Monitoring Dry Coastal Vegetation in the Tasmanian Wilderness World Heritage Area

Part 2: *Appraisal of Method*

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Department of
Primary Industries and Water

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Cover: Entrance to Freney Lagoon, Cox Bight.

CONTENTS

EXECUTIVE SUMMARY

The coastline of the Tasmanian Wilderness World Heritage Area (TWWHA) is a dynamic environment in which many floristic and geomorphic values have been identified. Anticipated changes in sea level and associated processes that result from climate change may adversely impact on dry coastal species and ecosystem values on the TWWHA coast. The rate and extent of change will affect the potential for loss of values. Monitoring is a key tool to understanding how the climate change impacts will develop and provide the data required to assess risks and respond to impact if practicable and necessary.

Monitoring changes along the remote TWWHA coastline is a major challenge. This report reviews a low cost method for monitoring change suitable for application in the Tasmanian Wilderness World Heritage Area. Two aspects to change were considered. The broadscale changes in the distribution of geomorphological types and vegetation communities; and the site level processes of change and adaptation of vegetation to sea level rise and other associated pressures.

Low cost digital aerial photography and photo-interpretation was investigated as a tool for remotely monitoring spatial change in the range of dry coastal vegetation and geomorphic types on the TWWHA coastline. A set of orthogonal transects on beaches were trialed for characterising the floristic and geomorphic change affecting representative sites.

The digital photography was a qualified success. The extent of the spatial errors in the images rectified only against the 25,000 imagery would currently eliminate accurate quantitative analysis of the distribution of coastal plant communities but would be sufficient for qualitative distribution assessments. Ground based differential GPS controlled rectification provided very accurate spatial resolution but will be more costly to implement. Obtaining a sub metre DEM would substantially aid rectification and accurate spatial analysis of digital photography.

Vegetation communities mapped using the digital aerial photography provided a substantial improvement on existing 1:25,000 scale mapping in the identification of different communities in the dry coastal zone. In particular, there was improved detection of beach grasslands, marsupial lawns, as well as greater resolution of frontline coastal shrubland and scrub communities than was previously possible. Sparse strandline herbfields and beach grasslands were still difficult to detect. Further mapping and associated surveys are required to develop a more comprehensive vegetation mapping guide for use with low altitude coastal digital imagery.

Site characterisation using perpendicular transects identified the complexity in geomorphic processes operating on a beach at any one time and the cyclic nature of erosional and depositional events. Further refinement in the geomorphic mapping is required however a similar method should identify trends coastal geomorphic processes. The related vegetation data was used to define the vegetation zonation perpendicular to the beach at representative sites and to identify the frontline vegetation type along the length of surveyed sites. Though a time series is required to verify the processes acting on species and community distributions, the limited data obtained suggested it will be possible to discriminate how species respond to retreat of dune systems. Marsupial lawns were mapped on the leading edge of eroding scrub canopies above dune erosion scarps which if they persist in this situation under a rapidly retreating dune scarp indicates maintenance of an environmental niche and persistence by dispersal for the species and community involved. This on ground survey work also provided floristic data to ground truth the vegetation mapping component.

To further develop this project it will be necessary to improve the mapping of the coastal geomorphology in the TWWHA to improve value identification, risk assessment and change monitoring. The high resolution aerial photographs may be used for broadscale geomorphological mapping in association with coastal vegetation mapping, however there are some mapping difficulties due to the presence of overhanging vegetation and fossil scarps.

A monitoring program for coastal vegetation and geomorphic change at the landscape and process level could be developed and integrated in a cost effective manner. Suggested monitoring frequency is in the order of 10 years and could target landscape level changes and representative areas for values potentially at risk.

Finally the anticipated outcomes of monitoring dry coastal vegetation are:
1. updating the status of TWWHA coastal values,
2. identification of values at risk,
3. identify potential intervention where translocation, *ex-situ* conservation or increased management for the protection of refuge areas from human impacts (eg fire and recreational uses) may be necessary and feasible.

