Inverloch Coastal Resilience Project

Inverloch Beach Monitoring Report

August 2018 to June 2020

South Gippsland Conservation Society Inc.

South Gippsland Conservation Society

Celebrating over 40 years of conservation

LORD MAYOR'S CHARITABLE FOUNDATION

EXECUTIVE SUMMARY

This report analyses the results of drone and laser level beach profile monitoring undertaken by South Gippsland Conservation Society (SGCS) volunteers along Inverloch surf beach and in Anderson Inlet between August 2018 and June 2020. The drone monitoring is being undertaken under the State Government's Victorian Coastal Monitoring Program, with training and support provided by researchers at Deakin and Melbourne universities. The laser level monitoring is supported by members of the Inverloch Coastal Protection Working Group, including the Department of Environment, Land, Water and Planning, Bass Coast Shire and Parks Victoria. Surveys are conducted every 4-6 weeks, and after storm events, over the 6 kilometre section of coastline from Flat Rocks to Screw Creek.

Since the monitoring commenced, more than 115,000 cubic metres of sand has been lost from the surf beach. The vegetated dunes behind the beach have receded from 9 to 20 metres between the Surf Life Saving Club and the Ozone Street access track, and the level of the beach has dropped by up to one metre. Pt Norman has experienced dune recession of 80 metres over the 21 month monitoring period, with the majority of this recession occurring between October 2019 and April 2020. These changes are in addition to the average 40 metres of coastline recession that occurred at the surf beach between 2013 and 2018, prior to the monitoring program commencing.

The analysis finds that coastline recession at Inverloch surf beach is accelerating, with the annual rate of coastline recession that has occurred between 2018 and 2020 exceeding the annual rate of recession between 2013 and 2018.

With protection works having been installed in front of the Surf Club and at the Cape Paterson Road/Toorak Road intersection, the most vulnerable, unprotected locations on the surf beach are at Wreck Creek and Flat Rocks:

- At Wreck Creek, west of the Surf Club, the April/May 2020 storms created a new opening to the ocean, with the remaining dune width between the creek and the ocean currently varying between 3-10 metres. Without protection, and if the current rate of recession (7 metres per year) continues, further breaches are likely to occur within the next 6-12 months, threatening the ecological values of the Wreck Creek system and leaving Surf Parade and adjoining residences exposed.
- At Flat Rocks, while only one metre of coastline recession has been recorded since 2018, the remaining mature Coast Banksia trees are already vulnerable and will be undermined within the next two years without protection, leaving the adjacent section of Cape Paterson Road at risk.
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The monitoring results support the findings and recommendations SGCS presented in its '*Inverloch Coastal Resilience Project Report*' released in August 2019 and our '*Coastline in Crisis'* documentary of May 2020 (www.sgcs.org.au). As well as providing further input to the long-term planning for the Inverloch coastline, the analysis highlights the need for short-term protection works to be implemented beyond the Surf Club and Cape Paterson Road sites while the Coastal Hazard Assessment study and RaSP processes continue. Based on the analysis of weather conditions contained in the report, August to December is a high risk period for the coastline. Further short- term protection involving regular dune renourishment over the remainder of 2020 will be necessary to avoid irreversible changes to coastline values.

TABLE OF CONTENTS

1.0 INTRODUCTION AND BACKGROUND

This report presents results of the drone and laser level beach monitoring surveys undertaken at Inverloch by South Gippsland Conservation Society (SGCS) volunteers at Inverloch between August 2018 and June 2020:

- Drone monitoring began in August 2018, covering the section of the Inverloch coastline between the Surf Life Saving Club and Point Hughes.
- Laser level monitoring began in September 2019 covering a wider area, from Flat Rocks, at the western end of the surf beach, to Screw Creek, in Anderson Inlet, east of Inverloch Township.

The report also provides an analysis of weather conditions experienced at Inverloch over 2019/2020, outlines other observations of coastline changes and draws a number of conclusions and recommendations.

It should be noted that monitoring commenced in 2018 after Inverloch Surf Beach had already experienced sustained coastline recession between 2013 and 2018. As detailed in SGCSs *'Inverloch Coastal Resilience Project'* (ICRP) report (August, 2019) and our *'Coastline in Crisis'* documentary, the average dune recession at Inverloch surf beach, between 2013 and 2018, was in the order of 40 metres. This equates to an average rate of coastline recession of 7 metres/year. Over the same period, the beach level lowered by more than 1.5 metres.

A preliminary analysis undertaken by geomorphologists Neville Rosengren and Tony Miner for ICRP estimated that the loss of sand from dune recession and beach lowering at Inverloch Surf Beach between 2013 and 2017 was in the order of 360,000 cubic metres. This equates to an annual loss of sand of 72,000 cubic metres.

2.0 DRONE MONITORING

Introduction

SGCS volunteers have been trained to operate drones under the State Government's Victorian Coastal Monitoring Program, with assistance from Karina Sorrell and Blake Allan from Melbourne and Deakin Universities. The current survey area extends from the Inverloch Surf Life Saving Club to the Abbott Street lagoon, within Anderson Inlet. Surveys are undertaken at approximately six-week periods to record changes that are occurring in the position of the toe of the dunes and in the beach level within the survey area.

Results

Between August 2018, when the drone monitoring commenced, and January 2020, the results have indicated that more than 100,000 cubic metres of sand was removed from the Surf Beach. Point Norman experienced a net loss of almost 50,000 cubic metres between August 2018 and January 2020, with an additional 16,500 cubic metres loss between January and May 2020. Over the 2018-2020 period, this equates to an annual loss of sand over the length of the Surf Beach of 82,000 cubic metres.

The dunes have receded between 9 and 20 metres between the Surf Life Saving Club and the Ozone Street access track over the monitoring period, while at Pt Norman, a retreat of over 80 metres was recorded between August 2018 and May 2020:

- Surf Club: 8.6m dune recession over the monitoring period, comprising:
  - 5.4m recession between 22/08/18 and 03/09/19
  - 3.2m recession between 03/09/19 and 13/05/20
    - including 3.3m recession between 28/01/20 and 13/05/20
  - This cross section was taken at approximately the same location as laser level monitoring position SP 5 (refer next section).
- Between Surf Club and Wave Street track: 10.1m dune recession over the monitoring period, including:
  - 9m recession between 22/08/18 and 03/09/19
  - 1.7m recession between 28/01/20 and 13/05/20
- Wave Street access track: 12.1m dune recession over the monitoring period, including:
  - 10.8m recession between 22/08/18 and 03/09/19
  - 2.1m recession between 28/01/20 and 13/05/20

  The cross section below was taken at this location, extracted from the Propeller Aero website. This cross section is at approximately the same location as laser level monitoring site SP 6.

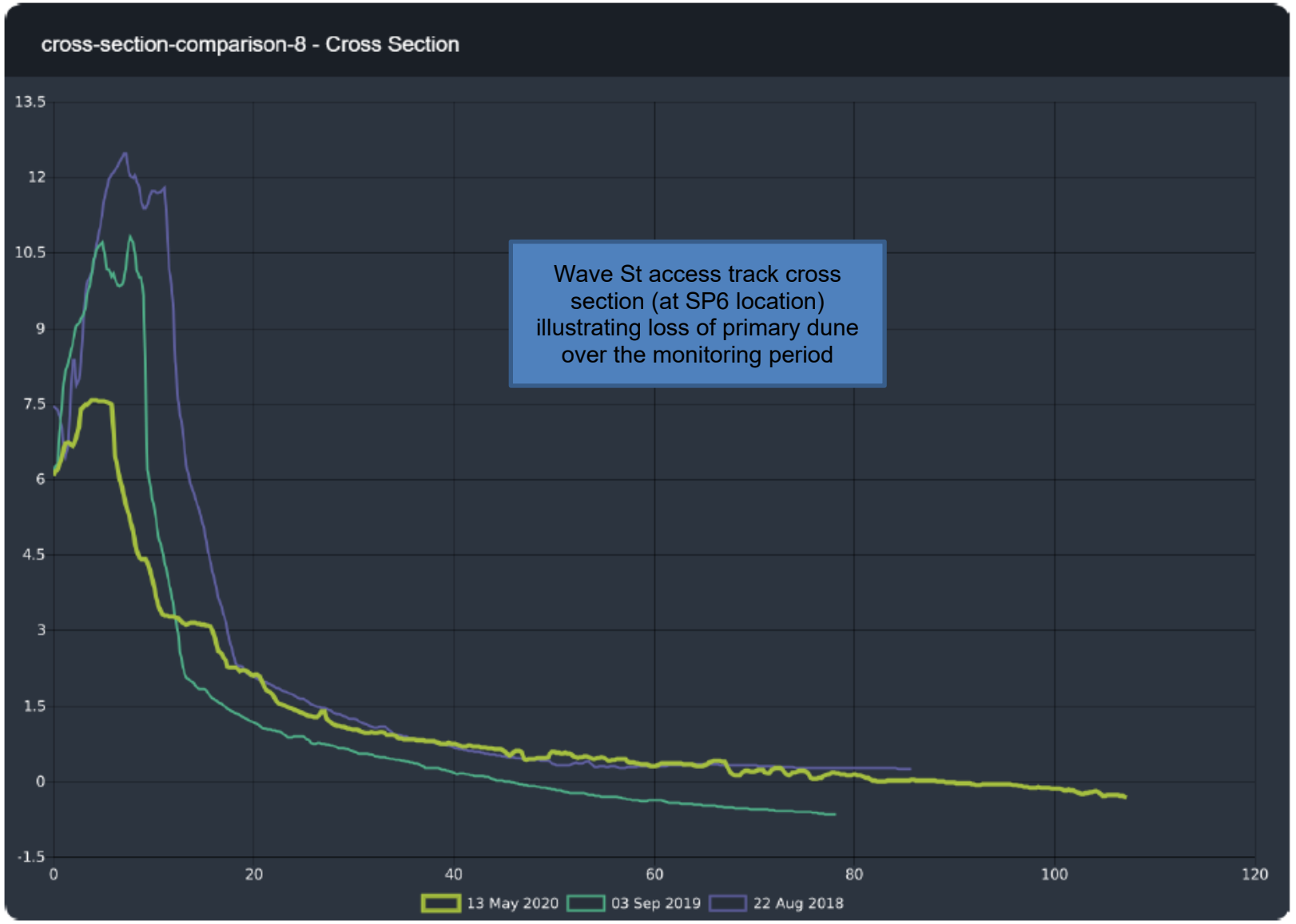


Figure 1 Propeller Aero Cross Section Wave St (Source: Propeller Aero software)

- Ozone Street track: 19.7m dune recession over the monitoring period, including:
  - 12.4m between 22/08/18 and 03/09/19
  - 1.6m between 28/01/20 and 13/05/20
- Pt Norman: 80m dune recession over the monitoring period, including:
  - 16m recession between 22/08/18 and 03/09/19
  - 48 m recession between 03/09/19 and 28/01/20
  - 16m recession between 28/01/20 and 13/05/20

    The cross section below was taken at this location, extracted from Propeller Aero website. This cross section was taken at approximately the same location as laser level monitoring site SP 7.

The level of the beach has also dropped between 25cm and one metre over the survey period.

