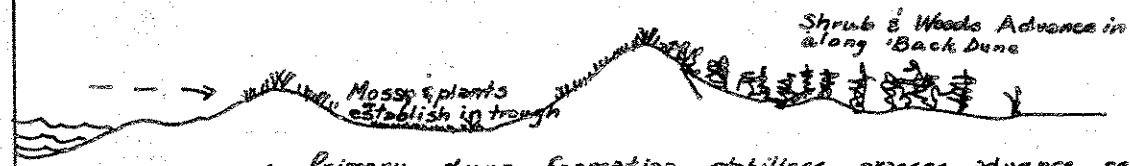

Stage 1. Unobstructed wind carries sand inland



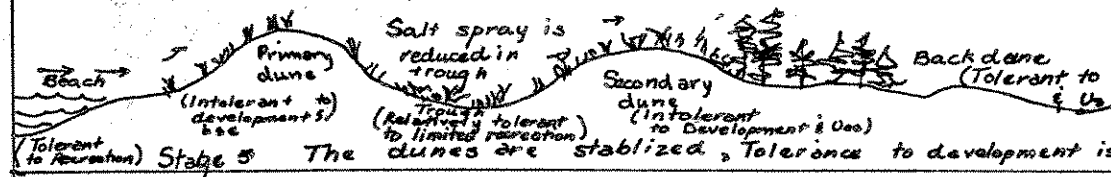

Stage 2 Dune formation begins + grasses in a north-south line along dune




Stage 3 Secondary Formation Begins as dune grass community becomes established




Stage 4. Primary dune formation stabilizes, grasses advance seaward




Stage 5 The dunes are stablized, Tolerance to development is shown.

Stages in sand dune formation & Vegetation Succession

fig 4

Each group of plants prepares the sand for the next group of plants. Each community anchors the sand to a greater degree. so that the landward edge of the dunes is less prone to disturbance than the sea-ward edge of the dunes.

The sand dunes support an amazing assemblage of plants. In addition to the grasses there are lichens, moss, algae, flowers, shrubs and some conifers growing in the dune area. Some species have been directly or indirectly introduced by man or birds. Ammophila arenaria, a major grass species occupying the dunes in the Tlell area, was introduced from Europe some years ago, to bind the dune sands and reduce erosion.

The generalized succession pattern of plants on the dunes is from 1) sand binding grasses, sedges, and sea rocket, to 2) a community I call the mossy carpet layer comprised of mosses, lichens, weed plants, flowers and ferns to 3) the shrub community and finally to the 4) climax forest community. (See fig.4)

As the dune forms a ridge, the grasses colonize and enhance its growth. A trough is formed behind the primary or first parallel dune ridge. The trough is more protected and the mossy ground carpet can establish itself here amid the grass community. The mossy community is characterized by an abundance of moss, the sand strawberry (Frageria chiloensis), a small leaved creeping plant (Glehnia littoralis), sorrel, dandelion, and the lichen (Cladonia spp.). Many brightly coloured flowers, such as lupines, tansy, thistle, yarrow and pearly everlasting

bloom in summer and inhabit this dune zone. These dune plants in order to survive, must be able to grow up through an increasing sand layer. Generally they have large seeds and fast growing roots. The mossy community is succeeded by (or followed) a shrub community in which salal is the predominant species. In some spots juniper or huckleberry is seen. Behind the shrubs or mixed right with the shrub layer is the Sitka Spruce forest. Sitka Spruce forests are the last or climax stage formed after long periods of time. Although Sitka Spruce is capable of absorbing magnesium through its foliage from salt spray and benefits from this source of nutrients, it never reaches its maximum size in the active sand dune environment. Some very small trees on dune ridges may be very old (see fig. 7).

Animals and the Dunes

A number of animals occupy the strand area between the ocean shore and the forest. Animals favor the active dune areas because they can rest and hide in the forest and come out to feed on the dunes and beach. Insects include sand-hoppers, spring-tails and ants. Racoons, mice and deer are the mammals that occupy the dunes. Birds are especially numerous. As well as the migratory geese and ducks that stop on the dunes to rest and feed, gulls, terns, kill-deer, plovers, eagles and ravens occupy the dunes for year round feeding purposes.

