4 RESULTS AND DISCUSSION

4.1 Aerial photography

Image resolutions achieved using a Canon 5D full frame sensor (35mm) with 12.8 megapixels were excellent for identification of individual canopies and small objects but the dynamic range of digital equipment used resulted in some washing out of detail on sandy beaches. Scattered light coloured beach grasses were difficult to detect on sand while seaweed and other flotsam was also difficult to distinguish from strandline vegetation such as *Cakile* or *Atriplex* species.

Problems experienced with visually maintaining flight lines along beaches in the first run were overcome by GPS based tracking and higher elevation in the second run. The same flight direction at each site was used for all photos taken in the second run to simplify creation of photo mosaics.

Fifty-six geo-reference points were taken along Cox (P1 – P56) and 19 points were taken along New Harbour (P58 – P77). For all but two of the points, positional uncertainty was less than 1.0 m and in most cases was less than 0.5 m (Appendix 2).

By mapping these points onto the geo-rectified photographs, the spatial error (between the mapped point and its known location on the photo) could be determined. For Cox Bight the geo-reference points were very near to the interface between the beach and the vegetation indicating that the geo-rectification of these photos was excellent. Actual spatial error is therefore mostly due to errors in base mapping which is stated as approximately 12.5 m. For New Harbour, some of the points were 11 m away from the beach-vegetation interface suggesting that geo-rectification of these photos was not as accurate as for Cox Bight. The spatial accuracy of the New Harbour photos is approximately 23 m (12.5 m from the base mapping and 11 m from the geo-rectification process), meaning the true location of the any given point on a photo is within 23 m of where it is depicted.

4.2 Vegetation community classification and mapping

Vegetation community classification and mapping had to be undertaken at a fine scale determined by the narrow zonation of vegetation communities found in coastal areas. As a result the standard 1:25,000 broadscale vegetation mapping methods, TASVEG was unsuitable for the task and a new method developed for this project.

4.2.1 Community classification of field data

The ground surveying of coastal communities worked well with the 10 m x 1 m sized quadrats with the exception of the sparse strandline communities for which the quadrats were too small. Where vegetation was taller than 5 m, the 10 m x 10 m quadrats were useful as they provided information on species composition over a larger area which was necessary when describing scrub and forest communities taller than 5m.

The surveyed vegetation was classified into 11 different vegetation communities, based on structure and species dominance (Table 4). Closed herbfield dominated by *Schoenus nitens* or *Leptinella* spp. was the most commonly sampled community, followed by coastal broadleaf woodland dominated by *Pomaderris apetala*. Coastal shrubland, heathland and scrubland were also frequently sampled and were split into three community types each with a different dominant species. One community type, *Melaleuca squarrosa* woodland, was sampled in only one quadrat (Table 4). There was no correlation observed between species richness and community-type. The highest species richness was recorded in Quadrat 18, which was *E. nitida* woodland with a mixed understorey and ground layers. The lowest richness was recorded in Quadrat 38, an *Isolepis nodosa* sedgeland.

4.2.2 Vegetation mapping

Vegetation communities may be defined according to structure, canopy height and density. Closed and open canopies as well as other aspects of vegetation texture and colour can be distinguished on aerial photography. Twelve different vegetation map units were used to show the distribution and size of vegetation communities at Cox Bight, New Harbour and Towterer Beach (Table 5).

Eucalypt dominated communities were easily seen on the photographs due to their height, crown size and the khaki green/brown colouration of the canopy. Closed herbfield were also easily seen when greater than 3 m^2, due to their extremely low, single strata and bright apple green colouration. Different coastal shrubland, heath and scrub communities could also be differentiated on the photographs. Nevertheless it was difficult to define some of the communities evident on the aerial photographs using the field data. For example the *Correa backhouseana*, *Leucopogon parviflorus* dominated shrubland and other mixed shrubland/heath communities appear very similar on the digital images. Therefore these communities were mapped as a single map unit, in areas lacking on ground vegetation data (Table 5). Vegetation mapping for Cox Bight, New Harbour and Towterer Beach (partial) is shown in Figures 5 – 8, respectively.

