

PROTECTION AND CONSERVATION OF COASTAL AREAS

Coastal Erosion In Otago

- The Ocean Grove Recreation Reserve Sand Dune Stabilisation Programme

By M.J. Harris

Soil Conservation Works Officer, Otago Catchment Board.

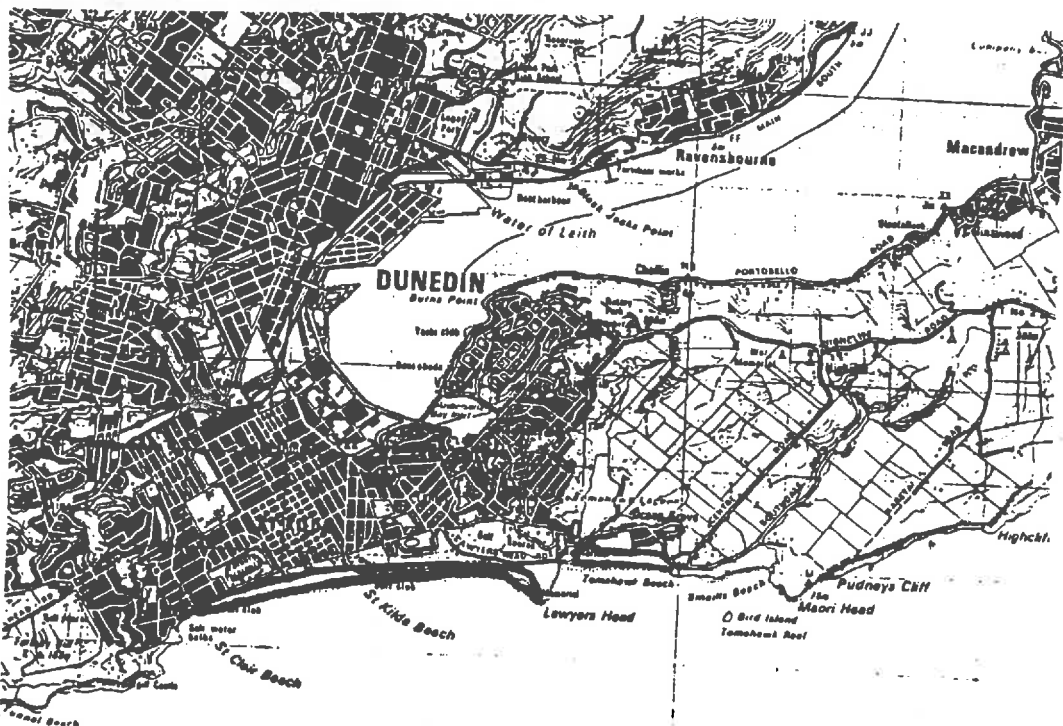
1. INTRODUCTION

The reserve bounds the Pacific Ocean adjacent to the north east of Dunedin City. The beach system is very similar to the problems experienced southwards for 10km on the land to the east of Dunedin City. The majority of the land south of Tomahawk comes under the jurisdiction of the Ocean Beach Domain Board and will be referred to in this paper.

The Ocean Grove Domain Board, which administered the reserve was abolished in March 1985. The vesting of the reserve in the Dunedin City Council was formally notified in the "Gazette" 1985, p. 3336. The reserve is approximately 29ha.

In accordance with Section 41 of the Reserves Act 1977 the Council i.e. Parks and Recreation Department (P.R.D.) prepared a management plan for the Reserve and the Board prepared a sand stabilisation programme to be implemented in conjunction with the management plan.

