# Dry Creek salt fields vegetation impact mapping

## Summary report

**Department for Environment and Water**

**August, 2021**

**Summary report of DEW Technical report 2021/14**

Government of South Australia

Department for Environment and Water

# Summary

In late 2020 dieback of mangrove and saltmarsh habitats south of St Kilda was observed. In March 2021, the Department for Environment and Water (DEW) developed a mapping approach to measure the extent and composition of dieback across the Dry Creek salt fields. The key points are as follows:

## Key points: outputs

- **Approximately 24 hectares of vegetation dieback were mapped using new high-resolution multispectral aerial imagery captured in March 2021.**
- **The March 2021 data covers the entire Dry Creek salt fields area and adjacent habitats for the first time.**
- **Hyperspectral aerial imagery captured in January 2021 classified dieback mapping into types: mangrove, saltmarsh, bare ground and water.**
- **The new dieback boundary contains approximately 9 hectares of mangrove; 10 hectares of saltmarsh; and nearly 5 hectares of bare, sparsely vegetated, or aquatic ecosystems.**
- **The dead mangrove area represents 0.45% of the local Barker Inlet mangrove community; the dead saltmarsh area represents 1.4% of the local intertidal saltmarsh community.**
- **No major increase in dieback extent was evident between December 2020 and July 2021.**
- **Small areas of mangrove in poor health are detectable adjacent to the boundary of manual mapping of dead vegetation. The data shows areas of decrease in condition within approximately 50m of the boundary. A Spring recapture of multispectral aerial imagery will monitor this for change.**
- **Mangrove and coastal saltmarsh habitats in this area have shown variation in condition historically due to natural or other drivers.**
- **Historic 1997 mapping shows that saltmarsh adjacent to the Section 2 and 3 salt evaporation ponds were generally degraded or dieback.**
- **March 2021 data shows some patches of saltmarsh mapped as degraded in 1997 have died (e.g., near the mangrove boardwalk), while others require further research to understand current condition.**
- **March 2021 data shows some patches of mangrove mapped as degraded in 1997 (e.g., south of St Kilda) declined further, while other patches (e.g., north of St Kilda) recovered.**
- **Further high-resolution multispectral aerial imagery will be captured in October 2021 along with ground observations of vegetation condition.**
- **All new data captured forms a high-resolution baseline for future research on these habitats.**
- **There is high confidence that no major areas of dead vegetation remain undetected based on the integration of new mapping and spectral analysis.**

## Key points: revised impact estimates

- **The total impact area estimates reported in January 2021 have been revised down from 45 hectares to 24 hectares based on outputs from the new March 2021 data.**
- **The revised mangrove dieback estimate is approximately 9 hectares, which is 1 hectare less than initially reported, due to different mapping techniques.**
- **The revised saltmarsh dieback estimate is approximately 10 hectares, which is 25 hectares less than the initial estimate due to different mapping techniques.**

# Introduction

Department for Environment and Water (DEW) developed a mapping approach to measure the extent and composition of native vegetation involved in the St Kilda dieback event in late 2020.

This summary report presents high-level results and insights from the integrated analysis, while the technical report presents full results, insights, describes methods used and outlines next steps. This work has been independently reviewed.

Initial SA Government estimates were based on manual mapping from satellite and limited drone images. In March 2021, DEW subsequently contracted new high-resolution colour infra-red aerial imagery over the entire salt field area and manually mapped the impacts at a fine scale. Various remote sensing techniques were then used to assess and describe the impact on mangrove and saltmarsh habitats.

The Dry Creek Salt fields and adjacent coastal ecosystems are situated on Gulf St Vincent, near the northern suburbs of Adelaide (Figure 1). The area houses nearly 2700 hectares (ha) of mangrove and saltmarsh habitats alongside a series of salt evaporation ponds (over 3500 hectares) that ceased operation, after many decades of production, in 2014. These habitats have been recognised for their high conservation value and are within the Adelaide International Bird Sanctuary National Park – Winaityinaityi Pangkara (AIBS) and Adelaide Dolphin Sanctuary, as well as Barker Inlet–St Kilda and St Kilda-Chapman Creek Aquatic Reserves.

DEW used a variety of mapping techniques and datasets to measure the extent of dieback. The accompanying Online Data Viewer lets users pan, zoom and compare datasets compiled and used in the analyses that follows.

