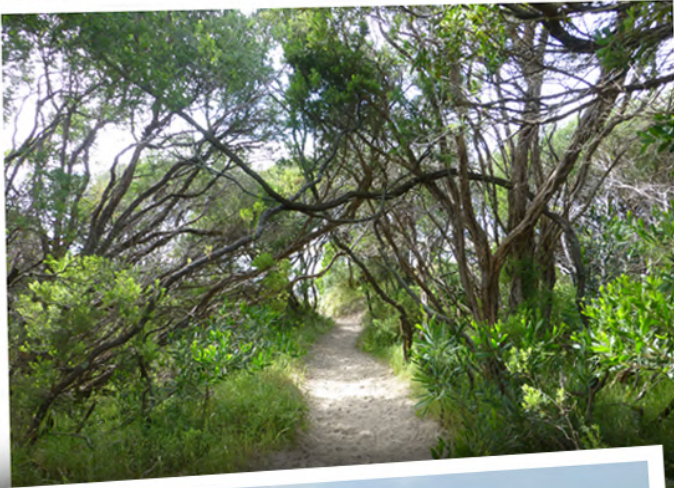


Inverloch Coastal Resilience Project

Project Report



South Gippsland Conservation Society Inc.
August 2019

EXECUTIVE SUMMARY

The Inverloch Coastal Resilience Project Report is the culmination of twelve months' investigation of the current erosion sequence at Inverloch and the values of the vegetated dune system that are under threat, as well as a variety of community and stakeholder consultations. It draws on the findings of four specialist consultant reports commissioned for the project, a review of previous investigations and historical aerial photography and incorporates the outcomes of a community survey administered during the public exhibition that was held in Inverloch and Wonthaggi between March and June 2019.

The key findings of the project are summarised below. *Chapter 8.2 – Recommendations* of the Project Report provides specific suggestions for both short and longer-term actions to assist in maintaining the environmental, cultural heritage, economic and community values of the Inverloch coast.

Inverloch Surf Beach Erosion and Anderson Inlet Accretion

1. The changes that have occurred at Inverloch surf beach since 2013 far exceed previous changes recorded and observed at Inverloch and, at an average rate of coastline recession of six metres per year, represent one of the most rapid changes along a sandy coastline in Victoria in European historical times, and are rated as 'severe' to 'extreme' by global comparison. The shoreline changes are most likely to have been a result of rising sea levels and more frequent and more intense erosion-producing storms.
2. Coincident with the surf beach recession, substantial accretion of sand has occurred in Anderson Inlet, as well as changes to the position of the ebb and flood channels at the entrance to the Inlet. Coastline erosion of the surf beach between Flat Rocks and Point Norman has been a substantial source of sand for what has become the Point Norman-Point Hughes coastal barrier, with eroded sand from the beach being deflected into Anderson Inlet. This contrasts with previous beach erosion events, where eroded sand from the surf beach was deposited offshore, available for later replenishment of the surf beach under favourable metocean conditions.
3. The movement of eroded sand from the beach into Anderson Inlet, which may be long term, has reduced the quantity of sand available for natural beach renourishment/recovery. This reduction in supply, combined with sea level rise and more frequent and intense WSW and SW waves, appears to have changed the Inverloch coastline dynamics. In doing so, the concept of 'cyclical' changes may be redundant, given that the backshore and beach no longer have the time, or sediment supply, to recover after each storm event.

Geomorphological, Ecological, Cultural Heritage and Economic Values under Threat

4. Continued erosion of the vegetated dunes behind Inverloch surf beach is already threatening coastal infrastructure, and geomorphological, ecological, cultural heritage and economic values of the vegetated dunes are being lost, as detailed in 5-17 below. The community survey undertaken for this project revealed that the natural setting provided by the vegetated dunes is rated as extremely important by 81% of respondents, comprising both Inverloch residents and visitors. A further 16% rated the natural setting as important, indicating that further loss of the dunes could have a significant impact on the attractiveness of Inverloch surf beach to both residents and visitors.

Geomorphological Values

5. The Inverloch coast is rated of State Geoscience significance, of great interest for historical and on-going studies of coastal landform evolution. The geomorphology of the backshore sand ridges and dunes between Flat Rocks

and Point Hughes record a history of accretion and recession extending across the late Pleistocene and Holocene, over more than 10,000 years. The rapid changes that have occurred since 2013 are already impacting on the history of accretion and recession that extends across the late Pleistocene and Holocene Periods (over more than 10,000 years), with over 50% of the established vegetated dunes having been removed.

Ecological Values

6. The Inverloch foreshore and Point Smythe dune systems feature a diverse ecology with eight Ecological Vegetation Classes present, including four threatened coastal vegetation communities. 175 native plant species have been recorded within the Inverloch dunes, with ten of these listed as rare or threatened, as well as 220 native fauna species, 53 of which are listed as threatened. The former foredunes of the Inverloch dune system provided important habitat for vulnerable shorebird species, such as the Hooded Plover.
7. The Inverloch foreshore is one of the few east-west Biolinks within Bass Coast Shire, and acts as an important corridor for wildlife movement along the coast, as well as for wildlife movement between the coast and hinterland areas.
8. Almost half of the dune system vegetation has been lost due to coastal recession since 2013, including:
 - Significant depletion of the mature Coast Banksia Woodland community at Flat Rocks
 - Incipient dunes (foredune) no longer exist between Flat Rocks to just west of Point Norman, resulting in complete loss of suitable nesting habitat for vulnerable shorebird species.
9. No further native vegetation should be removed from the Inverloch dune system, including the rear dunes adjacent to Surf Parade.
10. Increasing dune resilience through revegetation with appropriate native species is an essential element of the dune rehabilitation program that has begun with installation of the wet-sand fencing and dune renourishment. Other measures include thatching of steep dune slopes with eroded tea tree branches and debris, effective weed and pest control, enhanced management and education of beach users to avoid dune trampling and rationalising of beach access tracks.

Cultural Heritage Values

11. A search of the Aboriginal Heritage Register revealed the existence of fourteen Aboriginal places (shell middens/artefact scatters) in and adjacent to the study area. Four places are at high to very high risk from destabilisation of the dunes from sea level rise and associated erosion. As the study area has not been thoroughly surveyed, there is a high potential for more as yet unknown Aboriginal places to be at risk. Sites in the coastal reserve represent a diminishing resource, with many other sites adjacent to the study area already destroyed.
12. Consultation undertaken for this project has revealed that both the Bunurong Land Council Aboriginal Corporation and the Gunaikurnai Land and Waters Aboriginal Corporation consider that all the Aboriginal places identified in the study area are of high cultural significance and that urgent measures are required to address the potential impacts to the sites from climate change-related effects.
13. Sites reflect an occupation period from 6,000-7,000 years ago to the recent past, with older sites already submerged as sea levels rose prior to 6,000BP. If remaining coastal sites are lost, the record of past occupation by Aboriginal people will also be lost.

Economic Values

14. The coastline is arguably Australia's most important recreation resource. A broad range of passive and active recreation activities are undertaken by local residents and visitors, and natural, undeveloped settings are a major drawcard. The survey of residents and visitors undertaken for this project revealed that 93% of respondents rated visiting the beach among their favourite three activities in Inverloch.
15. Previous studies have highlighted the social and economic importance of beaches for tourism and recreation, but have also highlighted that recreation and tourism values are related to the condition of the assets. At worst, severe impacts could deter visitors from visiting a particular location.
16. Recreation and tourism impacts are already occurring at Inverloch surf beach, due to a variety of changes, such as very little or no dry sand on the beach at high tide, unstable dunes that pose a risk to beachgoers, and steep access tracks that are difficult to negotiate. A total of 82% of respondents were either significantly (44%) or moderately (38%) affected over the past summer, as indicated by responses to our community survey.
17. A preliminary economic valuation undertaken for this project used previous contingent valuation studies and consumer surplus values to determine that resident and tourism values for Inverloch at risk from further sustained coastline impacts, are in the order of \$3-5 million per annum.

Wet-sand Fencing Trial

18. The installed wet-sand fencing trial is supported, and our community survey revealed that 78% of respondents considered that it was extremely important that short-term action is taken. A further 19% of respondents considered that it was important. It is unfortunate that additional funding was not available to install a minimum length of fencing of at least 100 metres at both sites. A longer length of fencing would have made for a fairer trial as, with the end effect erosion that is occurring at the western extent of each fence, only around 20 metres of dune is being protected currently. Dune renourishment and the proposed revegetation will be severely exposed to storm surges without any increase in the length of the trial fencing.
19. If the trial proves to be successful after 12 months from installation (and with the qualifications noted in (18) above), consideration should be given to extending the length of the wet-sand fencing to protect the vegetated dunes over the full length of the surf beach, between Flat Rocks and Point Norman, in order to protect the geomorphological, ecological, cultural heritage, economic and community values outlined in this report. The cost of installing this length of fencing has been estimated as being less than the annual economic cost that would be incurred on the local economy if the vegetated dunes, as a highly valued feature of Inverloch surf beach, were lost.
20. Consideration needs to be given to the addition of a 45 degree return at the western ends of each section of wet-sand fencing, as well as measures to avoid human disturbance to the revegetating dune.

Scientific Investigations and the Local Coastal Hazard Assessment

21. While, if successful, wet-sand fencing may assist in managing surf beach erosion in the short term, further investigations (including those conducted as part of a Local Coastal Hazard Assessment (LCHA)) are required to identify feasible longer-term strategies to manage likely future surf beach erosion and Inlet accretion events. The LCHA has been 'on the agenda' for many years (most recently, it was a commitment made in the Gippsland Regional Coastal Plan 2015-2020) and with the rate of erosion that is currently being experienced in Inverloch,

it is crucial that investigations commence as soon as possible, otherwise the environmental, social and economic values identified in this report will have been lost before any longer-term measures have been identified.

22. A key element of the LCHA will be to analyse the complex relationships between offshore coastal processes, Anderson Inlet and Point Smythe, including:
- Sources and dynamics of sand for the entire coastal area
 - Analysis of tidal dynamics to determine sand pathways on ebb and flood tides.

The LCHA also needs to analyse the implications of predicted global warming effects on the Bass Coast, including further sea level rise and the likelihood of increased frequency and intensity of future storm surge events.

23. Scientific studies are also required to analyse the factors that have contributed to the coastline changes that have occurred since 2013, including:
- Further analysis of factors that have contributed to beach shoreline changes since 2013, such as rising sea levels, increases in the frequency and intensity of erosion-inducing storms, changes in the direction of approach of high energy waves and reduction in sediment supply
 - Analysis of reasons for the movement of sand from the surf beach into Anderson Inlet, and further estimation of the volumes of sand involved in the beach recession and inlet accretion since 2012
 - Investigation of the likely future configuration of Anderson Inlet, including assessment of whether the Point Norman-Point Hughes coastal barrier will remain within Anderson Inlet.

Ideally, these studies would be undertaken as part of the proposed LCHA. However, if there are further delays to funding of the LCHA, it will be important that funding is arranged through DELWP and BCSC to enable these investigations to proceed at the earliest opportunity.

24. In addition to the scientific investigations identified in (23), other relatively low-cost actions to enhance understanding of coastline changes include shoreline monitoring by drone and laser level, analysis and monitoring of metocean conditions, analysis of tidal dynamics of Anderson Inlet, investigation of sources and dynamics of sand for the Inverloch coast and a suite of on-ground measures to build resilience into the dune system, as detailed in (10).

South Gippsland Conservation Society urges the Victorian Government and its Agencies, including Bass Coast Shire Council, to consider the content, findings and recommendations of this Project Report and its supporting specialist consultant reports in future planning for the Inverloch coast, including the proposed Bass Coast Local Coastal Hazard Assessment. In particular, the apparent change in Inverloch coastline dynamics since 2013, and the geomorphological, ecological, Aboriginal cultural heritage, economic and community values of the Inverloch dune system, need to be examined carefully in any future assessment of risk associated with coastal recession at Inverloch.

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1. *Coastal Geomorphology and Geomorphological Values*, Neville Rosengren with contributions by Tony Miner, June 2019
2. *Ecological Values of the Inverloch and Point Smythe Dune System*, Alison Oates, June 2019
3. *Aboriginal Cultural Heritage Values, Current Status and Potential Threats*, Joanne Freslov, 2019
4. *Preliminary Economic Assessment*, David Cotterill, July 2019

1.0 INTRODUCTION

South Gippsland Conservation Society (SGCS) initiated the Inverloch Coastal Resilience Project in late 2018 in response to the sustained coastal erosion that has occurred at Inverloch surf beach since 2013. Inverloch is situated on the Bass Coast, between Western Port Bay and Corner Inlet, approximately 140 kilometres south east of Melbourne. Its coastline is located within Venus Bay, between the headlands of Cape Paterson and Cape Liptrap. *Figure 1 - Study Area* captures the project study area, featuring Inverloch surf beach, Point Norman, Anderson Inlet, Point Hughes and Point Smythe.



Figure 1 Study Area

Figure 2 - Project Method shows the various elements of the project. As indicated, the principal aims of the project are:

- To increase the resilience of the Inverloch coastal dune system and its communities to the threat of further beach erosion by raising understanding of the changes that are taking place and investigating possible causes
- To identify environmental and community values that are at risk from further beach erosion and that should be considered in the development of a coastal adaptation strategy for the Inverloch coastline.

This Project Report covers:

- Inverloch' s changing coastline (Chapter 2) and the extent of recent beach erosion (Chapter 3)
- Factors that may have contributed to the beach erosion (Chapter 3.2)
- Environmental and community values that are under threat (Chapter 4)
- Results of the survey administered during our public exhibition (Chapter 5)
- The wet-sand fence trial (Chapter 6)
- Shoreline monitoring (Chapter 7.1)
- The Sustainably-seeking Inverloch initiative (Chapter 7.2)
- Community and Stakeholder Consultation (Chapter 7.3)
- Key findings, study recommendations and next steps (Chapter 8).

SGCS acknowledges the support provided by the Lord Mayor's Charitable Foundation in funding the project, as well as the following consultants who have generously provided their time and expertise:

- Neville Rosengren and Tony Miner – *Coastal Geomorphology and Geomorphological Values*, June 2019
- Alison Oates – *Ecological Values of the Inverloch and Point Smythe Coastal Dune System*, June 2019
- Joanna Freslov – *Aboriginal Cultural Heritage Values: Current Status and Potential Threats*, June 2019
- David Cotterill – *Preliminary Economic Assessment*, July 2019.

This Project Report draws from the findings of these studies, as well as previous investigations and the outcomes of consultations undertaken during the course of the project.

The assistance provided by the Victorian Government and its authorities, including the Department of Environment Land Water and Planning (DELWP), Bass Coast Shire Council (BCSC), Parks Victoria (PV) and West Gippsland Catchment Management Authority (WGCMA) is acknowledged. The support provided by SGCS volunteers at the exhibition was greatly appreciated, as has inputs from various community organisations such as the Inverloch Surf Life Saving Club, the Inverloch Historical Society and the Port Fairy Coastal Group. The project team (Philip Heath, Dave Sutton and Alison Oates) also wishes to thank Bryony Cosgrove, Colin Suggett, Aileen Vening, Kate Lance, David Bills-Thompson, Bronwyn Teasdale, Karen Jolly and Dr David Smith for their important contributions.

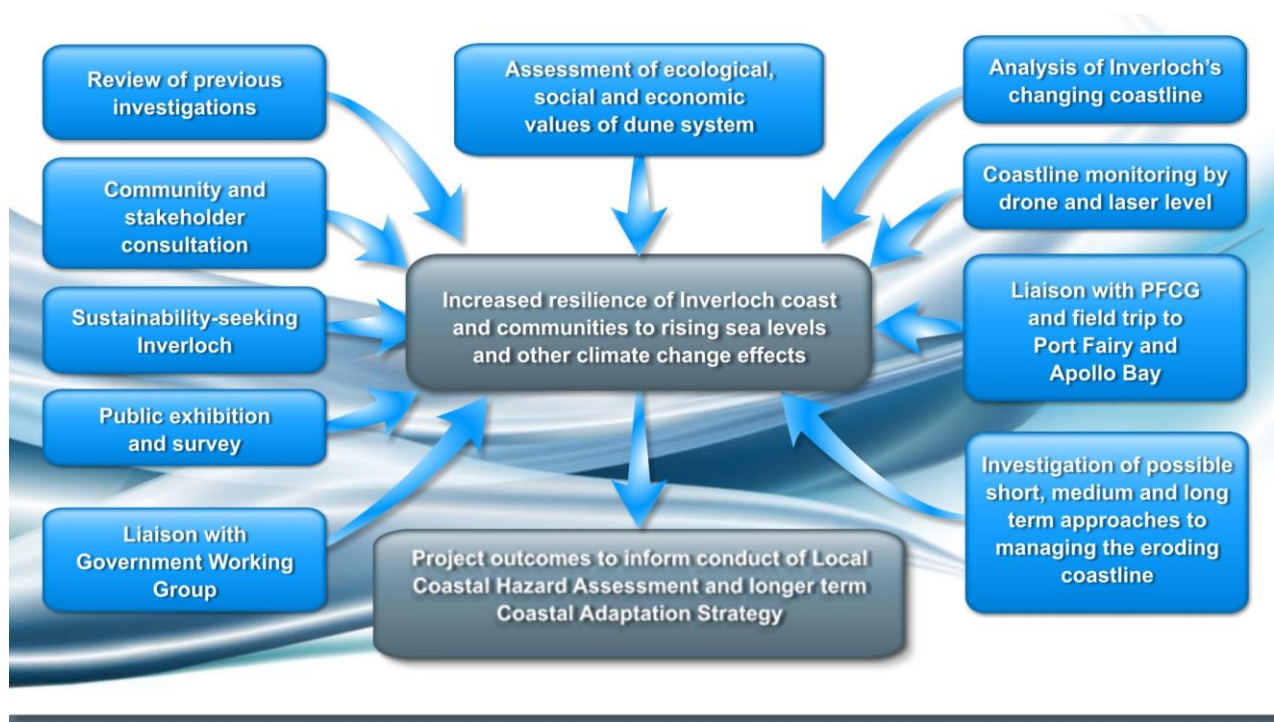


Figure 2 Project Method

2.0 OUR CHANGING COASTLINE

The Inverloch coast is a dynamic system featuring complex relationships between Inverloch surf beach and its backshore dunes, the Point Norman rock platform/sand spit, Anderson Inlet, the geomorphology of which features strong ebb and flood tide currents in a network of shifting channels, and the Point Smythe coastal barrier composed of multiple curving ridges.