1 INTRODUCTION

This report is Part 2 of a 2 part series on the dry coastal vegetation in the Tasmanian Wilderness World Heritage Area (TWWHA). The first report, Monitoring Dry Coastal Vegetation in the Tasmanian Wilderness Part 1: Monitoring Priorities (Rudman *et al*. 2008) makes an initial assessment of the values of the TWWHA that may be affected by coastline change resulting from climate change. The report acknowledges the limitations of the risk assessment particularly in relation to the lack of a detailed vegetation mapping and geomorphic models of coastal change. However, monitoring may improve our understanding of the processes and the spatial impact of coastal change on dry coast vegetation in the TWWHA.

This report examines how process and spatial monitoring may be employed on the TWWHA coastline to assess the impact on WHA values.

2 AIM

The National Biodiversity and Climate Change Action Plan 2004–2007 (NRMC 2004) sought national action to identify the long-term monitoring programs needed to assess the impacts of climate change on biodiversity over time and to evaluate the long-term effectiveness of adaptation strategies and actions. This included the action:

> *4.3.1 Identify the impacts of erosion on marine, coastal and estuarine ecosystems resulting from storm surges and changes in sea level and surface water flow (and changed nutrient loads) as a consequence of projected climate.*

Under the Tasmanian Wilderness World Heritage Area Management Plan (PWS 1999) the potential impacts of climate change fall within the general prescription to:

> *document evaluate and report on threatening processes, their impacts on the WHA flora, particularly high conservation value assets.*

This project was initiated to trial a method for long-term monitoring of floristic values of the TWWHA dry coastal environment that may be at risk from coastal recession. The project aimed to:

- Determine if low cost digital photography could be used for fine scale mapping and monitoring change in dry coastal vegetation communities.
- Develop a method for monitoring the process of change in dry coastal vegetation communities and their adaptability or resilience to coastal climate change pressures.

Geomorphic processes will be a major determinant of the dry coastal vegetation responses to coastal recession. This project necessarily included a geomorphic component but has not specifically addressed the mapping and monitoring method in this area.

3 METHOD

3.1 Study area

The study area comprises the sections of the TWWHA coastline that were identified as vulnerable to coastal erosion by Sharples (2006). Vulnerable areas were deemed to have a significant chance of erosion due to sea-level rise, increased storm surges, altered tidal action and/or flooding, within the next 50-100 years (Figure 1). Sandy shorelines and muddy shorelines were identified as being the most sensitive type of shore, having the greatest potential for change in the near future (50-100 years). Sandy shores were more extensive than muddy shores over the TWWHA coastline. Other shoreline types eg rocky shorelines, clayey/gravelly shores and unclassified shores were excluded from the study.