LOCALITY MAP

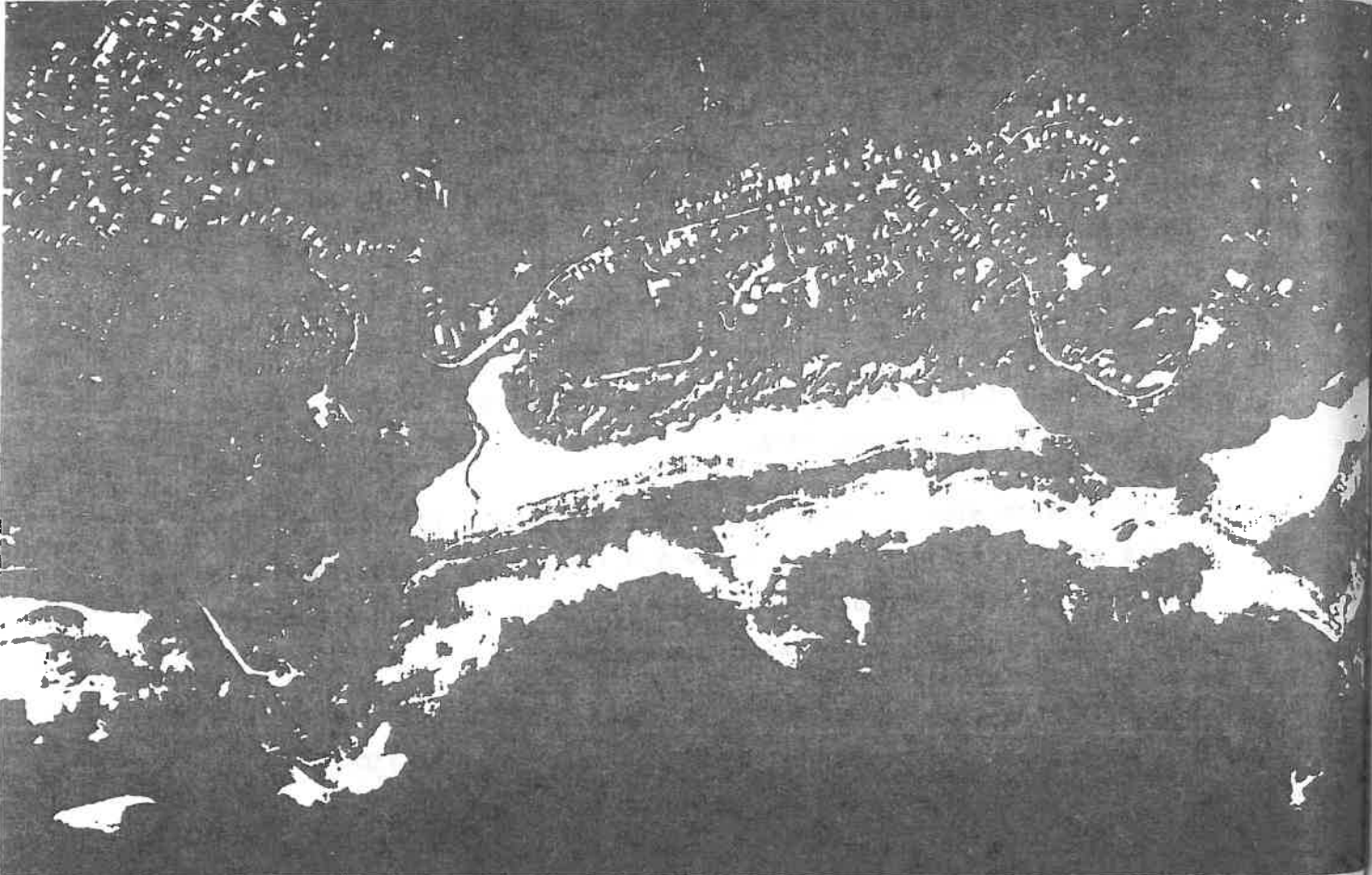


OCEAN GROVE RECREATION RESERVE - Tomahawk Beach Area

DUNEDIN CITY

TOMAHAWK LAGOON

OCEAN GROVE TOWNSHIP
(Part Dunedin City)



OCEAN BEACH
DOMAIN BOARD
N.E. END

LAWYERS HEAD

Taken : C. McKenzie
O.C.B.
July 1986

2. HISTORICAL OVERVIEW COASTAL OTAGO

Various studies have been conducted over the past fifteen years to assess the rate of erosion along the coast of Otago and Southland and determine the sediment budget for the transport and loss of coastal material.

A sediment budget for the South Otago continental shelf and coast between Nugget Point and Otago Peninsula, suggests modern (post 6500 years) sediment input is dominated by the Clutha River (total 3.14 Mt yr^{-1} where $\text{Mt} = 10^6$ tonnes). Bedload that escapes storage (1.1 Mt yr^{-1}) is transported north eastwards to be deposited on beach and inner shelf environments just north of the Otago Peninsula (Carter 1986).

Reviews of historical records (Gibb 1978; Kirk 1980) suggests that input into the sediment budget from coastal erosion is minimal. Sandy stretches of the South Otago coast undergo periods of accretion punctuated by erosional phases, e.g. as was observed in 1977 and 1978 at Tomahawk Beach. This led Kirk (1980) to infer that the Otago beaches are largely in a state of equilibrium.

3. COASTAL EROSION - THE OCEAN BEACH DOMAIN AREA

In the early 19th century the dunes in the area Tomahawk to St. Clair beach were devoid of marram grass and other vegetation. These are now largely vegetated (Figure 1). Storm events are common from the south and south east directions and these have caused severe erosion and degradation of the foredunes. These storms also cause inundation and flooding of the landward side, e.g. 1887, 1891 at the Ocean Beach Domain Board.

Some of the early erosion problems were related to the removal of sand during the development of areas such as Tahuna Park and neighbouring playing fields. The sand was mined and used to reclaim considerable areas in Dunedin City from as early as 1883.

Changes in the beach foredune boundary from 1942-1970 are shown in Figure 2.