The project has carried out a thorough analysis of historical aerial photography and previous studies, the detail of which is provided in the *Coastal Geomorphology and Geomorphological Values Report* (Attachment 1).

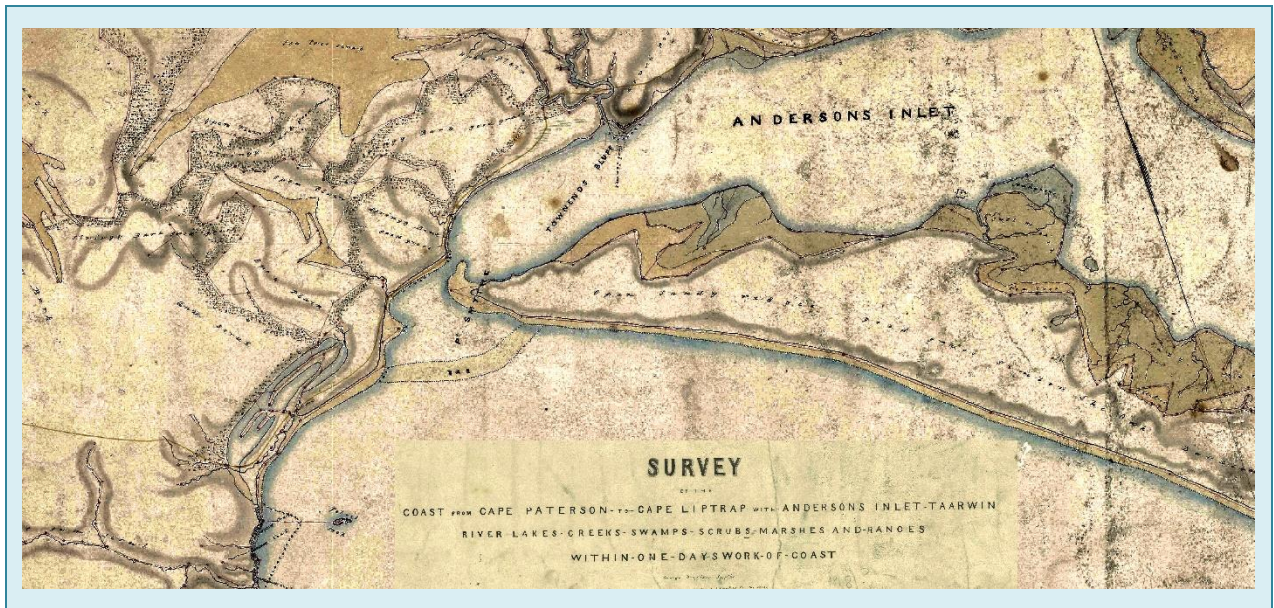


Figure 3 George Smythe Map

Figure 3 - George Smythe Map shows the earliest known mapping of the coast by George Smythe in 1848-49. A striking feature is the extension of Point Smythe to just offshore from Point Hughes, with a very narrow entrance to Anderson Inlet. The map also highlights the shore platforms at both Flat Rocks and Point Norman.



Figure 4 1950 Aerial Photograph

Figure 4 - 1950 Aerial Photograph is the earliest available aerial photograph of the Inverloch foreshore. It shows a much-reduced extent of Point Smythe (compared with the George Smythe map), but with an extensive mass of sand adjacent to it, as well as the main channel into Anderson Inlet located close to Point Norman, and a wide, sandy surf beach.

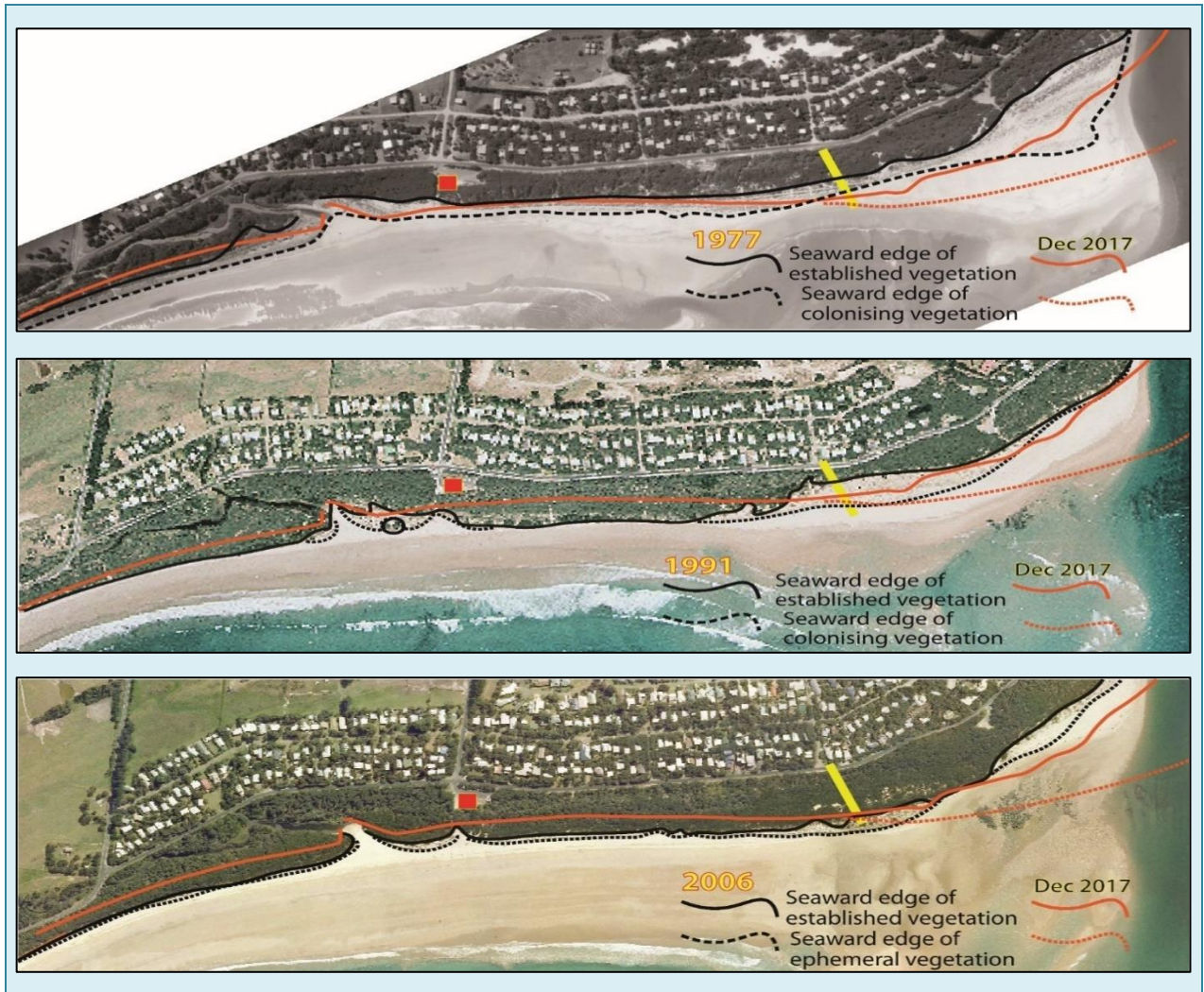


Figure 5 Historical aerial photography 1977, 1991 and 2006, with 2017

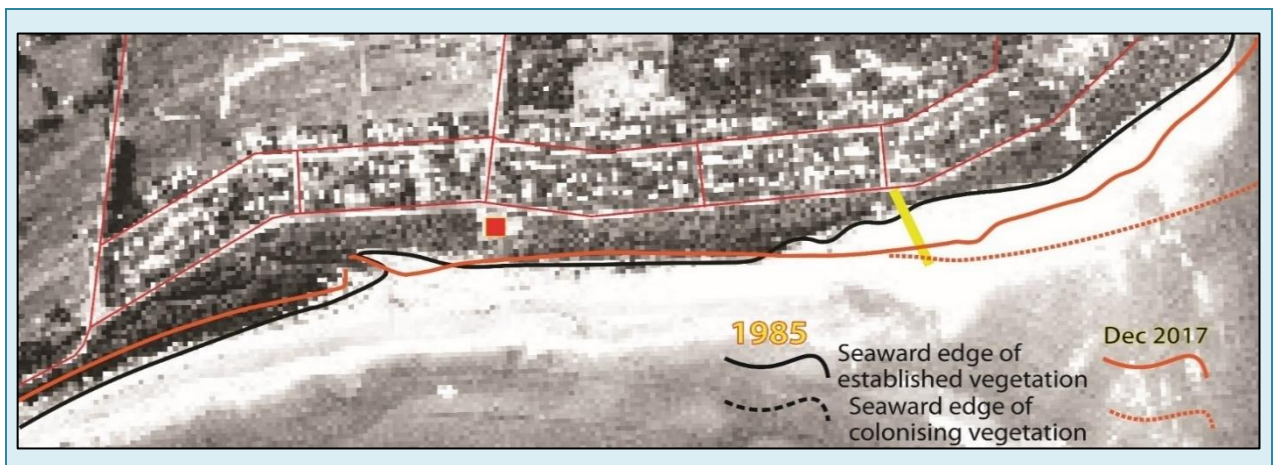


Figure 6 Ozone Street Track Erosion

Figure 5 - Historical aerial photography 1977, 1991 and 2006, with 2017 shows variations in the width of the vegetated dunes, but a consistent configuration of Inverloch surf beach and Anderson Inlet entrance comprising:

- Established dune vegetation behind the main surf beach- wider in 2006
- Wide sandy spit at Point Norman – particularly pronounced in 2006
- Anderson Inlet main channel located close to the coastline at Point Norman.

The photographs highlight the loss of vegetation between 2006 and 2017, which became more pronounced during 2018 and 2019.

Figure 6 - Ozone Street Track Erosion illustrates a notable erosion event that occurred over a 400 metre section of coast between the Surf Club and Point Norman, adjacent to the Ozone Street access track, where coastline recession of between 50 and 80 metres occurred between February 1977 and September 1985. It is noteworthy that this coastline recession was not accompanied by substantial sand deposition in Anderson Inlet, in marked contrast with the accretion that has occurred in the Inlet since the current erosion sequence commenced in 2013. Also, accretion that occurred adjacent to the Ozone Street track between 1985 and 2006 returned the coastline to its earlier position. This may indicate that the eroded sand had been deposited offshore from the surf beach and was therefore available to replenish the surf beach under favourable metocean conditions.

3.0 CURRENT EROSION SEQUENCE

3.1 Extent of Changes

Figure 7 - Comparison of 2006 and 2018 aerial photographs illustrates the coastline recession that has occurred along the entire length of the surf beach, between Flat Rocks and Point Norman, and the significant change in configuration that has occurred in Anderson Inlet since 2013. The surf beach has been transformed from a wide, gently-sloping, sandy beach, with a 100 metre-wide zone of established vegetated foredunes and a grassy incipient foredune, to a significantly-lowered beach with a much narrower established dune zone, and with no incipient foredune.

Eroded sand from the surf beach has been deflected into Anderson Inlet as spits, forming a now continuous barrier between Point Norman and Point Hughes, enclosing a lagoon where the main channel had been. The movement of sand into the Inlet may be a function (or a cause of) the main channel having moved east, allowing south-west waves breaking in shallow water at the Inlet entrance to carry sand into the Inlet. Meanders of the tidal channels within the Inlet may also be a contributing factor.

The comparison highlights how the rock platform west of Point Hughes is now completely covered with sand, and also the erosion that has occurred on the Inlet shore of Point Smythe.

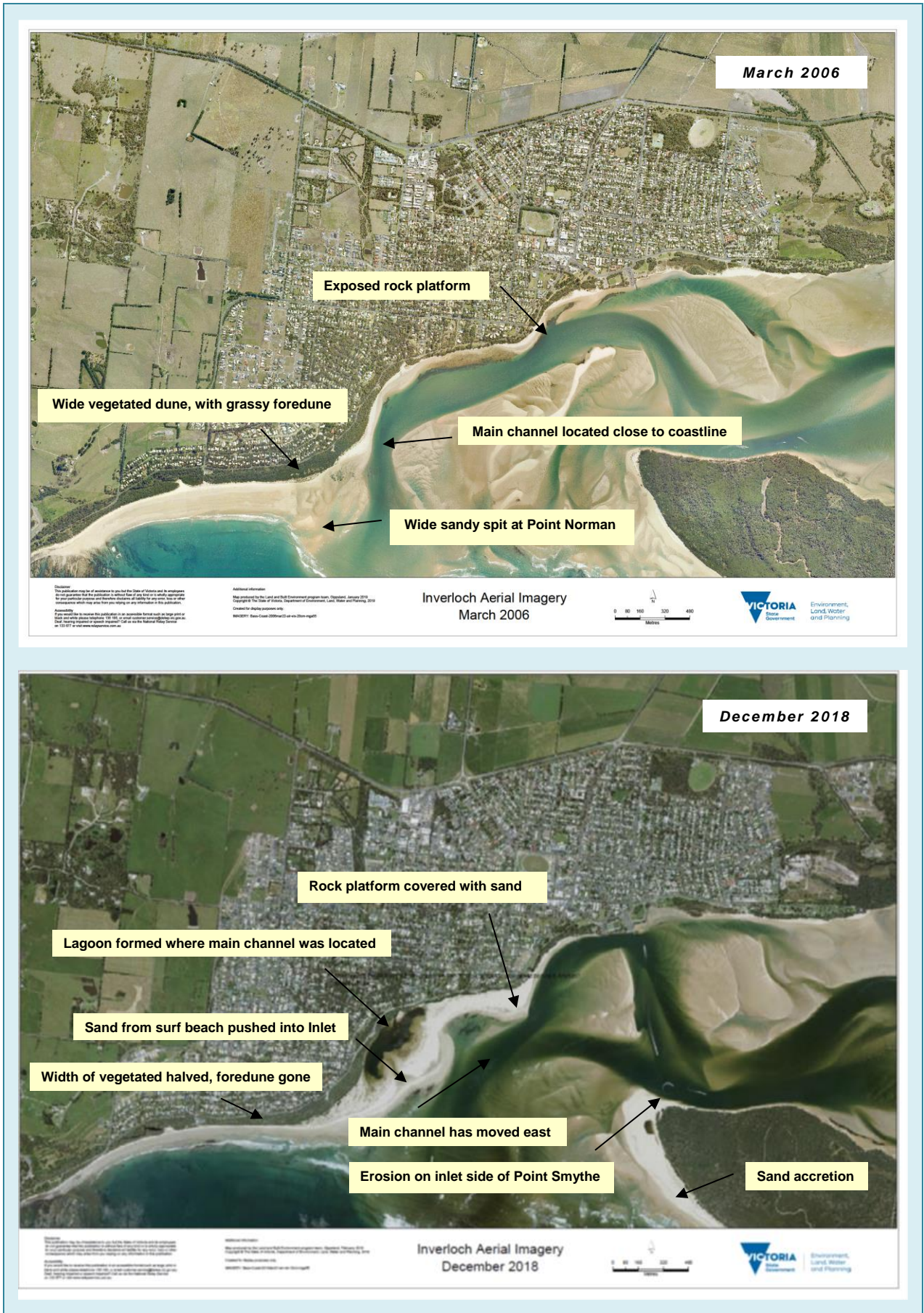


Figure 7 Comparison of 2006 and 2018 aerial photographs

Figures 8 - 11 provide a pictorial chronology of the changes that have taken place at Inverloch Surf Beach between 2003 and 2019. In summary, since 2013, Inverloch surf beach between Flat Rocks and Point Norman has lost more than 40 metres of the width of its vegetated dunes, with an average rate of six metres per year, over a two kilometre length of the beach. The current shoreline position between Flat Rocks and west of Wreck Creek, and between the Surf Club to west of Ozone Street, is at the most landward location recorded. Over the same period, the beach has lowered by more than 1.5 metres, with low tides occurring much closer to the shore than previously (based on observations).