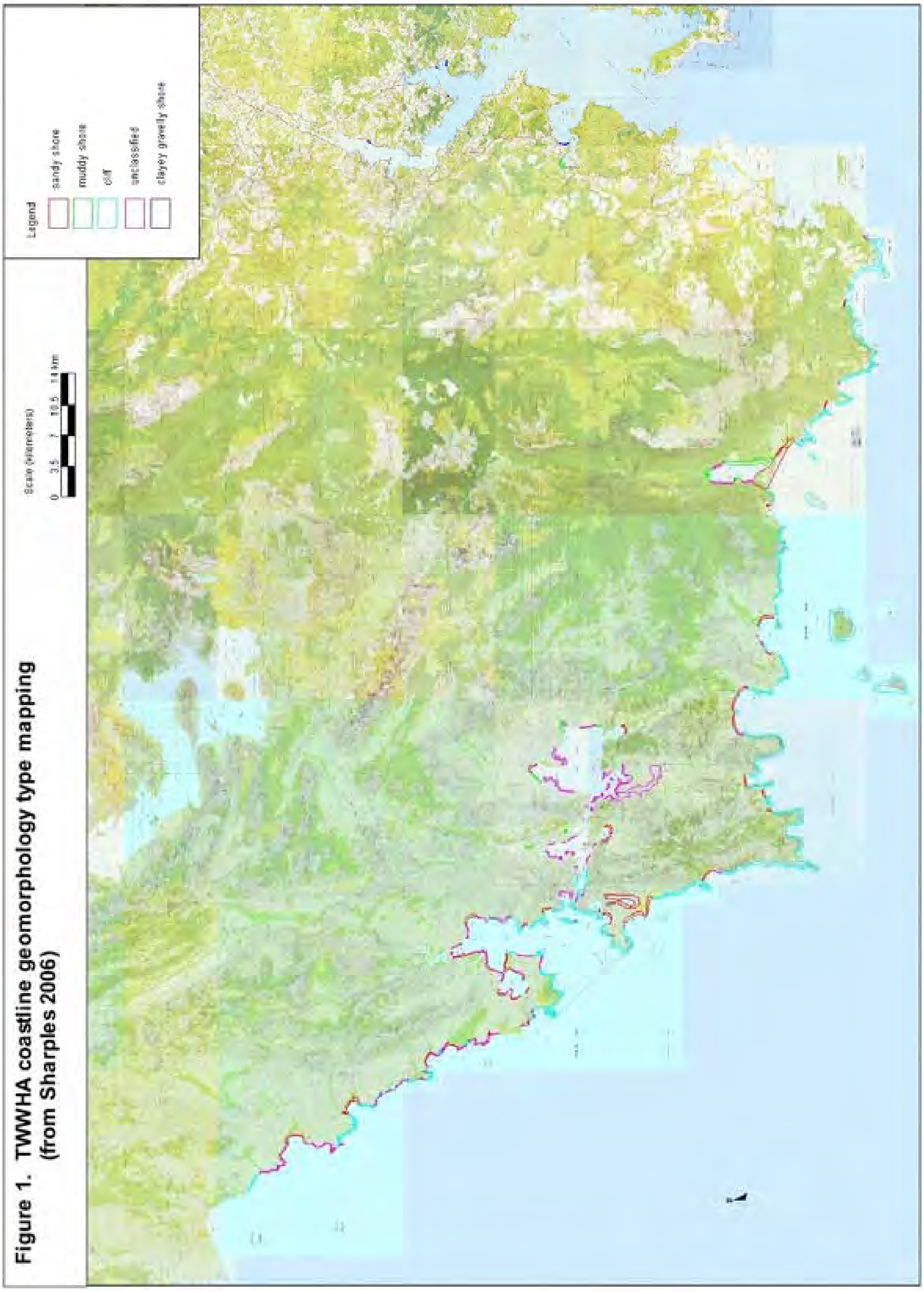

Figure 1. TWWHA coastline geomorphology type mapping (from Sharples 2006)

3.2 Aerial photography

Aerial photography was flown over all the major beach and dune systems with the exception of Port Davey, where only the Hannant Inlet was photographed. Photos were taken using a Canon 5D 12 megapixel digital camera (Stuart Wells Photography) through a viewing hole in the floor of a Cessna 206 light plane. Photos were taken at variable intervals.

Digital aerial photographs were taken on two occasions. The first run was flown along the west coast at about 2000 feet, while the second run along the south coast, was flown later in the season at about 2900 feet. The higher altitude captured a broader area in each image (Table 1). Photos were taken in fine weather in the middle of the day to minimise shadows. A GPS linked to a laptop computer was used to log the flight course. The photo EXIF time data was matched with GPS track time data to derive grid references for photo centres. However the photographs could only be matched to the nearest second with the GPS data. Photos were not precisely vertical so the generated photo centroid is approximate only.