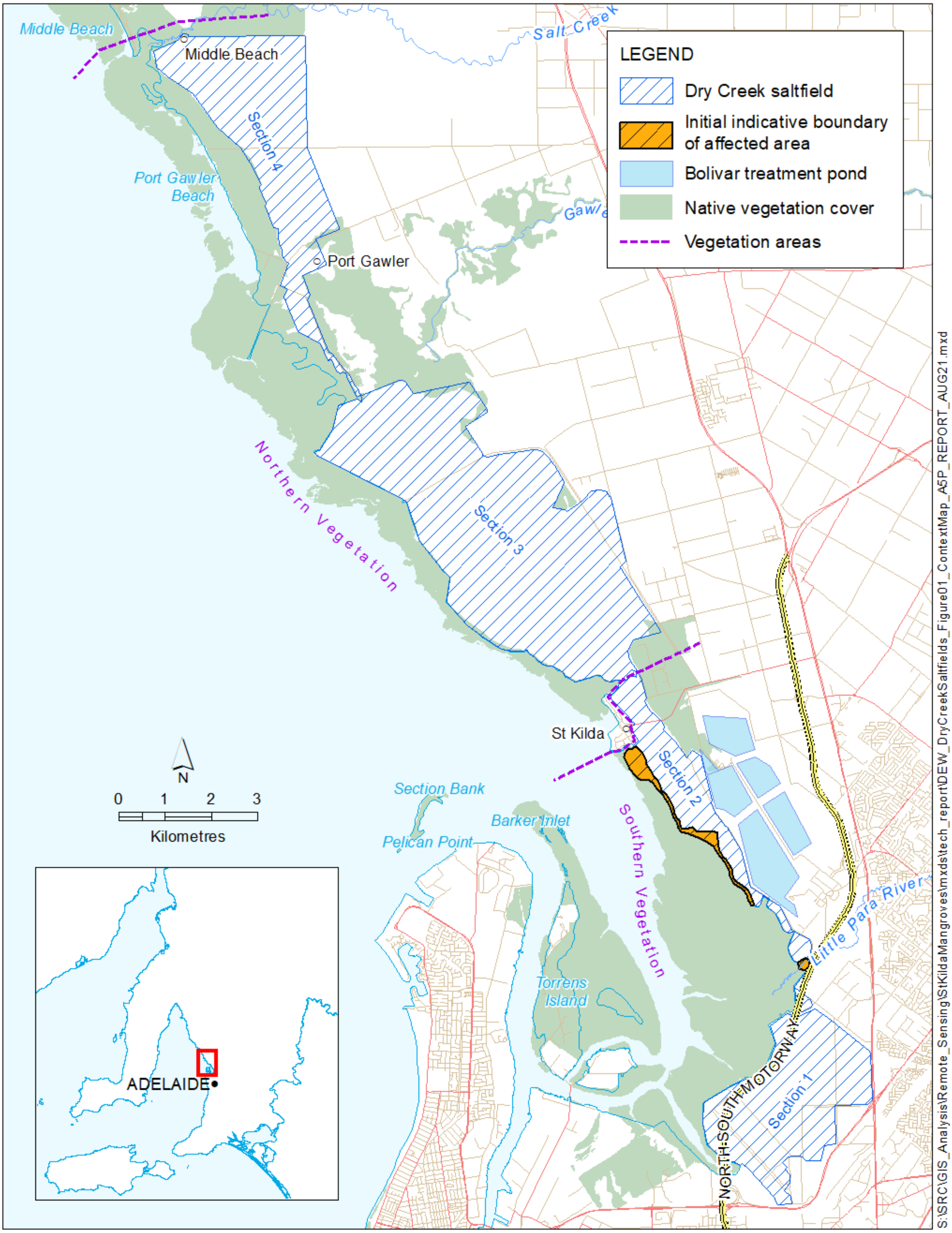


**Figure 1 site map of Dry Creek salt field on Gulf St Vincent, showing northern and southern vegetation areas and initial indicative boundary of affected area.**

# Data and methods

This investigation used the following datasets and techniques:

- 2021 dead vegetation mapping: manual mapping of vegetation dieback near the mangrove boardwalk and across section 2; mapped at 1:800 scale using the new March 2021 multispectral imagery, see black outline in Figure 2, Figure 3,Figure 5 and Figure 6.
- 1997 vegetation mapping: manual mapping of coastal saltmarsh and mangrove habitats; here mapped at 1:10,000 scale using 1997 aerial photography. The mapping of coastal saltmarsh and mangrove areas for the entire coastline of South Australia was published in 2002, by the then Office for Coast and Marine (OCM), of the Department of Environment and Heritage (DEH). See Figure 4, Figure 7 Figure 9 (DEH, 2006).
- 2021 hyperspectral data of vegetation types: Broad vegetation / land cover mapping (mangrove, saltmarsh, bare ground, open water) derived from hyperspectral research dataset. E.g. Figure 5, Figure 6 (DEW, 2021a).
- 2020-2021 Satellite vegetation index: Normalised Difference Vegetation Index (NDVI) time series from Sentinel2 satellite data from June 2020 to July 2021. See Figure 2 (SARA, 201).
- 2018 to 2021 vegetation Index change: NDVI difference mapping (dNDVI) derived from comparing newly acquired March 2021 aerial imagery and an overlapping 2018 NDVI dataset from a previous capture. E.g. see Figure 3 Figure 9 (DEW, 2021b).
- LiDAR elevation surfaces: collected in March 2021 elevation data can produce highly detailed topographic surfaces for drainage mapping, canopy models and broad land cover (DEW, 2021c).
- Ground surveys of vegetation condition; vegetation plot surveys were undertaken at 6 sites to the south of St Kilda in April 2021(EPA, 2021).

Normalised Difference Vegetation Index (NDVI) is a measure of the state of plant health based on how the plant reflects light during photosynthetic activity at certain frequencies (some wavelengths are absorbed, and others are reflected). Dead and stressed plants exhibit low NDVI whereas healthy plants have high NDVI values. (Rouse Jr. et al. 1974).

# Southern vegetation

In the late 1990's the entire coastline of SA was mapped to delineate coastal saltmarsh and mangrove habitats (DEH, 2006). The 1997 vegetation mapping for this area mapped 1,963 ha of mangrove and saltmarsh habitats south of St. Kilda. Nearly 1,900 ha of these habitats were mapped as being healthy, with a further 65 ha (3%) being mapped as in poor condition. This was mapped from contact aerial photography prints by hand at the time and is partly displayed in Figure 4.

Between June and December 2020, time series satellite data shows a significant drop in NDVI adjacent to section 2 ponds in both mangrove and saltmarsh areas (Figure 2). These impacted areas align with both 2021 manual mapping (black outlines in Figure 2) and NDVI change mapping. The time series shows that the area of impact within mangrove areas did not expand between December 2020 and February 2021. This was the case through July 2021, and will be monitored again in October 2021.

The NDVI difference mapping between 2018 and 2021 (dNDVI) provides more detail. In mangrove areas, significantly reduced NDVI aligns well with 2021 manual mapping of dead mangrove trees (orange and yellow tones in Figure 3). In addition, a smaller yet still noticeable drop in NDVI is evident just on the seaward side of the 2021 mapped boundary of dead trees. In this area, trees have not yet died, but their reduced condition (lower photosynthetic activity) is clear. This band is commonly around 10m and up to 50m in some places, in advance of the manual mapping (see arrow indicating yellow pixels between orange and blue tones on the seaward side of black line in Figure 3).