Figure 8 Surf Beach Changes: 2003 - 2013



Figure 9 Surf Beach Erosion 2014 - 2018

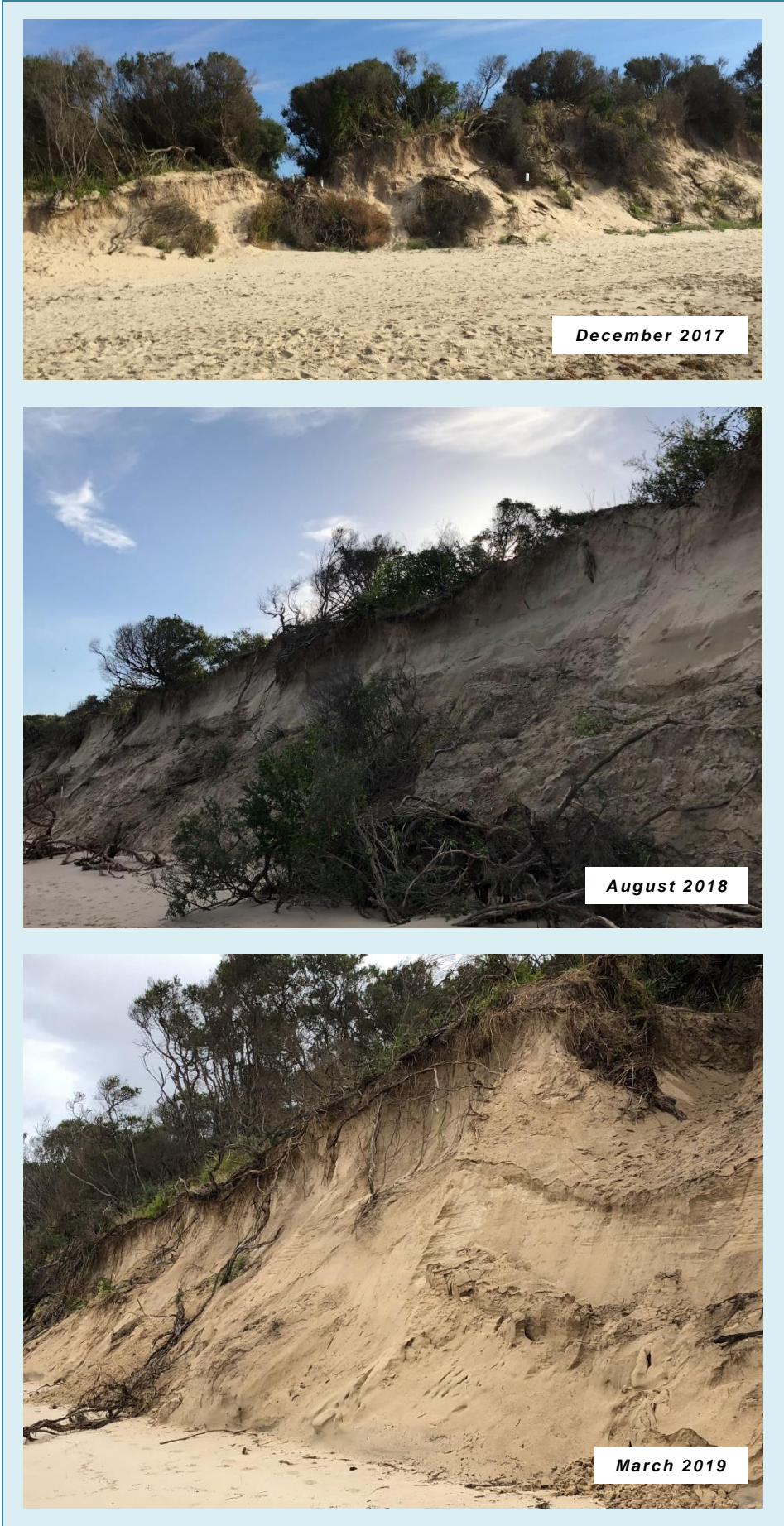


Figure 10 Surf Beach Erosion 2017 - 2019



Figure 11 Surf Beach: Storm Events 2019

Beach erosion is not only threatening Inverloch Surf Life Saving Clubhouse and Cape Paterson Road, but also the environmental, community and economic values of the dunes, as detailed in Chapter 4.

A preliminary analysis undertaken by the Coastal Geomorphology Assessment has indicated that the estimated loss of sand from dune recession and beach lowering is in the order of 360,000 cubic metres. Coincident with this recession, the adjacent coastline between Point Norman and Point Hughes has undergone substantial accretion – possibly around 1,400,000 cubic metres. Coastline recession of the surf beach between Flat Rocks and Point Norman has been a substantial source of sand for the Point Norman-Point Hughes coastal barrier, with other sources likely to be from stores inside Anderson Inlet and offshore sources.

The combined recession and accretion events represent the most rapid change along a sandy coastline in Victoria in European historical times. Further, the recession rates over the past seven years at Inverloch are at the high end of the scale by global comparison and are classed as ‘severe’ to ‘extreme’.

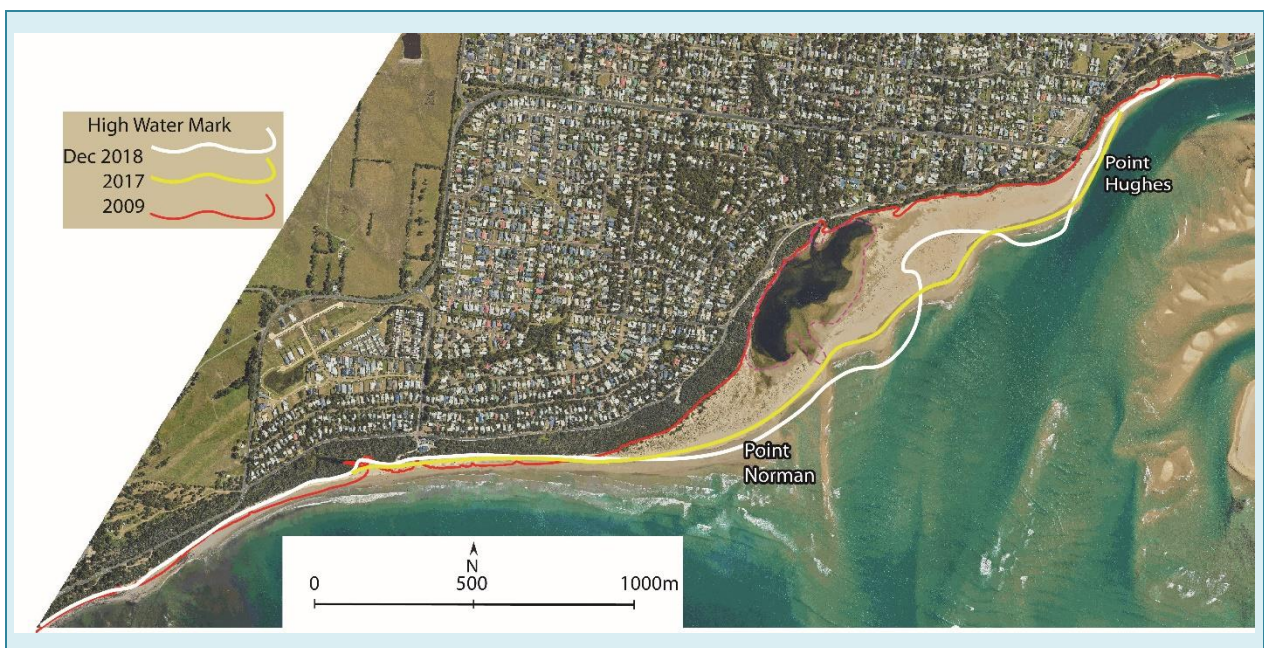


Figure 12 2009/2017/2018 Comparison

Figure 12 - 2009/2017/2018 Comparison shows significant change in coastline between Pt Norman and Pt Hughes between 2009 (red), and 2017 (yellow) and 2018 (white).

Figure 13 - Anderson Inlet changes 2015-2017 shows the continuous coastal barrier has formed between Point Norman and Point Hughes, with a now-enclosed lagoon behind the barrier. The barrier appears to be progressively extending east into Anderson Inlet. The photographs also show how the former exposed rock platform west of Point Hughes has been completely covered by sand between 2015 and 2017.

Figure 14 - Ayr Creek Lagoon and Coastal Barrier highlights the colonisation of newly-deposited incipient foredune sand on what was the former main channel. Analysis undertaken for this project indicates that this sand can only be removed by a westward (shoreward) migration of the ebb-tide channel eroding the accumulated barrier.



Figure 13 Anderson Inlet changes 2015-2017



Figure 14 Ayr Creek Lagoon and Coastal Barrier

3.2 Factors contributing to Shoreline Changes

Investigations undertaken for this study have indicated that the factors most likely to have contributed to these shoreline changes include:

- Rising sea levels resulting in stronger wave and swash action at high tides, eroding the backshore dunes and accompanied by lowering of the beach profile. This effect will continue to increase with further sea level rise (SLR):
 - Since 1901, there has been a global SLR of 0.19m
 - Projected SLR from present is between 0.07- 0.19m by 2030
 - By 2090, further SLR increase could range between 0.27 – 2.7m.
- Increases in the frequency and intensity of erosion-inducing storms that lead to increasing wind speed and wave heights, particularly for extreme events:
 - Young and Ribald (2011) and Young et al. (2019) have demonstrated a global trend of increasing values of wind speed and wave height, with the rate of increase being greater for extreme events
 - More frequent, longer and more intense storm sequences are predicted for the Southern Ocean
 - WSW and SW waves (the major wave windows for Inverloch) already break obliquely to shore, generating long-shore drift to the east – more frequent and intense WSW to SW waves may exacerbate the eastward drift
 - As a consequence, the backshore and beach does not have time to recover between each storm event. As an illustration, there have been four storm surge events at Inverloch between March and end of May 2019 that featured 5.5m WSW swells and gale-force WSW winds, combined with high tides, each resulting in further dune erosion.
- Reduction in sediment supply:
 - Previously (e.g. 1979 Ozone Street track erosion event), sand eroded from the surf beach was deposited offshore and when conditions were favourable, this sand was available to replenish the beach. With the current erosion sequence, eroded sand from the surf beach has been deflected into Anderson Inlet, where it is currently trapped. If the sand doesn't become available to replenish the surf beach, the beach dune system will be susceptible to further losses from future storm surge events, as is currently happening.

These factors may have combined to render the concept of 'cyclical' changes (where periods of erosion lasting several years corresponding to periods of extreme storminess, are followed by periods of 'recovery' during more settled years) redundant at Inverloch. The current situation far exceeds previous changes recorded and observed at Inverloch and there has been no indication of any recovery, with the rate of coastline recession accelerating during 2018/2019. Chronic or on-going lowering of the beach profile and backshore recession indicates a substantial change in beach and nearshore sediment dynamics, which appears to be the case at Inverloch.

Detailed coastal studies are urgently required to analyse these possible causes in more detail and to identify appropriate medium and long-term measures to better manage possible future occurrences of the mass movement of eroded beach sand into Anderson Inlet.

Figure 15 - W and SW Wave Windows highlights how major wave windows for Inverloch are from the west and south west. W and SW waves are refracted around Cape Paterson headland, breaking obliquely to shore, creating sand drift to the east.

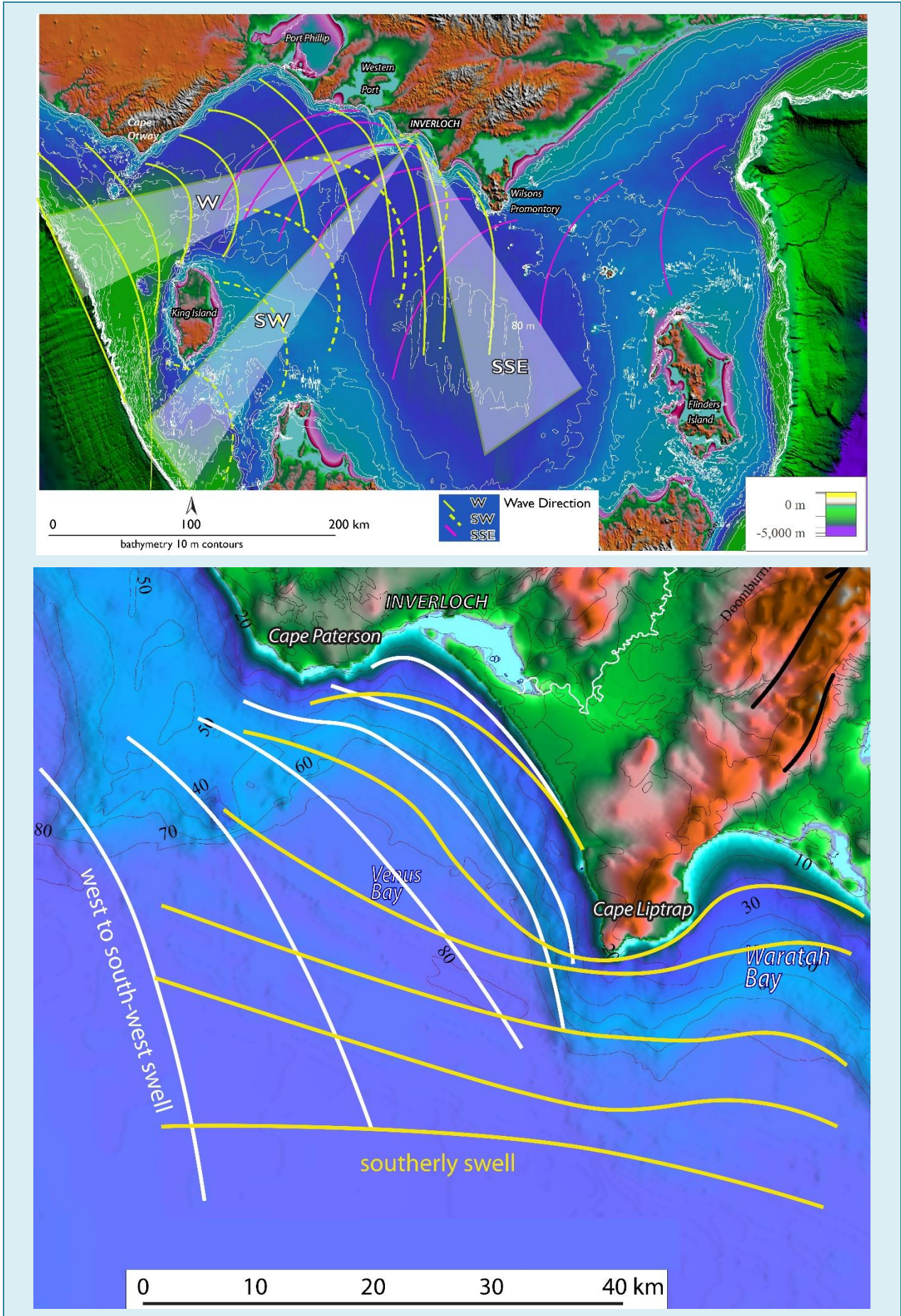


Figure 15 W and SW Wave Windows

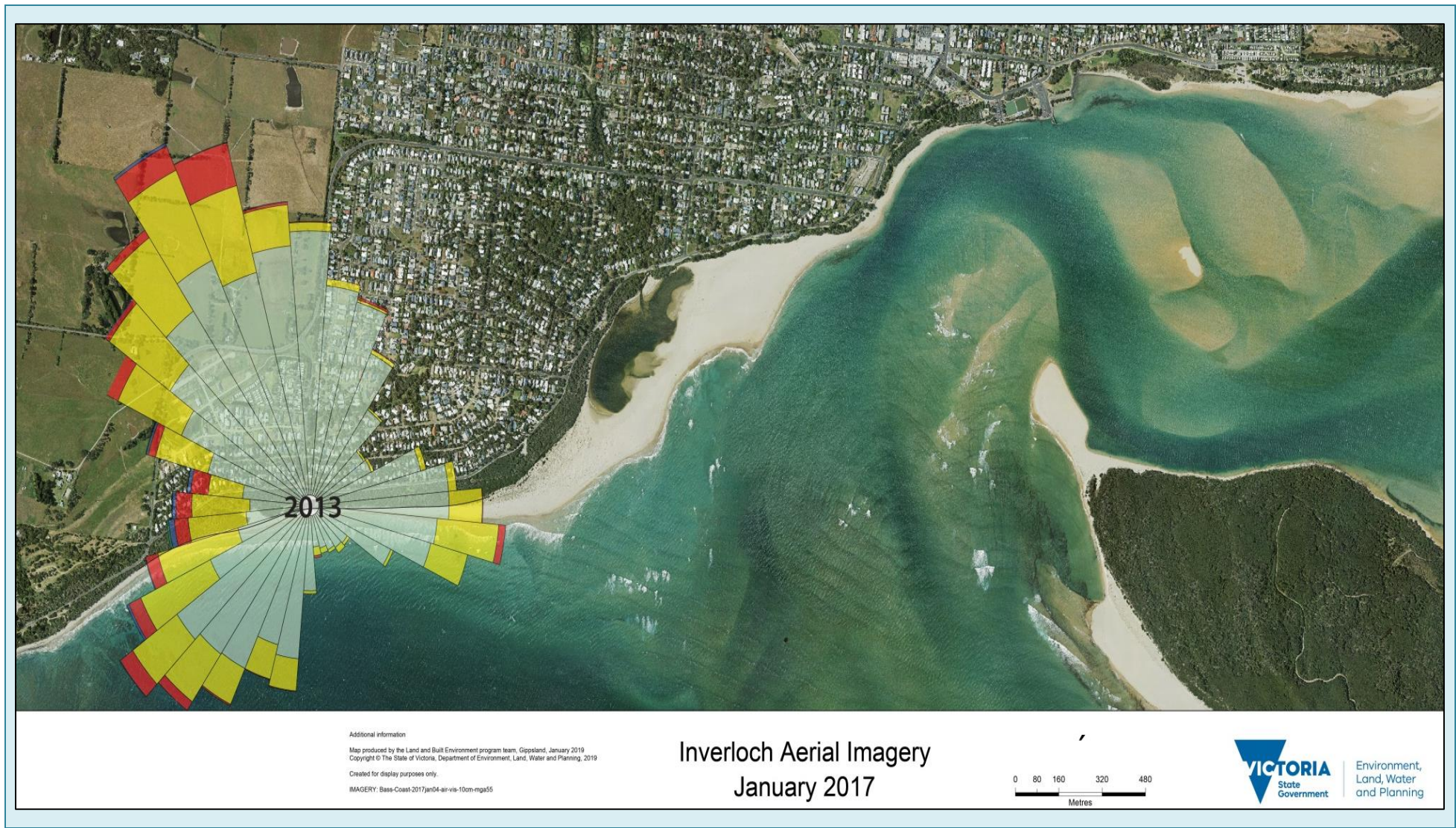


Figure 16 Annual wind rose overlay

Figure 16 - Annual wind rose overlay shows how the most frequent N and WNW winds are offshore. WSW to SW winds are strong and relatively frequent, which further assist the wave break to be oblique to the coast. These winds are stronger and more frequent than waves influenced by easterly winds.