Results from the July 2020 drone survey indicated that some rise in beach level has occurred since the May 2020 survey, consistent with the benign weather conditions that have been prevalent over this period. No change in dune toe locations were recorded and the level of the beach rose as follows:

- Between Surf Club and Wave Street access track: 0.3 m
- East of Wave Street access track: 0.4 m
- Near Ozone Street access track: 0.3 m
- Pt Norman: 0.7 m.

SGCS has submitted a request for the drone monitoring to extend further west from the Surf Club, in order for the at-risk Wreck Creek and Flat Rocks sections to be monitored, as detailed in the following section.

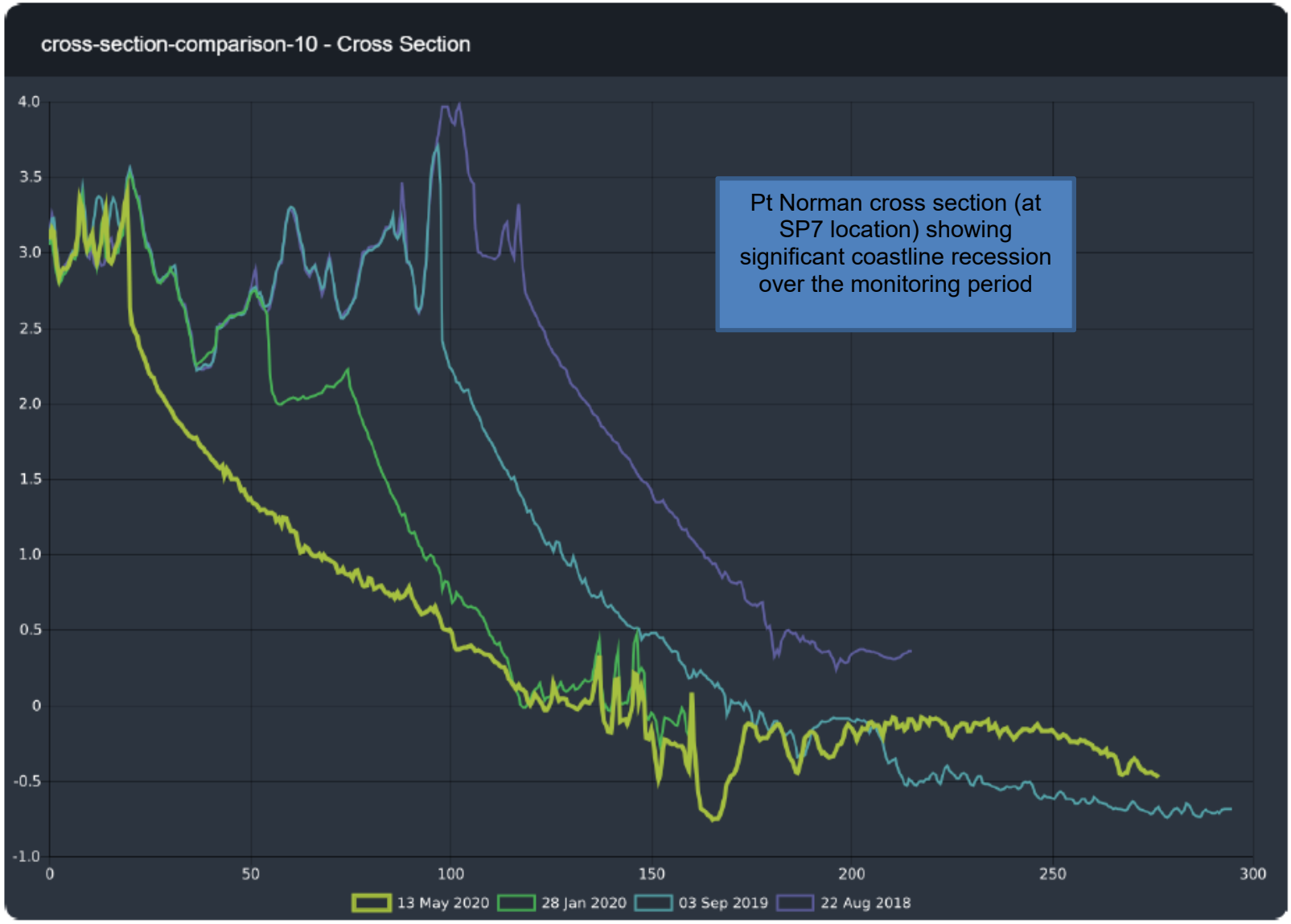


Figure 2 Propeller Aero Cross Section Pt Norman (Source: Propeller Aero software)

3.0 LASER LEVEL MONITORING

Introduction

SGCS volunteers monitor ten sites on the Inverloch main surf beach and in Anderson Inlet, over a wider area than covered by the drone monitoring:

- SP1-SP7 are located on the main surf beach, between Flat Rocks and Pt Norman
- SP8- SP10 are located in Anderson Inlet, between the Abbott Street lagoon and Screw Creek.

The locations of the laser level survey points are shown in Appendix A.

The sites were selected in consultation with the Inverloch Coastal Protection Working Group and posts were installed in August 2018 with assistance from Parks Victoria, Bass Coast Shire Council and the Department of Land, Water, Environment and Planning.

Monitoring is normally undertaken every four weeks by our team of volunteers. Surveys are also carried out after storm surge events. David Bills-Thompson, from the Port Fairy Coastal Group, has provided valuable advice throughout the setting up and establishment phases, including configuring the results spreadsheets.

A laser level was purchased by SGCS from Its Inverloch Coastal Resilience Project funds, with assistance from the Lord Mayor's Charitable Foundation.

The laser level monitoring is undertaken to supplement the drone monitoring. Comparison of the results of the two monitoring techniques in late 2019, undertaken with the assistance of Dr Blake Allan from Deakin University, demonstrated there was close correlation between the drone monitoring and the laser level monitoring results. The drone monitoring technique has a level of accuracy of 3-5cm horizontal accuracy and 5-10 cm vertical accuracy.

Status of Reference Points

In the establishment phase, six new reference posts were installed (SP1, SP3, SP4, SP6, SP7, SP9) and four sites utilised existing infrastructure:

- SP2 – central post of Cape Paterson Road wet sand fence site
- SP5 – central post of Surf Club wet sand fence
- SP8 – staircase post adjacent to Ramsey Boulevard, east of Abbott St lagoon
- SP10 – existing fence post, adjacent to Screw Creek walk, west of Screw Creek.

Of the 6 new posts installed, posts have been lost due to coastline recession associated with storm surges at three sites:

- SP3 – post lost during storm surge of 11 April 2020, replaced in June 2020
- SP4 - post lost in January 2020, replaced in June 2020
- SP7 – multiple posts lost: first post lost in August 2019, second post lost in April 2020.

At SP4, a temporary reference point was established at the back of the dune, and has since been replaced by a new steel pipe post.

At SP7, a reference point (star picket) has been established 90 metres inland from original post.

At SP8, a timber post was installed during 2019 on the Inlet-side of the 2nd Lagoon. This post has become unstable and monitoring has reverted to a reference point utilising existing infrastructure near the staircase post. This reference point has a better line of site than the original staircase post.

Further coastline recession at SP10 will threaten the integrity of the fence-post, but it was stable at the time of writing (June 2020).

A new reference point utilising existing infrastructure has been established at SP1a – East Flat Rocks and a new reference point also utilising existing infrastructure is proposed for SP2a – eastern end of rock wall, when the rock wall construction is complete.

Results

Monitoring commenced on 17 September 2019, with further surveys conducted on 30 October 2019, 28 November 2019, 5 December 2019, 17 January 2020, 25 February 2020, 15 April 2020, 16 June 2020 and 27 June 2020. The onset of the COVID-19 virus forced a break in the program during May 2020.

Excel spreadsheet survey results to date have been provided separately. Annotated copies of the results at each of the monitoring sites are provided below, and a chart showing the extent of coastline recession at each site is included below.

SP1 – Flat Rocks

- Between September 19 and June 20 there has been:
  - 0.8m dune recession, with almost all of this recession occurring since 25/02/20
    - No appreciable accretion was recorded over the 19/20 Summer between 05/12/19 and 25/02/20
  - 0.4m drop in beach level at the post - the drop in level extends from the post to 30m seaward
    - 0.6m drop in beach level has occurred since 25/02/20, following an earlier 0.2m rise in level

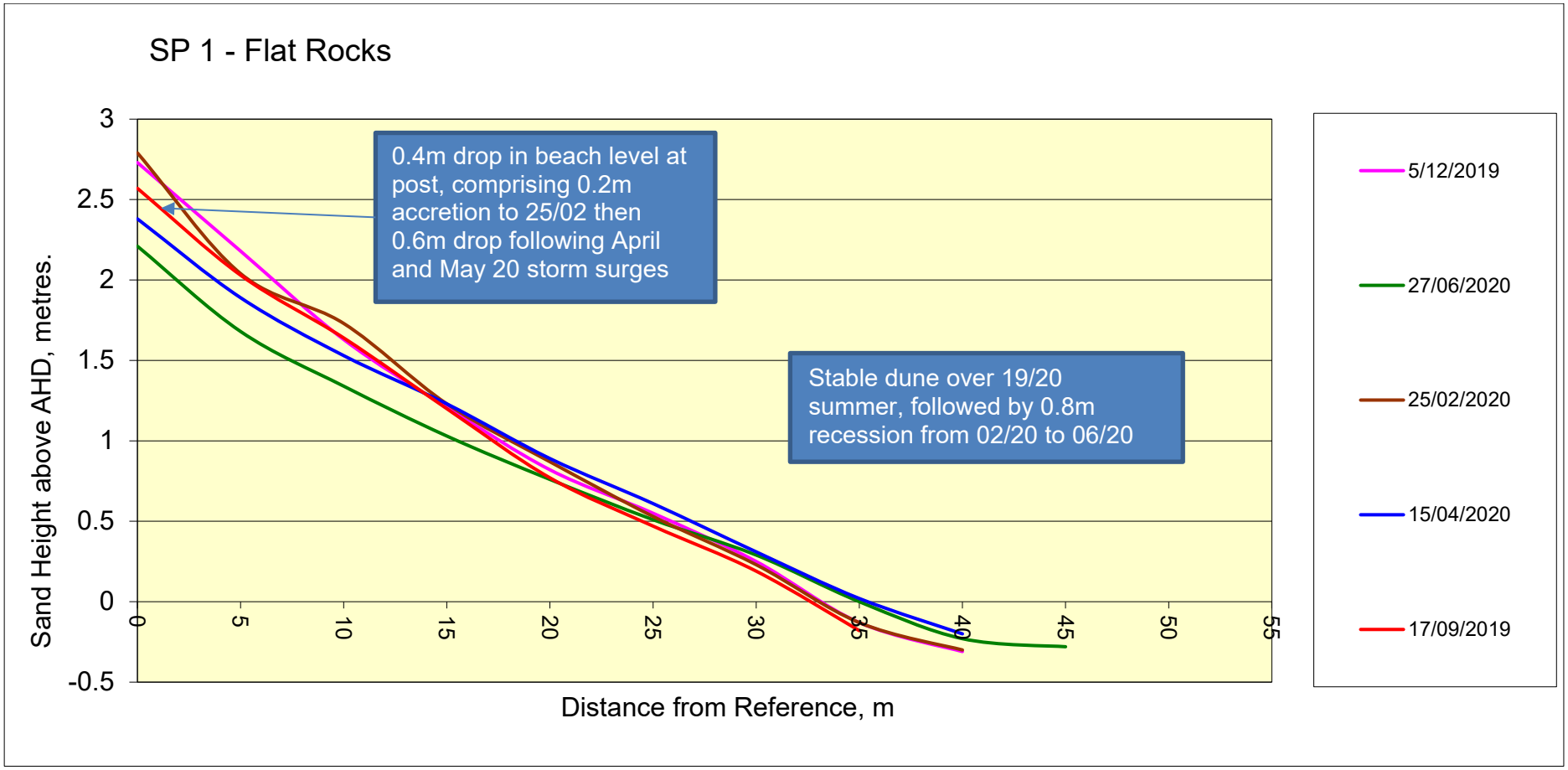


Figure 3 Laser Level Monitoring Chart SP1 – Flat Rocks

SP2 – Cape Paterson Road wet sand fence

- Between October 19 (first survey at this site on 30/10/19) and May 20 (04/05/20) there has been:
  - 7.3m dune recession, which occurred mainly between 28/11/19 and 05/12/19
    - Some accretion (0.1m) was measured over the 19/20 summer between 05/12/19 and 25/02/20
  - 0.6m drop in beach level at the wet sand fence, including a drop of 0.2m between 25/02/20 and 04/05/20
    - This drop occurred during the two storm surge events that occurred in early April 20, as photographs taken in late March 20 show the wet sand fence almost completely covered by sand
- This site was not surveyed in June 20 due to the rock wall construction.