The collection of more field data will allow a greater understanding of the relationship between vegetation communities on the ground and their appearances on high-resolution aerial photography. Most importantly, the extent of variation within each community needs to be established and linked to aerial photo interpretation. Methods need to be developed to distinguish between vegetation with similar colour texture on photos that actually represent a range of floristically distinctive plant communities.

The high-resolution digital images allowed more detailed mapping of the coastal vegetation communities than provided within TASVEG maps as vegetation communities occupying small areas are more readily distinguished and therefore mappable (Figure 9). The minimum area of detectable vegetation depends on the resolution of aerial imagery. For Towterer Beach this was approximately 3 m^2 but was slightly more for Cox Bight. For the first time communities covering limited areas such as closed herbfield (marsupial lawn) and narrow coastal grassland strips were mappable. Although the high-resolution digital photos enabled more detailed vegetation mapping it was still not possible to map vegetation communities that occupy extremely small areas or which occur sparsely (such as strand line herbfield, some sedgelands and grasslands) or which are obscured by an overhanging canopy from adjacent vegetation (some marsupial lawns).

By comparing vegetation mapping of communities at the same location but at different times, vegetation community changes are likely to be detectable. By mapping the vegetation communities at Cox Bight using historic aerial photographs from 1985, and comparing this to the 2007 mapping, vegetation changes were evident. One of the most obvious changes is the development of coastal rainforest just east of Point Eric at Cox Bight, seen on the 2007 photos but absent on the 1985 photo (Figure 10). A number of changes in the vegetation are also evident at New Harbour when the 1988 historic aerial photograph is compared to the 2007 imagery. Firstly, the location of the creek outlet is different, the marsupial lawn on the eastern side of creek at New Harbour has significantly increased in size and there has been development of an *Isolepis nodosa* sedgeland on the beach, on the eastern side of the creek outlet.

Table 4. Vegetation community descriptions (by dominance) used for this study and based on the survey data. Corresponding TASVEG communities are listed. TASVEG classes; SSC= coastal scrub , GHC= coastal grass & herbfield, SBR=broadleaf scrub, CRF= coastal rainforest, WNL= *Eucalytpus nitida* forest over *Leptospermum*, SLW= *Leptospermum* scrub, NLE= *Leptospermum* forest.

Vegetation Code This study	**Dominant Species**	**Vegetation Structure**	**Typical non-dominant species (present in at least half the quadrats)**	**Quadrats**	**TASVEG equivalent**
Cb	*Correa backhouseana*	Open scrub to Closed scrub	*Dianella revoluta, Hydrocotyle hirta, Leptecophylla juniperina, Leptinella reptans, Leptospermum scoparium, Oxalis exilis, Schoenus nitens*	16, 20, 21	SSC
Crf	*Anopterus glandulosus, Pittosporum bicolor, Pomaderris apetala*	Low woodland to Open forest	*Hydrocotyle hirta, Pittosporum bicolor, Pomaderris apetala*	8, 23	CRF
En	*Eucalyptus nitida*	Low woodland to Open forest	*Acacia verticillata, Dianella revoluta, Drymophila cyanocarpa, Leptospermum scoparium, Monotoca glauca, Pteridium esculentum*	5, 14, 15, 17, 18	WNL
Gl	*Austrofestuca littoralis, Poa poiformis*	Open grassland	*Juncus* spp.	22, 26, 30, 42, 44	GHC
Hf	*Schoenus nitens, Leptinella reptans*	Closed herbfield	*Acaena pallida, Hydrocotyle hirta, Leucopogon parviflorus, Viola hederacea*	1, 2, 3, 4, 11, 12, 31, 34, 36, 37, 41	SSC
In	*Isolepis nodosa*	Open sedgeland	*Acaena pallida, Actites megalocarpa, Carex pumila, Poa poiformis*	38, 39, 43	GHC
Lp	*Leucopogon parviflorus*	Low shrubland, Open heath or Open scrub	*Pomaderris apetala*	7, 27, 32, 40	SSC
Ls	*Leptospermum scoparium*	Tall shrubland to Open scrub	*Acacia verticillata, Drymophila cyanocarpa, Leptecophylla juniperina*	6, 19	NLE
Mg	*Monotoca glauca*	Low closed forest to Open forest	*Drymophila cyanocarpa, Melaleuca squarrosa, Pimelea drupacea*	9, 10	NLE
Ms	*Melaleuca squarrosa*	Low woodland	*Hydrocotyle hirta, Zieria arborescens*	13	SMR
Pa	*Pomaderris apetala*	Low open woodland to Open forest	*Anopterus glandulosus, Leptecophylla juniperina, Microsorum pustulatum, Polystichum proliferum, Pteridium esculentum*	24, 25, 28, 29, 33, 35	SBR