4.0 COASTAL VALUES UNDER THREAT

Bass Coast is renowned for its natural, undeveloped coastline. Inverloch's surf beach is highly valued by residents and visitors and is a major attraction for swimmers, surfers, nippers, kite surfers, fishermen and beach walkers. The beach features an extensive, vegetated dune system, stretching from Flat Rocks to Point Smythe and Venus Bay, with a range of geomorphological, ecological, cultural heritage and economic values, as detailed below.

4.1 Geomorphological Values

The *Coastal Geomorphology and Geomorphological Values Assessment* (Attachment 1) found that the Inverloch coast, between Flat Rocks and Pt Smythe, is rated of State Geoscience Significance, of scientific interest for historical and on-going studies of coastal landform evolution, based on the following attributes:

- Transition from active coastal cliffs and platforms to a stranded marine cliff now a coastal bluff
- Preserved backshore sand ridges between the bluff and the youngest Holocene dunes and fringing shore platforms
- Exchange of sediment between adjacent shore sectors both inside and outside Andersons Inlet
- Substantial changes occurring in the position of ebb and flood channels across the entrance to Andersons Inlet
- Processes of shoreline change and the rate and mechanism of foredune initiation and subsequent development
- The relationship of different vegetation species and associations in determining the morphology of coastal dunes.



Figure 17 Coastal Bluff and Dune Ridges

Figure 17 - Coastal Bluff and Dune Ridges highlights the former sea cliffs, now an abandoned coastal bluff, and the Holocene dune ridges and swales. The geomorphology of the backshore sand ridges and dunes between Flat Rocks and Pt Hughes records a history of accretion and recession extending across the late Pleistocene and Holocene, over more than 10,000 years.

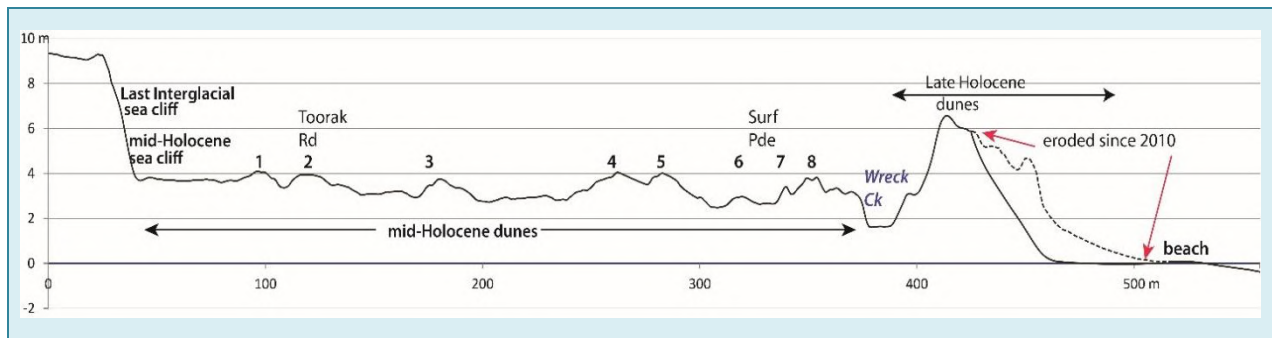


Figure 18 Dune Ridges Cross-section

The ocean coast is backed by a continuous zone of late Holocene to modern established vegetated foredunes, formed by wind action over the last 3,000-4,000 years, once the previously higher sea levels (about one metre higher than present) fell and stabilized. As indicated in *Figure 18 - Dune Ridges Cross-section*, almost 50% of the volume of these dunes have been removed since 2013 as a result of shoreline recession:

- Prior to 2010, the sector between the Surf Club and west of Ozone Street had three parallel vegetated established foredune ridges with the highest reaching 12m
- Since 2013, the two seaward ridges have been eroded leaving a high scarp on the remaining dune east of the surf club building.

4.2 Ecological Values

The *Ecological Assessment of the Inverloch and Point Smythe dune systems* (Attachment 2) revealed the following ecological values that are under threat with the current coastline recession:

- Eight Ecological Vegetation Communities (EVCs), representing all main coastal dune vegetation communities, are present within the dune systems. Of these, DELWP has classified two as 'vulnerable' and two as 'depleted', at the Bioregional Conservation Status level.
- The dunes contain a diverse range of plant species (175 native plant species), including ten vascular plant taxa that are listed by DELWP as being rare or threatened in Victoria.
- 220 native fauna species have been recorded over the Inverloch dunes, with a total of 47 bird species, four mammal species and two reptile species listed as threatened under either the relevant Victorian or Commonwealth Government Acts over the study area.
- The Inverloch foreshore is one of the few east-west Biolinks within Bass Coast Shire, and is recognised in BCSC's Biodiversity Biolinks Plan. It acts as an important corridor for wildlife movement along the coast, as well as wildlife movement between the coast and hinterland areas.
- The former foredunes of the Inverloch dune system provided important habitat for vulnerable shorebird species, such as the Hooded Plover, until their recent removal.

Almost half of the dune system vegetation has been lost due to coastal recession since 2013, including:

- Significant depletion of the mature Coast Banksia Woodland community at Flat Rocks
- Incipient dunes (foredune) no longer exist between Flat Rocks to just west of Point Norman, resulting in complete loss of suitable nesting habitat for vulnerable shorebird species.



Figure 19 Dune Ecology

Given the fragility of the dune system and the dynamic processes occurring at the Inverloch surf beach, it is vital that no further vegetation be removed from the Inverloch foreshore. This applies not only to the remaining ocean-side dunes but also the rear dunes adjacent to Surf Parade and the Cape Paterson Road.

Increasing dune resilience through revegetation with appropriate native species is an essential element of the proposed dune rehabilitation program, to be undertaken following dune protection works (by wet-sand fencing) and reinstatement of the foredune (by dune renourishment). Revegetation will assist in stabilising the dune system and enhancing flora and fauna habitat. Other measures include thatching of steep dune slopes with eroded tea tree branches and debris, weed and pest control, enhanced management and education of beach users to avoid dune trampling and rationalising of beach access tracks.

As shown in *Figure 19 - Dune Ecology*, the newly-formed dune system at Point Hughes is mainly being colonized by Marram Grass and Sea Wheat-grass which form steep-sided dunes that are unsuitable for beach-nesting shorebirds.

4.3 Cultural Heritage Values

The *Aboriginal Cultural Heritage study* (Attachment 3) assessed the likely impacts of coastal erosion on Aboriginal places in the study area.

The Registered Aboriginal Parties (RAPs) and Traditional Owners (TOs) are:

- Inverloch and Anderson Inlet north coast – Bunurong Land Council Aboriginal Corporation (BLCAC) (RAP)
- Anderson Inlet and Venus Bay coasts – BLCAC and Gunaikurnai Land and Waters Aboriginal Corporation (GLaWAC) (TOs).

At European settlement, the region was occupied by people of the Bunwurrung and Gunaikurnai language groups:

- Bunwurrung people moved between the coast and the inland with the seasons, with campsites next to potable freshwater. They hunted large mammals (including possums and kangaroos) and caught large quantities of eel, including at Screw Creek, and shellfish
- Gunaikurnai people occupied Tarwin River area and exploited wetlands, lakes and river mouths for fish, birds, swan eggs and eels.

A search of the Aboriginal Heritage Register (AHR) revealed 14 Aboriginal places (shell middens/artefact scatters) in and adjacent to study area, comprising five in the study area and nine just outside the study area. Four sites in and adjacent to the study area are at high to very high risk, due to a combination of nearby urban development, proximity to tracks and rising sea levels. Three sites are located between Point Norman and Point Hughes, and the fourth at Point Smythe.

Sites in the coastal reserve represent a diminishing resource, as many other sites adjacent to the study area have already been destroyed. The sites reflect an occupation period from 6,000-7,000 years ago to the recent past, with older sites have already been submerged as sea levels rose prior to 6,000BP. If the remaining sites are lost, the record of this particular facet of Aboriginal history will also be lost.

Due to the very limited previous surveys of the study area, a site predictive model was developed and the likely location of further sites mapped using a set of criteria, such as proximity to rock platforms, proximity to beaches and proximity to fresh water. Coastal areas with the highest potential for more sites, and at most risk, are Flat Rocks to Groke Street, Veronica Street to the Bowling Club and the Angling Club to Screw Creek.

Consultation undertaken with BLCAC and GLaWAC for this project revealed that both groups consider that all the Aboriginal places identified in the study area are of high cultural significance and that urgent measures are required to address the potential impacts to the sites from climate change-related effects. Both groups consider that insufficient investigation has been carried out to date and that there is likely to be more as yet unknown Aboriginal sites in the study area. Further investigation is required to establish a better understanding of the Inverloch coast.

4.4 Economic Values

The *Preliminary Economic Assessment* (Attachment 4) undertook a preliminary evaluation of the value that the dune system provides to both residents and visitors.

The Importance of Coastlines

The coastline is arguably Australia's most important recreation resource:

- A broad range of passive and active recreation activities are undertaken by local residents and visitors
- It is a motivator of long-term migration into a region
- Natural, undeveloped settings are a major drawcard for tourists.

In recent years, there has been an increased recognition of the importance of dunes.

Previous studies have highlighted the social and economic importance of beaches for tourism and recreation, but also that recreation and tourism values are related to the condition of these assets:

- Victorian Coastal Council (VCC) surveys highlight the value that beachgoers assign to natural, unspoilt environment, free of debris
- At worst, severe impacts could deter visitors from visiting a particular location.

Commercial activities that service tourist needs are a primary source of regional income and jobs that are potentially threatened by a change in the quality of beach systems.



Figure 20 Inverloch Recreation: Historical



Figure 21 Surf Beach Recreation: Summer 2018/2019

Recreation and Tourism Threats

Recreation and tourism impacts are already occurring at Inverloch surf beach:

- There is very little or no dry sand at high tide
- Unstable dunes pose a risk to beachgoers
- Inverloch SLSC lookout tower had to be moved to a relatively remote location last summer, and has now been dismantled
- The former main beach access track has had to be closed and a new, indirect path cut through dune vegetation
- Other access tracks are steep and difficult to negotiate.

Also, Cape Paterson Road is threatened by coastal erosion, including access to RACV Inverloch, Cape Paterson and scenic destinations along the Bunurong Coastal Drive.

Economic Values at Risk: Inverloch Residents

The Inverloch/Pound Creek population was 5,525 in 2016, and is projected to increase to 7,413 by 2036, based on a 1.5% per annum increase. Based on previous contingent valuation studies, the potential value of the Inverloch coastline and the activities it provides to current and projected future Inverloch residents is estimated as:

- \$171,924 in 2016
- \$230,699 in 2036.

Economic Values at Risk: Bass Coast Mainland

The population of residents of the wider area of Bass Coast Mainland (defined as the areas not on, or directly associated, with Phillip Island, including Wonthaggi, San Remo, Waterline and the rural balance) was 22,646 in 2016, and is projected to increase to 32,660 by 2036, based on a 1.8% per annum increase.

Based on previous contingent valuation studies, the potential value of the Inverloch coastline and the activities it provides to current and projected future Bass Coast Mainland residents is estimated as:

- \$532,837 in 2016
- \$785,687 in 2036.

Economic Values at Risk: Inverloch Tourists

Inverloch offers a range of holiday accommodation and shopping/dining experiences. Inverloch beach is used by a range of commercial and community organisations and individuals:

- Active: walking, swimming, surf life-saving, surfing, stand-up paddling, wind surfing
- Passive: yoga, fishing, nature appreciation, sunset viewing.

Analysis of Bass Coast Visitor Information Centres (VICs) suggests that there are between 40,000-60,000 visitors to Inverloch per annum (conservative). This level of tourism equates to a 2016 tourism benefit of between \$2.74M and \$4.11M per annum, based on consumer surplus values.

Economic Values at Risk: Preliminary Valuation

Combining these assessments (and noting that the resident and tourist values have been calculated using different methods) for this preliminary valuation, the resident and tourism values for Inverloch at risk from further sustained coastline impacts, are in the order of \$3M to \$5M per annum. These results are indicative only, based on conservative visitor estimates, and review by, and further collaboration with, BCSC is sought.

5.0 PUBLIC EXHIBITION AND ANALYSIS OF SURVEY RESPONSES

5.1 Introduction

A public exhibition was mounted at:

- Inverloch Community Centre – 22 March to 18 April 2019
- Inverloch SLSC – 19-21 April 2019
- Wonthaggi Library – 11-28 June 2019.

The exhibition presented information about Inverloch's changing coastline, the environmental and community values that are at risk from further erosion of the surf beach, as well as information about coastline monitoring that is underway and the wet-sand fence trial. The exhibition also highlighted the further investigations required to identify medium and longer-term strategies to manage the effects of rising sea levels and the more frequent and intense storms predicted to occur with climate change. An on-line version of the exhibition is available at www.sgcs.org.au.



Figure 22 Public Exhibition

SGCS volunteers staffed the exhibition at peak times and administered a community survey. The survey sought to gain feedback from the Inverloch residents and visitors on the erosion threat and the values that they ascribe to the vegetated dunes. To the end of June 2019, there have been 354 responses, with the principal place of residence evenly distributed between Inverloch and Melbourne:

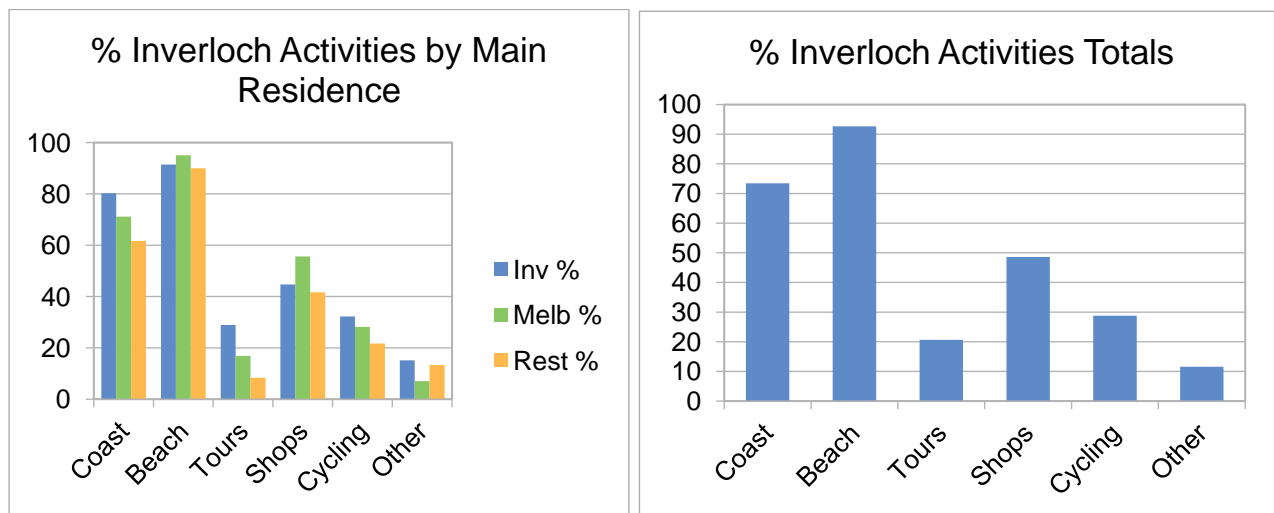
- Inverloch- 152 responses
- Melbourne – 142 responses
- Other (mainly elsewhere in South Gippsland) – 60 responses.

The graphs in the report below record responses from Inverloch, Melbourne and other areas, as well as the combined responses. As can be seen, the responses to each question followed a similar pattern for each of the places of residence.