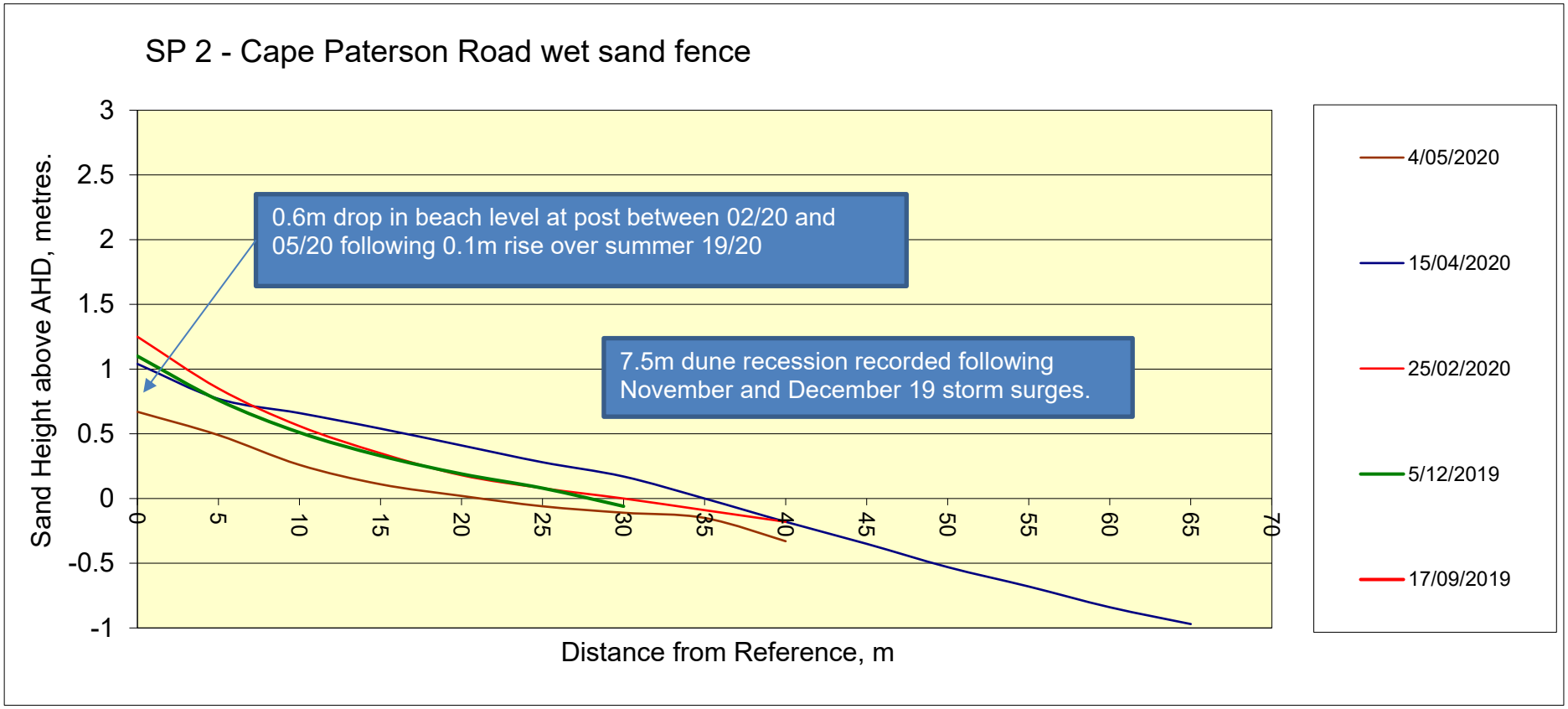


Figure 4 Laser Level Monitoring Chart SP2 – Cape Paterson Road wet sand fence

SP3 – Amazon Shipwreck site (between Cape Paterson Road wet sand fence and Wreck Creek)

- Between September 19 and June 20:
  - 4.9m dune recession from 17/09/19 to 16/06/20
    - This overall recession includes 6.7m recession since 25/02/20
  - 0.8m drop in sand level overall, with 1.0m drop between 25/02/20 and 27/06/20

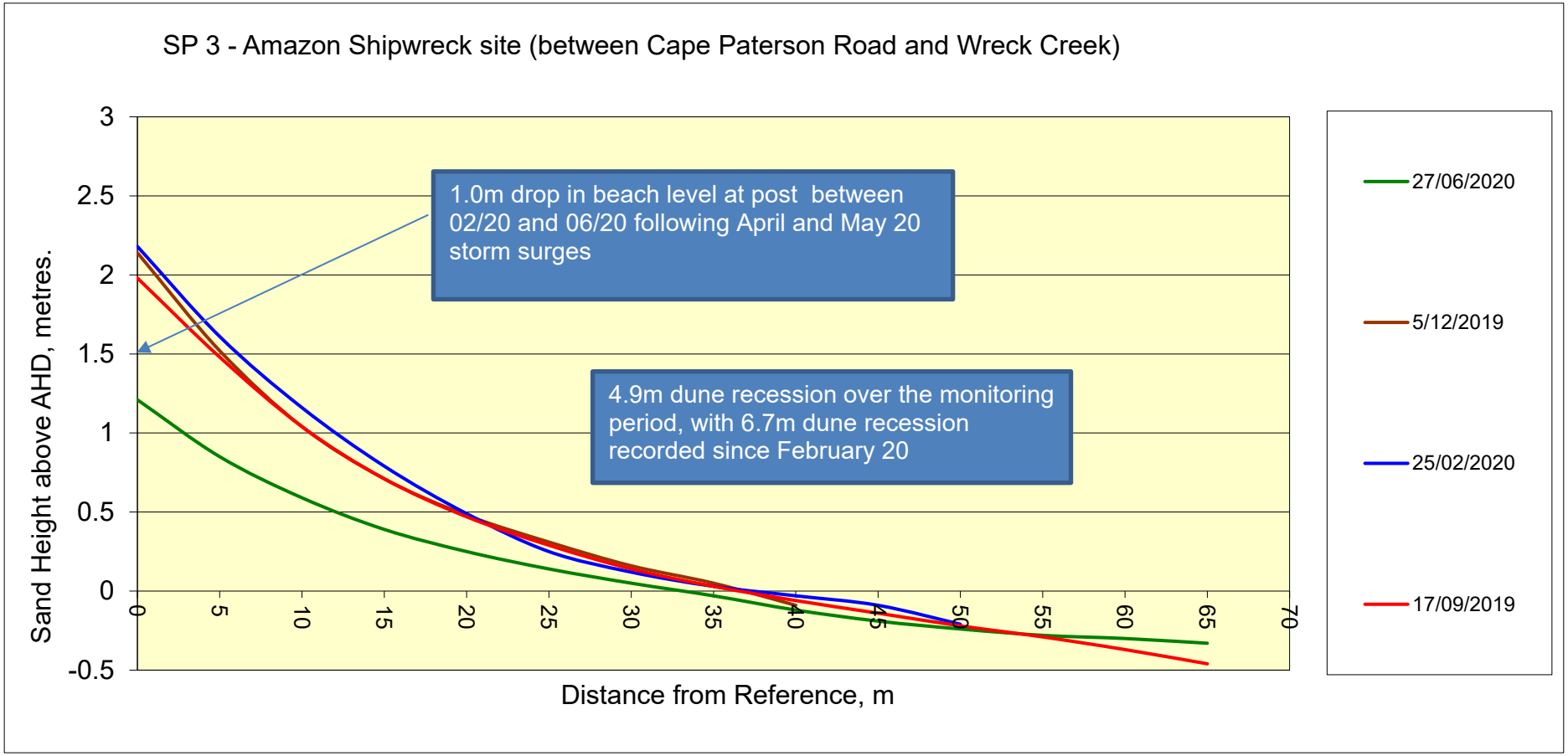


Figure 5 Laser Level Monitoring Chart SP3 – Amazon Shipwreck site

SP4 – Wreck Creek site

- Between September 19 and June 20:
  - 3.2m dune recession between 17/09/19 and 27/06/20, including:
    - 0.7m accretion between 05/12/19 and 25/02/20
    - 3.9m recession between 25/02/20 and 27/06/20
  - 0.1m drop in beach level between 17/09/19 and 27/06/20
    - This includes a 0.7m drop in level between 25/02 and 27/06