Table 1. Relationship between altitude and resolution of images

Altitude (m)	Altitude (ft)	Image Area m	Pixel per square metre
600m	1968ft	617 x 411	50.4
700m	2296ft	720 x 480	37.2
800m	2624ft	823 x 549	28.1
900m	2952ft	925 x 617	22.1
1000m	3280ft	977 x 651	17.6

3.2.1 Geo-rectification of aerial photographs

Three locations, Cox Bight, New Harbour and Towterer Beach were selected for geo-rectification of digital aerial imagery. Standard rectification processes using the digital elevation model and 1:25,000 series mapping layers were unsuitable for applying to the high resolution of the digital aerial photography. This problem was addressed by first orthorectifing the historical aerial photographs from which the digital linework and elevation datasets were derived. These 1:25,000 scale orthorectified photos were then used as the reference datasets for the orthorectification of the digital photography using observable points in common such as bedrock outcrops.

The Cox Bight digital air photos were rectified against the historic 1:25,000 1988 and 1:5,000 1985 WHA aerial photographic series. The New Harbour and Towterer Beach photos were rectified against a combination of the 1:25,000 1988 and 1:42,000 2004 aerial photographic series. Individual digital air photos for each location were joined into a mosaic of the whole beach region. Large TIFF (.tif file extension) mosaic files were converted to ecw image files. The 1:25,000 and 1:42,000 aerial photographs of each location were rectified against the 1:25,000 TASMAP topographic base maps, which were mapped in the Map Grid Of Australia (GDA) 1994 projection and lie in Zone 55. The specified accuracy for the topographic base maps is that a “not less than 90% of points of well defined detail are within 12.5 metres of their true positions at map scale”. The control points used for georectification are shown in Appendix 1.

3.2.2 Collection of geo-reference points

Accurate geo-reference points were recorded on the ground using a Leica series GX1230 dual frequency (12 L1 + 12 L2) differential GPS with AX1202 standard survey antenna. Points were taken as near to the coastal vegetation line (interface between vegetation and beach sand) as possible. When the point had to be taken in a different location (in order to receive the satellite signal), the distance from recording point to the vegetation line was measured. Approximately 30 seconds was spent at each point to get pre-determined (sub-metre) accuracy. Additional reference points were taken at obvious locations that could be clearly seen on the aerial photography.

Georeference points were differentially post-processed by DPIW using two base stations (the Lands Building and Hobart Airport). A combination of precision quality from the data processing and coordinate repeatability based on two independent base stations was used to determine the positional uncertainty (ie spatial error) for each differential GPS. The following formula was used to calculate the positional uncertainty. Positional uncertainty = √ (Combined point precision^2 + (coordinate repeatability) squared). These georeference points were then mapped in MAPINFO™ professional for assessment of errors in georectification of aerial digital images.

3.3 Vegetation and geomorphology survey

3.3.1 Sampling design

Two locations, Cox Bight and New Harbour, were chosen for field surveys. These locations were selected for their accessibility, presence of threatened species and vegetation communities of conservation value, and were representative of relatively low energy sandy and cobbly beaches within the TWWHA that are vulnerable to increased erosion. Higher energy beaches of the west coast were not included in the initial surveying due to time constraints and access difficulties.

Sampling was undertaken for two different purposes. One was to describe the existing variation in vegetation as a reference data set to guide broadscale vegetation mapping using low altitude digital photography. To this end sites were selected for survey on a stratified basis such that geomorphically distinct parts of each beach were all sampled at least once and each of the common plant assemblages was sampled in at least three places during the survey. Individual sample sites were subjectively located without preconceived bias on the basis of this stratification. A total of 15 of these ‘supplementary’ quadrats were surveyed at Cox Bight and another 16 ‘supplementary’ quadrats were surveyed at New Harbour (Figures 2-4).

A vertically nested plot system was used to record various environmental parameters. Quadrats 1 m x 10 m in size were subjectively located so as to be placed within zones of relatively homogenous vegetation so that the long side was orientated parallel to the beach. This quadrat size is compatible with vegetation data collected in a statewide coastal vegetation survey undertaken by Kirkpatrick and Harris (1995). Within this 1 m x 10 m plot the percentage cover of all vascular plant species with heights under 5 m was recorded together with heights for each of these species (see below for the complete list of parameters recorded). Where the vegetation included plants 5 m or greater in height, an additional 10 m x 10 m quadrat centred along the 1 m x 10 m plot was used to record the cover and height of all vascular species of plants greater than 5 m in height. Thus within each of these vertically nested quadrats a plant species could be recorded twice with two different covers and heights if it was represented by plants both less than and greater than 5 m in height.