5.2 Survey Responses

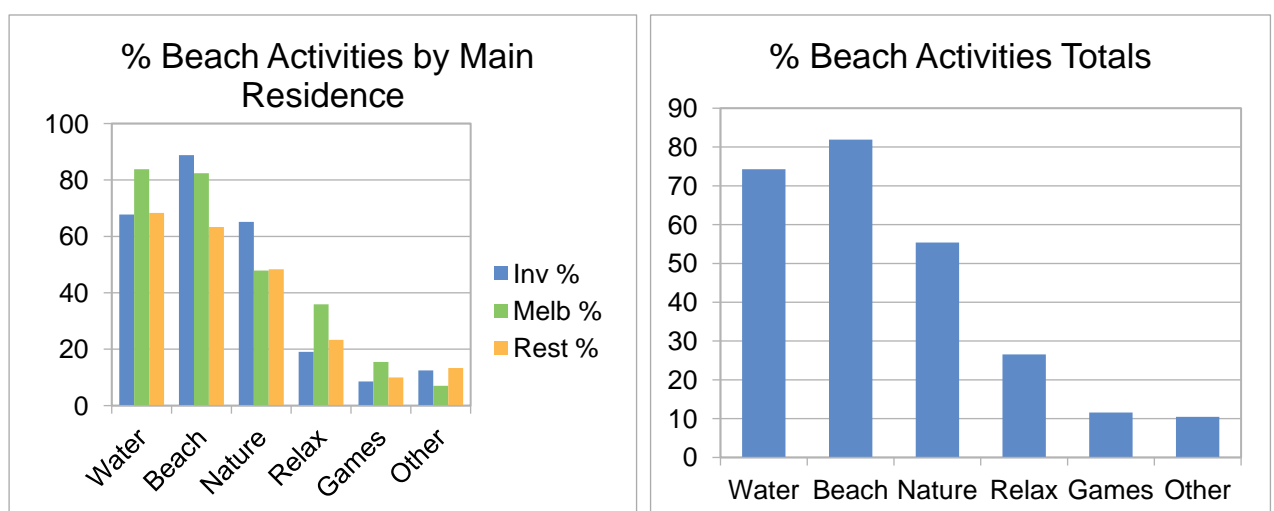
Question 3 – What are your favourite activities in Inverloch?

Visiting the beach rated among the three favourite activities for 93% of respondents. The other two most popular activities were sightseeing/coastal walks (73%) and visiting markets/cafes/shops (49%).



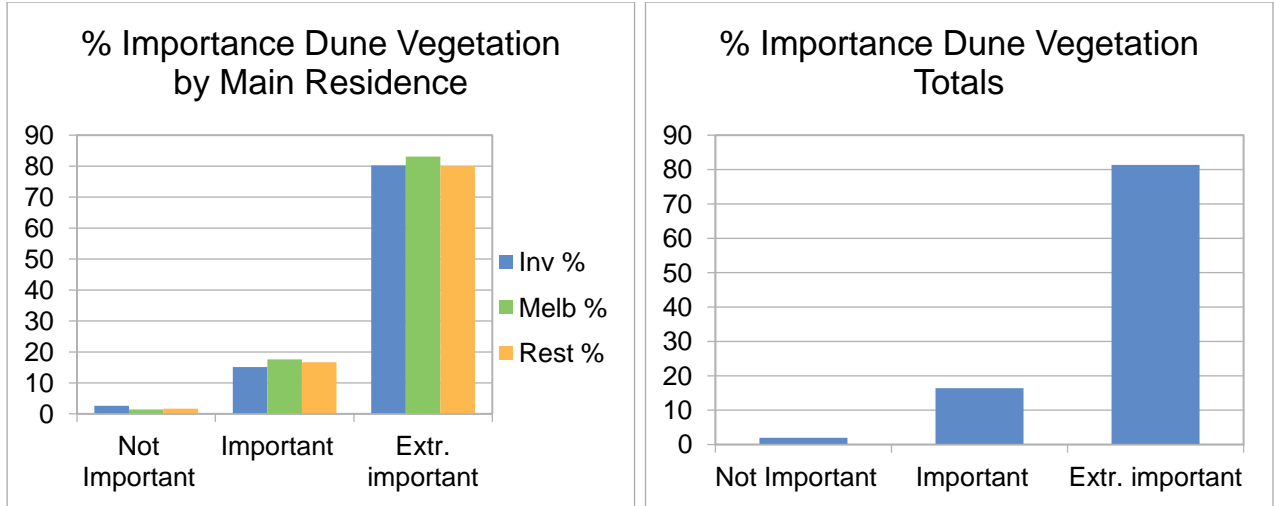
Question 4 – What are your favourite beach activities?

The three favourite beach activities of respondents were beach walks (82%), water activities (74%) and nature appreciation/sunset viewing (55%).



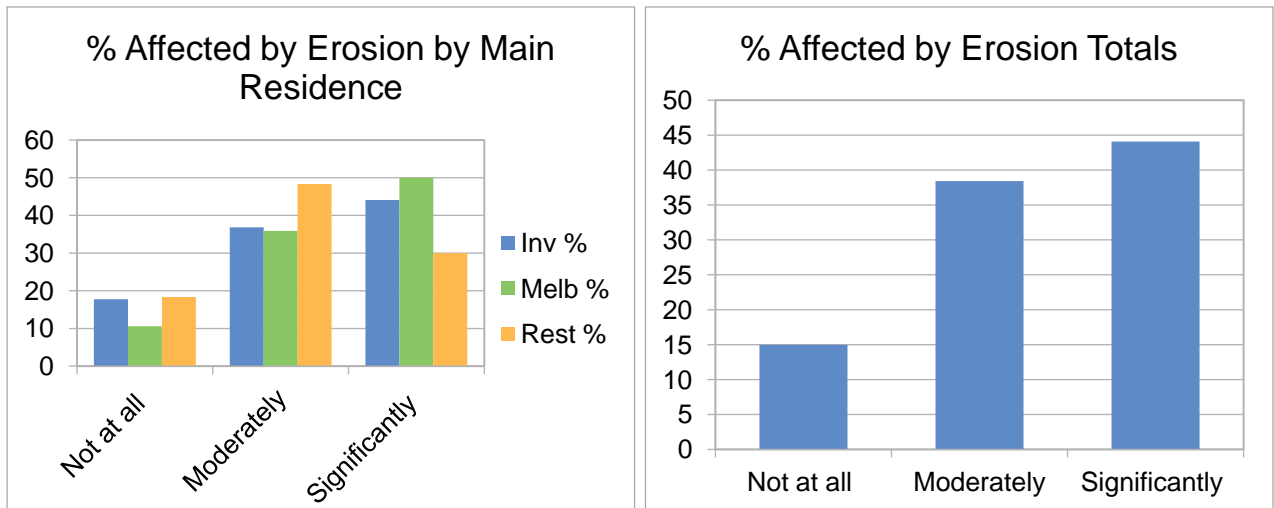
Question 5 – How important is the natural setting that the vegetated dunes provide to your experience at Inverloch Surf Beach?

The natural setting provided by the vegetated dunes was rated as extremely important by 81% of respondents. A further 16% rated the natural setting as important.



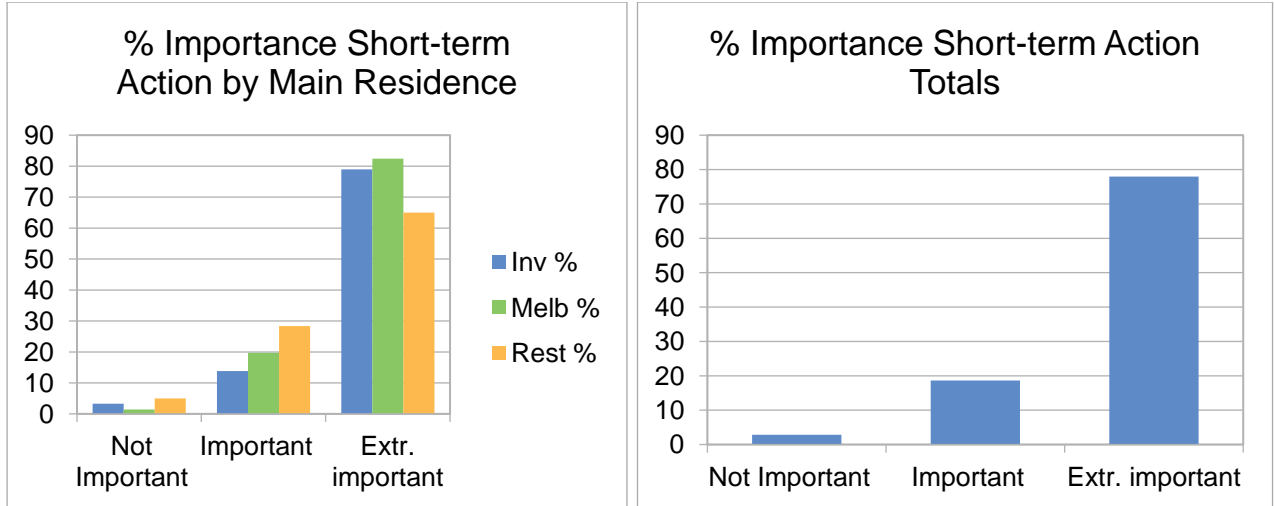
Question 6 – How has the erosion of Inverloch surf beach and the build-up of sand in Anderson Inlet affected you this summer?

A total of 82% of respondents were either significantly (44%) or moderately (38%) affected by surf beach erosion and sand accretion within Anderson Inlet over the past summer.



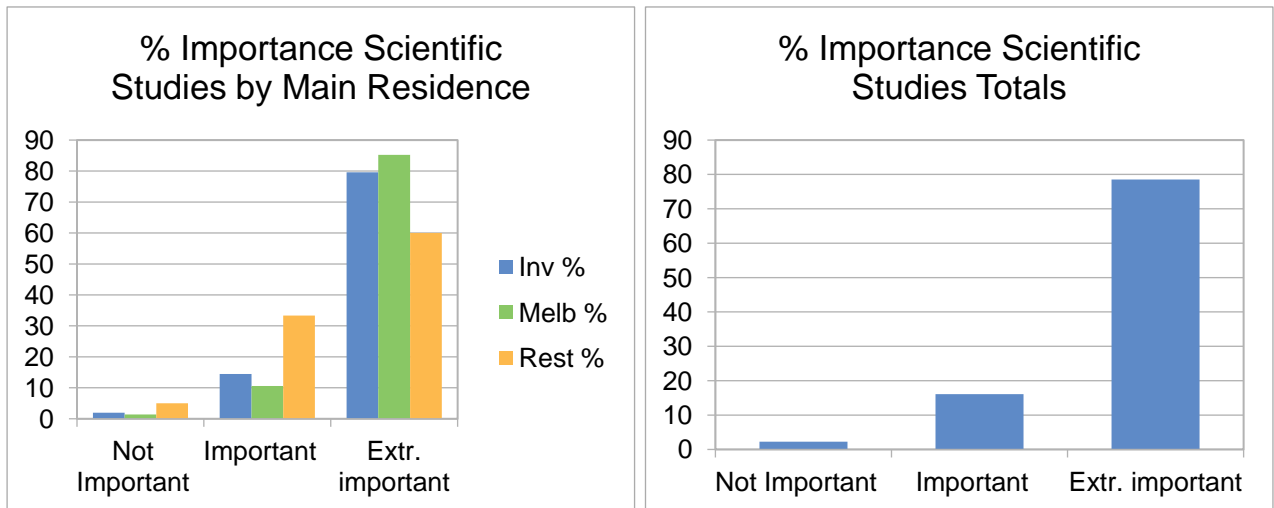
Question 7 – How important to you is it that short-term action is taken to protect coastal infrastructure and the Inverloch dunes from further erosion?

78% of respondents considered that it was extremely important that short-term action is taken. A further 19% considered that it was important.



Question 8 – How important is it that detailed scientific investigations are funded to identify adaptation measures to manage future erosion at Inverloch surf beach and Anderson Inlet?

79% of respondents considered that it was extremely important that detailed scientific investigations are funded, with a further 16% considering it important.



Question 9 – Would you be interested in participating in further discussions to identify actions consistent with a sustainably-seeking Inverloch?

56% of respondents (197 people) indicated that they would like to participate in further discussions. These respondents were split between Inverloch (90 people), Melbourne residents (87 people) and elsewhere (20 people).

These discussions are proposed to occur during the next phase of the project.

Question 10 – Do you have any other comments about the beach erosion issue and this exhibition?

The highest number of responses (49) to this open question related to the exhibition, with very strong support given to the information presented and the issues raised. A number of responses highlighted the benefit of further communication:

- 'More people should see this to create more awareness of what is happening in our own backyard and environment'
- 'It's essential that awareness provided by this exhibition is constantly brought to the attention of locals, visitors and Government so that appropriate action can be taken before it's too late'
- 'Very good exhibition. We need public information sessions run by Council and/or SGCS – about the erosion issues, causes and solutions'.

These responses and another 35 indicated strong support for South Gippsland Conservation Society in taking the initiative with the Inverloch Coastal Resilience Project:

- 'It's fabulous to have local organisations pursue a strong environmental program'
- 'Wonderful to see local action and reaching out to educate public. Definitely more support needed to protect this natural heritage'
- 'Very sad to observe. Exhibition very welcome as to what is being done. Council+ Government finance and support imperative'.

Twenty responses highlighted the urgency of taking action, given the change that has occurred over the past 6 years. Both immediate and longer-term measures were supported:

- 'It's frightening how quickly things are changing'
- 'Short term stop gaps may give us time to research and develop long term fixes'
- 'Immediate action is required. We are quickly losing the beautiful beach'
- 'The exhibition has revealed the severity of the erosion, action is urgently required'
- 'Have heard many comments about the shifting sand/eroding dunes being part of a 'cycle'- however it appears that the current environmental movements are drastically outside of any usual cycle!'

A number of responses (9) made suggestions about possible remedial actions, such as:

- 'Please no rocks along the Surf Beach'
- 'Anecdotal evidence is that a rock groyne would be of assistance to stop sand migration from the surf beach'
- 'Need to put in some rock groynes to keep sand in place'
- 'I feel that the sand build up at Ayr Creek needs to be removed and repositioned around the corner to the surf beach. So the 'lake' is de-established'
- 'Lake Stinky' must go'
- 'Don't ruin the beauty by creating awful levees'
- 'Remove marram grass/trees (dead) from western inlet entrance to allow sand to move back'.

Nine responses highlighted the need to avoid any further removal of dune vegetation:

- 'Don't remove any more vegetation'
- 'I am concerned that continuation of the walking path and subsequent car parking changes will impact on the vegetation between Surf Parade and the sea. This needs immediate consideration before it's too late'
- 'Do not put in the path which further reduces vegetation and dune'
- 'Don't let Council remove dune vegetation to put in parking'
- 'Make Surf Parade one way only'

- 'Suggestion to protect the remaining vegetation – do not widen Surf Parade – make it one way to allow parking without removal of vegetation'.

Many responses (9) highlighted the damage to the dunes caused by people clambering on them over the summer:

- 'Sick of seeing people climbing all over the dunes – they need protection'
- 'Last summer children on the beach were climbing all over the sand cliffs with on one stopping them! V dangerous.'
- 'Ensure that people cease sliding down and running up sand dunes'
- 'Better signs needed and education of parents'
- 'Patrol and signage of children climbing dunes'
- 'What actions are being taken to stop visitors climbing/jumping and pulling out vegetation?'

Other comments included:

- 'Accept that dune systems are temporary features in a dynamic coastal environment'
- 'The big change to the Inverloch foreshore over 40 years is allowing the Point Smythe sea protection to fall into disrepair and allow 100m of the point to wash away!'
- 'Trial fence needs to be longer'
- 'Great fences but need to be placed further along and more of them'
- 'There is no time for trialling the wet sand fence. It really should be immediately installed to protect our coastline'
- 'Need council and Government to help with funding to save our beach'.

Question 11 – What is your age and sex?

The majority of respondents were aged between 40-80 years old:

- 53% of respondents were aged between 60-80 years old
- 27% between 41-60 years old.

The majority of respondents were female.

5.3 Conclusions

The survey responses provide very strong evidence that visiting the beach is the number one recreation activity in Inverloch, for both residents and visitors. At the surf beach, the natural setting provided by the vegetated dunes is highly valued by residents and visitors and their partial removal by beach erosion is already having a significant impact on beach recreation activities.

Residents and visitors consider that it is extremely important that both short-term action and longer-term planning is undertaken to manage future changes at Inverloch surf beach and within Anderson Inlet. The exhibition was supported very strongly, and further communication is urged to continue to raise public awareness. Respondents consider that Council and Government communication and support is imperative.

Respondents also consider that it is vital that removal of any further dune vegetation is avoided, given the loss of dune vegetation that has occurred since 2013. The installed length of trial wet sand fencing needs to be extended and the dunes need to be better managed at peak visitor times.

6.0 WET-SAND FENCE TRIAL

As a trial measure, two 50-60m sections of double row, wet-sand fencing were installed in March 2019 to protect threatened infrastructure at Inverloch Surf Life Saving Club and Cape Paterson Road. Constructed using thin, vertical slats of timber connected by wire, the fences are designed to decrease the energy of incoming waves, allowing sand to accumulate behind the fence. In addition, a 50 metre stretch of foredune was filled to approximately 1.5m above the beach level, on the dune side of the fence, in June 2019. Revegetation with indigenous grasses and shrubs is planned for spring/summer 2019/20.