The fate of some 0.3 ha of mangrove dieback in 1997 mapping, is also of note as it is outside the main 2021 manually mapped dieback area. The arrows in Figure 4 indicate these old dieback areas. The northernmost indicated area shows regrowth and emergence of open water, while the southernmost indicated area has regressed further to predominantly bare soil (see Figure 5). Figure 4 also shows that the approximately 10 ha of dead saltmarsh aligns almost completely with the approximate 10 ha of degraded samphire mapped in 1997.

In saltmarsh areas, inconsistent NDVI values in relation to condition as discussed in the technical report are problematic to resolve. It is for this reason that NDVI change mapping is not used as a method to delineate saltmarsh that has died since 2018. However in the form of dNDVI it is used to validate 2021 manual mapping (see Figure 5Figure 6). A dNDVI fall of more than -0.2 describes the edge of dead mangroves, and any fall in NDVI (dNDVI < 0) aligns well with the edge of dead saltmarsh in the manual mapping and ground survey observations.

In addition, dNDVI at pixel level can be highly informative when considered in conjunction with other datasets. For example, a comparison with elevation data suggests that topographically driven drainage and flushing across tidal flats and creeks impacts NDVI values, and therefore dNDVI. Ground observations of species composition and plant health helps to interpret NDVI values and also explain why a single threshold approach across an image cannot be used to determine extent of impact. This is illustrated in Figure 3 by the conundrum of both rises in NDVI (blue tones at a) as well as falls in NDVI (yellow tones at b) within the manually mapped dead saltmarsh validated by ground survey.

The final analysis then, combined the hyperspectral vegetation / land cover types with dNDVI values within the thresholds stated above (-0.2 for mangrove and 0.0 for saltmarsh). Figure 5 and Figure 6 show the resulting dataset classes of *Mangrove NDVI fall* and *Saltmarsh NDVI fall* aligning in extent with 2021 manual mapping of dead vegetation areas. Vegetation survey data also affirmed where the dead saltmarsh extended to. Overall, plants at transects adjacent ponds PA6, 7 and 8 were in the main dead, and in transects adjacent ponds PA9, 10 and 11 were in a healthy state.

While this investigation has found that a purely NDVI based delineation of vegetation condition does not comprehensively match observed conditions, it has been used in conjunction with ground observations and other remotely sensed analyses to validate the manual mapping with confidence that no major areas of impact remain undetected.

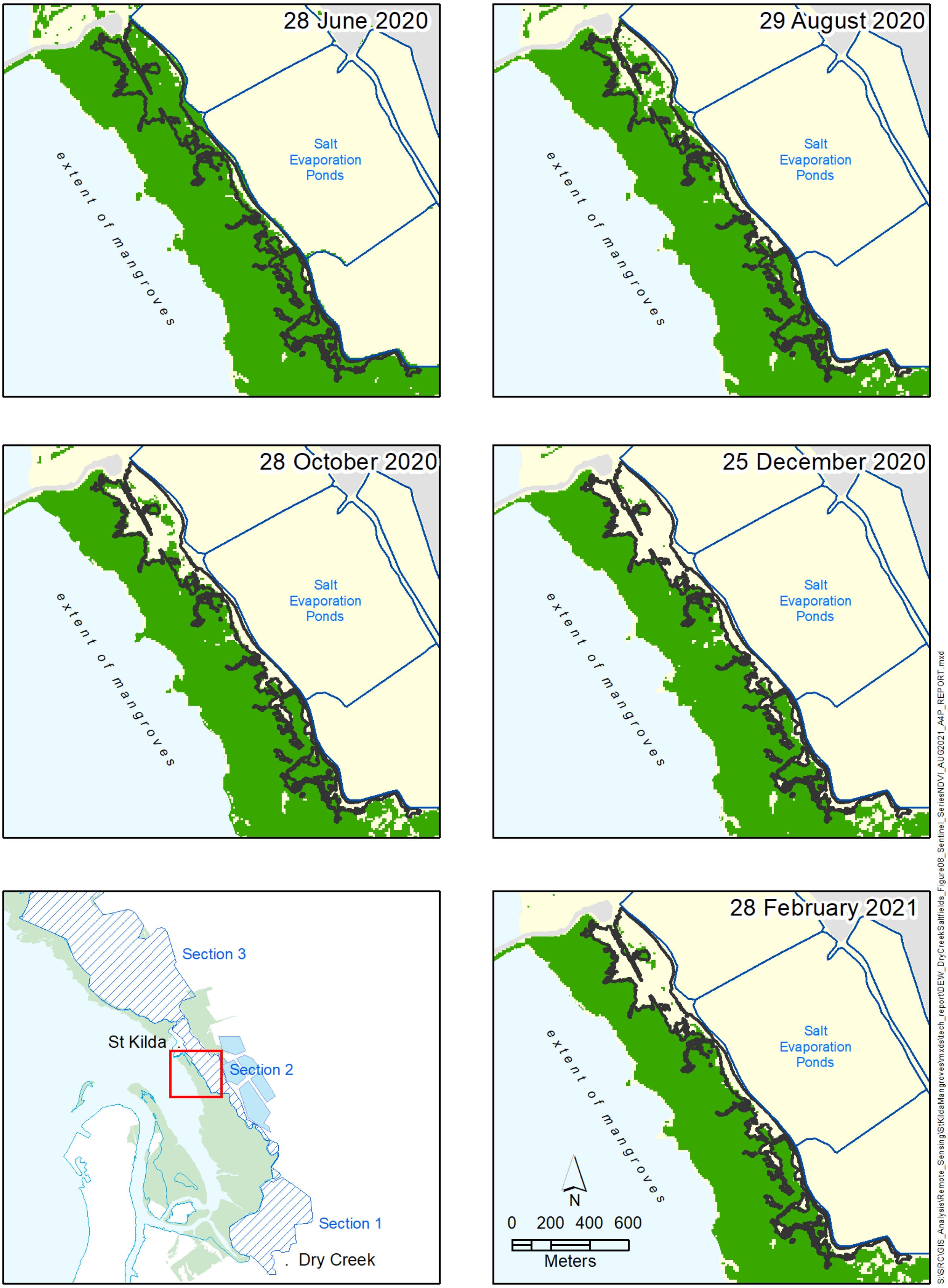


**Figure 2 Satellite time series data of threshold NDVI (green = high NDVI) showing expansion of dead vegetation up to the manually mapped maximum extent shown in black outline, between June 2020 and February 2021.**