Table 5. Description of vegetation map units based on the 2007 digital aerial images

Polygon Colour	Appearance	Vegetation Community Description	Vegetation Community (from field data)
green	Canopy cover 10-30%, large crowns, 4 -10m tall, olive green	*Eucalyptus nitida* woodland or forest, occasionally dominated by *Melaleuca squarrosa*	En, Ms
yellow	Canopy cover 10-90%, 1.5 - 4m tall, mixed colours	Mixed sclerophyll shrubland with undetermined dominance. Dominated by either *Correa backhouseana*, *Leucopogon parviflorus*, *Leptospermum scoparium* or *Leptecophylla juniperina*	Cb, Lp, Ls
orange	Canopy cover 10-90%, 1.5 - 4m tall, mixed colours	Mixed sclerophyll shrubland dominated by *Correa backhouseana*	Cb
pale yellow	Canopy cover 10-90%, 1.5 - 4m tall, mixed colours	Mixed sclerophyll shrubland dominated by *Leucopogon parviflorus*	Lp
pale orange	Canopy cover 10-90%, 1.5 - 4m tall, mixed colours	Mixed sclerophyll shrubland dominated by *Leptospermum scoparium*	Ls
purple	Canopy cover 30-70%, 8-10m tall, darker green	Coastal rainforest, eucalypts absent	Crf
dark blue	Canopy cover > 30%, 2-18m tall, mixed colours	Broadleaf woodland mostly dominated by *Pomaderris apetala*, but occasionally dominated by *Monotoca glauca*	Pa, Mg
light blue	Canopy cover > 30%, 2-18m tall, mixed colours	Broadleaf woodland dominated by *Monotoca glauca*	Mg
black	Canopy cover < 30%, to 4m tall	Tall shrubland, dominated by *Melaleuca squarrosa*	Ms
red	Canopy cover 10-70% < 100cm tall, mid green	Grassland dominated by *Austrofestuca littoralis* or *Poa poiformis* or, sedgeland dominated by *Isolepis nodosa*	Gl, In
pink	Canopy cover 10-70%, < 100cm tall, mid green	Sedgeland dominated by *Isolepis nodosa*	In
white	Canopy cover 30-70%, < 50cm tall, bright green	Herbfield dominated by *Schoenus nitens* or *Leptinella* spp., with occasional emergents	Hf