Dunes Near Tlell River Spit

Near Tlell there is a"developing dune area with successive bands of driftwood some distance from the shore. Several well stabilized sand dunes are well vegetated and new semi-stabilized dunes are being formed behind the driftwood zone. Just south of Tlell, the semi-stabilized zone has been destroyed by surf action and beach foreshore is replacing elevated and stabilized sand-dune meadows. Steep sand cliffs and vegetation patches are undermined by storms." (Calder and Taylor, 1968)

Dunes at Rose Spit

Another extensively sand-duned area exists at Rose Spit. An Ecological Reserve has been set aside here, to preserve this unique sand-dune community. At this north-eastern most tip of the island, the sea from the north-west (Dixon Entrance) meets the sea from the south-east (Hecate Strait). The dunes on the northern side of the spit are fairly well stabilized. In late June and July the wild flowers bloom on the spit. Blue Lupines and white strawberry flowers cover the spit as fas as the eye can see. The southern side of the spit is not stabilized and is constantly changing. Successive bands of driftwood interspersed with forming dunes and colonizing grasses can be seen. Huge dunes, unvegetated expanses of sand, and flying sand give one the impression of wandering in a wild dark desert during a wind-storm on this south-eastern portion of the spit.

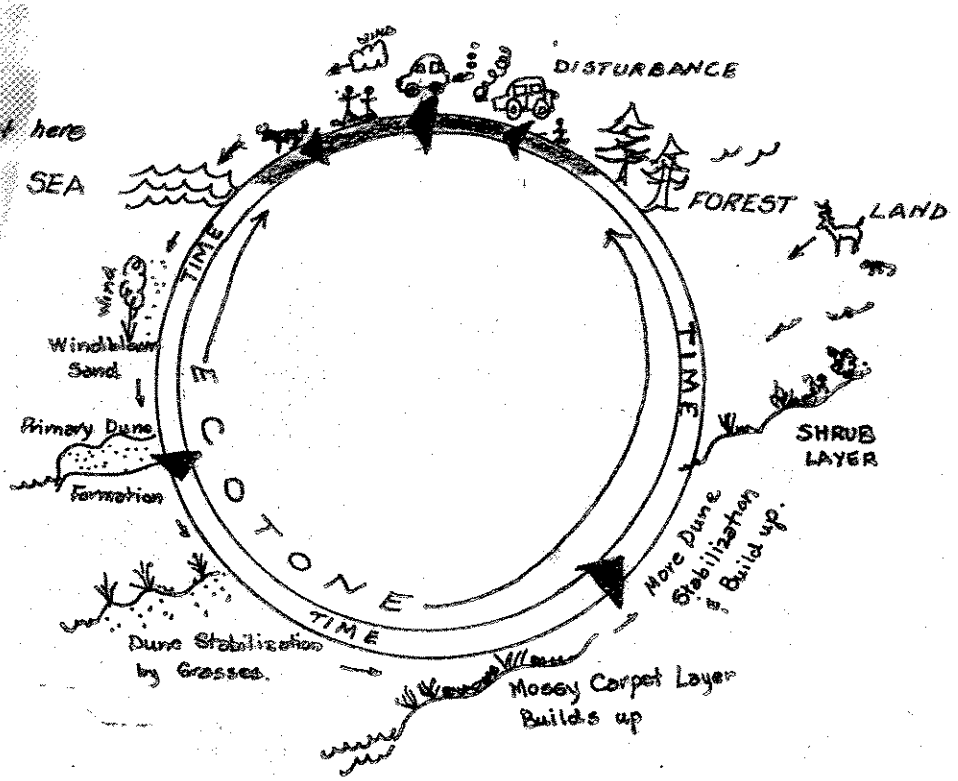



FIGURE 5 SCHEMATIC DIAGRAM SHOWING TIME TAKEN FOR SHORE TO BECOME ESTABLISHED WITH FOREST IN COMPARISON WITH SHORT TIME IT TAKES WITH DISTURBANCE FOR FOREST (LAND) TO REVERT TO FORCES OF SEA.

There are many other extensive sand dune areas on the east coast (and a few on the west coast) of Graham Island besides those described above (see fig. 1). Each is unique yet all are subject to the same forces of wind, sea, sand and stabilizing plants.

The Value of the Dunes

What is the value of this ecological description of sand dunes and plant succession?