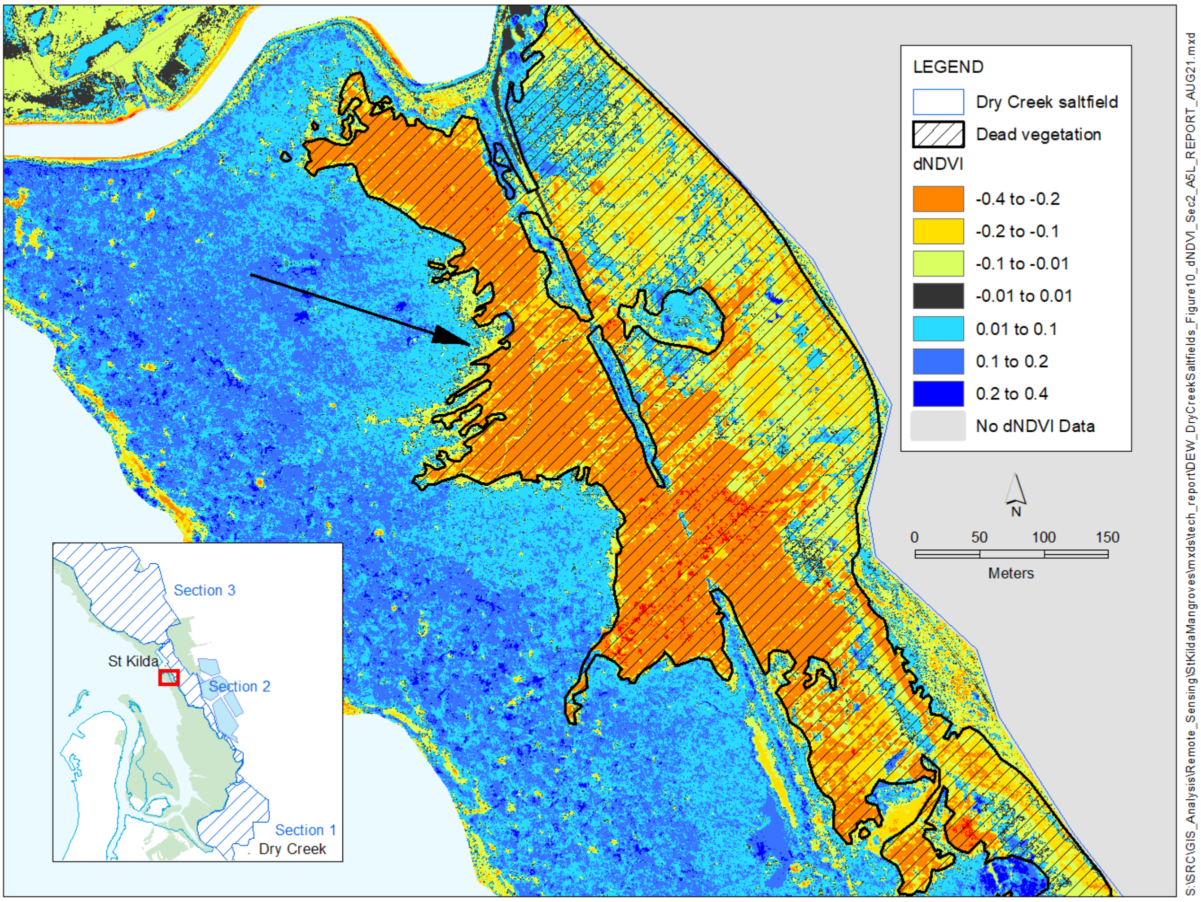


**Figure 3 NDVI change mapping (dNDVI) between 2018 and 2021 showing alignment of manual mapping (black outline) with reduced NDVI (orange and yellow tones), plus the conundrum of both a rise in NDVI (blue tones at a) as well as a fall in NDVI (yellow tones at b) within the manually mapped dead saltmarsh.**