Figure 5 Cox Bight (west) vegetation community classification and mapping

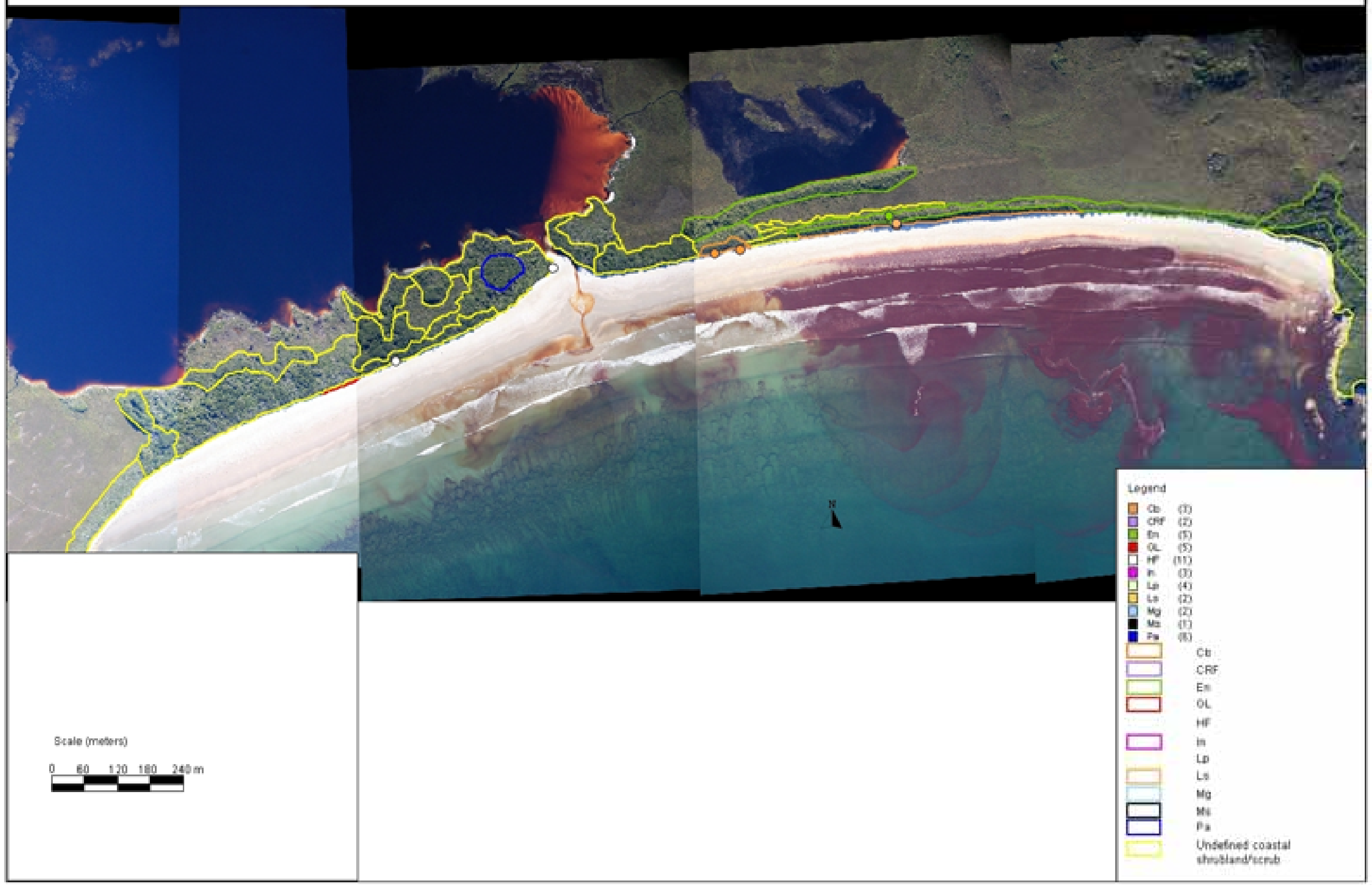