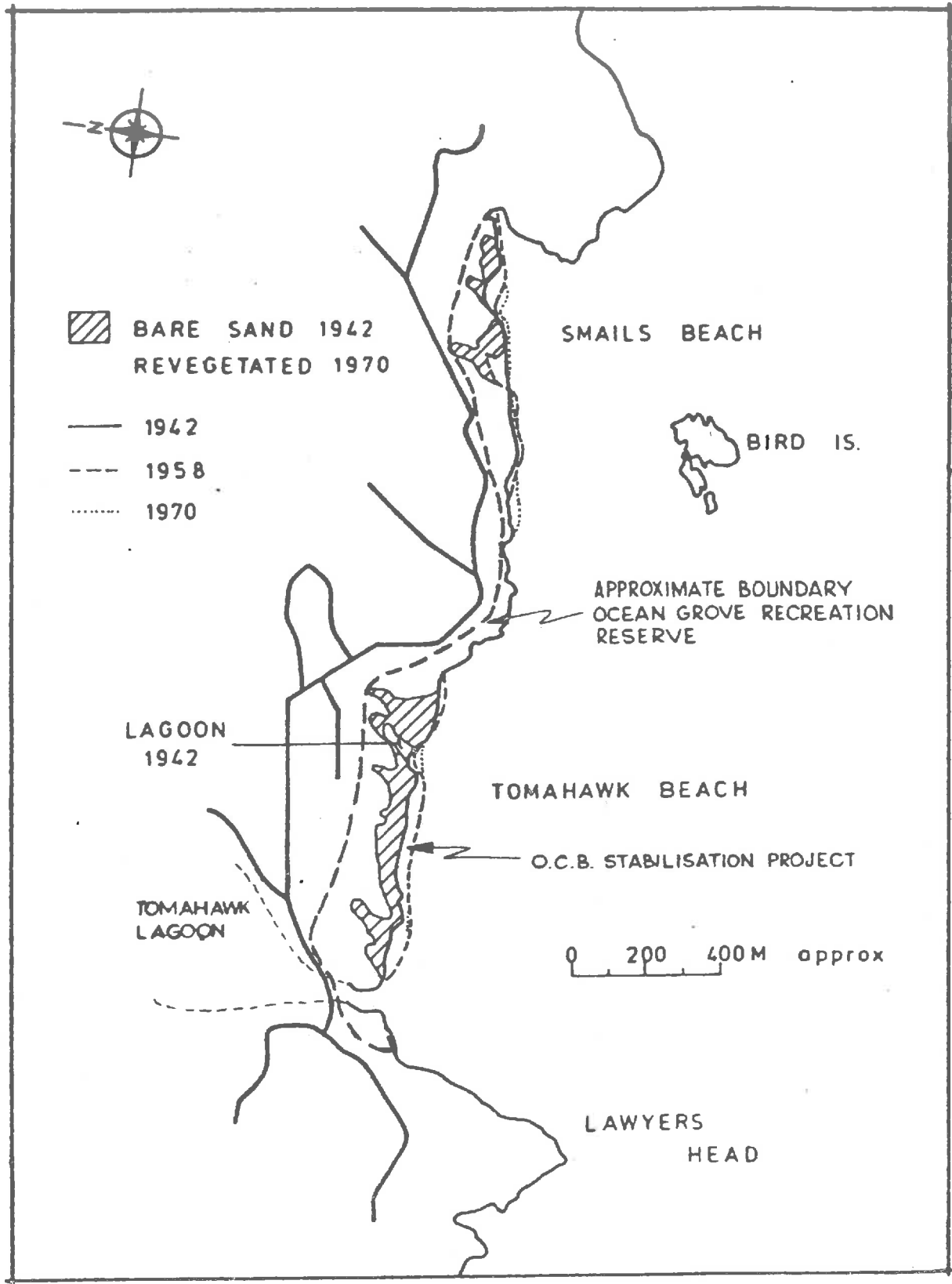


FIGURE 1 : TOMAHAWK AND SMAILS BEACH
 1942 - 1970 CHANGES IN BEACH/DUNE
 BOUNDARY

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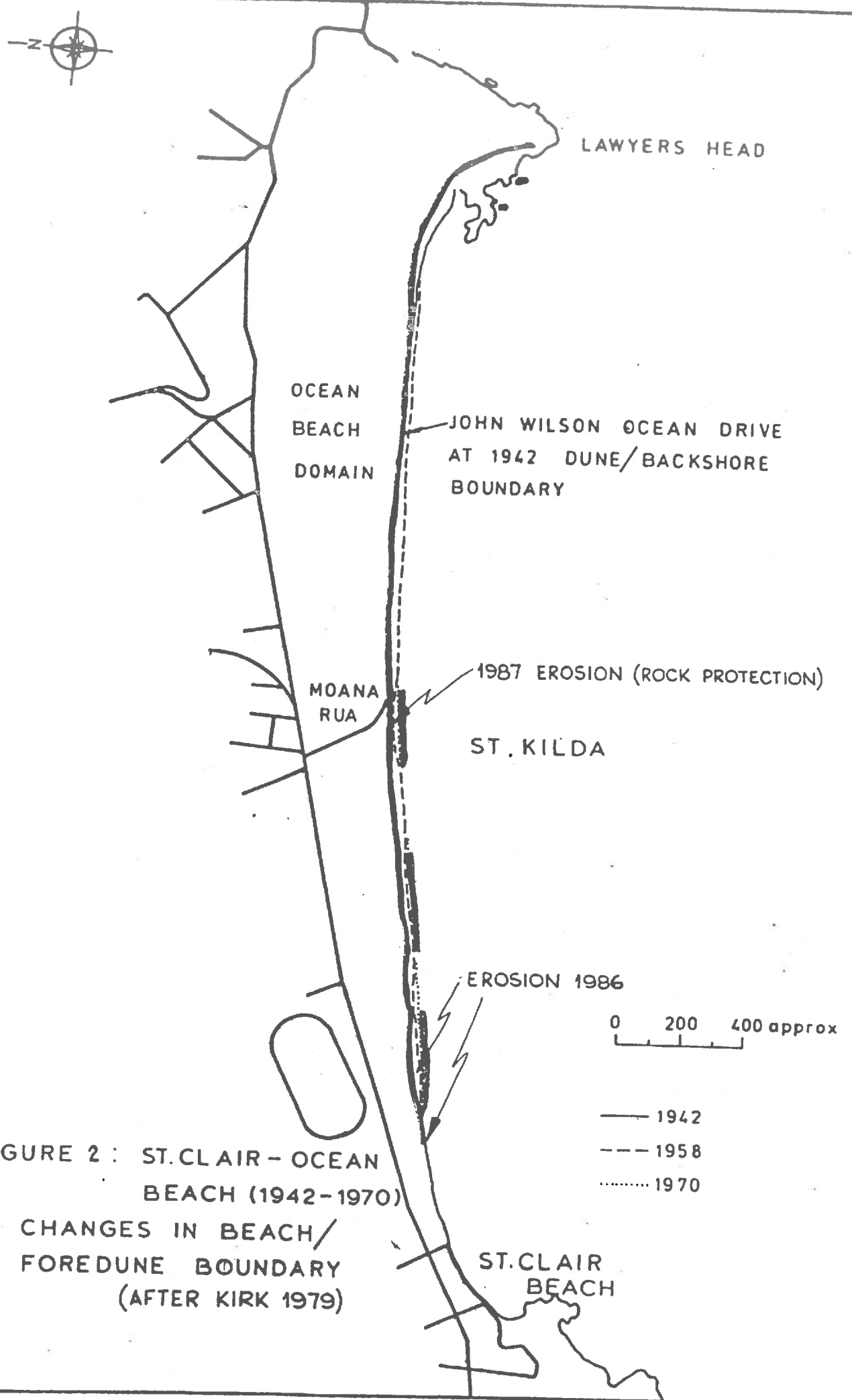


FIGURE 2 : ST. CLAIR - OCEAN BEACH (1942-1970)
 CHANGES IN BEACH/ FOREDUNE BOUNDARY (AFTER KIRK 1979)

0 200 400 approx

— 1942
 --- 1958
 1970

4. COASTAL EROSION - THE TOMAHAWK BEACH AREA

I.E. (PART OCEAN GROVE RECREATION RESERVE)

Kirk (1979) showed that there was an accretion of 30m from 1942-1958 and no growth after that date. Heavy seas and storm events in July 1977 and 1978 caused erosion of the toe of the foredunes and created "blowholes" on the front dune faces. Other storm events in June 1980 and October 1982 also caused further erosion of the dune faces.

Furthermore, following the initial wave damage high velocity winds transported sand inland onto the adjoining urban area affecting the Ocean Grove school and sewage pond. Sand was also carried further inland and deposited in the Tomahawk Lagoon.

Sand Mining - One mining licence exists in the reserve area and occupies the foreshore and beach area at the Tomahawk Lagoon outlet. Approximately 7-10,000m³ of sand has been removed annually from the licence area which includes a maximum of 1,000m³ from the Beach area. This operation dates back to 1952.

It seems likely that sand extraction has acted to halt beach accretion (Kirk 1979). However if greater quantities of sand were removed annually the resultant effect could be the initiation of severe fore-dune erosion.