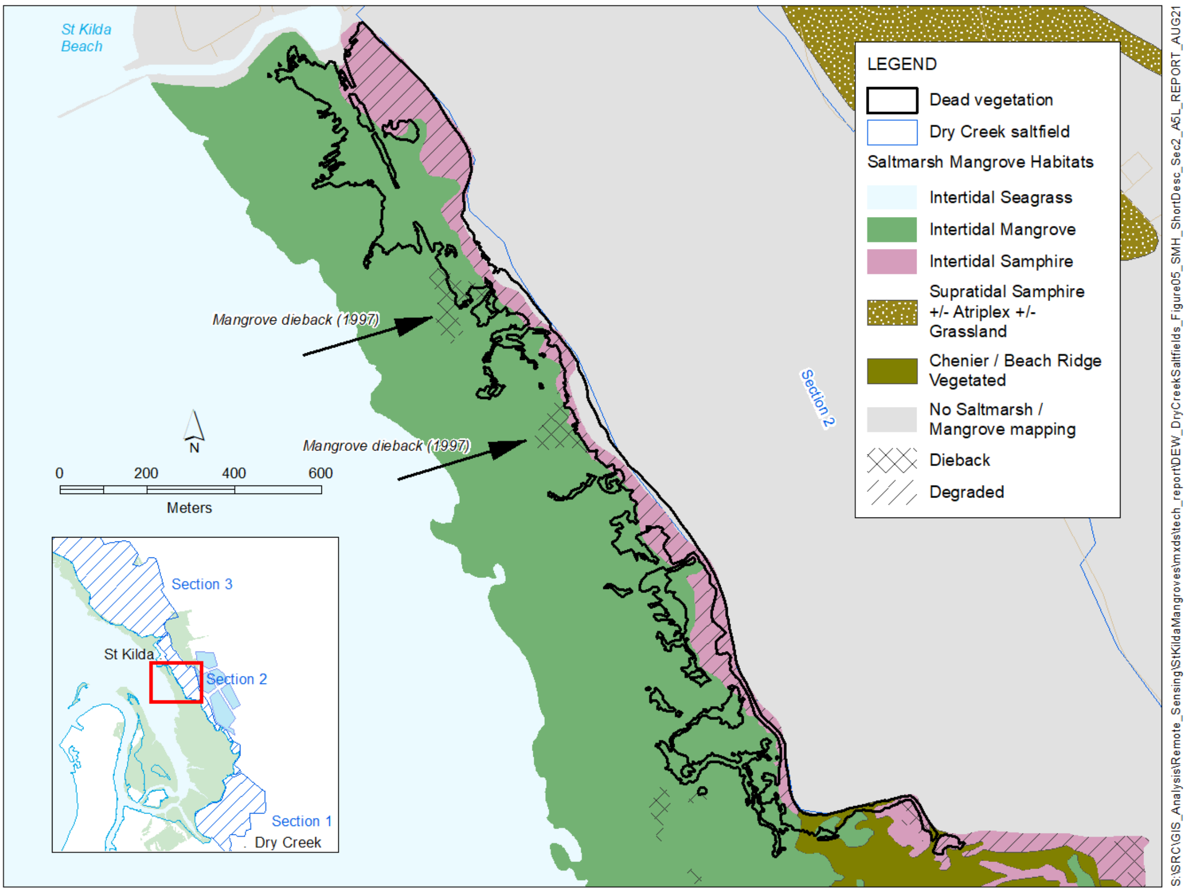


**Figure 4 manual mapping area overlying 1997 vegetation and condition polygons to the south of St Kilda. Arrows indicating areas mapped as mangrove dieback in 1997.**

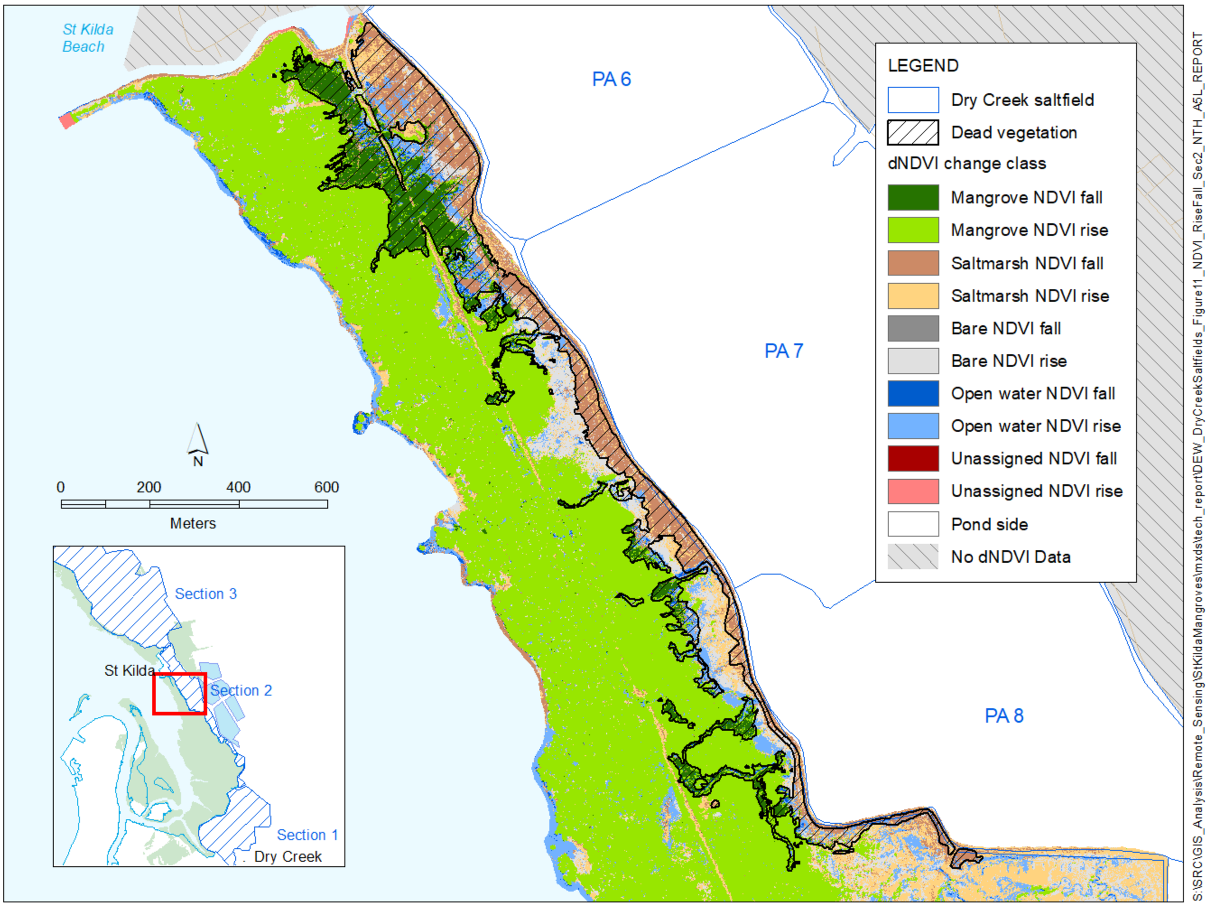


**Figure 5 dNDVI thresholded hyperspectral vegetation/ land cover classes overlaid with manual mapping in northern parts of section 2.**