At installation, the tops of the fences were positioned below the level of the beach. At the time of writing (July 2019), the tops of the surf-side rows of fencing are more than one metre above the current beach level, with four storm surge events between April and the end of May 2019 having resulted in substantial additional beach erosion. The storms also caused considerable damage to the fences, with the pickets of both surf-side rows of fencing having been removed from the fence supports and a number of the supporting posts being lifted.

The fencing is being re-designed and upgraded (July 2019) to better cope with the harsh coastal environment at Inverloch, but in the meantime previously-scheduled dune renourishment works proceeded in June 2019. Much of the imported sand has already been removed from behind the fences following storms in June and July. Further renourishment will be required once the upgraded fences have been reinstated.

Notwithstanding these set-backs, early indications are that the fences are providing a degree of protection to the dune faces, with some accretion apparent behind the fences, prior to the dune renourishment. However, it was also clear that a noticeable end effect was occurring at the western ends of both sections of fencing, caused by the oblique angle that SW waves reach the beach.

SGCS supports the trial and the proposed dune rehabilitation program. It was unfortunate that budget constraints meant that only 50-60 metre lengths of fencing were able to be installed at each site. With the end effect evident at the western ends of both sections of fence, there is only around 20 metres of dune that is being protected.

The Government Working Group is intending to evaluate the trial 12 months after installation i.e. March 2020. Should the trial be assessed as successful, SGCS advocates extension of the fences over the full length of the surf beach, from Flat Rocks to Point Norman, to protect the environmental and community values identified in this report, as well as coastal infrastructure and housing. Fencing of the full length of the beach would cost less than the annual cost of the loss of recreation and tourism values if the beach was to lose its dune system, as determined by the *Preliminary Economic Assessment* (Attachment 4). Consideration of extending the length of the trial fencing within the trial period (to make for a 'fairer' trial), is also encouraged.

Hopefully the fences will 'buy some time' and provide a level of dune protection in the short term, particularly if they are extended. However, it seems likely that other medium and long-term measures will be required in the future.

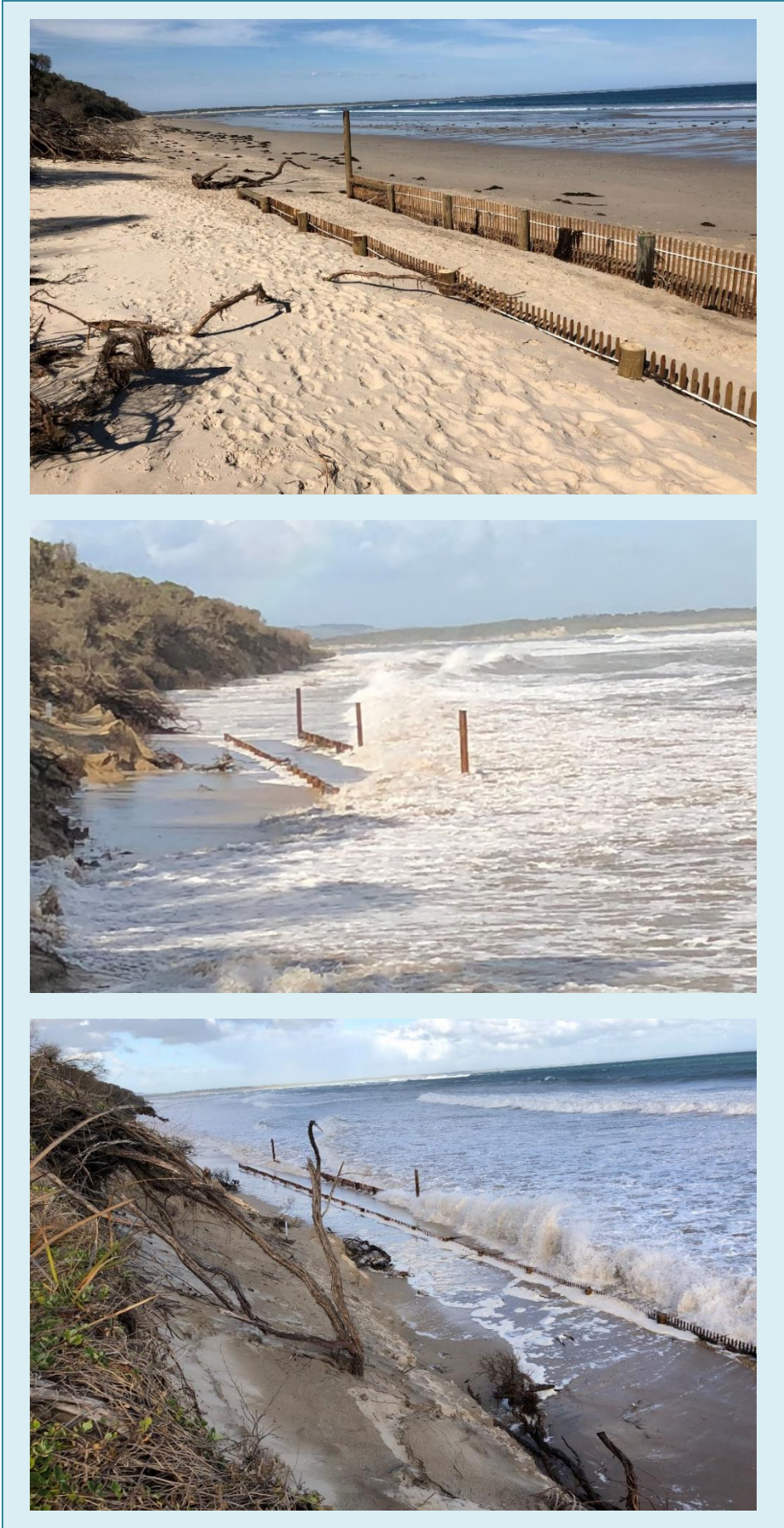


Figure 23 Wet-sand Fence Trial

7.0 OTHER ICRP ACTIVITIES

7.1 Shoreline Monitoring

Inverloch has been selected as one of 17 priority sites to be regularly monitored under the Victorian Government's Victorian Coastal Monitoring Program. UAV or drone monitoring commenced in September 2018, and is undertaken every six weeks. Research scientists from Deakin and Melbourne Universities are training SGCS citizen scientists in the use of drones, with a team of volunteers to complete their training by mid/late 2019. Survey results are uploaded to the Propeller Aero portal, which enables cross-section and volume comparisons to be made from one survey to the next, and the extent of coastal erosion and accretion to be monitored.

Supplementary laser level monitoring by SGCS volunteers is to commence at ten sites shortly, once monitoring posts have been installed. The laser level monitoring will enable the effect of individual storm events to be monitored, compared with the drone monitoring, which is only undertaken every six weeks and requires relatively still and clear conditions to proceed.

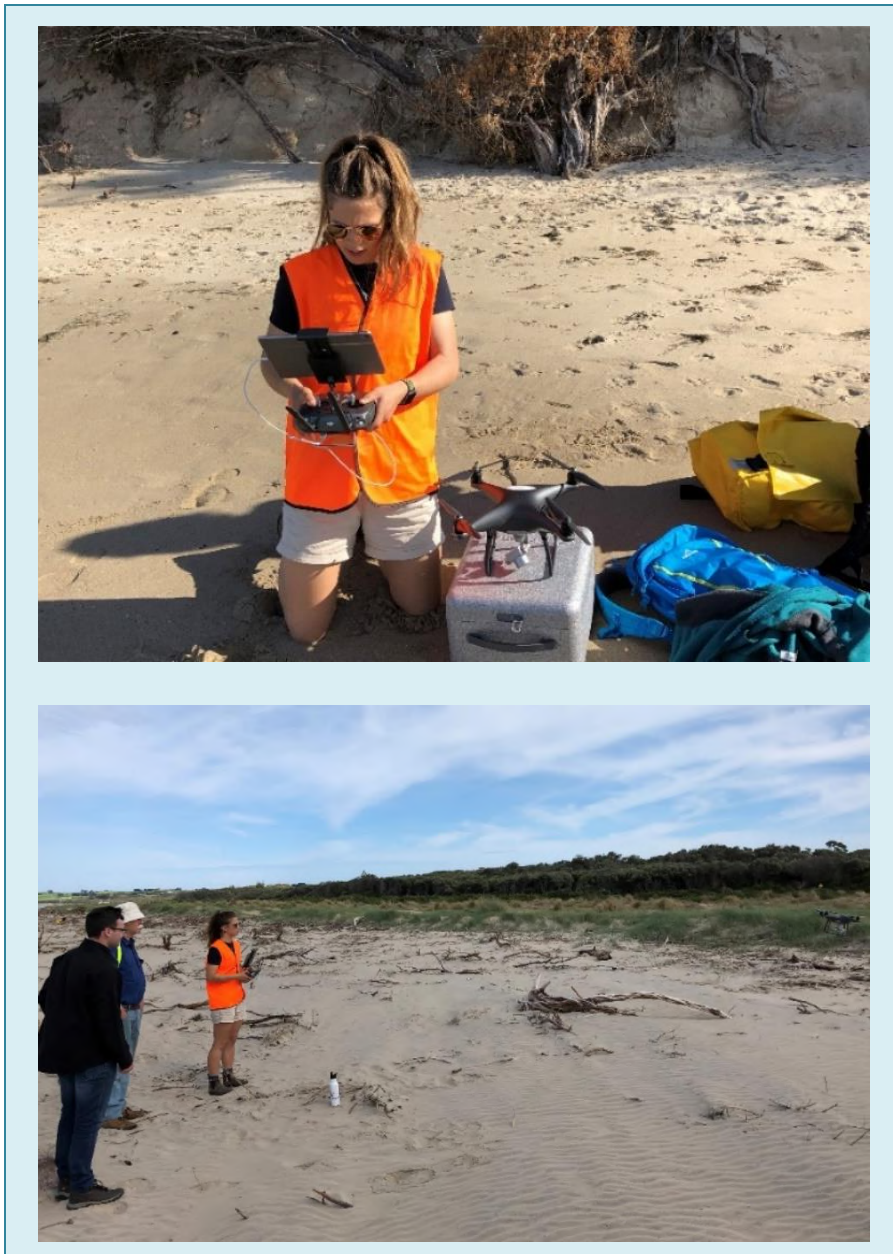


Figure 24 Drone Monitoring

7.2 Sustainably-seeking Inverloch

The Sustainably-seeking Inverloch initiative is aiming to identify what actions the Inverloch community could adopt to demonstrate a commitment to playing its part in limiting or avoiding predicated climate change impacts. Preliminary work has commenced on a framework for local actions that are consistent with limiting global temperature increase to less than two degrees, in accordance with the 2015 Paris Climate Agreement.

Possible actions by 2030 could include achieving 50% renewable energy and battery storage, installing electric vehicle charging stations, hydrogen-powered buses and trucks, providing a network of bike lanes and shared paths, maintaining town boundary limits, establishing wildlife corridors, installing community gardens for food production and encouraging low impact recreation activities.

Following a strong positive response to this initiative in the community survey run at our public exhibition, workshops are planned to develop the framework during Phase 2 of ICRP. SGCS will also look to integrate with activities underway for the Renewable Energy Roadmap initiative.

7.3 Community and Stakeholder Consultation

The project team has met with many Government Agencies and community groups over the course of this project. An initiation meeting with DELWP and Bass Coast Shire Council in August 2018, was followed by meetings with West Gippsland CMA, Parks Victoria and South Gippsland Shire Council in late 2018, and follow-up meetings with BCSC staff.

Environmental and community organisations consulted include BirdLife Australia, Inverloch Historical Society and Inverloch Surf Life Saving Club, each of which have provided valuable source material and support. Port Fairy Coastal Group (PFCG) has provided advice in a number of areas, including performance of wet sand fences and Wave Energy Dissipation (WED) structures, dune revegetation and laser level and drone monitoring, and generously provided their time during a site visit in late 2018, as did representatives of the Apollo Bay – Otway Coast Committee (see Appendix 1 for details).

The project team has liaised regularly with the Inverloch Coastal Erosion Working Group, comprising representatives of DELWP, Bass Coast Shire Council, Parks Victoria, Regional Roads Victoria and West Gippsland CMA, including presentations of project findings and progress reports at regular meetings held between December 2018 and June 2019. Working Group members have also provided reports, design plans and aerial photography, and have assisted with the mounting of the public exhibition and installation of monitoring posts (current).

The project team and SGCS looks forward to further developing its relationship with the Working Group in the next phase of the project. Once the project report has been distributed, we will seek to collaborate in identifying agreed study recommendations and their implementation, and to provide on-going environmental and community inputs to further planning for the coastline, including the conduct of the proposed Local Coastal Hazard Assessment.

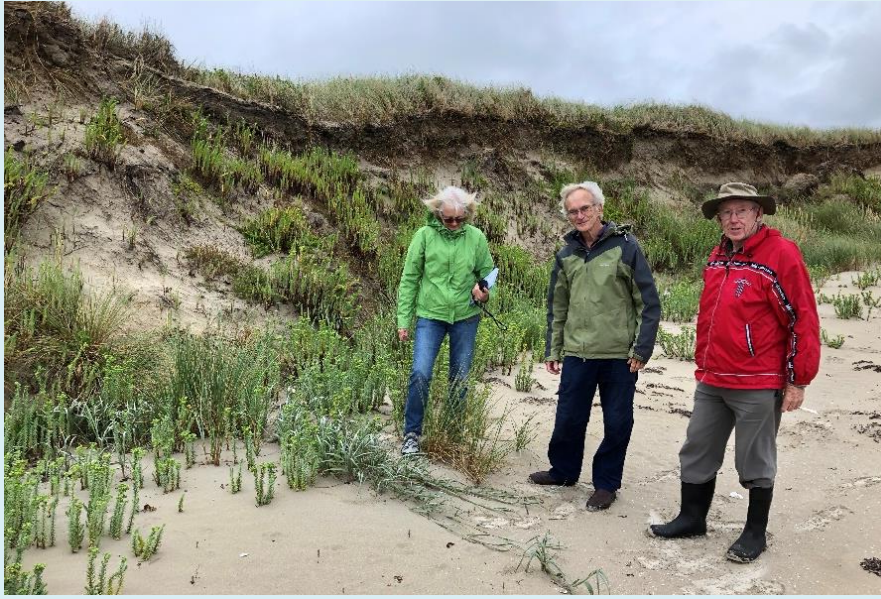


Figure 25 Collaboration

A major element of the consultation program was the public exhibition and community survey, as detailed in Chapter 5. In addition, briefings and presentations have been provided at the Bunurong Environment Centre in Inverloch, and newspaper articles have been generated in the Age (<https://www.theage.com.au/national/victoria/oceans-rising-can-we-save-our-collapsing-coastline-20190111-p50qvy.html>), Sentinel Times, Bass Coast Post and the Southern Star. Philip Heath participated as a panel member in a forum on coastal erosion for Jon Faine's Conversation Hour on ABC Radio in January 2019 and presented a paper on Inverloch beach erosion at the Victorian Marine and Coastal Forum in Melbourne in May 2019.



Figure 26 Media

A project video is in preparation. The video will record the coastline changes that have occurred during 2018/19 and feature interviews with team members and community representatives.

8.0 KEY FINDINGS AND RECOMMENDATIONS

8.1 Key Findings

Inverloch Surf Beach Erosion and Anderson Inlet Accretion

1. The changes that have occurred at Inverloch surf beach since 2013 far exceed previous changes recorded and observed at Inverloch and, at an average rate of coastline recession of six metres per year, represent one of the most rapid changes along a sandy coastline in Victoria in European historical times, and are rated as 'severe' to 'extreme' by global comparison. The shoreline changes are most likely to have been a result of rising sea levels and more frequent and more intense erosion-producing storms.
2. Coincident with the surf beach recession, substantial accretion of sand has occurred in Anderson Inlet, as well as changes in the position of the ebb and flood channels at the entrance to the Inlet. Coastline erosion of the surf beach between Flat Rocks and Point Norman has been a substantial source of sand for what has become the Point Norman-Point Hughes coastal barrier, with eroded sand from the beach being deflected into Anderson Inlet. This contrasts with previous beach erosion events, where eroded sand from the surf beach was deposited offshore, available for later replenishment of the surf beach under favourable metocean conditions.
3. The movement of eroded sand from the beach into Anderson Inlet, which may be long term, has reduced the quantity of sand available for natural beach renourishment/recovery. This reduction in supply, combined with sea level rise and more frequent and intense WSW and SW waves, appears to have changed the Inverloch coastline dynamics. In doing so, the concept of 'cyclical' changes may be redundant, given that the backshore and beach no longer have the time, or sediment supply, to recover after each storm event.

Geomorphological, Ecological, Cultural Heritage, Community and Economic Values under Threat

4. Continued erosion of the vegetated dunes behind Inverloch surf beach is already threatening coastal infrastructure, and geomorphological, ecological, cultural heritage and economic values of the vegetated dunes are being lost, as detailed in (5) - (17) below. The community survey undertaken for this project revealed that the natural setting provided by the vegetated dunes is rated as extremely important by 81% of respondents, comprising both Inverloch residents and visitors. A further 16% rated the natural setting as important, indicating that further loss of the dunes could have a significant impact on the attractiveness of Inverloch surf beach to both residents and visitors.