Sand dunes are a simple environmental defence of the land against the violent forces of the sea. If the sands are high and well vegetated, the dunes stand up well and resist the erosive forces of wave action. Sand dunes consolidated by roots of sand loving plants are an important natural defence against beach erosion on low-land coasts. "In the Netherlands, the people have been engaged for centuries in an uncertain balance between the land and sea. Between the sea and man stand two barriers, the dunes and the dykes. The dunes stabilized by grasses, are more flexible than dykes, absorbing and reducing the effects of storm waves. The dune is the natural defence of the country. Where there are no dunes, the Dutchmen have built dykes. As a measure of protection for the dunes, the public is denied access to the sand dunes. In the Netherlands, man's dependence on the stability of the sand dunes is well recognized." (McHarg, 1969)

Sand dunes were among the earliest sites settled by man.

They accompany and present an attractive backdrop to beaches to which people go for food gathering and recreation purposes. Dunes have often been used with little understanding and disasterous results. Sands re-mobilized by the removal of stabilizing plants have overwhelmed adjoining land settlements elsewhere in the world such as in the Great Lakes area and on the Eastern Seaboard of the United States.

The hardy dune grasses, able to withstand the forces of wind and sand are not able to stand the force of man. Grasses which stabilize the sand are vulnerable to trampling by man, cattle and destruction by rubber-tired vehicles. On the Queen Charlottes where some degree of survival by the sea is dependent on the protective dune, small regard is given to the fragile nature of the sand dune.

Protection of the Dunes

To maintain the vast scenic and recreational qualities of Graham Island's east coast, as well as the integrity of its coastal landscape, some degree of protection and maintenance of the dunes is necessary. Appropriate use of the dunes considers the future needs of the people and the ecology of the sand dune.

Some factors to be considered when planning for any development or use of the sand dunes:

a) A permanent fall of 15 cm. of ground-water level can be fatal to dune vegetation. The building of shallow wells can affect ground water level.

b) Building of docks, groins or any structure at an angle to the coast, hinders littoral drift and the supply source of sand to the dunes.

c) Oil pollution has a detrimental effect on dune plants and animals.

d) The critical vegetation which stabilizes sand dunes is vulnerable to trampling.

e) The fore-dunes are extremely intolerant to any development while the shallow sloping back-dunes with the woody forest vegetation and stabilized sand are far more tolerant of man's use.

f) Where access to the beach and dune is desired, specific pathways, designed and monitored to protect the sand from erosion, should be considered and used on a rotational basis.

May this ecological description help us become aware of part of the delicate and dynamic balance existing on the islands. Let us act accordingly, and tread gently on the sand dunes.

# An Obeisance to Grass.

Of all that lives and grows
Most humble is the grass.
High pride is the rose
And vanities that pass
Are clothed in arrogance.
As blood is in the heart
As strength is in the sea,
So grass is in the earth,
And sings as bright a song -
As pure and humble mirth -
As sings in blood the heart,
As sings in strength the sea.

For grass is sea and sun,
Is dust of earth in song,
Is blood in vein and bone;
Most humble and most strong.

John Howland Beaumont

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Appendix 1.

## PLANT SUCESSION ON A DRY ACTIVE DUNE (major species)

### SAND BINDERS & COLONIZERS

Dune tops →
- Poa macrantha
- Poa confinis
- Ammophila arenaria

Dune grasses.

- Carex macrocephala - Sedge
- Glehnia littoralis
- Cakile edentula — Sea Rocket
- Franseria chamissonis

### SEMI-STABILIZED MOSSY CARPET LAYER.

- Hypochaeris radiata (Dandelion)
- Tanacetum huronense (Tansy)
- Rumex acetosella (Sorrel)
- Achillea millefolium (Yarrow)
- Lupinus littoralis (Lupin)
- Polypodium gleyrhiza (Fern)
- Pteridium aquilinum (Moss)
- Fragaria chiloensis — sand strawberry
- Cladonia sp. (Lichen)

### DRY SHRUB COMMUNITY

- Gaultheria Shallon (Salal)
- Arctostaphylus uva-ursi (Kinnikinnik)
- Juniperus communis (Juniper)

### FOREST

Picea sitchensis — Sitka Spruce

and a thick understory of Moss and Salal.