Furthermore, the Otago Catchment Board recognises that the sand removal plays an important role in maintaining the channel outlet and minimising the flooding problems in the Tomahawk Lagoon and neighbouring residential land.

The ability of this beach to replace sand mined for aggregate is not constant from year to year. The foredune requires monitoring by profile surveys and photography (Kirk 1979) to assess the impacts of mining.

Recreation/Other Uses

Four-wheeled drive vehicles, trail bikes and horses on the beach and the lower foredunes, have had a major impact on the stability and cover over the past ten years. These uses have created a large number of tracks and denuded the vegetative cover on the tops and front of the foredunes. The hind-dunes are not so exposed to the coastal environment and therefore have a better vegetative cover.

The beach is not used by surfers and swimmers due mainly to the discharge of sewerage from the Dunedin City outfall at Lawyers Head.

5. O.C.B. - SOIL CONSERVATION MANAGEMENT PROPOSAL

Following discussions with the D.C.C. P.R.D. in 1985 it was decided that the Board should prepare a long term revegetation - stabilisation programme to protect the dunes, residential area and sporting facilities nearby.

Note: Financial approval was granted by the O.C.B. earlier in 1987 for the stabilisation project over the next five years. The Labour Government's budget on 17 June 1987 brought about major changes in the future funding of such projects, the full extent of these will not be known until 1988.

6. SOIL CONSERVATION MANAGEMENT PROPOSAL

6.1 Objectives

The Board has approved a five year revegetation-stabilisation programme for the Ocean Grove Recreation Reserve.