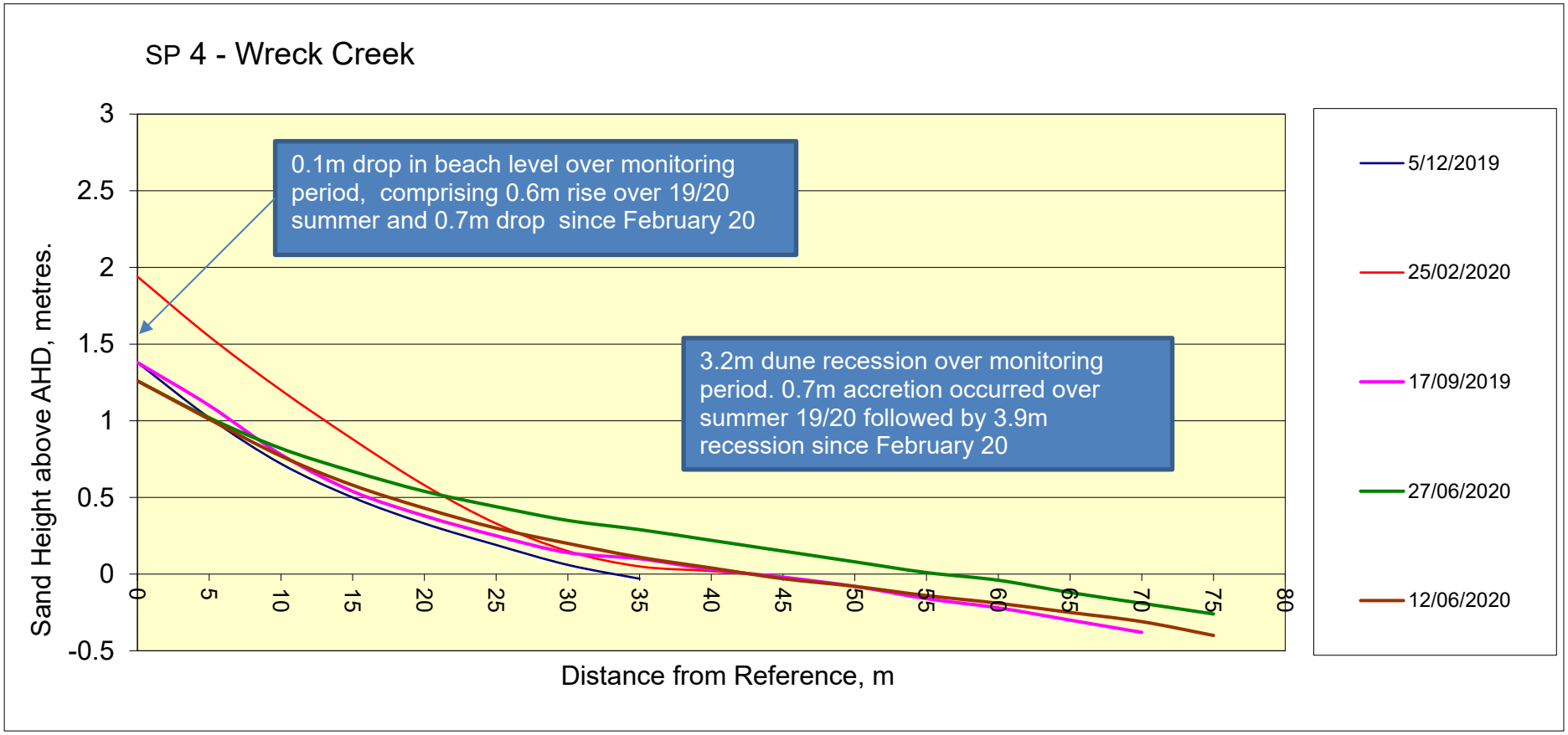


Figure 6 Laser Level Monitoring Chart SP4 – Wreck Creek Site

SP5 – Surf Club wet sand fence site

- Toe of dune accreted by 4.6m between 30/10/19 and 12/06/20, including:
  - 2m recession between 30/10 and 05/12
  - 1.6m accretion between 05/12 and 17/01
  - Readings since January 20 have been affected by construction of the sand bag wall – the 4.6m accretion recorded was due to the toe of the dune being measured at the base of the sand bag wall
- There were no survey results for September 19 as the wet sand fence had not been constructed, or between January 20 and March 20 due to construction of the sand bag wall
- Sand level was higher (0.53m) from the wet sand fence post to 50m out to sea at the time of the April 20 survey, most likely due to dune renourishment that was undertaken during construction of the sand bag wall. Prior to construction of the sand bag wall, recorded beach levels were:
  - 0.1m drop between 28/11/19 and 05/12/19
  - 0.3m rise between 05/12/19 and 17/01/20

SP6 – Wave Street Track

- Toe of dune receded by 0.8m between 17/09/19 and 12/06/20, including:
  - 0.6m recession between 17/09 and 05/12
  - 1m accretion between 05/12 and 25/02
  - 1.2m recession between 25/02 and 12/06
- Sand level at the post increased by 0.1m between 17/09/19 and 12/06/20
  - This includes a 0.1m drop between 25/02 and 12/06
- Sand level from 5-40m on the seaward side of the post rose by 0.1m overall in the period, including:
  - 0.2m drop in level between 17/09 and 05/12
  - 0.5m rise in level between 05/12 and 25/02
  - 0.6m drop in level between 25/02 and 15/04
  - 0.2m rise in level between 15/04 and 12/06

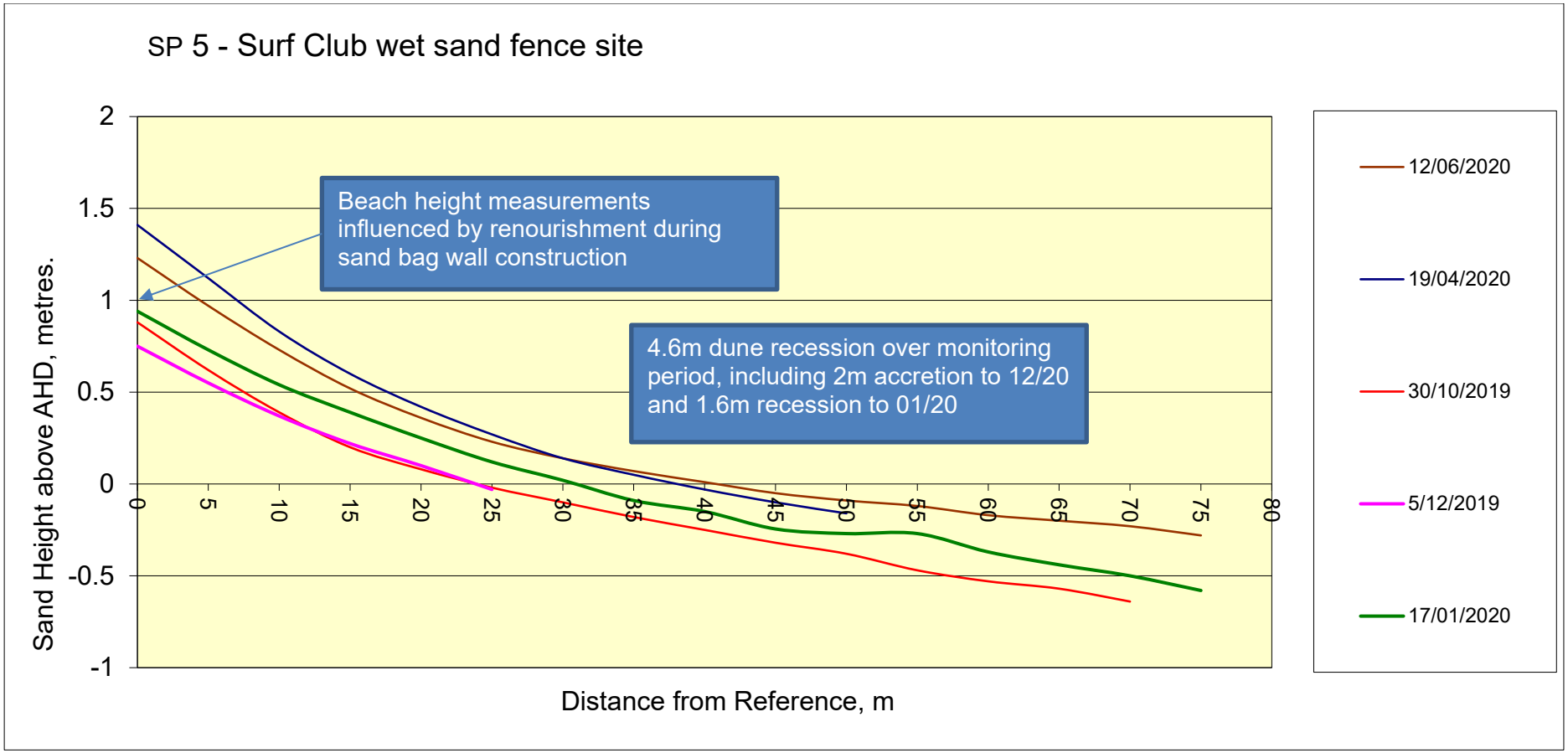


Figure 7 Laser Level Monitoring Chart SP6 – Surf Club Wet Sand Fence Site

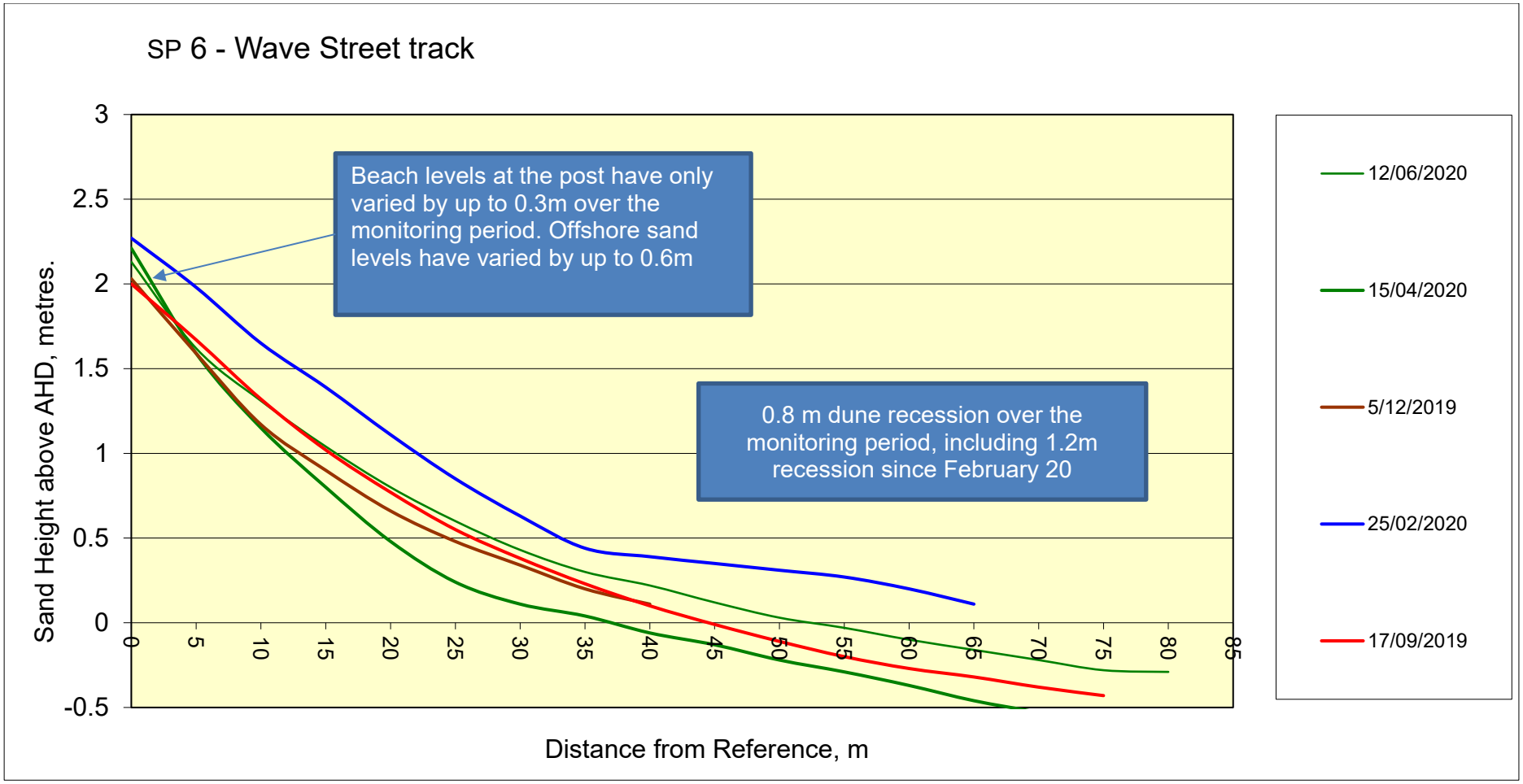


Figure 8 Laser Level Monitoring Chart SP6 – Wave Street Track

SP7 – Pt Norman

- Toe of dune has receded by 70m between 17/09 and 12/06, including:
  - 28m recession between 30/10 and 28/11
  - 30m dune recession between 25/02 and 15/04
  - No additional recession between 15/04 and 1/06
- Sand level on the seaward side of current reference point has dropped by at least 1.6m