Geomorphological Values

5. The Inverloch coast is rated of State Geoscience significance, of great interest for historical and on-going studies of coastal landform evolution. The geomorphology of the backshore sand ridges and dunes between Flat Rocks and Point Hughes record a history of accretion and recession extending across the late Pleistocene and Holocene, over more than 10,000 years. The rapid changes that have occurred since 2013 are already impacting on the history of accretion and recession that extends across the late Pleistocene and Holocene Periods (over more than 10,000 years), with over 50% of the established vegetated dunes having been removed.

Ecological Values

6. The Inverloch foreshore and Point Smythe dune systems feature a diverse ecology with eight Ecological Vegetation Classes present, including four threatened coastal vegetation communities. 175 native plant species have been recorded within the Inverloch dunes, with ten of these listed as rare or threatened, as well as 220

native fauna species, 53 of which are listed as threatened. The former foredunes of the Inverloch dune system provided important habitat for vulnerable shorebird species, such as the Hooded Plover.

7. The Inverloch foreshore is one of the few east-west Biolinks within Bass Coast Shire, and acts as an important corridor for wildlife movement along the coast, as well as for wildlife movement between the coast and hinterland areas.
8. Almost half of the dune system vegetation has been lost due to coastal recession since 2013, including:
 - Significant depletion of the mature Coast Banksia Woodland community at Flat Rocks
 - Incipient dunes (foredune) no longer exist between Flat Rocks to just west of Point Norman, resulting in complete loss of suitable nesting habitat for vulnerable shorebird species.
9. No further native vegetation should be removed from the Inverloch dune system, including the rear dunes adjacent to Surf Parade.
10. Increasing dune resilience through revegetation with appropriate native species is an essential element of the dune rehabilitation program that has begun with installation of the wet-sand fencing and dune renourishment. Other measures include thatching of steep dune slopes with eroded tea tree branches and debris, effective weed and pest control, enhanced management and education of beach users to avoid dune trampling and rationalising of beach access tracks.

Cultural Heritage Values

11. A search of the Aboriginal Heritage Register revealed the existence of fourteen Aboriginal places (shell middens/artefact scatters) in and adjacent to study area. Four places are at high to very high risk from destabilisation of the dunes from sea level rise and associated erosion. As the study area has not been thoroughly surveyed, there is a high potential for more as yet unknown Aboriginal places to be at risk. Sites in the coastal reserve represent a diminishing resource, with many other sites adjacent to the study area already destroyed.
12. Consultation undertaken for this project has revealed that both the Bunurong Land Council Aboriginal Corporation and the Gunaikurnai Land and Waters Aboriginal Corporation consider that all the Aboriginal places identified in the study area are of high cultural significance and that urgent measures are required to address the potential impacts to the sites from climate change-related effects.
13. Sites reflect an occupation period from 6,000-7,000 years ago to the recent past, with older sites already submerged as sea levels rose prior to 6,000BP. If remaining coastal sites are lost, the record of past occupation by Aboriginal people will also be lost.

Economic Values

14. The coastline is arguably Australia's most important recreation resource. A broad range of passive and active recreation activities are undertaken by local residents and visitors, and natural, undeveloped settings are a major drawcard. The survey of residents and visitors undertaken for this project revealed that 93% of respondents rated visiting the beach among their favourite three activities in Inverloch.

15. Previous studies have highlighted the social and economic importance of beaches for tourism and recreation, but have also highlighted that recreation and tourism values are related to the condition of the assets. At worst, severe impacts could deter visitors from visiting a particular location.
16. Recreation and tourism impacts are already occurring at Inverloch surf beach, due to a variety of changes, such as very little or no dry sand on the beach at high tide, unstable dunes that pose a risk to beachgoers, and steep access tracks that are difficult to negotiate. A total of 82% of respondents were either significantly (44%) or moderately (38%) affected over the past summer, as indicated by responses to our community survey.
17. A preliminary economic valuation undertaken for this project used previous contingent valuation studies and consumer surplus values to determine that resident and tourism values for Inverloch at risk from further sustained coastline impacts, are in the order of \$3-5 million per annum.

Wet-sand Fencing Trial

18. The installed wet-sand fencing trial is supported, and our community survey revealed that 78% of respondents considered that it was extremely important that short-term action is taken. A further 19% of respondents considered that it was important. It is unfortunate that additional funding was not available to install a minimum length of fencing of at least 100 metres at both sites. A longer length of fencing would have made for a fairer trial as, with the end effect erosion that is occurring at the western extent of each fence, only around 20 metres of dune is being protected currently. Dune renourishment and the proposed revegetation will be severely exposed to storm surges without any increase in the length of the trial fencing.
19. If the trial proves to be successful after 12 months from installation (and with the qualifications noted in (18) above), consideration should be given to extending the length of wet-sand fencing to protect the vegetated dunes over the full length of the surf beach, between Flat Rocks and Point Norman in order to protect the geomorphological, ecological, cultural heritage, economic and community values outlined in this report. The cost of installing this length of fencing has been estimated as being less than the annual economic cost that would be incurred on the local economy if the vegetated dunes, as a highly valued feature of Inverloch surf beach, were lost.
20. Consideration needs to be given to the addition of a 45 degree return at the western ends of each section of wet-sand fencing, as well as measures to avoid human disturbance to the revegetating dune.

Scientific Investigations and the Local Coastal Hazard Assessment

21. While, if successful, wet-sand fencing may assist in managing surf beach erosion in the short term, further investigations (including those conducted as part of a Local Coastal Hazard Assessment (LCHA)) are required to identify feasible longer-term strategies to manage likely future surf beach erosion and Inlet accretion events. The LCHA has been 'on the agenda' for many years (most recently, it was a commitment made in the Gippsland Regional Coastal Plan 2015-2020) and with the rate of erosion that is currently being experienced in Inverloch, it is crucial that investigations commence as soon as possible, otherwise the environmental, social and economic values identified in this report will have been lost before any longer-term measures have been identified.
22. A key element of the LCHA will be to analyse the complex relationships between offshore coastal processes, Anderson Inlet and Point Smythe, including:

- Sources and dynamics of sand for the entire coastal area
- Analysis of tidal dynamics to determine sand pathways on ebb and flood tides.

The LCHA also needs to analyse the implications of predicted global warming effects on the Bass Coast, including further sea level rise and the likelihood of increased frequency and intensity of future storm surge events.

23. Scientific studies are also required to analyse the factors that have contributed to the coastline changes that have occurred since 2013, including:

- Further analysis of factors that have contributed to beach shoreline changes since 2013, such as rising sea levels, increases in the frequency and intensity of erosion-inducing storms, changes in the direction of approach of high energy waves and reduction in sediment supply
- Analysis of reasons for the movement of sand from the surf beach into Anderson Inlet, and further estimation of the volumes of sand involved in the beach recession and inlet accretion since 2012
- Investigation of the likely future configuration of Anderson Inlet, including assessment of whether the Point Norman-Point Hughes coastal barrier will remain within Anderson Inlet.

Ideally, these studies would be undertaken as part of the proposed LCHA. However, if there are further delays to funding of the LCHA, it will be important that funding is arranged through DELWP and BCSC to enable these investigations to proceed at the earliest opportunity.

24. In addition to the scientific investigations identified in (23), other relatively low-cost actions to enhance understanding of coastline changes include shoreline monitoring by drone and laser level, analysis and monitoring of metocean conditions, analysis of tidal dynamics of Anderson Inlet, investigation of sources and dynamics of sand for the Inverloch coast and a suite of on-ground measures to build resilience into the dune system, as detailed in (10).

8.2 Recommendations

The following recommendations are made as suggestions, for consideration mainly by DELWP and BCSC. They are based on the key findings of this project, and include commitments by SGCS to further assist with a coordinated response to managing the erosion threat to the Inverloch coastline. SGCS will welcome the opportunity to discuss and work through these suggestions with representatives from DELWP and BCSC.

Recommendation	Who?	Suggested timing	Suggested actions
Analysis of Coastline changes			
Coastal Planning and the Local Coastal Hazard Assessment			
<p>LCHA 1. The content, findings and recommendations of the Inverloch Coastal Resilience Project Report and its supporting consultant studies should be considered by Government and its authorities in future planning for the Inverloch coast, including the proposed Bass Coast Local Coastal Hazard Assessment (LCHA).</p> <p>In particular, the apparent change in Inverloch coastline dynamics since 2013 and the geomorphological, ecological, Aboriginal cultural heritage, economic and community values of the Inverloch dune system need to be examined carefully in any future assessment of risk associated with coastal recession at Inverloch.</p>	DELWP, BCSC	2019/20	DELWP and BCSC to consider the Inverloch Coastal Resilience Project Report in future planning of the Inverloch coast
<p>LCHA 2. The scope of the LCHA needs to analyse the factors that have contributed to the significant coastline changes that have occurred since 2012, as well as identifying the risk of further changes.</p> <p>With the delay in funding of the LCHA, an option to consider would be to undertake the analysis of the changes that have already occurred as a separate study, prior to commencement of the LCHA. See 'Scientific Investigations – Analysis of Past Events' below.</p>	DELWP, BCSC	2019	DELWP and BCSC to consider funding investigations of past events, prior to commencement of LCHA
<p>LCHA 3. The LCHA needs to analyse the complex relationships between offshore coastal processes, Anderson Inlet and Pt Smythe, including:</p> <ul style="list-style-type: none"> • Sources and dynamics of sand for the entire coastal area • Analysis of tidal dynamics of Anderson Inlet to determine sand pathways on ebb and flood tides • Likelihood of continuation of current coastline recession • Potential for future movement of sand from surf beach into Inlet • Investigation of likely future configuration of Anderson Inlet, including assessment of whether Pt Norman-Pt Hughes coastal barrier will remain within Anderson Inlet. 	<p>Coastal processes and hydrodynamics specialist consultant.</p> <p>SGCS offers to provide environmental and community input during LCHA process, including scoping, progress meetings and review of draft reports</p>	2019/20	DELWP and BCSC to consider recommended scope
<p>LCHA 4. The LCHA should examine potential climate change effects on the Bass Coast, including further sea level rise and the likelihood of increased frequency and intensity of future storm surge events, and their implications for coastline erosion.</p>	Coastal processes and hydrodynamics specialist consultant	2019/20	DELWP and BCSC to consider recommended scope

Recommendation	Who?	Suggested timing	Suggested actions
LCHA 5. The LCHA should identify feasible longer-term measures to manage future beach erosion and Inlet accretion events, such as augmentation of Point Norman rock platform and offshore reefs, utilizing eco-engineering principles	Research organisations such as the National Centre for Coasts and Climate, Melbourne University	2019/20	DELWP and BCSC to consider recommended scope
Scientific Investigations – Analysis of Past Events, pre-LCHA			
<p>SI 1. Analysis of factors that have contributed to beach shoreline changes since 2012, such as increases in the frequency and intensity of erosion-inducing storms, rising sea levels, changes in the direction of approach of high energy waves and reduction in sediment supply.</p> <p>Investigation of specific factors that have contributed to the movement of sand from the surf beach into Inlet, including lateral shift of main channel, hydraulic groyne effects and changing metocean conditions.</p> <p>This analysis should also investigate whether the frequency of occurrence of combined swell/tide/wind storm swell events has increased significantly since 2012 to the present.</p>	<p>Analysis of Past Events would ideally be undertaken as part of LCHA, or alternatively, if LCHA is further delayed, as an input to the LCHA.</p> <p>Coastal processes and hydrodynamics specialist consultant.</p> <p>SGCS has undertaken, or is proposing to undertake, a number of preliminary investigations that could provide input into the LCHA:</p> <ul style="list-style-type: none"> • SGCS (Rosengren) has carried out a wind analysis of Pound Creek BoM met station records from 2011-2018 • SGCS (Rosengren) is proposing to undertake metocean data analysis with CSIRO Aspendale as part of ICRP Phase 2, subject to success with 3CA Grant application. 	2019/20	<p>DELWP and BCSC to consider funding investigations of past events, prior to commencement of LCHA</p> <p>DELWP and BCSC to consider recommended scope</p> <p>SGCS (Rosengren) to continue to liaise with CSIRO</p>
SI 2. Further analysis of the volumes of sand removed from surf beach and inlet accretion since 2012	<p>SGCS (Rosengren) has undertaken a preliminary analysis for ICRP Phase 1.</p> <p>SGCS (Rosengren) in association with VCMP/Deakin/ Melb Universities using Propeller Aero/drone monitoring results, historical aerial photography and LiDAR, subject to 3CA Grant Application</p>	2019	Recommended task to be discussed with VCMP management
SI 3. Sampling and analysis of beach and nearshore areas (grain size and shape, composition, stratification) to determine the source of sand at the Pt Norman-Pt Hughes coastal barrier	<p>SGCS (Rosengren) has commenced sampling.</p> <p>SGCS (Rosengren) to undertake analysis, subject to success with 3CA Grant Application</p>	2019	Complete sampling and conduct analysis, if 3CA funding is secured

Recommendation	Who?	Suggested timing	Suggested actions
Monitoring Task (pre-LCHA)			
The following monitoring task will also provide input to the LCHA and can be undertaken prior to commencement of the LCHA: M 1. Monitoring of the configuration of the Anderson Inlet entrance and the ebb-tide deltas	SGCS volunteers, in association with VCMP	2019/20	SGCS to discuss with VCMP management
Values Assessments			
Geomorphological			
G1. Investigation of age of foredunes based on palaeosols analysis	SGCS (Rosengren) in association with Waikato University	2019	Subject to success with 3CA Grant Application
G2. Analysis of composition and age of backshore ridges	SGCS (Rosengren) in association with Vic Uni and consultants	2019	Subject to success with 3CA Grant Application
G3. BCSC to undertake further assessment in considering the possible inclusion of the Inverloch Coast as a site of geomorphological significance in the Bass Coast Planning Scheme	BCSC DELWP	2019 2019	For BCSC consideration. SGCS (Rosengren) offers input DELWP to consider ICRP Project Report content and findings as an input to the Bass Coast Distinctive Areas and Landscapes Program
Ecological			
<i>Note: Ecological actions related to the wet-sand fencing trial are covered in WSF2-WSF5.</i>			
E1. No further infrastructure development on the Inverloch dune system and no further removal of native vegetation on an already fragile dune system that is under threat from coastline recession	BCSC, DELWP, PV	2019	For BCSC and DELWP consideration in deliberations on proposed Surf Parade path extension proposal
E2. Supplementary planting of rear dune, including Coast Banksia Woodland Community at Flat Rocks and within mapped areas of Coastal Dune Scrub, including taller understory shrubs	BCSC, PV	2019/20	For consideration. SGCS (Oates) offers input
E3. Preparation of a 5-year weed management action plan for the Inverloch foreshore to ensure that invasive weeds are controlled and dune resilience enhanced	BCSC, PV	2019/20	For consideration. SGCS (Oates) offers input
E4. Implement effective pest control program targeting foxes and rabbits	BCSC, PV	2019/20	For consideration. SGCS offers input

Recommendation	Who?	Suggested timing	Suggested actions
E5. Consider rationalizing the number of beach access tracks and install post and wire fences on remaining tracks, where required	BCSC, PV	2019/20	For consideration
E6. Cordon off toe of eroded dunes adjacent to the Surf Life Saving Club to prevent human trampling, especially during the summer period	BCSC	2019/20	For consideration
E7. Monitor density of introduced grasses on newly-formed dunes between Pt Norman and Pt Hughes to ensure that it does not become too dense for Hooded Plover habitat	Possible extension to Melbourne Uni Research Project that is underway	2019/20	SGCS offers to discuss with Professor David Kennedy
E8. Implement education program for residents and visitors to highlight the ecological values of the vegetated dunes and the fragility of the dune system	BCSC, SGCS	On-going	For consideration
Cultural Heritage			
CH1. Collaboration with BLCAC and GLaWAC in developing a grant application for cultural heritage survey of study area, from Flat Rocks to Screw Creek, including possible salvage and development of management program	BCSC, SGCS (Freslov)	2019/20	SGCS (Freslov) offers to discuss with BCSC and PV
Economic			
E1. Further development of preliminary Economic Valuation, including BCSC review of study assumptions and visitor number estimates	BCSC	2019/20	For consideration
Wet-sand Fences			
WSF1. Complete rebuild of both sections of damaged wet-sand fence as soon as possible so they function as intended over the remainder of winter 2019	BCSC, DELWP, RRV, PV	2019	BCSC is in process of engaging contractor
WSF2. Consider extending the trial length of fencing to at least 100 metres at both sites and consider adding a 45 degree return to existing fences (particularly on the western side) to better manage end effect erosion	BCSC, DELWP, RRV, PV	2019	For consideration
WSF3. Maintenance, and if necessary, replenishment of sand renourishment behind the two wet-sand fences over winter 2019, prior to revegetation with indigenous plants, including Hairy Spinifex and appropriate coastal herbs and shrubs	BCSC, DELWP, RRV, PV	June 2019 (renourishment) and Spring/early Summer 2019 (revegetation)	For consideration. SGCS (Oates) offers input to development of planting schedule for dune revegetation
WSF4. Trial thatching of the steep dune slopes behind the wet-sand fencing with tea tree branches and debris from the eroded dunes to help stabilize the dune, and plant Hairy Spinifex on the crest and face of the dune	BCSC, DELWP, RRV, PV	2019	For consideration. SGCS (Oates) offers input
WSF5. Cordon off the area between the toe of the dune and either end of the wet-sand fences to minimise disturbance when revegetating the foredune, and supplement with community education program	BCSC, DELWP, RRV, PV	2019	For consideration

Recommendation	Who?	Suggested timing	Suggested actions
WSF6. Monitor performance over Winter/Spring/Summer 2019, and if trial deemed successful, consider extending fencing over full length of beach, from Flat Rocks to Pt Norman	BCSC, DELWP, RRV,PV	2020	For consideration
Shoreline Monitoring			
SM1. Continued 6 weekly drone monitoring of beach profile and monitoring of results via Propeller Aero website	VCMP, SGCS	Ongoing	VCMP to transfer drone equipment to SGCS during 2019
SM2. Supplementary laser level beach profile monitoring, including immediately following storm surge events	DELWP, PV, SGCS,	Ongoing, from start in August 2019	Posts to be installed in July 2019. SGCS to commence monitoring in August 2019
ICRP Phase 2			
Further geomorphological assessment, as detailed in SI 1-3, G1 and G2	Neville Rosengren, VCMP/Propeller	2019/20	Subject to success with 3CA Grant Application
ICRP3. Research of medium and long-term adaptation approaches	SGCS	2019/20	Subject to success with 3CA Grant Application
ICRP4. Development of sustainably-seeking Inverloch framework	SGCS	2019/20	Subject to success with 3CA Grant Application
ICRP5. Stakeholder and community group liaison	SGCS	2019/20	Subject to success with 3CA Grant Application
ICRP6. Project video preparation	SGCS (Smith)	2019/20	Subject to success with 3CA Grant Application

8.3 Next Steps

Release the Inverloch Coastal Resilience Project Report and its recommendations to Government, its Agencies (including Bass Coast Shire Council), community groups and the public.