- To erect brush protection fences where required in vulnerable areas, e.g. "sand blow" areas.
- Brush fences were erected in 1984 and these fences have been very successful in trapping sand.
- To erect fences around and through the dune system. The fences will ensure that beach users are restricted to the access ways and allow the new plants to establish.
- To erect protection walkways of slatted wood or matting for access from the residential area through the dunes to the beach area. These boardwalks can be lifted from time to time. Three main access ways, will be constructed for access to the beach.

6.2 Foredune Revegetation

Once the brush fences have been erected the initial planting programme can commence using marram grass and similar suitable seedlings on the bare sand.

In the mid-dune and part of the hind-dunes lupins and other species will be established (as cover).

It is interesting to note that in the early 1950s 750 macrocarpa trees were planted to prevent sand drift and deposition onto the sports fields and local sewerage plant. These trees have recently been removed. Furthermore, some earlier plantings of marram were undertaken in the 1970s.

6.3 Revegetation of the Hind-Dune Area

To ensure long term stability to the dunal system it is proposed to plant out in suitable shrub and tree species the older dunes once the protection fences have been erected.

The initial programme will concentrate on planting only the southern area.

Note: Not all the above works are grant assisted by the Board.

6.4 Other Management Objectives

Mining of Sand

This operation should be monitored to ensure that the long term stability of the foredunes and beach is not affected and that the quantity of sand that is permitted in the mining licence is strictly adhered to (i.e. 1000³/yr from the beach area).

Public Use of Area

In the Reserve management plan public use of the area will be encouraged but in doing so it will be necessary to educate the public about the prohibition on the use of the dunes. The access ways must be used when passing to and from the beach.

7. FUTURE PROGRAMMES

The objective of the initial proposal was to stabilise the major eroding areas, i.e. the frontal foredunes, as well as providing a 5-year programme of stability planting in the hind-dunes. The first two to three years of planting on the bare frontal dunes may take longer than planned, depending on the supply of marram plants.

It is envisaged that the planting programme could take up to ten years overall. The second stage programme will concentrate on planting the remainder of the hind-dunes.

Refer to Appendix I for specifications and guidelines on Revegetation of the Dunes.

8. SUMMARY OF ESTIMATED PROGRAMME OF EXPENDITURE 1987-1991

<u>Work</u>	<u>Est. Cost</u> <u>(exc. fees)</u>	<u>Grant</u> <u>Rate</u> <u>(net)</u>	<u>Grant</u>	<u>Local</u> <u>Share</u>
1,550m protection fences @ \$4,830/km (incl. foot accessways)	7,486	35	2,620	4,866
1.8ha marram planting @ \$1,260	2,268	35	794	1,474
450m brush fences @ \$4,435/km	1,995	35	698	1,297
1.2ha hind-dune protection planting @ \$1,470/h	1,764	35	617	1,147
	-----		-----	-----
	13,513		4,729	8,784
Plus non-grant assisted works by D.c.C. (estimate)	4,000		-	4,000
	-----		-----	-----
	\$17,513		\$4,729	\$12,784
	=====		=====	=====

9. PLANNING CONTROLS

Various guidelines and controls exist. Refer to Appendix II for a summary of the important controls.

10. IMPLICATIONS OF FUTURE SEA LEVEL RISING

Within the first 10-15km of the earth's atmosphere the partial trapping of thermal radiation (infra-red) from the earth by radioactivity absorbing particles such as CO₂, CH₄, N₂O, chlorofluorocarbons and ozone helps to increase global temperatures - this process is referred to as the "Greenhouse effect".

CO₂ levels have risen due to the use of fossil fuels and destruction of forest cover.

Concurrent with the trend of increasing levels of greenhouse gases over the last 100 years global mean temperatures have risen about 0.5°C (Jones et al 1986). The resulted impact of the greenhouse effect could double or even quadruple the present effects causing global warming of at least 1°C and possibly more than 5°C by 2,050 (Dickison and Cicerone 1986). Heating the entire ocean by 1°C would rise its level by 600mm (Henderson-Sellers and McGuffie 1986).

Gibb (1986) summarises findings of research data from various sources on sea level rises (refer Appendix III).

Possible Effects of Sea Level Rise

1. Increased coastal erosion and inundation.
2. Initiation of landslides and erosion on steeper lands adjoining the sea, e.g. Kilmog area of Otago and parts of Otago Peninsula.
3. Loss of considerable areas of land including various coastal reserves, urbanised areas.
4. Rise in coastal watertables and lagoon and waterway alterations.

11. LONG TERM MANAGEMENT

Land managers and planners should be aware of the long term effect of sea level rise when preparing management plans or in the general management of coastal reserves and adjoining lands.

This may mean adjusting fencelines, roads and considering the best long term location of buildings and other assets. It is recommended that all coastal dune areas at risk to erosion should have comprehensive stabilisation programmes prepared.

12. COASTAL HAZARD IDENTIFICATION

The O.C.B. as part of its responsibility in the identification of lands subject to hazards such as erosion, flooding and landslip is presently co-ordinating a coastal hazard mapping project from the Taieri River northwards to the Pleasant River.