The second purpose was to establish long term monitoring transects and record at least some of the baseline data required for assessing the rate of change in vegetation over time. Relatively little effort was put into this part of the sampling and further baseline data collection is still required for the established transects as well as for other transects not yet located.

One 30 m long transect was established at Cox Bight and one at New Harbour. Transects were located in representative areas that showed evidence of geomorphic change. Each is perpendicular to the beach, commencing at the vegetation line (0 m) and extending about 30 m back from the beach. The distance of 30 m was considered appropriate to the scale of the coastal zonation and likely impact. At intervals along the transect 10 m by 1 m plots were located perpendicular to the transect line and extending eastwards. Plots were located subjectively so as to best sample the natural variation in the vegetation. The vertically nested quadrat system was used for these permanent transects.

At Cox Bight quadrats were surveyed at 0 – 1 m (Quadrat 10), 14 – 15 m (Quadrat 14), 23 – 24 m (Quadrat 13), 27 – 28 m (Quadrat 12) and 29 – 30 m (Quadrat 11) along the transect. At New Harbour, quadrats were surveyed at 0 – 1 m (Quadrat 30), 5 – 6 m (Quadrat 31), 10 – 11 m (Quadrat 32) and 30 – 31 m (Quadrat 33) along the transect (Figures 2 – 4).

Transects were permanently marked with stakes, and GPS locations at the start and end of each transect was recorded (Figures 2-4). For permanent transects, the beach profile was sketched. For each quadrat the following data was collected:

- location – easting /northing;
- photograph number;
- percentage cover of each vascular plant species for each strata, maximum height and health score;
- additional species not within the quadrat but present in the same type of vegetation in the adjacent area;
- evidence of recruitment and regeneration;
- general condition and health of vegetation;
- and extent (width and length) of the zone occupied by the vegetation assemblage being recorded.

Geomorphic and other environmental data:

- aspect and slope;
- position in beach profile;
- distance from high tide;
- geology - basalt, dolerite, mudstone, granite, sandstone, greywacke, quartzwacke, quarzite, limestone, laterite, sand;
- percentage cover estimates for: bare ground, sand, burrows, litter, rock and disturbed ground (type – trampling, grazing, fire, vehicle, rubbish, drainage, nesting), other;
- soil – litter depth, A horizon depth, depth of peat layer, soil pH (at 5 cm), texture/grainsize, soil type;
- geomorphic process (eroding, depositing, stable, unknown);
- and geomorphic status (active, dormant recent, stable, no evidence, prograding)

3.4 Vegetation analysis and mapping

3.4.1 Vegetation community classification

The statewide vegetation classification, TASVEG (Harris and Kitchener 2005) was not used as a basis for monitoring as the mapping of the specialised floristic communities recognised on the coast (Kirkpatrick and Harris 1995) was not possible under that classification. A new classification with a higher level of community resolution based on high resolution digital photography was developed for the purpose.

Each quadrat was classified according to dominant flora species. Dominant flora species was defined as the tallest species with at least 15% projected foliage cover. In this way sparse emergent species were excluded as dominants. In cases where several species had a similar height the species with greatest cover was selected as the dominant species. Where the dominant species was one of a number of rainforest species (eg. *Anopterus glandulosus* or *Pittosporum bicolor*), the quadrat was classified as coastal rainforest, rather than as a dominance community. Flora species composition for each surveyed quadrat was compared to species lists for the coastal dominance communities described by Kirkpatrick and Harris (1995). This provided confirmation that this classification system was compatible with previously described community types.