Figure 6 Cox Bight (east) vegetation community classification and mapping

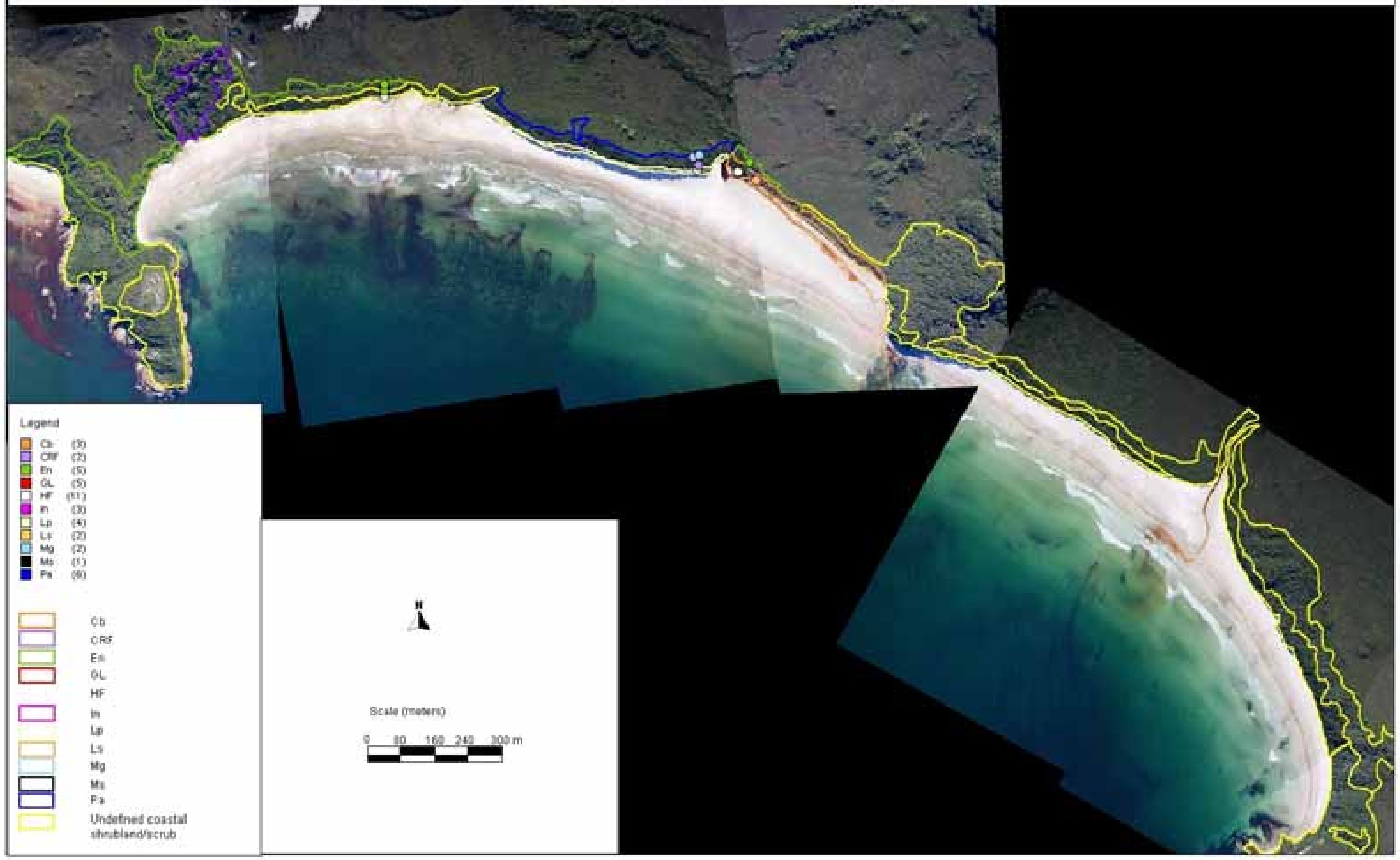