There are various organisations involved with an interest and responsibility such as the Otago Harbour Board, Dunedin City Council, Dunedin Drainage and Sewerage Board, Silverpeaks County Council and The Ocean Beach Domain Board. The objective of the study is:

- (a) To identify existing rates of coastal erosion or accretion.
- (b) To prepare preliminary coastal hazard maps for 50 and 100 year zones.
- (c) To prepare preliminary coastal hazard maps for the scenario of a 1 metre and 2 metre rise in mean sea level.
- (d) Finally to prepare coastal hazard zones as are considered appropriate for inclusion into the relevant District Scheme or management plans, e.g. Ocean Grove Recreation Reserve Management Plan.

Once this study is completed other coastal areas in Otago will be investigated along similar lines.

13. CONCLUSION

The coastal environment in New Zealand is very vulnerable and subjected to various changes over time, some due to man's management and others due to natural causes.

Coastal reserves such as the Ocean Grove Recreation Reserve and Ocean Beach Domain Board and any new reserves should have taken into account the possible implications and effects of increased coastal erosion and inundation due to a rise in mean sea level over the next 100 years.

Soil and Water Conservation management plans should be considered and implemented as an integral part of reserve management.

ACKNOWLEDGEMENTS

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APPENDIX I

SPECIFICATIONS AND GUIDELINES FOR REVEGETATION OF DUNES

1. Foredune Revegetation

This is to take place on priority areas behind the brush fences. On some sites additional brush fences will need to be constructed to trap sand.

Trial Plantings

It is suggested that trial plantings be undertaken on a specific area in the stage 1 plan to assess the best species to use, planting time and fertiliser requirements.

Recommended Programme is:

1. Plant all bare sand with marram grass at 0.6m centres to a minimum depth of 20cm if possible before August.
2. Topdress the same area with a compound fertiliser, e.g. ammophos 13:6:11 or 16:6:6 at a rate of 125kgs/ha and repeat the dose in late spring and again before the moisture deficit occurs in late summer. Alternatively 100kg/ha of nitrolime can be applied.
3. On areas further back near the mid-dune yellow lupins can be sown.

Do not plant any trees or shrubs on the seaward side of the brush fence as they can interfere with the natural windflow and create blowouts.

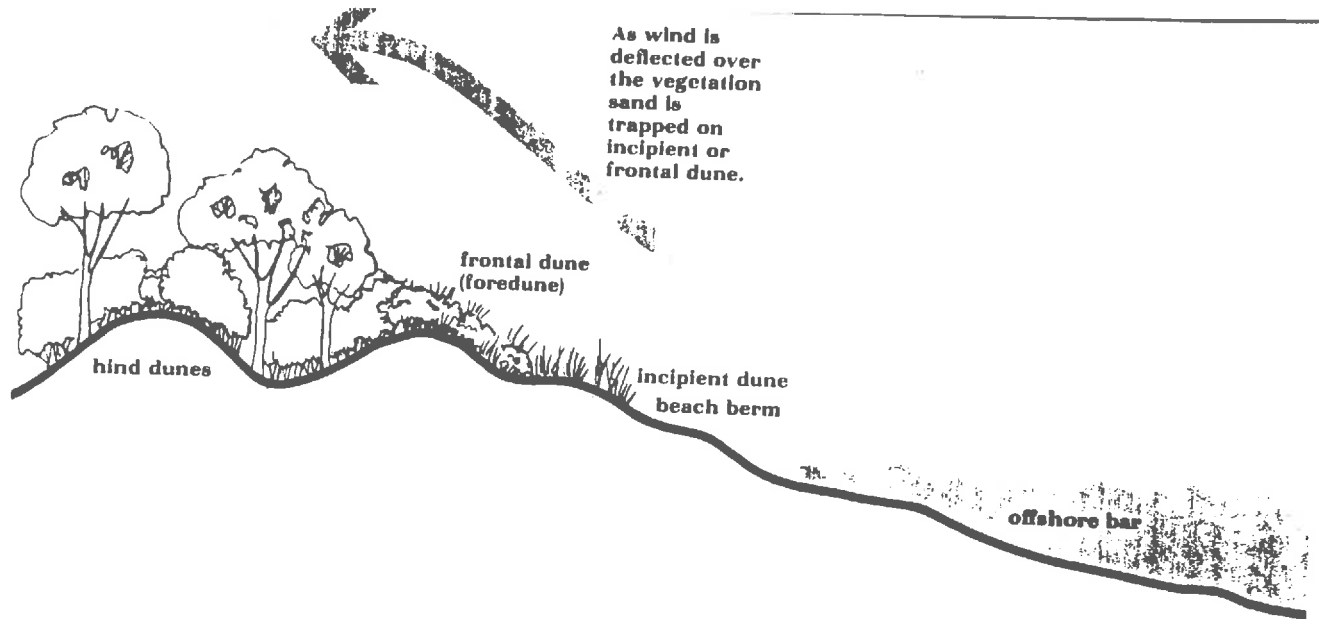
4. Maintenance of plantings is essential to ensure no "blowouts". On problem areas hay mulch (or similar type ground protection) should be used. The hay mulch is also recommended on sensitive or harsh sites around the marram seedlings.

Protection fences are not required on the frontal foredune as the brush fences are providing protection.