Figure 2 Sampling locations at Cox Bight (west)

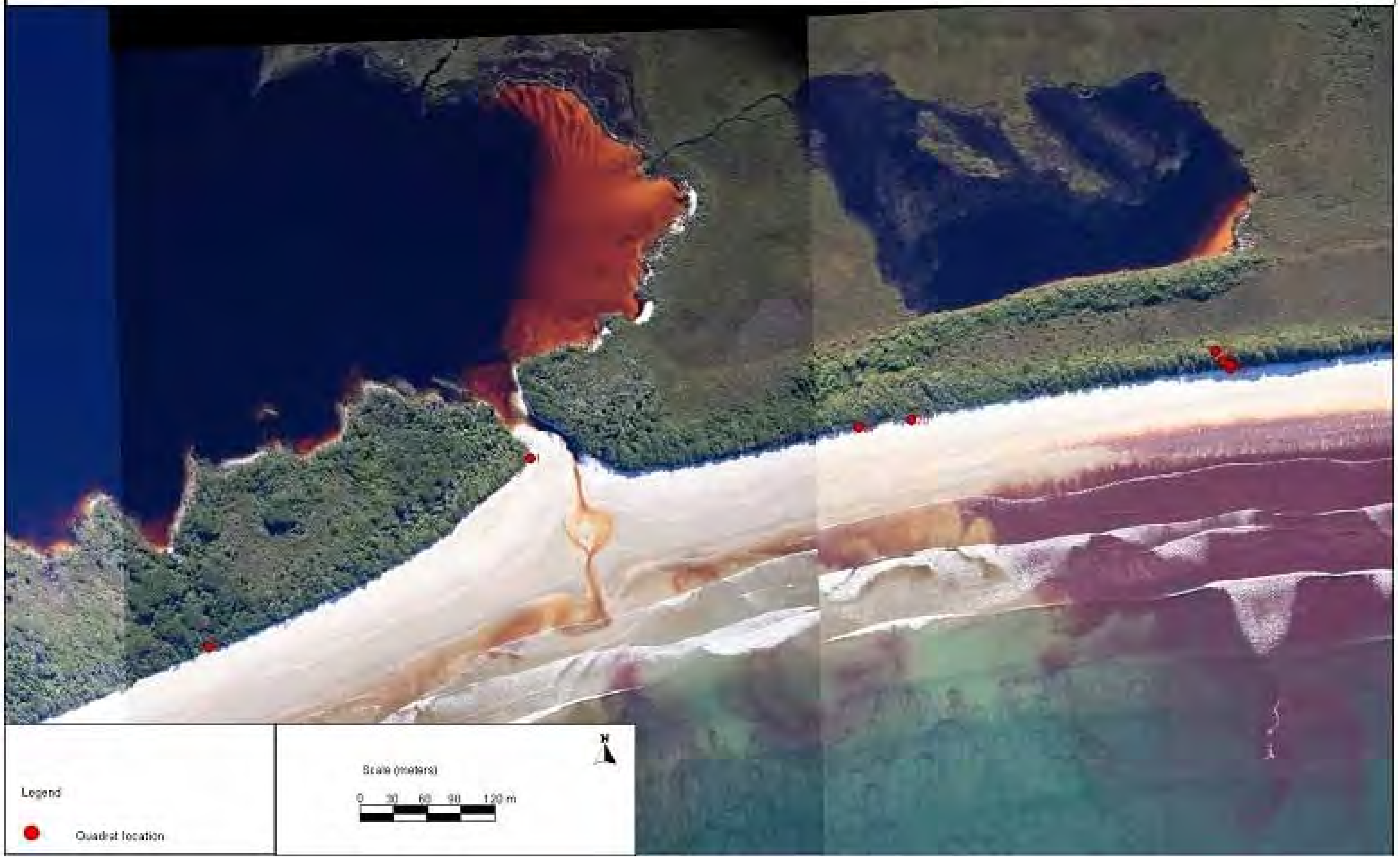

Figure 3 Sampling locations at Cox Bight (east)

Figure 4 Sampling locations at New Harbour

3.4.2 *Photo interpretation and vegetation mapping*

The digital aerial photographs were interpreted and mapped using MAPINFO Professional software. Photo interpretation of vegetation community types was based on canopy cover, density and colour of the vegetation. Areas of relatively homogenous vegetation were enclosed within each polygon. Polygon boundaries are subjectively inferred from the aerial photographs and in reality transitions between vegetation communities are often gradual rather than abrupt.