Figure 7 New Harbour vegetation community classification and mapping

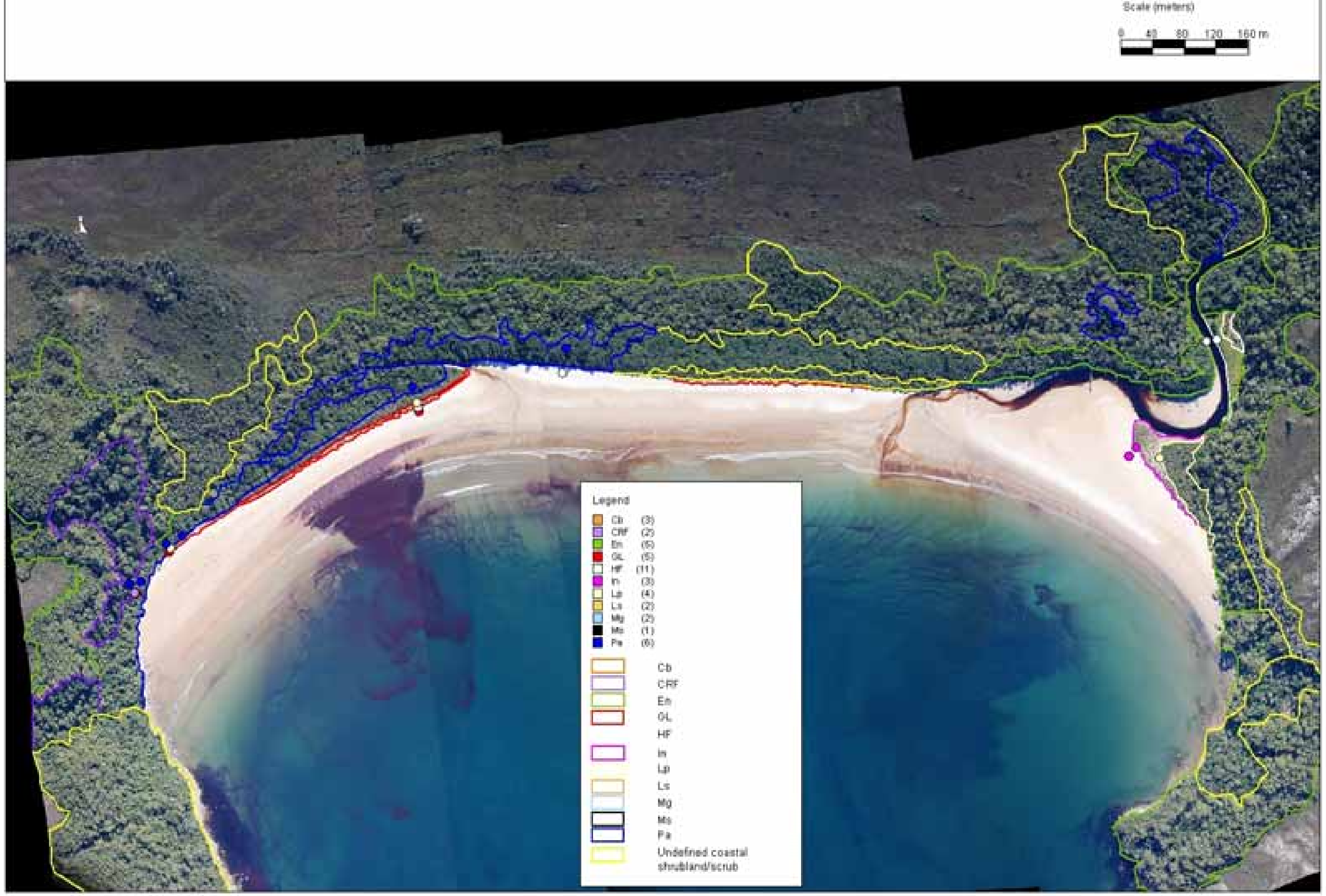