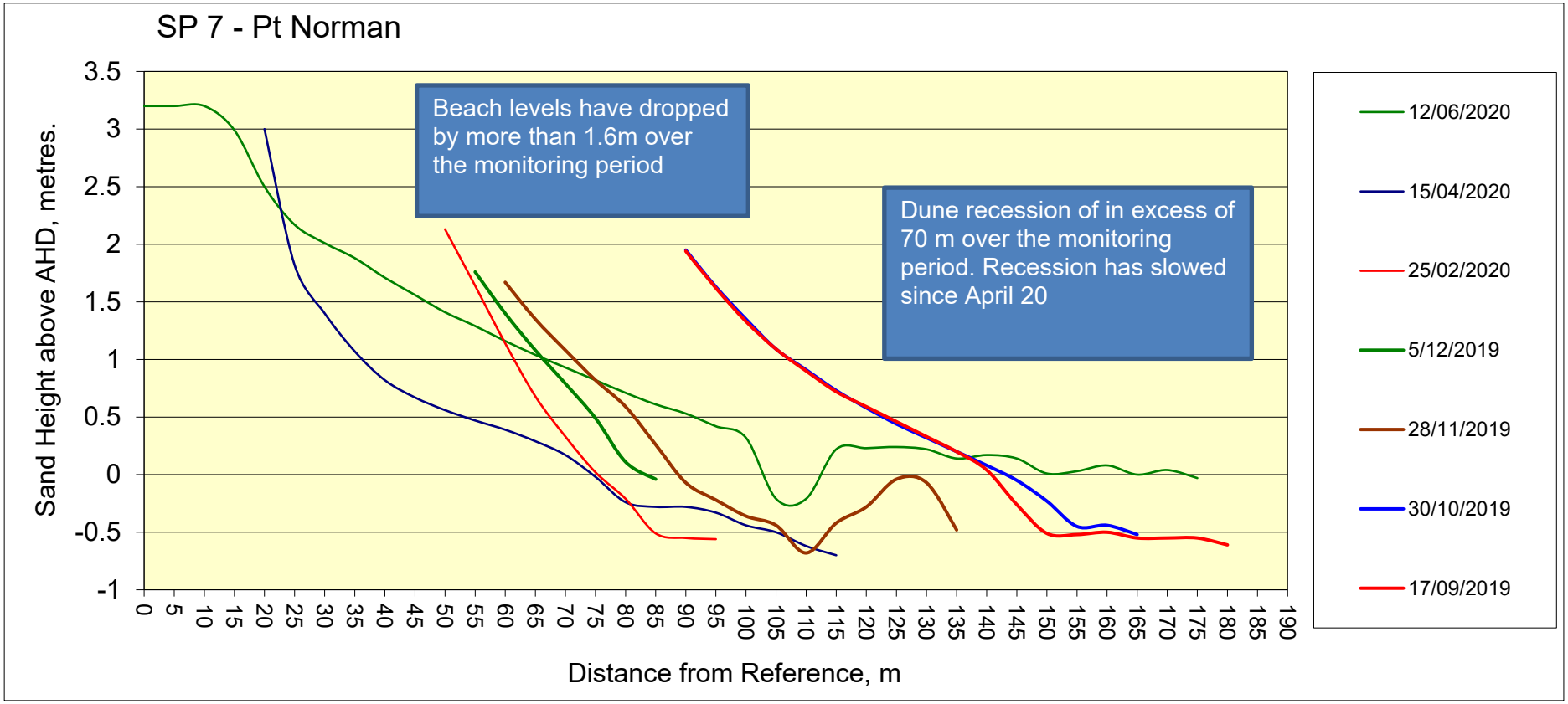


Figure 9 Laser Level Monitoring Chart SP7 – Pt Norman

SP8 – Abbott St Lagoon

- The dune system profile has generally been stable over the monitoring period, except for:
  - Drop in sand level of 1.3m close to the Anderson Inlet shoreline

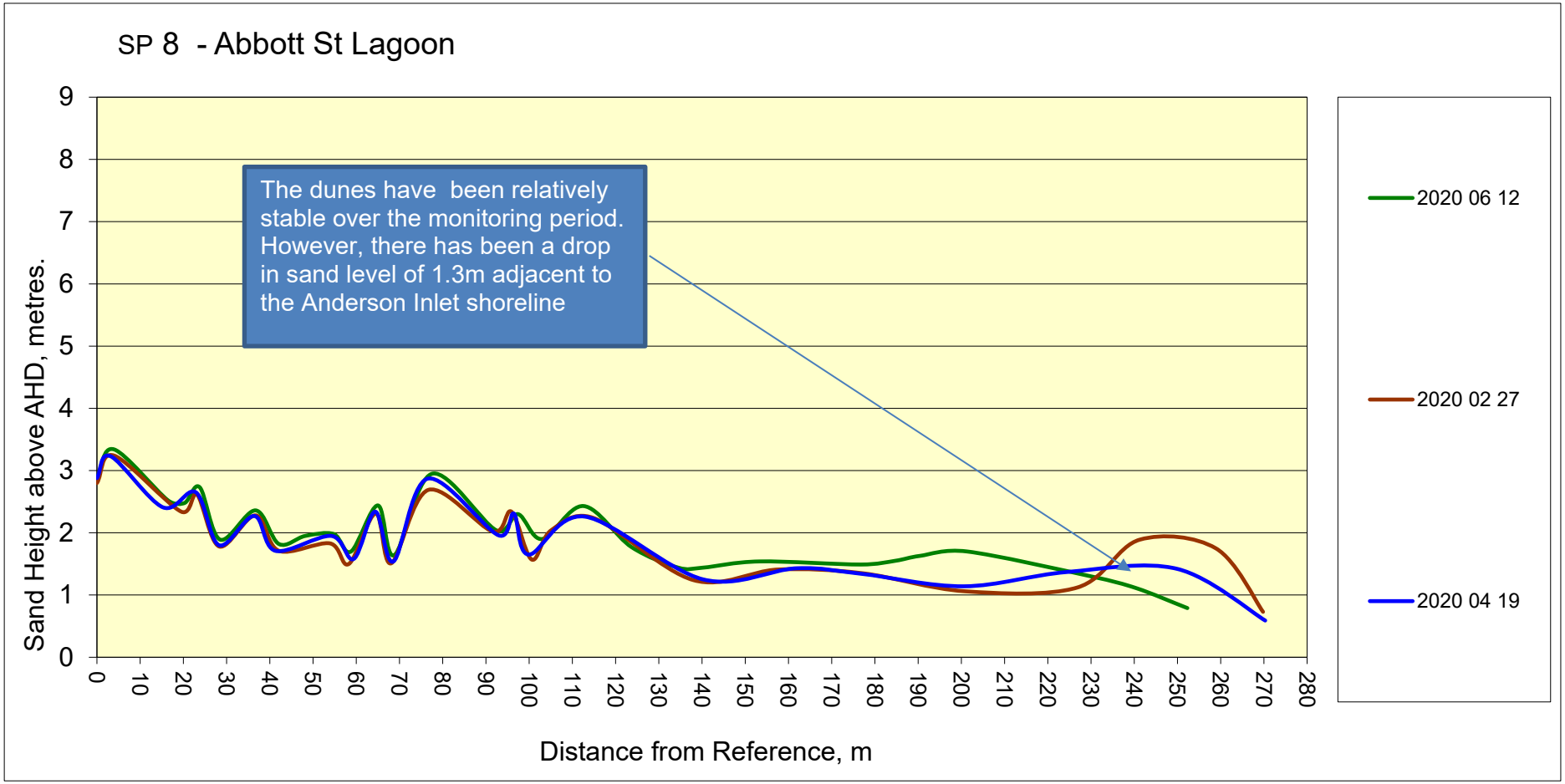


Figure 10 Laser Level Monitoring Chart SP8 – Abbott St Lagoon

SP9 – Angling Club

- No change in position of toe of dune
- Rise in sand level of 0.4m between 17/09 and 15/04:
  - Mainly between September 19 and February 20

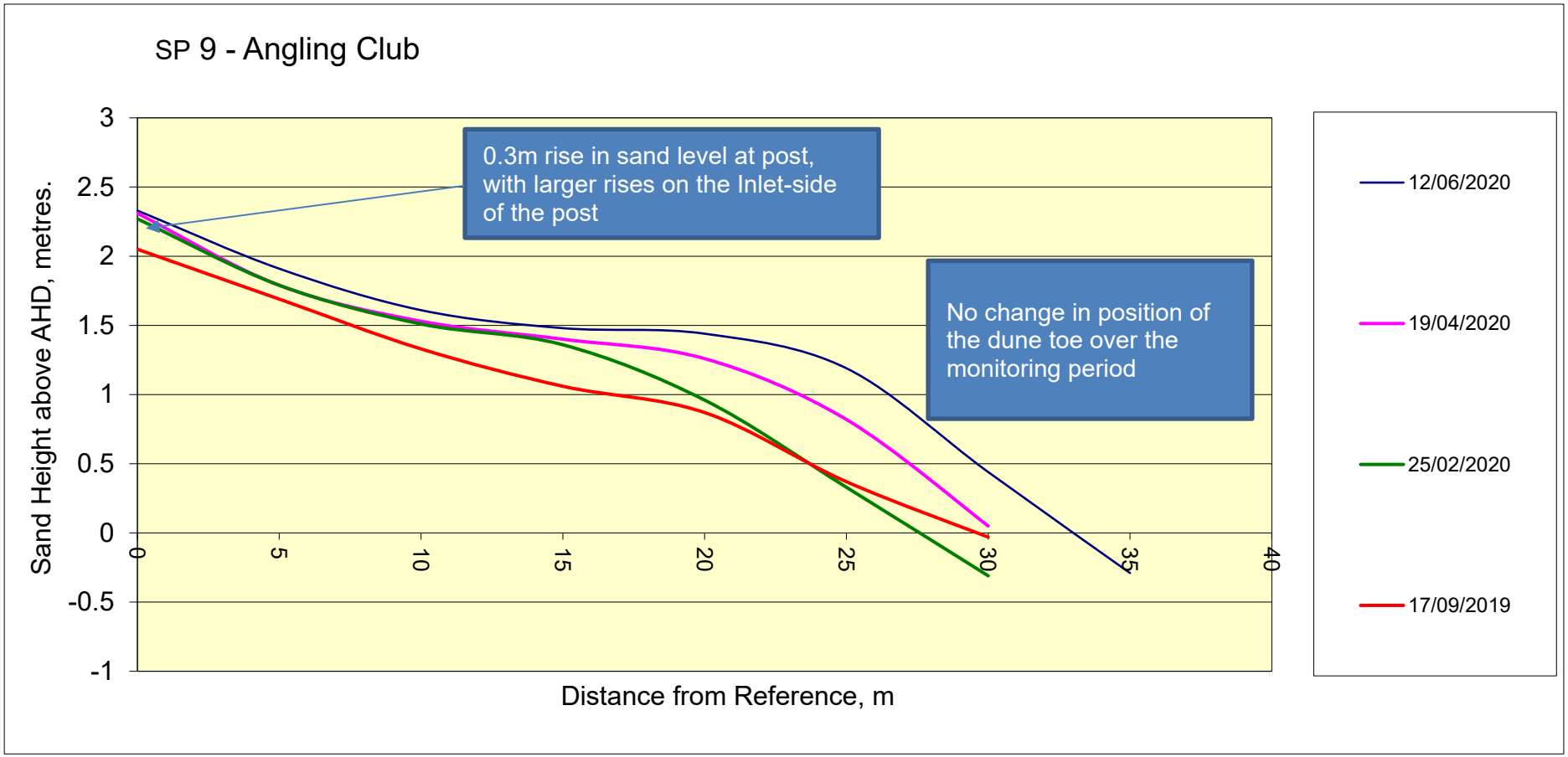


Figure 11 Laser Level Monitoring Chart SP9 – Angling Club

SP10 – Screw Creek

- Distances to toe of dune impacted by reconstruction of path
- 0.2m drop in sand level at post between 17/09 and 19/04, including:
  - A rise in level between 2-10m from post.