Individual polygons were then compared to on-ground vegetation data from quadrat surveys. Where field data existed for polygons, the vegetation community within the polygon was defined according to its dominance classification (see 4.2.2). In most cases, no field data existed for individual polygons. These polygons were defined by one of two methods. If the polygons contained vegetation of a similar appearance to verified polygons they were attributed to the same vegetation community. If the polygons contained vegetation that appeared distinct from any polygons with verified field data, the WHA vegetation mapping and map descriptions were used to classify the vegetation community.

All polygons that contain the same vegetation community were grouped as a map unit (MU) with the vegetation description of each map unit corresponding to at least one of the dominance classifications defined using the field data.

3.5 Geomorphology analysis and mapping

Detailed mapping of geomorphic units was outside the scope of this feasibility study however limited geomorphic data was collected from some sites. Geomorphic mapping associated with vegetation transects perpendicular to the beach was desirable but not completed within the limited resources of the project. For each point geomorphic information was categorised as follows:

Substrate = hard or soft
Vector = aeolian, marine or fluvial
Rate = peat present/absent and cyclic or non-cyclic process
Current state of scarp = eroding, depositing, stable
Current state of beach = eroding, depositing, stable

Beaches were characterised by surveying points at intervals along the toe of the foredune/scarp along the length of the Cox Bight and New Harbour beaches. At each reference point, general notes describing the plant communities, geomorphology and geomorphic processes were recorded. Geomorphic descriptions included details of geomorphic characters indicating current activity, such as the presence of peat, cobble stones and the shape of the dune (Table 2).

Table 2. Geomorphology characters that indicate current activity

Geomorphic process	Erosional	Depositional
Wave process	Truncation	Ridges Berms
Wind process	Blow outs Deflation	Incipient dunes Parabolic dunes

Field notes contained information on the current geomorphic form and process at each of the geo-reference points. These notes, along with geomorphic mapping by Cullen (1998), known history, wind direction, wave/swell direction, energy level of the locations, hydrological features and vegetation complexity (which indicates age/stability), were used to classify the coastal geomorphology into one of three zones of current activity: eroding, depositing or unknown. A scoring system was developed based on the current state of the scarp and beach which gave 12 different categories (Table 3) used to classify each survey point. The coastline was then mapped as one of the four broad processes of erosional, depositional, stable or unknown.

Table 3. Geomorphic classification codes based on the current geomorphic state of the scarp and the beach at each point assessed.

Scarp	Beach	Map Code
Not recorded	Not recorded	0
Erosional	Erosional	1
Erosional	Stable	2
Erosional	Depositional	3
Erosional	Unknown	4
Stable	Depositional	5
Stable	Stable	6
Stable	Erosional	7
Stable	Unknown	8
Depositional	Depositional	9
Depositional	Unknown	10
Depositional	Stable	11
Depositional	Erosional	12

3.6 Linking vegetation and geomorphology

It is desirable that the impacts of climate change on the coastal vegetation be closely monitored in association with the underlying geomorphic type and process. Though this study has not fully developed the data, field observations were used to help interpret any correlation between geomorphology types and vegetation. The geomorphic and vegetation classification of sites were compared to discern any relationship between geomorphic process at the shoreline (ie erosion) and vegetation community.


New Harbour, coastal vegetation zonation.


New Harbour, estuarine marsupial lawn.


Cox bight, erosion of dunes


Stephens Bay, high energy coastline.


Cox Bight, sand accumulation.


South Cape Bay, beach grasslands with coast candles.


Cox Bight, marsupial lawn on eroding dune edges.


New Harbour, coastal rainforest developing immediately behind the beach.