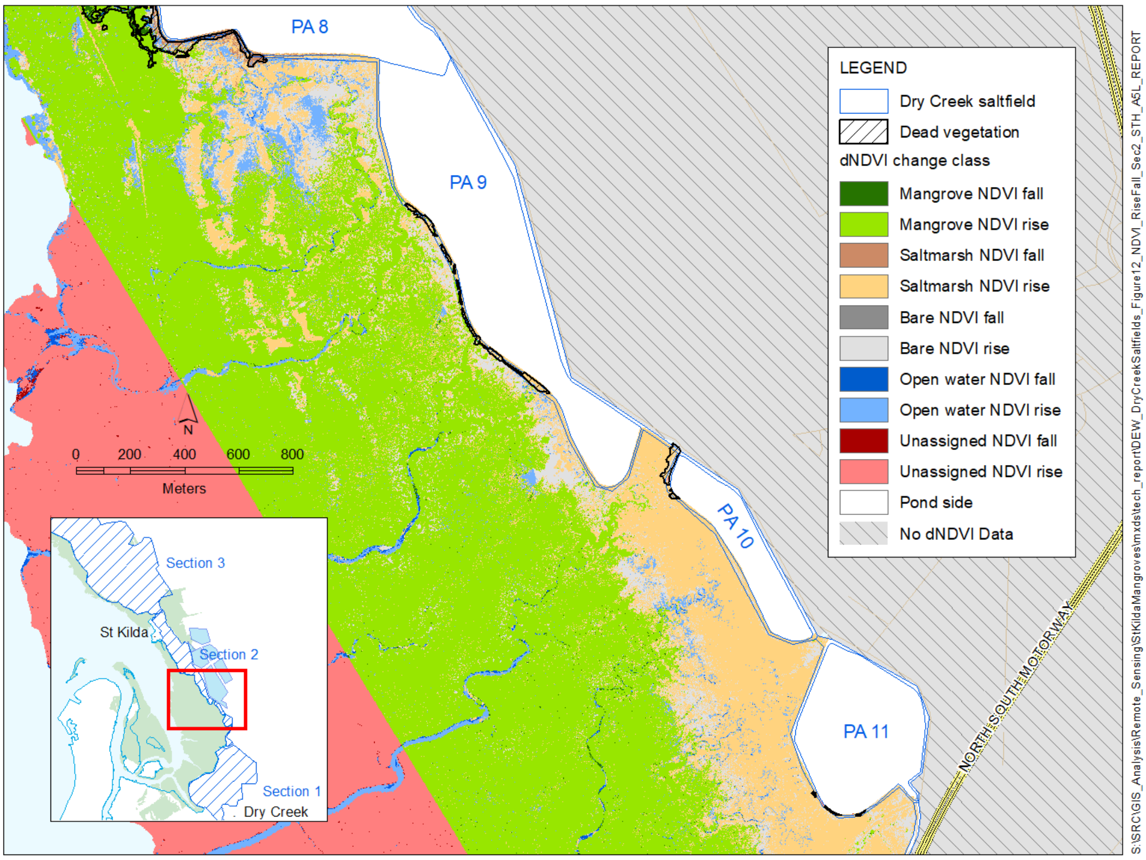


**Figure 6 dNDVI thresholded hyperspectral vegetation/ land cover classes overlaid with manual mapping in southern parts of section 2.**

# Northern vegetation

Of the 1,390 ha of saltmarsh and mangrove habitat mapped north of St Kilda in 1997, more than 1,200 ha was mapped as healthy, with around 10% (61 ha of mangrove and 67 ha of saltmarsh) in poor condition (impacted or dieback, e.g., Figure 7). In addition, this area recorded 209 ha of degraded chenier/beach ridges, which has mostly been used as a recreational off-road track for many years.

Between June and December 2020, time series satellite data in this area shows high NDVI across all mangrove areas, indicating no loss in condition over that time. A single NDVI image derive from the newly acquired March 2021 aerial imagery (Figure 7) concurs with the satellite-derived NDVI data in showing high NDVI values in mangroves. There is no 2018 NDVI over this area to compare with, except for the small area shown in Figure 9, south of XB8a. However, comparing the 1997 mapping with the March 2021 NDVI imagery found that, in some areas, mangroves mapped as in poor condition in 1997 are now healthy (see Figure 9 where 1997 dieback has blue tones in 2021).

Saltmarsh areas show varying NDVI across their range, in both the satellite derived data and the March 2021 NDVI image. The dNDVI image in Figure 9 shows the edge of NDVI change mapping and in saltmarsh areas, generally shows small rises in NDVI (blue tones) but also some falls (yellow tones). The 2021 aerial photograph shows that most of that saltmarsh is now bare soil with no vegetation. Without further detail to explain, this appears to challenge the general blue tone results from dNDVI.

Where there is no dNDVI (west of pond XB8a), there is saltmarsh and mangrove mapped as degraded and dieback in 1997. Aerial photography comparisons between 1997 and 2021 show improvement in many mangroves of these areas but are less able to inform a condition assessment of the saltmarsh areas without ground survey validation.