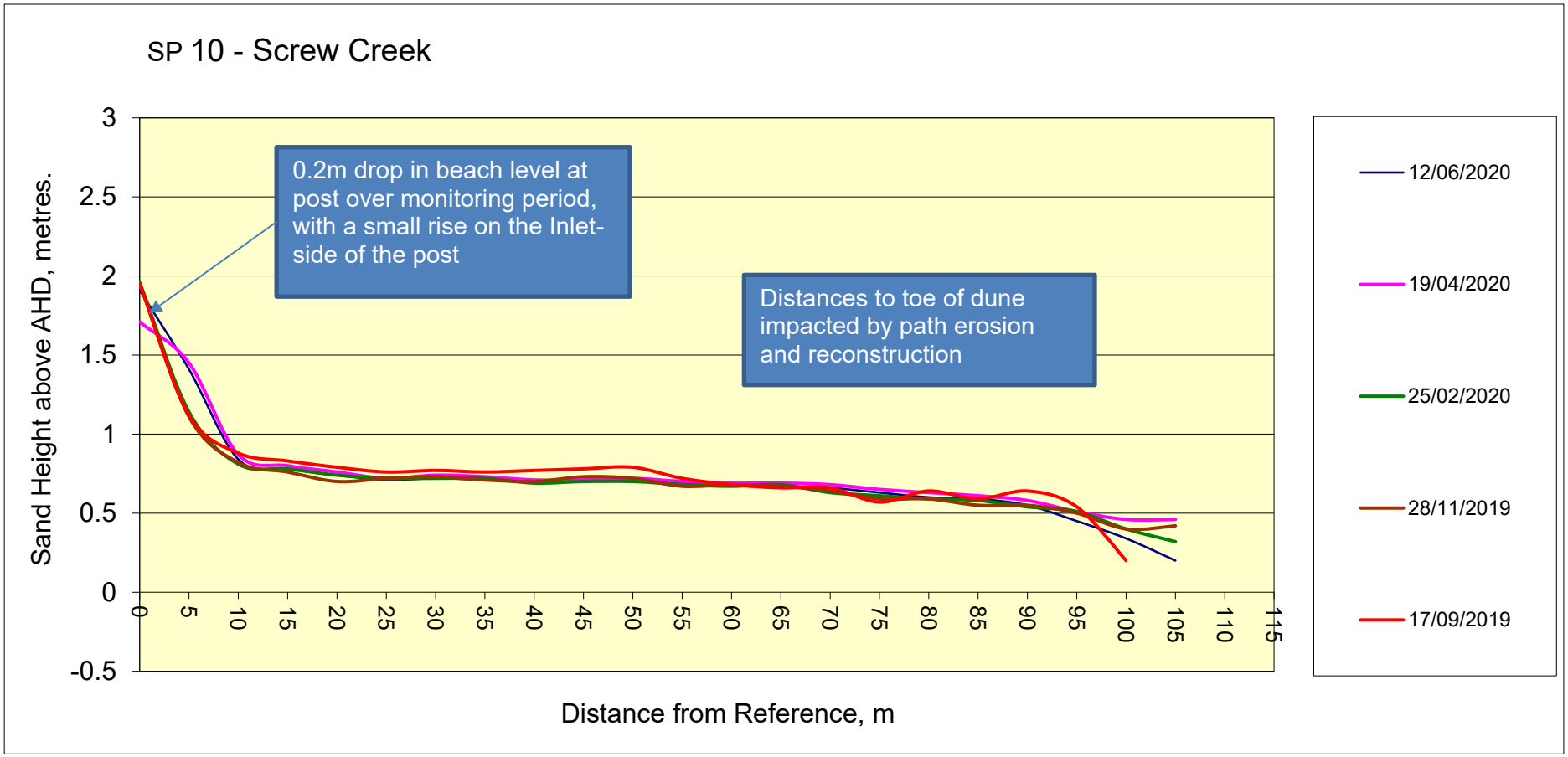


Figure 12 Laser Level Monitoring Chart SP10 – Screw Creek

Overall, and with reference to 'Figure 13 – Inverloch Beach Post to Dune to Distance Chart', SP7 (Pt Norman) has seen the largest extent of coastline recession over the monitoring period. The dune face receded approximately 64m over the monitoring period, with the most significant change occurring between November 19 and May 2020. SP2 (Cape Paterson Road wet sand fence site) and SP3 (Amazon Shipwreck site) experienced 6.4m and 4.9m recession respectively in less than one month, between the November and December 19 surveys. SP3 site has also experienced substantial recession (6.6m) between the April 20 and June 20 surveys.

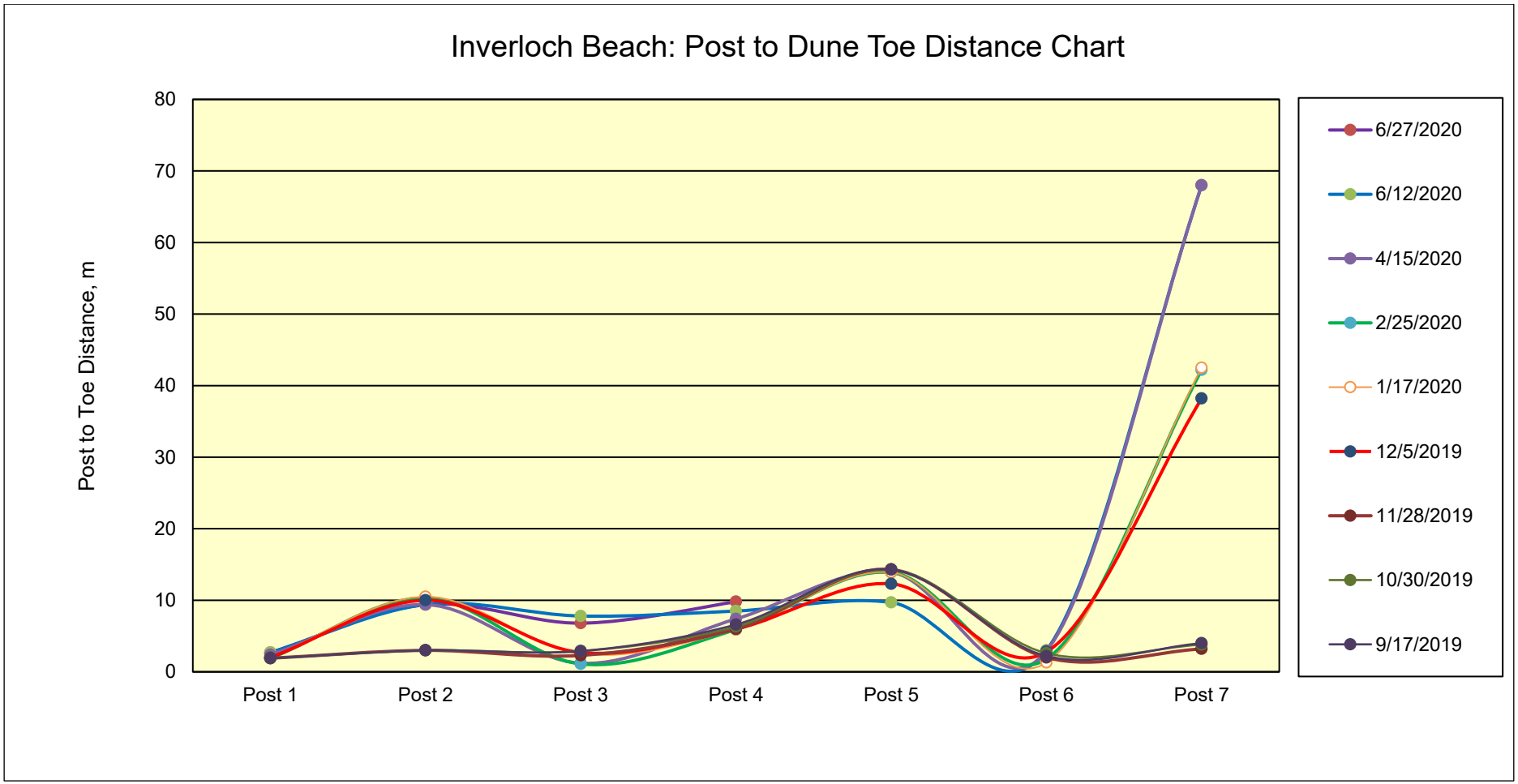


Figure 13 Inverloch Beach Post to Dune Toe Distance Chart

4.0 REVIEW OF WEATHER CONDITIONS OVER THE PERIOD

Weather conditions were recorded throughout 2019/2020 by review of Bureau of Meteorology (BoM) observations for Pound Creek, BOMs Willy Weather app and the VicWaves website, utilising results recorded by the Inverloch wave buoy.

Based on observations, the weather conditions most conducive to coastline recession at Inverloch Surf Beach comprise south-westerly swells combining with strong winds from the west/south-west/south and high tides. Northerly winds tend to flatten southerly swells and easterlies traditionally assist in returning sand to the surf beach from offshore. Accordingly, BoM daily weather observations for Pound Creek were analysed for each month as follows:

- Number of days that south/south-west/west wind gusts exceeded 28 kph
- Number of days that winds occurred from the north (from north-west to north-east)
- Number of days that winds occurred from the south-east (from east to south-east).

Weather Analysis 2019/2020

In 2019, stormy conditions were clustered in two main periods – January/ February 2019 and August/ September/ October/ November/ December 2019. Numerous storm surge events occurred during these periods, triggered by the coincidence of high tides (2.8m or above), west/south west/southerly wind gales (in excess of 28kph) and big south westerly swells (in excess of 5 metres). While it is traditionally considered that winter constitutes the critical period for coastline recession at Inverloch, in 2019 coastline recession was more likely to occur in autumn, spring and early summer, when more frequent south west storm swells combined with strong south west winds and high tides.

Notwithstanding these general observations, specific storm surge events were recorded on:

- 25 March 2019
- 26 April 2019
- 27 May 2019, 28 May 2019
- 18 June 2019
- 9 August 2019, 20 August 2019, 21 August 2019, 22 August 2019.