- Follow-up discussions to action adopted recommendations

If the Community Climate Change Adaptation (3CA) Grant application is successful, SGCS will continue with ICRP Phase 2, including:

- Further geomorphological assessment, including metocean analysis
- Research of medium and long-term adaptation approaches
- Development of sustainably-seeking Inverloch framework
- Further stakeholder and community consultation
- Prepare video.

Beach Monitoring

- Installation of laser level posts (DELWP/PV/BCSC) and commence monitoring
- Complete drone training and citizen science transition to regular drone monitoring.

Provide input to scientific investigations and Local Coastal Hazard Assessment:

- Environmental and community values to be considered
- Scope of LCHA
- Information inputs to LCHA.

APPENDIX 1 Apollo Bay and Port Fairy Field Trip Report

Port Fairy trip by Philip Heath and Alison Oates, December 19-20, 2018.

Meeting with Port Fairy Coastal Group (PFCG) members: Ian Tebbutt, Matt Hayes, Jackie Kelley, Debbie and Max on December 19

Background Discussion

By way of introductions, Matt was the founder of PFCG and Ian undertook the number crunching for the questionnaire administered in February 2015. Ian has access to Tableau reader software and offered to assist us with analysis of survey outcomes.

Discussed the Local Coastal Hazard Assessment prepared by UNSW – report suffered by study team not having visited Port Fairy or consulted with PFCG and residents. Assumptions were not made explicit and the study used out-dated bathymetry charts. Amongst other things, the study concluded that opening of the causeway to Griffith Island (the South West Passage, which currently acts as a barrier to sand movement) would not have a beneficial impact on Port Fairy's coastal erosion issue. This is still a point of debate in Port Fairy. The feeling of the group is that forcing the long-shore sand movement around Griffith Island means that Apollo Bay East Beach is bypassed and therefore misses out on this natural source of renourishment.

A Climate Change Adaptation report has been prepared by Moyne Shire and is on their website. This report drew on the PFCG survey results. Ebony Perrin, Environmental Services team leader with Moyne Shire undertook an overseas study tour of beach erosion management techniques and would be a good person to talk to. Ebony advocates a two-pronged approach of combining hard defences such as rock walls and other armour with sand renourishment and soft engineering projects for sand retention such as revegetation and fencing.

The background document to the Belfast Coastal Management Plan provides some useful information on dune values.

The 'Yolla' vessel is from Deakin University and is currently doing seabed/bathymetry analysis.

Consider all potential funding sources, such as company that operates the Bald Hills Wind Farm (was Mitsui).

Ross Martin, Overseas projects, DELWP at Warrnambool could be a good source of information Contact details: M. 0457 533 902; Ross.Martin@delwp.vic.gov.au.

PFCG has had contact with the Indented Head Community Group.

Marin grass was introduced at East Beach in the 1900s. It helped to stabilise the dunes but also resulted in the dunes getting higher, according to Matt.

Matt highlighted the importance of defining relationships and the need to forge a true partnership. Minute meetings and get Council to sign off. Moyne Shire has been very supportive of PFCG and has provided practical assistance with installation of monitoring posts etc.

Matt also loaned us a scrap book of media reports of the coastal erosion issue, as well as an article in New Civil Engineer on works underway in the British holiday resort of Borth.

Questionnaire

The aim of the questionnaire was to determine 'How the community uses and values coastal assets'.

It was administered between November 2014 and March 2015 and featured intensive use of posters in cafes, bars and markets to attract attention, and also going into cafes and other meeting places to undertake surveys. Consultants designed the questionnaire layout to enhance its attractiveness and so encourage people to pick up and complete. Use of social media is increasingly important. We should get Council to assist.

The PFCG survey divided the town into six sections based on potential for inundation maps, which isn't recommended for our situation. 755 responses were received, of which 288 were on-line responses. Results provided information on the type and frequency of activities undertaken; the importance respondents placed on continuation of the range of current amenities (including maintenance of environmental integrity); investment priorities (e.g. environment habitat, beach and dune retention, beach access etc.).

Consider extending the coverage of the survey to beyond Inverloch – Cape Paterson, Venus Bay, Wonthaggi and possibly Latrobe Valley.

There's a need for an open question somewhere in the survey. Should include age group, gender but place at the end of the questionnaire. If the contributors want a summary of the survey report then have a page separate to the questionnaire where email addresses can be recorded.

Max made offer to assist with community engagement.

See also Ian Tebbutt's presentation to Council on 13 March. Ian used Survey Monkey to analyse results.

Inspection of the South West Passage

The South West Passage was a seaway connecting with the Moyne River with an adjacent wetland. In 1913 a causeway was built across the passage to enable access to the lighthouse. This has resulted in the accumulation of sand in the passage (and constant need to dredge the passage) and has also been linked to increased erosion on East Beach.



Meeting with Port Fairy Coastal Group dune erosion monitoring team: David Bills-Thompson and Nick Abbott, December 19-20

Beach erosion at East Beach was first identified at the night soil site (most southern of the two land fill sites) from PFCG review of aerial photography in 2011. Moyne Shire responded by installing seven initial measuring posts in 2012 and PFCG commenced monitoring of a 4.5km section of the beach with a laser level manual system.

In 2013, unusual erosion (one metre per year compared with the previously estimated three cm per year) was detected over the central section of the beach encompassing the two former landfill sites (a night soil site and a general tip site). Moyne Shire responded to the threat by installing a 30m length of two rows of wet sand fending at the night soil site later in 2013. Erosion at the general tip site led to construction of a Wave Energy Dissipation Structure (WEDs) to dissipate wave energy and to protect the dune toe from further erosion. The 150m structure was completed in June 2014 and proved to be successful in protecting the dune over the following winter, although some undercutting of the dunes at either end of the wall did occur.

The WEDs was then extended to 210m and two rows of 30m long double sand trap fences were added at either end in 2015.

Sand Fences

Two parallel 30m sand fences were installed in 2015 at either end of the 210m WEDs, located adjacent to the carpark near the Port Fairy Links Golf Course.

The two sand fences that had been installed further south, closer to the township, at the night soil site in 2013 have since been buried by sand as beach accretion has occurred over the past few years.

For every metre of fence height, approximately 6m of distance behind the fence will have effective protection.

The fences were installed at 1.5m above the sand level and are 1m in height. Posts are approximately 18cm in diameter and 2.3m apart and are reinforced with cable. The closest fence is approximately 5m from the toe of the dune.

The sand fences were strengthened after storms. It was noted that the outer sand fence is out of alignment in places due to wave pressure.

In some areas, a low fence has been installed in front of the toe of the dune with 1m stakes and covered with a geofabric material to provide shelter at the toe of the dune and encourage plant growth. Sand has built up to form a dune to approximately 1-2m in height behind these fences.



Wave Energy Dissipater Structures (WEDs)

A 210m long rock wall (WEDs) is located approximately 7m out from the dune toe. It comprises a double layer of large rock boulders.

Monitoring undertaken by PFCG has shown the WEDs to have provided effective protection of the dune toe from further erosion.



Laser-level monitoring

In 2012-13 monitoring commenced with 12 monitoring posts being installed along East Beach. The number of posts has since expanded to 30, comprising 20 at East Beach and another 10 at South Beach.

Monitoring posts 4 and 6 are now buried under the sand due to natural accretion of sand.

Monitoring posts are approximately 13 cm treated pine posts.

A rope is laid on sand perpendicular to the dune and measurements are recorded at 5m intervals, including the distance from the post to the toe of the dune.

A rope marked at 5m intervals is used and the rope is on a wooden reel.

Measurements from post to shoreline can be up to 100m long.

Time to monitor one site is approximately 7 minutes.

Three people in a team-one to measure, one to monitor and one to take photographs.

Port Fairy SLSC allows the Group the use of a room at the club and use of an ATV to do the monitoring.

Moyne Shire Council installed the monitoring posts.

Data from monitoring is recorded in Excel in a database developed by David using Excel's 'conditional formatting' program. David has kindly offered to use his spreadsheet to record our laser level monitoring results.



Drone Monitoring

Dr Blake Allen from Deakin University, Warrnambool is teaching the PFCG members how to fly the drone, as part of the Victorian Coastal Monitoring Program. Drone monitoring is done around every 6-8 weeks over the central area of East Beach, with supplementary laser level monitoring continuing at either side of the extent of drone monitoring.

Drone monitoring data is being analysed by Deakin Uni but PFCG is also entering data into an Excel spreadsheet. Drone monitoring results are integrated with the laser level monitoring results.

Drone data also uses AHD.

Drone limitations:

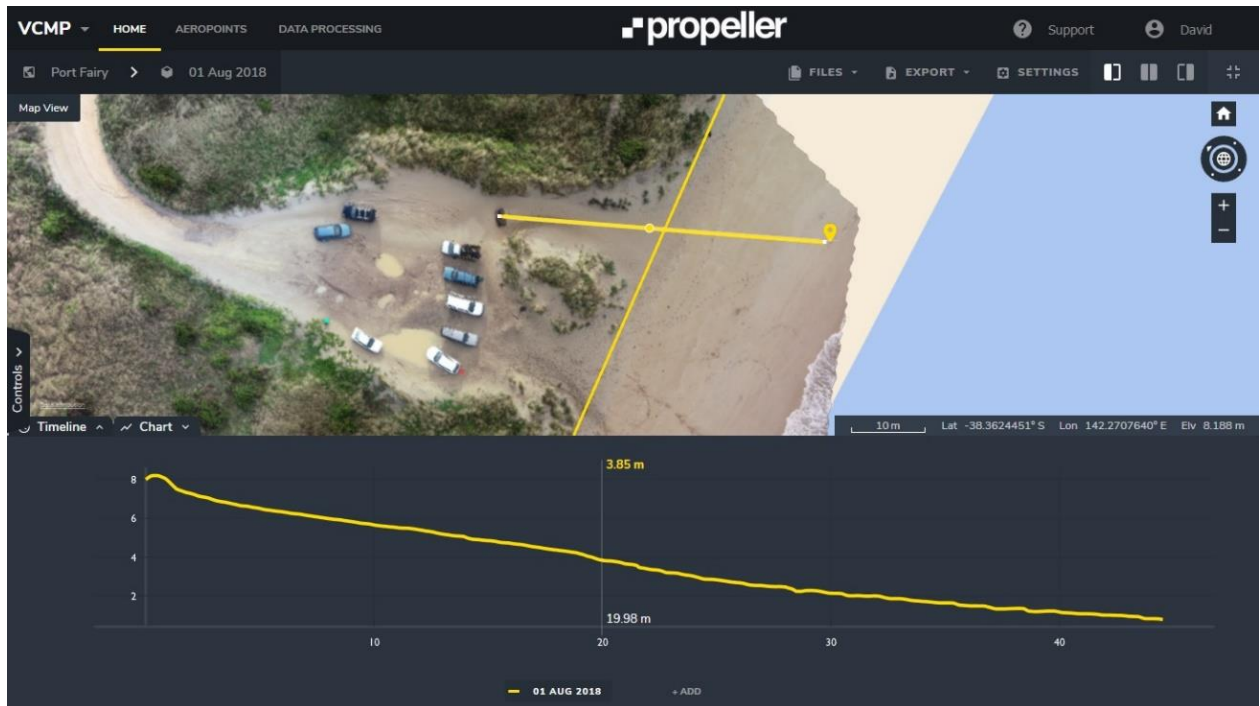
- Unable to take measurements in shallow water (water depth needs to be <1m)
- Weather dependent

Deakin University drone footage can be viewed at the following website:

www.propelleraero.com

Login: vcmp@deakin.edu.au

Password: propellervcmp



Revegetation

Moynes Council carried out a revegetation program on the dune slope behind the sand fence but the dune is now dominated by Marram Grass and Sea Spurge. It is not known what species were originally planted by the Council.

Matting was first placed on the dune slope and then revegetation took place.

East Beach dunes are dominated by Marram Grass and Sea Spurge. In early 1900's Marram Grass was grown at Port Fairy and exported to other countries.

Very little Hairy Spinifex (*Spinifex sericeus*) was apparent. It has been outcompeted by introduced Marram Grass. Occasional Coast Fescue (*Poa labillardierei*) is present. Scattered patches of Coast Everlasting (*Ozothamnus turbinatus*) bushes were spotted.

Patches of Bower Spinach (*Tetragonia implexicoma*) are colonising the dunes in some areas.



Sand re-nourishment

Sand re-nourishment has not been carried out at East Beach. Sand has accreted naturally on East Beach in recent times as evidenced by some of the monitoring posts and one of the sand fences being buried by sand.

Port Fairy Harbour

Dredging and pumping of sand slurry from the South West Passage appeared to be taking place, with the slurry being piped over the rock wall and onto the beach.

Deakin University's 'Yolla' research vessel was seen profiling sand levels offshore.



Surf Life Saving Club Beach Access

The construction of a new concrete disability pedestrian path and an ATV access path to the beach outside the Surf Lifesaving Clubrooms has just been completed. As indicated in the photographs, the rock walls and concrete paths present as an urbanised character, compared with the current situation at Inverloch surf beach.

A consultation session is being held in January 2019 to gain community feedback on a draft masterplan for Port Fairy East Beach.



Timber groynes

A number of old timber sand groynes are still in existence to the west of the Lifesaving Club.



Pea Soup Beach

A large rock wall has been constructed at Pea Soup beach to protect private houses with contributions for funding from both the Council and private landholders. The revegetation area consists almost entirely of Sea Spurge and Marram Grass.



General

Other groups carrying out similar monitoring work in Australia: Bengello Beach north of Moruya Heads, NSW (group has been monitoring for 40 years), Collaroy Beach near Narrabeen, Sydney and Tasmania. Also Indented Head, Victoria.

Key Points from Port Fairy visit

- Sand fencing can be an effective short-term measure.
- Sand fence needs to be flanged at either end towards the sea to stop erosion at either end.
- Would be useful to record weather conditions such as wind speed and direction. Also wave height and direction when carrying out the beach monitoring –possible link between beach erosion and El Nino events.
- Opportunity to revegetate with native species such as Hairy Spinifex on the dune behind the sand fence.
- Benefits of revegetating with Hairy Spinifex which will form a low incipient dune compared with Marram Grass which forms a steep-sided dune and is not suitable for shorebird habitat.
- Bower Spinach is a good sand-binder on East Beach, together with Rounded Noon-flower (*Disphyma crassifolium* subsp. *clavellatum*) and Coast Wattle (*Acacia longifolia* subsp. *sophorae*).
- Need to liaise with David Martin re appropriate plant species lists for sand dune restoration.
- Mitigation measures for coastal erosion require a two-prong approach- a combination of artificial structures such as rock walls and sand fences as well as sand re-nourishment and revegetation of the sand dunes.
- Need to engage with and receive support from Bass Coast Shire Council
- BCSC to assist with installation of the monitoring posts with a backhoe and to purchase some of the monitoring equipment such as a laser level, staff, tape measure and a rope marker set up on a wooden reel measuring up to 100m.
- Future strategies for Inverloch Coastal Resilience Project
- Questionnaire - Need to go 'to the people' with the questionnaire, e.g. cafes and also distribute questionnaires outside of Inverloch in towns such as Venus Bay and Cape Paterson and visitors from towns such as Leongatha, Warragul and the Latrobe Valley.
- Develop an overall strategy for the project and potential interactions with Governmental Working Group by way of a flow chart, including stakeholder engagement
- Rename project as Inverloch Coastal Resilience Project.