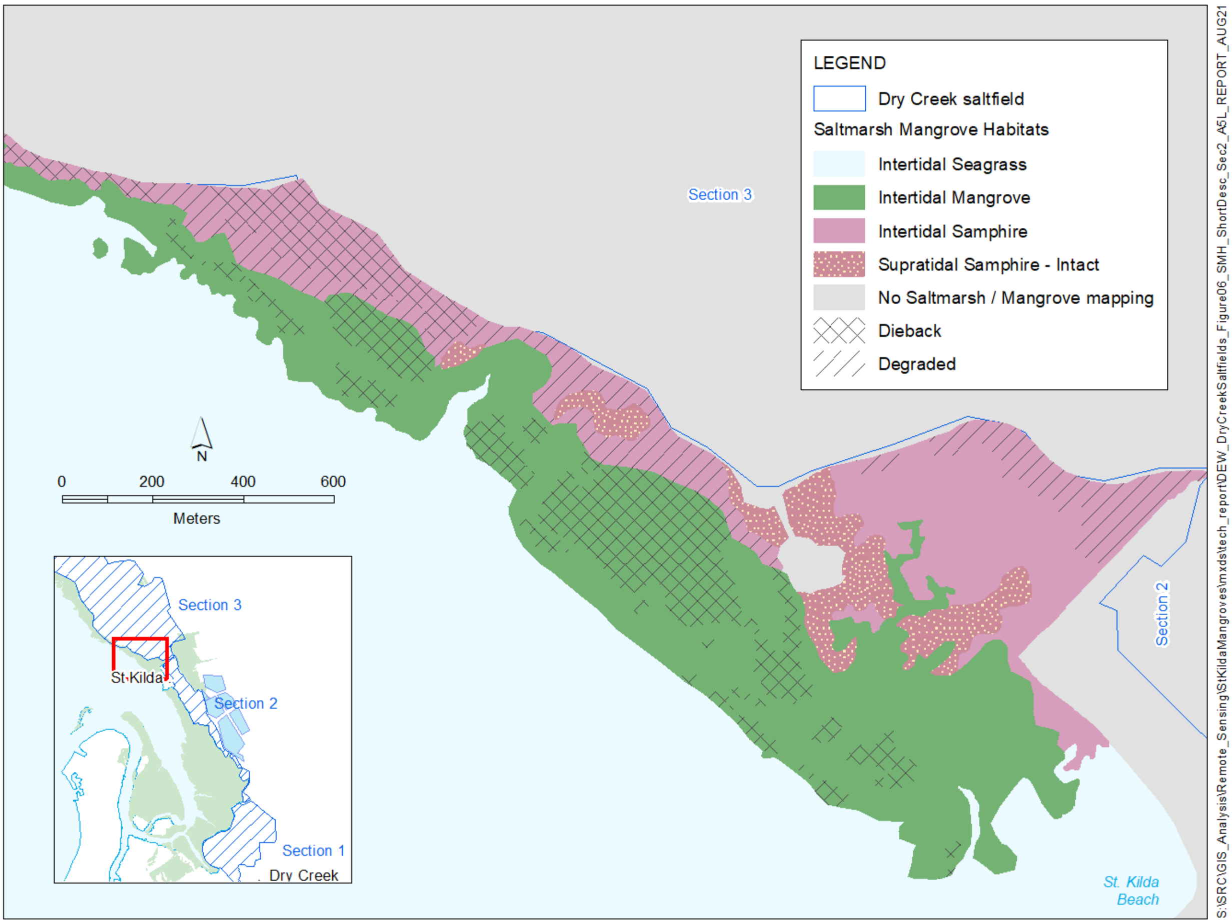


**Figure 7 1997 polygon mapping including integrity (condition) in area immediately north of St Kilda township.**

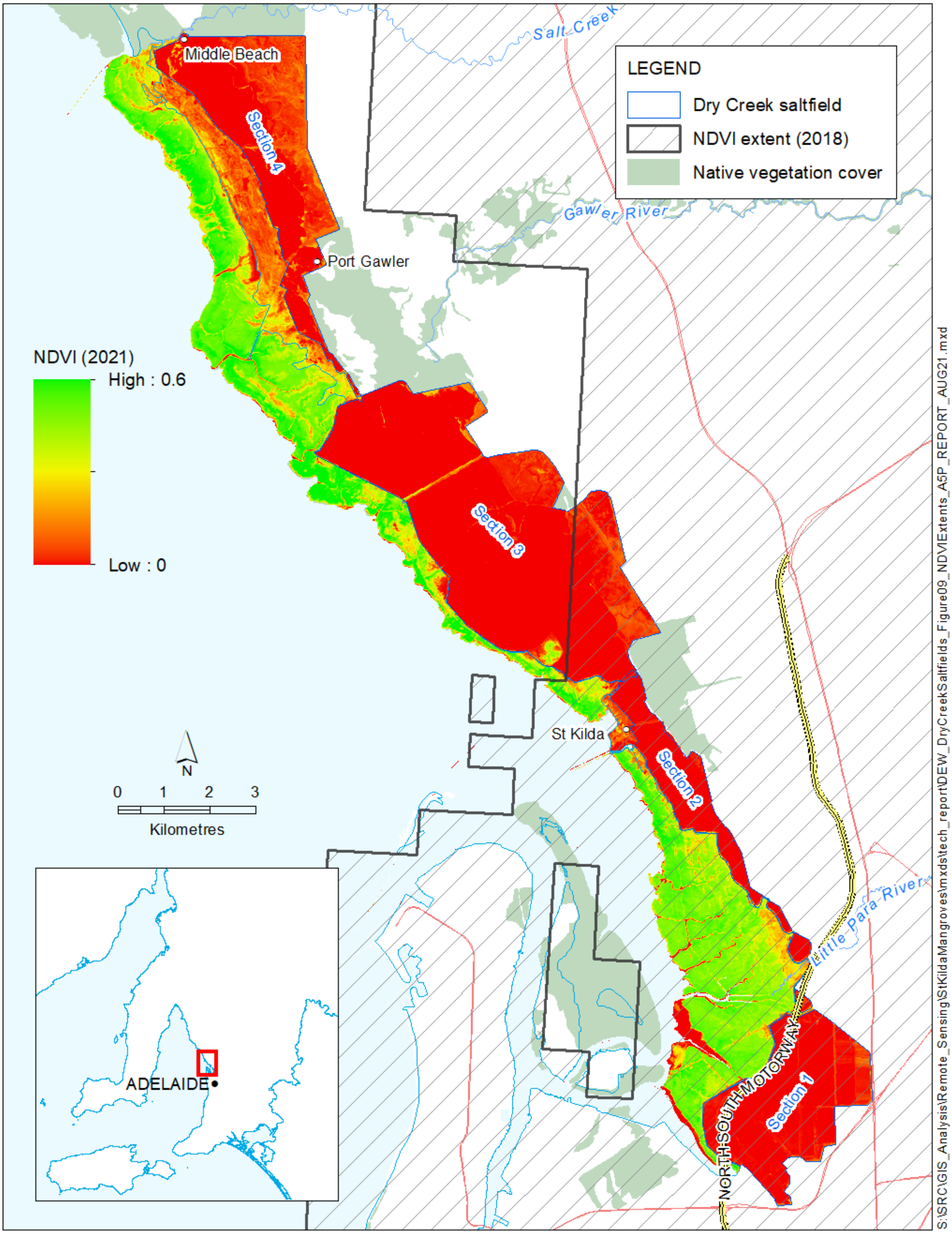


**Figure 8 NDVI data derived from March 2021 capture of 4 band imagery showing extent of 2018 NDVI image and therefore extent of NDVI change data.**