Recording of individual storm surge events was not undertaken during late August/ September/early October 2019, but BoM records indicate that stormy conditions continued from late August to late December 2019, with W/WSW/SW/S wind gusts in excess of 28kph occurring on the following number of days in each month:

-
- September 2019 – 17 days
- October 2019 – 14 days
- November 2019 – 22 days
- December 2019 – 21 days.

W/WSW/SW/S storm conditions began to abate in January 2020, but there were still 16 days that experienced W/SW/S wind gusts in excess of 28kph during January 2020. E/SE/SSE winds became more prevalent in January (occurring on 11 days), and there were 5 days with N/NE/NW winds.

This observed change in conditions continued during February 2020, with 15 days with W/SW/S wind gusts in excess of 28kph, 11 days with E/SE/SSE wind gusts and two days of northerlies.

Northerlies became more frequent in March/April/May/June 2020 (7 days, 16 days, 16 days and 16 days respectively) and the number of days with strong S/SW/W wind gusts progressively reduced (16 days, 11 days, 10 days and 6 days), as did the number of days with easterly winds (7 days, 3 days, 1 day and 1 day).

To end June 2020, weather conditions in 2020 are mirroring what occurred in 2019. If this pattern continues, August to December appears to represent the period when the Inverloch coastline will be most susceptible to further coastline recession. This is reinforced by analysis of tides over 2020. Spring tides (>1.5m height) occurred on a number of days in April/May/June 2020, and are predicted in October/November/ December 2020. However, no spring tides will occur for July/August/September 2020.

Storm Surge Events in 2020

As at end June 2020, significant storm surge events have been observed on 11 April (Easter Saturday), 1 May, 2 May, 3 May, 9 May, 10 May. Weather conditions on these days comprised:

- High tide in excess of 2.5m
- South west swell in excess of 4.0m
- Low air pressure (around 1000hPa)
- SW/W winds of over 30kph.

Coastline recession in excess of 0.5m was observed as a result of the 11 April and 9 May events, when the high tide of 2.9m coincided with maximum wind speed (in excess of 40kph) and swell height (around 5m).

Review of the Inverloch wave buoy data indicated a strong correlation between significant wave height days and days of strong S/SW/W winds.

5.0 OTHER OBSERVATIONS

Regular beach inspections are held to verify survey results, check on the current situation and to photograph changes in beach and dune conditions. Some key observations, not specifically covered by either the drone or laser level monitoring results, are outlined below.

Wreck Creek- some accretion was observed at the dune adjacent to Wreck Creek on 27/03/20, with the Amazon shipwreck less exposed than previously. This situation had reversed by 05/05/20, with appreciable dune recession having occurred, the Amazon being much more exposed and a new opening of Wreck Creek to the ocean occurring west of the previous opening, adjacent to the Amazon. The extent of the new opening continued to widen in June 2020, with two channels now evident (late June 2020). On 27/06/20 inspection, the minimum width of the remaining dune between Wreck Creek and the ocean was measured at 3 metres. The Estuarine Reedbed along Wreck Creek, dominated by Common Reed (*Phragmites australis*) has died back significantly since the new breach, most likely due to the tidal influence and resultant high concentrations of salinity.

Cape Paterson Road/ Toorak Road site – on 27/03/20 the wet sand fence was observed as being almost completely covered by sand, following accretion that had occurred over the summer. It was noted at the time that this meant that the fence would not provide any protection from future storm surges. As it turned out, storm surges over Easter 2020 resulted in substantial coastline recession which in turn led to the installation of the first temporary 500 tonne rock wall, subsequently replaced by the longer 7,000 tonne rock wall that is under construction at end June 2020. Photographs were taken of the eroded dune face at either end of the rock wall on 26 June 2020.

Surf Life Saving Club – recent inspections of the sand-filled geotextile retaining wall indicate that it successfully withstood the April and May storm surges. Planning is in process to revegetate behind the wall with indigenous shrubs and grasses and brush.

Wave Street track- significant additional coastline recession was observed at the dunes located between the Wave Street access track and the Ozone Street access track during an inspection conducted on 05/05/20.

Flat Rocks – receding south-easterly facing dunes between the Cape Paterson Road/Toorak Road site and Flat Rocks were photographed during the 26/03/20 inspection. This was in a period of general beach accretion, possibly caused by the south-easterly winds that were more prevalent at this time. Threatened mature Coast Banksia trees were also identified and photographed at Flat Rocks. During the 27/06/20 inspection, a measurement of 12 metres was recorded from the edge of the Cape Paterson Road formation at the toe of the dune, near where a culvert crosses under the road.

Pt Norman – as noted elsewhere in this report, the rock shelf at Pt Norman became progressively more exposed between January and May 2020. This was recorded in photographs taken during inspections on 30/03/20, 05/05/20 and 25/05/20 and coincided with a period of south-easterly winds that may have acted to counteract the longshore, easterly movement of sand along the surf beach. The 28/06/20 inspection revealed that the rock shelf was not as exposed, possibly caused by the longshore movement of sand that had been removed from the surf beach during the April and May 2020 storms (see Appendix D). It was also noted that a sand spit had re-formed off Pt Norman. This coincided with the advent of prevalent northerly winds over May and June 2020.

Abbott Street Lagoon – a new opening of the Abbott Street lagoon to Anderson Inlet was observed during the 05/05/20 inspection, resulting from the significant coastline recession that had occurred following the April and May 2020 storm surges. The 28/06/20 inspection revealed that the opening was not running at low tide, but that flushing of the lagoon was still occurring at high tide.

Pt Norman-Pt Hughes sand barrier – Inspection on 05/05/20 revealed changes to the shape of the sand barrier between Pt Norman and Pt Hughes. Significant changes are occurring adjacent to Pensioner's Point, where a previously wide sand bank has been reduced to less than 10 metres width at high tide. Sand that has been removed from this location has exposed the eastern end of the rock shelf that was covered with sand in around 2015 (see Appendix D). It was also observed that the sand bar on the Pt Smythe side of the Inlet has grown substantially.

6.0 ANALYSIS OF MONITORING RESULTS

Overall

Dune recession is accelerating at Inverloch surf beach:

- Since August 2018, coastline recession along the surf beach has occurred at between 5-12 metres per year, while coastline recession at Pt Norman averaged 40 metres per year.
- Prior to commencement of monitoring, in the 2013-2018 period, coastline recession at the surf beach was occurring at an average rate of 7 metres/year.

The volume of sand being removed from the surf beach is also accelerating. The annual rate of sand removal since August 2018 is 82,000 cubic metres. This compares with an annual rate of 72,000 cubic metres between 2013 and 2018.

These results are consistent with the theory that a new coastline dynamic is operating at Inverloch surf beach, as detailed in SGCSs '*Inverloch Coastal Resilience Project*' report and our '*Coastline in Crisis*' documentary. While prior to 2013, periods of coastline recession were followed by periods of accretion, the surf beach is now losing sand annually, and the rate of sand loss is increasing, with no sign of recovery.

Adverse weather conditions peaked in late spring/early summer 2019, with storm surge conditions extending through to December 2019. This meant there was only a very brief period (January/February 2020) of accretion assisted by more frequent easterly winds, before storm surge events returned in April and May 2020.

A change in weather conditions from mid-May to end June 2020, with more frequent northerlies, has meant that beach conditions have generally stabilised for the moment, with the exception of the Wreck Creek area (SP3). However, as detailed in the weather analysis section of this report, this mirrors what occurred during 2019, when coastline recession-inducing weather conditions returned in August 2019 and continued unabated through to December 2019.

Critical Locations

Pt Norman has experienced the most significant coastline recession since August 2018 (see next section). However, review of the monitoring results indicates that the most vulnerable locations along the length of Inverloch Surf Beach are:

Cape Paterson Road/Toorak Road site – 7m dune recession occurred between October 2019 and February 2020, mainly between 28/11/19 and 5/12/19 when strong to gale force south westerlies were recorded. This recession left the Cape Paterson Road/Toorak Road site vulnerable to inundation and undermining. Although some accretion was recorded in January/ March 2020, the threat was exacerbated by further dune recession caused by the storm surges that occurred in April and May 2020. Protection works are now underway (June 2020) with the construction of a 120m rock wall.

Inverloch Surf Life Saving Club – 9m dune recession occurred between August 2018 and May 2020 leaving the Surf Life Saving Club building vulnerable. Over 5m of this recession occurred during 2019, prior to construction of the sand filled geotextile container wall. This work commenced in January 2020 and is now complete (June 2020).

Wreck Creek - this is currently (June 2020) the most vulnerable location along the length of Inverloch Surf Beach, with the width of vegetated dunes varying between 3-10 metres. Almost 5m of dune recession was recorded between September 2019 and June 2020 (9 months), equivalent to an annual rate of 6.7m/year. This includes 3 metres dune recession since 25/02/20 that resulted from the April/May 2020 storm surges. If this rate of recession continues, the remaining dunes will be removed over the next 6- 12 months. Removal of the remaining dunes would result in loss of the ecological values of Wreck Creek (see Appendix B for details) and expose Surf Parade and adjoining low-lying housing to inundation.

Flat Rocks – one metre of coastline recession and 0.5 metres of beach level drop was recorded between September 2019 and June 2020 at this location. The remaining mature Coast Banksia Woodland is already in varying states of vulnerability (see Appendix C for details) due to the dune recession that occurred between 2013 and 2019. Any additional dune recession at this location will result in the loss of the ecological values of the remaining Woodland and its associated understorey and expose Cape Paterson Road to undermining and inundation. The distance from the edge of the Cape Paterson Road formation and the toe of the dune was 12 metres at June 2020.

Other locations where significant coastline recession has occurred

Pt Norman- the largest changes over the entire length of the Surf Beach have occurred in the Pt Norman area:

- More than 80 metres of dune recession occurred between August 2018 and June 2020
- Sand levels dropped between 1.6 – 3 metres.

Significant changes at Pt Norman began in November 2019 when dune recession of 28 metres was recorded in one month. Recession continued over the December 2019 to April 2020 period, with the next most significant recorded change of 26 metres between late February 2020 and mid-April 2020. The coastline recession at Pt Norman began while strong south-westerly winds prevailed in November 2019, but then continued during the occurrence of easterly winds that were prevalent between January and March 2020.

The Pt Norman rock shelf was uncovered over this period, appearing for the first time in more than 10 years (see Appendix D). A possible explanation of the sequence of events follows:

- The easterly winds that prevailed from late January/February/early March 2020 meant that the longshore movement of sand from the Surf Beach towards Pt Norman stopped, leading to a gradual uncovering of the Pt Norman rock shelf – this is consistent with the maximum exposure of the reef occurring in late March 2020
- The April/May 2020 storm surges resulted in a resumption of the longshore movement of sand towards Pt Norman, leading to the rock shelf being partly covered with sand during June 2020.

Benign weather conditions (northerlies predominating) during May/June 2020 meant that the rock shelf has acted as a partial anchor, with sand accumulating further at Pt Norman, and a sand spit forming off Pt Norman. The anchoring function of the Pt Norman rock shelf is explained further in '*Geomorphic & Ecological Investigation between Western St and Cape Paterson- Inverloch Road, Inverloch'* (Water Technology, July 2019).

Pt Norman is a dynamic location where significant changes have been observed in the past – the coastline recession that has occurred over the past 7 months has eroded the dunes that had been deposited at Pt Norman during the 2013-2019 period.