<u>Cost Estimate</u>	<u>Per Hectare</u>
Marram plans	200.00
Labour	600.00
Fertiliser (2 applications)	180.00
Transport	20.00
Other (e.g. mulching and re-establishment)	200.00

	1,200.00
Plus 5% contingency	60.00

	\$1,260.00/ha
	=====



Role of Dune Vegetation

2. Hind-dune protection planting

This will be in a variety of shrubs and trees for long term soil stabilisation. The recommended species should be adaptable to the coastal environment and be small to moderate in height at maturity. The spacing suggested for trees and shrubs will depend on the species chosen but should be approximately 2 x 2m to 3 x 3m.

Recommended Species: Mixture of the following

Chatham Island Ake Ake
Golden Ake Ake
Broadleaf
Cabbage Tree
Taupata

Karo
Tarata
Black Matipo
Corokia
Ngaio
Lacebark

Olearia Traversii
Olearia Forsteri
Griselinia Littoralis

Coprosma Baueri
Coprosma repens
Pittosporum cressifolium
Pittosporum Eugenioides
Pittosporum tenuifolium
Corokia contoneaster
Myoporum lateum
Hoheria spp.

The above list is not inclusive but indicative of some species which should be planted. Other species already established in this coastal environment should be used.

<u>Protection Planting</u>	<u>Per Hectare</u>
Trees	800.00
Hand clearing planting spots	150.00
Planting trees	300.00
Application fertiliser, further releasing	100.00
Other (transport, layout out)	50.00
	<hr/>
	1,400.00
Plus 5% contingencies	70.00
	<hr/>
	\$1,470.00/ha
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3. Sand Deposition Fences

To trap sand in the foredune areas it is recommended that these be constructed normally at right angles to the prevailing wind. The fences can be constructed out of brush material or using polymesh leno (available from Reid Sarlon Limited).

The areas requiring brush fences are the more depleted exposed blow out sites and need fences to accommodate sand prior to planting of marram plants. Normally these fences require posts 4-5m apart with 3-4 strands of no. 8 gauge wire.

Note: Posts do not need to be tanalised.

<u>Estimate</u>	<u>Per 20m</u>
Materials (fence and brush)	60.00
Labour	20.00
Laying out and cartage	4.47
	<hr/>
	84.47
Plus 5% contingencies	4.23
	<hr/>
	\$88.70 or \$4,435/km
	=====

4. General Recommendation and Specifications for access tracks, board and chain walkways and steps

Access Tracks

Width: 1.8m to 2.4m (wider where used for surf boat emergency access).

Maximum slope: 30 per cent.

Surface treatment: 15cm gravel, light seal of fine aggregate and bitumen.

Cross Section: Crown 5cm to 7cm higher than edges.

Maintenance: Annual or as necessary.

Board and Chain Walkways

Slopes: 30 to 60 per cent.

Construction: 1.8m lengths of 7cm x 4cm sawn hardwood, bolted on 30cm centres with galvanised bolts, nuts and washers to long link galvanised chain.

Steps

Slopes greater than 50 per cent.

Steps: 100cm x 30cm x 5cm hardwood.

Vertical height between steps 15 to 30cm.

Steps should be firmly anchored using timber, sunk into sand especially at the lower beach end.

Maintenance: Normal maintenance to keep in a safe condition, with extra work necessary if damaged by high seas.

Signs

Signs requesting the public to use the tracks, and not to destroy the stabilising vegetation, should be placed preferably at each end of the access track.

Summary

Wherever a stable frontal dune exists, or where an unstable frontal dune can be re-stabilised and the beach is being used by people, the problem of safe access to the beach exists.

Safe and stable access can be provided for foot traffic by using fences, narrow gravelled and sealed access tracks, board and chain walkways or steps in locations convenient to the public. The effective usage of these can often be improved by the erection of suitably worded signs. Maintenance of all of these installations is necessary.

APPENDIX II

EXAMPLES OF COASTAL PLANNING CONTROLS

1. Harbours Act Section 165 (2)

The D.C.C. has adopted Bylaws (approved by Minister of Transport) to control the foreshore for a period of 21 years from 1 December 1985.

2. Soil Conservation and Rivers Control Act 1941

The objectives specified for the National Water and Soil Conservation Authority (N.W.A.S.C.A.) and catchment authorities.

- promotion of soil conservation
- minimisation and prevention of damage from erosion
- minimisation and prevention of damage from floods
(section 10)

Furthermore, catchment authorities may promote, plan, carry out and maintain works for the above objectives and bylaws can be made to achieve the above objectives (section 150).

3. Conservation Act 1987

Section 24 marginal strips means land that lies on the high side and within 20 metres of any foreshore (foreshore being defined as any part of the bed, shore or bank of the sea that is covered and uncovered by the flow and ebb of the tide at ordinary spring tides).

Under Section 24 of the Act specific provisions apply:

1. No interest in a marginal strip shall be granted or disposed of.
2. Every marginal strip shall be held for conservation purposes, and subject to Sections 18-23 of this Act, shall be managed:
 - (a) For the conservation of its natural and historic resources and those of the adjacent water; and
 - (b) Subject to the conservation of those resources, so as to enable public access to the adjacent water.