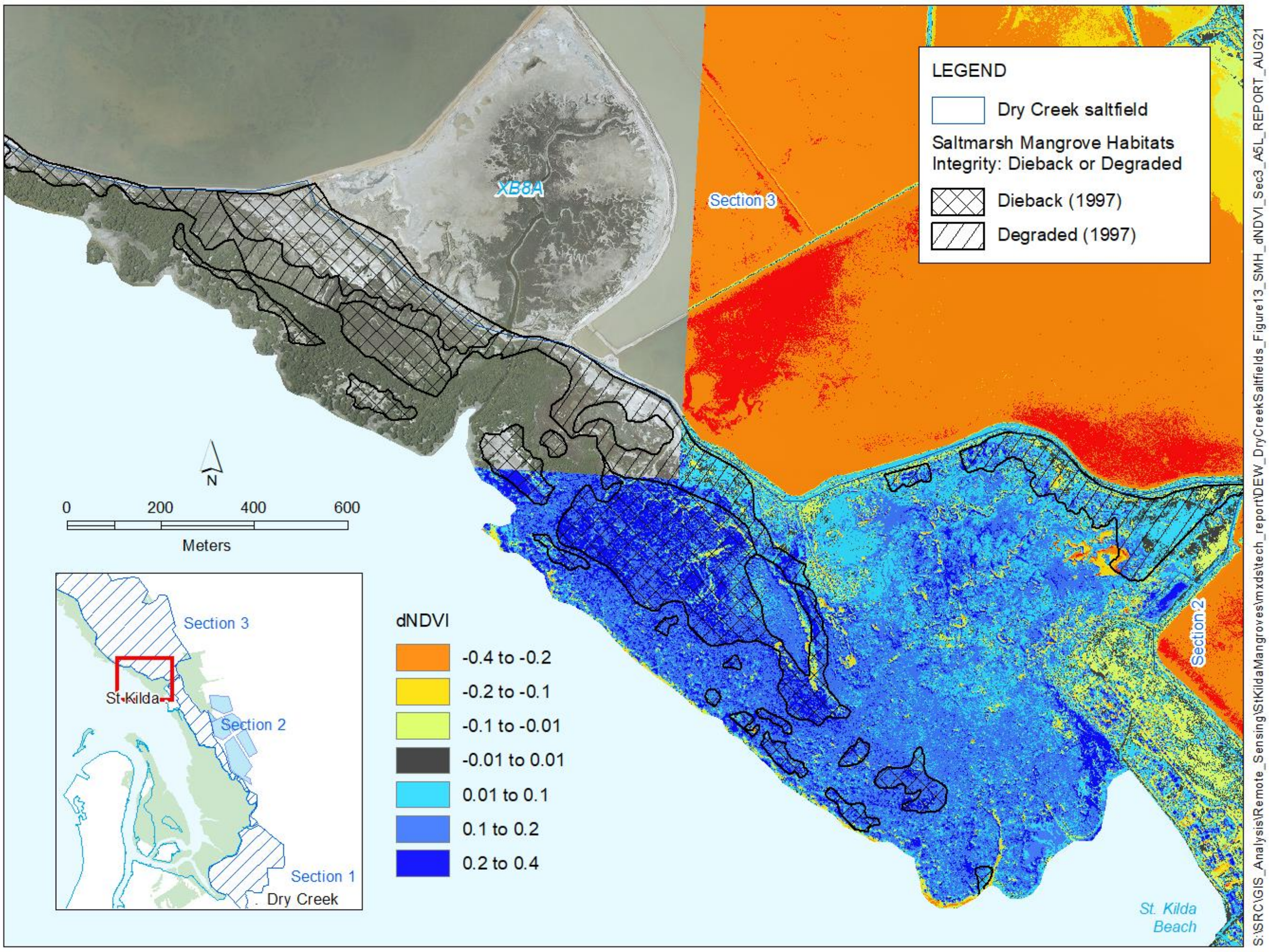


**Figure 9 1997 mangrove and samphire condition mapping overlying NDVI change data in area immediately north of St Kilda.**

# Conclusion

In conclusion, we have used a variety of mapping techniques and datasets to determine that overall severe impact near section 2 ponds, is approximately 24 hectares. This can be represented as approximately 9 ha of mangrove, over 10 ha of saltmarsh and nearly 5 ha of bare, sparsely vegetated, or aquatic ecosystems.

In addition to this we have compiled a series of datasets that demonstrate a dynamic ecosystem that has shown variation in condition historically due to natural or other drivers. Patches of dieback, large and small, appear and sometimes recover within an area of over 3,000 ha of mostly healthy mangrove and saltmarsh. However, there is a pattern through the time-series of poor, degraded, or dead saltmarsh adjacent to the salt evaporation ponds in sections 2 and 3.

New data acquisitions have captured a high-resolution baseline across the entire site for the first time. Comparing this with a Spring recapture both from the air and on ground will be a valuable addition to the many research projects currently underway in the area.

# References

DEH (2006). Coastal Saltmarsh and Mangrove Mapping. http://location.sa.gov.au/lms/Reports/ReportMetadata.aspx?p_no=886&pa=dewnr

DEW (2021a). ARA hyperspectral analysis description: St Kilda dieback. January 2021

DEW (2021b). *Dry Creek Salt fields: vegetation impact mapping*, DEW Technical report 2021/14, Government of South Australia, Department for Environment and Water, Adelaide.

DEW (2021c). Elevation - St Kilda Mangroves LiDAR 2021 http://location.sa.gov.au/LMS/Reports/ReportMetadata.aspx?p_no=2595

Rouse Jr. et al (1974). Monitoring vegetation systems in the Great Plains with ERTS - NASA Technical Reports. https://ntrs.nasa.gov/citations/19740022614

SARA (2021). Sentinel Australasia Regional Access https://copernicus.nci.org.au/sara.client/#/home

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