Ozone Street Access Track -The coastline adjacent to the Ozone Street access track has experienced 20 metres of recession between August 2018 and May 2020. Most of this recession occurred during 2019, with only 2 metres of recession occurring between January and May 2020. As detailed in the Inverloch Coastal Resilience project report and 'Coastline in Crisis', this section of the Surf Beach has experienced significant previous erosion, notably during the 1979/1985 period.

Wave Street Access Track- The beach adjacent to the Wave Street access track suffered the second largest dune recession over the monitoring period, with 12 metres of landward movement occurring between August 2018 and May 2020. The majority of this coastline recession occurred during the 2019 storm surge events, with 9 metres of recession recorded to September 2019. The Surf Club to Ozone Street access track section of the surf beach is the most popular swimming and sunbathing section of the beach. It features the highest remaining dunes that are highly valued by residents and visitors, as detailed in the '*Inverloch Coastal Resilience Project'* report and '*Coastline in Crisis'*.

7.0 CONCLUSIONS AND RECOMMENDATIONS

1. Coastline recession at Inverloch Surf Beach is accelerating and, with the outcomes of the Inverloch Coastal Hazard Assessment/RaSP process unlikely to be implemented within the next 2 – 3 years, short term management actions involving regular dune renourishment is required to avoid further loss of the ecological values of the remaining vegetated dunes and to protect additional sections of Cape Paterson Road, Surf Parade and adjoining residences from undermining.

2. With the installation of protective measures at Cape Paterson Road/Toorak Road and Inverloch Surf Life Saving Club, the most vulnerable section of coastline is at Wreck Creek, west of the Surf Club. If the rate of coastline recession recorded over the monitoring period (August 2018 to June 2020) is maintained or exceeded, the remaining dunes at this location will be removed within the next 6-12 months. Additional erosion is already occurring at both ends of the rock wall, and it appears that coastline recession will be accelerated at this location. Removal of the remaining dunes would not only result in the loss of the ecological values of the Wreck Creek system, but would leave Surf Parade and adjoining residences vulnerable.

3. The remaining mature Coast Banksia Woodland trees at Flat Rocks are in varying degrees of vulnerability, with more than 25% of the stand already having been undermined by coastline recession since 2013. If the rate of recession is maintained or accelerates, the majority of the remaining Coast Banksia trees will be lost within the next two years. Removal of the mature Coast Banksias and associated understorey will leave Cape Paterson Road vulnerable to undermining adjacent to Flat Rocks. Active short-term management is recommended at this location over the next 12 months.

4. Close monitoring of changes to the shape of the Pt Norman-Pt Hughes sand barrier is recommended, particularly in the vicinity of Pensioner's Point.

5. Based on the analysis of weather conditions undertaken over the monitoring period, late summer/early autumn and late spring/early summer represent the times when the coastline is most vulnerable to recession. Short-term protection measures need to be planned for these periods, until such time that the outcomes of the LCHA/RaSP process are known.

6. The drone monitoring being undertaken under the VCMP is providing a valuable supplement to the laser level monitoring. It is recommended that approval be sought for extending the length of the Surf Beach able to be covered by the drone surveys, so that the Wreck Creek and Flat Rocks hotspots are covered.

APPENDIX A - Laser Level Monitoring Sites

Station	Length	Direct_90N	Direct_0E
SP 1	57	329	57
SP 2	87	301	87
SP 3	97	293	113
SP 4	101	287	107
SP 5	107	276	96
SP 6	101	267	88
SP 7	170	270	90
SP 8	182	292	112
SP 9	36	259	78
SP 10	10	296	115

Inverloch Main Beach
Monitoring Station Map 2

1:5,000

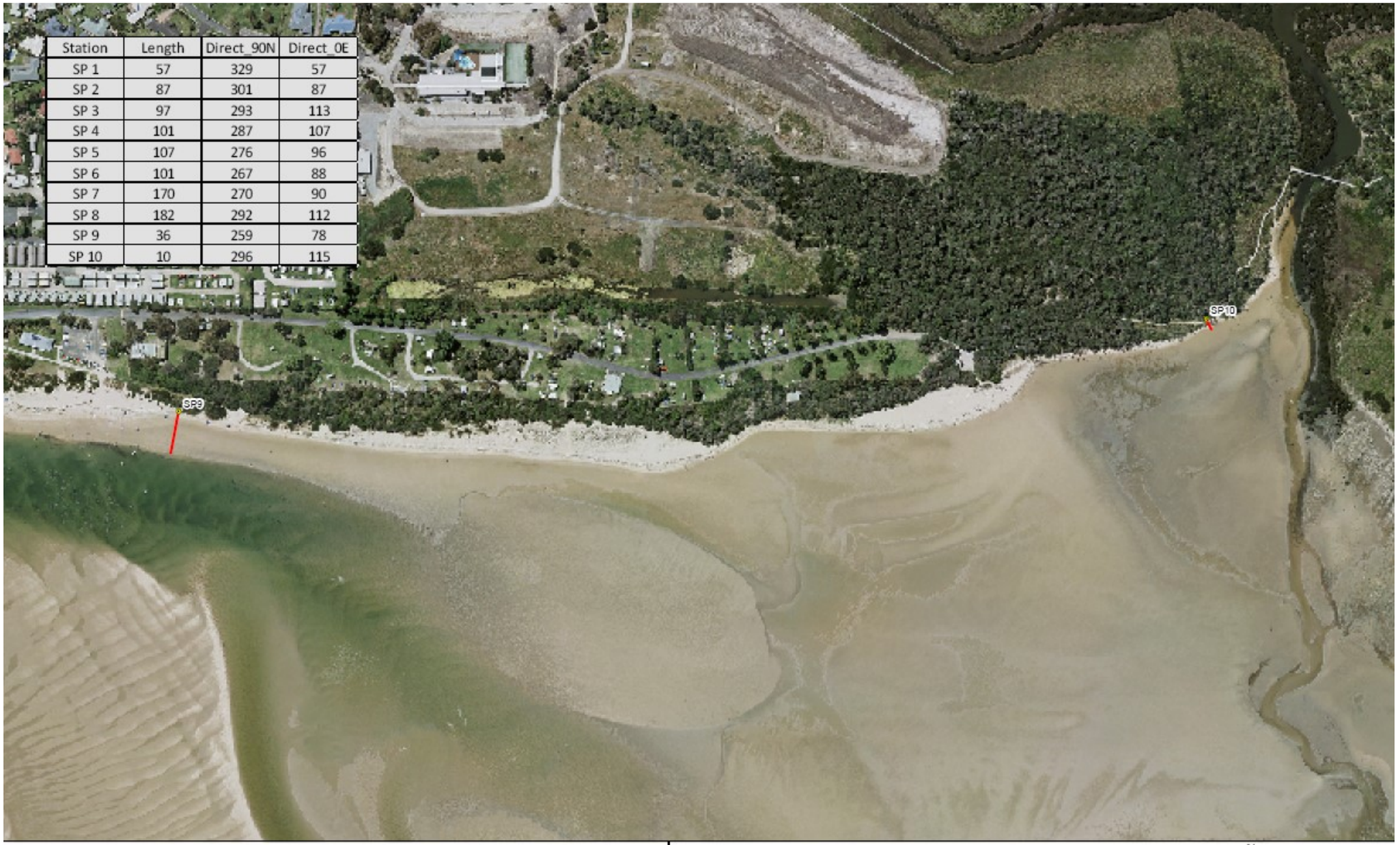
User Name: ws03

Date: 28/06/2019

SP_2
Survey Direction_Length
Sand Fence Option
Sand_Fence

0 25 50 100 150 200
Meters

Station	Length	Direct_90N	Direct_0E
SP 1	57	329	57
SP 2	87	301	87
SP 3	97	293	113
SP 4	101	287	107
SP 5	107	276	96
SP 6	101	267	88
SP 7	170	270	90
SP 8	182	292	112
SP 9	36	259	78
SP 10	10	296	115



Inverloch Main Beach
Monitoring Station Map 3

N
1:3,000

User Name: ws03

Date: 28/06/2019

SP_2
Survey Direction_Length
Sand Fence Option
Sand_Fence

0 15 30 60 90 120
Meters

APPENDIX B - Wreck Creek

Wreck Creek is a regionally important estuarine lagoon system. The dominant EVC along this section of creek is Estuarine Reedbed, which is classified as 'vulnerable' within the Gippsland Plain bioregion. It is dominated by Common Reed (*Phragmites australis)* which cannot withstand inundation deeper than 30cm, except for short-term flood events. These reedbeds do not tolerate high levels of salinity. Other plant communities fringing the estuarine system (with their Victorian Bioregional Conservation Status in brackets) include Coastal Dune Scrub (depleted) and Coast Banksia Woodland (vulnerable).

Wreck Creek provides habitat for aquatic fauna such as Black Bream and migratory Short-finned eels (*Anquilla australis*). Other fish identified by West Gippsland CMA during sampling in January 2017 were Common Galaxias, Spotted Galaxias, Flatheaded Gudgeon and Yellow-eyed Mullet. The riparian vegetation also provides habitat for a number of threatened water birds, such as the Eastern Great Egret and Australasian Bittern, which are listed as 'vulnerable' and 'endangered' respectively. Other significant bird species present include the Australasian Shoveler (vulnerable), Black-faced Cormorant (near threatened) and Caspian Tern (near threatened).

Following the coastline recession that occurred during April and May 2020, the width of the remaining dune between Wreck Creek and the high water mark varies between 3-10 metres, with a new breakthrough from the creek to the ocean having occurred since Easter 2020. Review of historical aerial photography indicates that this is the narrowest width of vegetated dune at this location since 1968. The narrow remaining dune, combined with the new breakthrough, means that not only are the ecological values of the Wreck Creek estuarine system threatened, but Wreck Creek itself is highly vulnerable and at risk of being swept away completely along this section of beach. Loss of the creek would not only mean the loss of the significant ecological values outlined, but threaten Surf Parade and adjoining low-lying housing with inundation.

2010 aerial photograph of Wreck Creek, Surf Parade and adjoining housing

Wreck Creek and riparian vegetation, June 2020

New twin channel opening of Wreck Creek in June 2020

Narrow strip of vegetated dune between Wreck Creek and the ocean at June 2020

APPENDIX C - Flat Rocks

Significant depletion of the Coast Banksia Woodland community at Flat Rocks is already occurring.

Coast Banksia Woodland is rated as ‘vulnerable’ under the Victorian Bioregional Conservation Status of EVCs. At least 25-30% of the mature Coast Banksia trees, estimated to be between 60-80 years’ old, have been swept away by the receding coastline since 2013.

Around 15 mature Coast Banksia trees remain, in varying degrees of vulnerability, with their root systems being progressively undermined through the loss of beach sand. Loss of these remaining trees and associated understorey vegetation would represent a significant loss of ecological values and would leave the adjacent section of Cape Paterson Road, west of the turnoff to the RACV resort, more vulnerable.

Threatened mature Coast Banksias at Flat Rocks, May 2020

Threatened mature Coast Banksias at Flat Rocks, May 2020

Threatened mature Coast Banksias at Flat Rocks, May 2020

Threatened mature Coast Banksias and Cape Paterson Road, June 2020

APPENDIX D - Other Photographs

Coastline erosion west of rock wall, June 2020

Rock shelf adjacent to Pensioner's Point, March 2020

Pt Norman rock shelf, April 2020

Pt Norman rock shelf, June 2020

Amazon Shipwreck, June 2020