4. Reserves Act 1977

5. Noxious Plants Act 1978

6. Land Act 1948

7. Mining Act 1971

8. Town and Country Planning Act 1977

This Act provides for united and regional councils and territorial authorities (county, borough, district and city councils) to undertake regional, district and maritime planning.

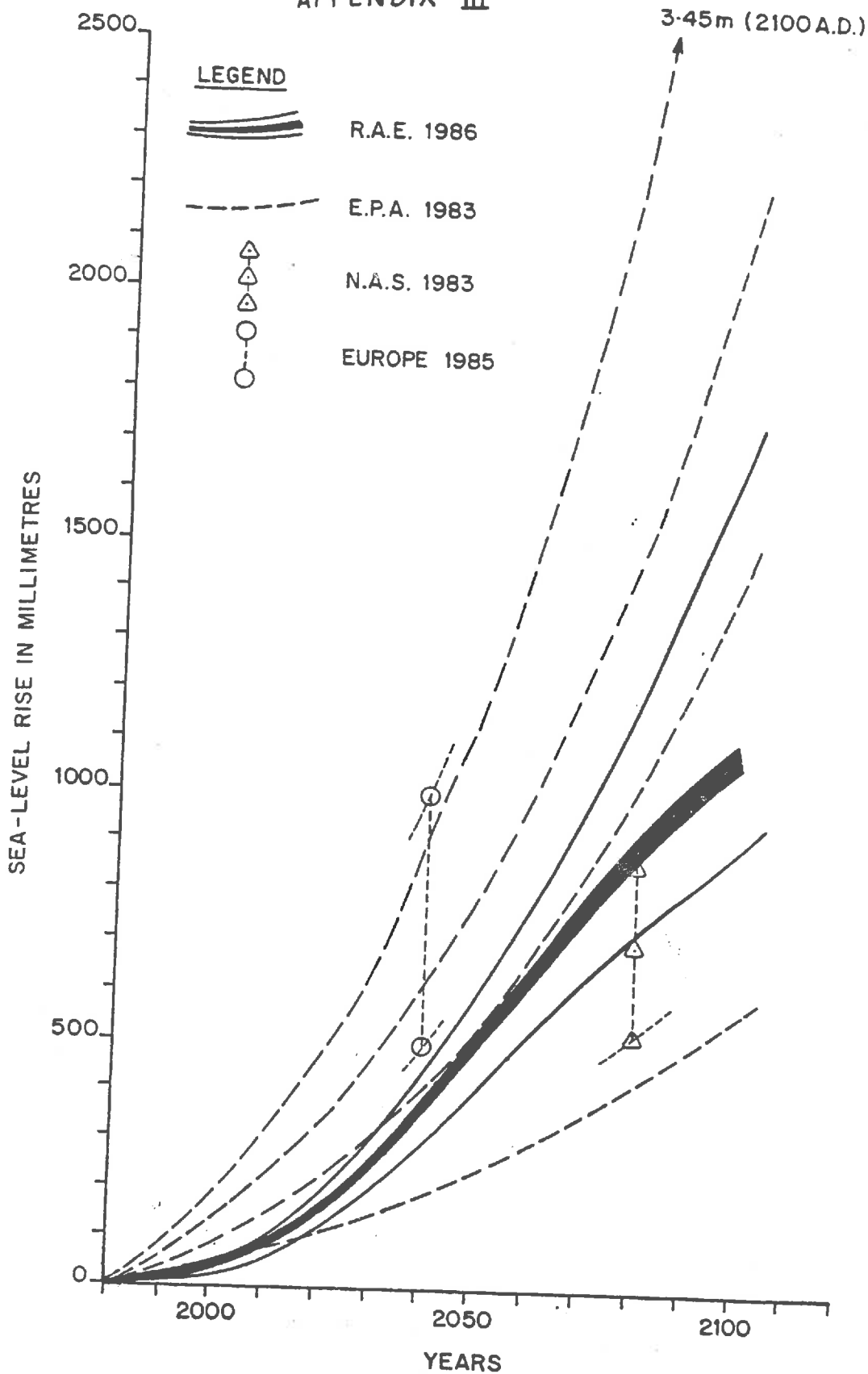
(Sec. 9, 38, 98)

9. Local Government Act 1974

Part 20 of the Act deals with subdivision and development of land.

(s. 271)

APPENDIX III



Atmospheric CO₂ induced sea-level rise predictions plotted by the writer from the following data sources: RAE, Royal Airforce Establishment, Farnborough, UK (R H Thomas); EPA, United States Environmental Protection Agency (J. S Hoffman, D Keyes, J G Titus); NAS, United States National Academy of Sciences (R R Revelle); Europe, Conference at Villach, Austria.

(AFTER J. GIBB 1986)

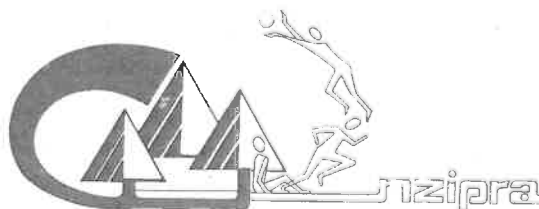
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CONFERENCE PROCEEDINGS