Figure 8 Towterer Beach vegetation community mapping

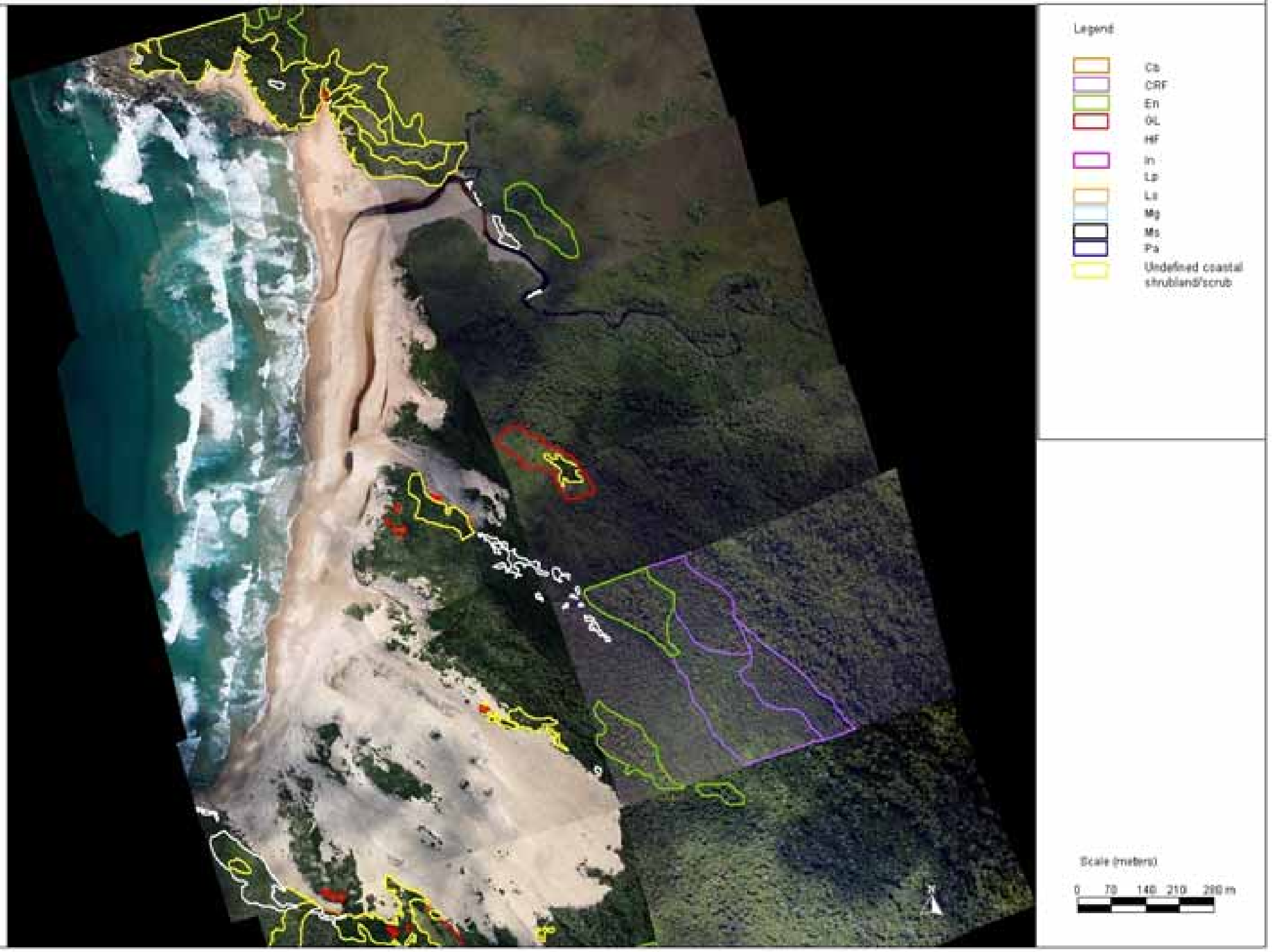
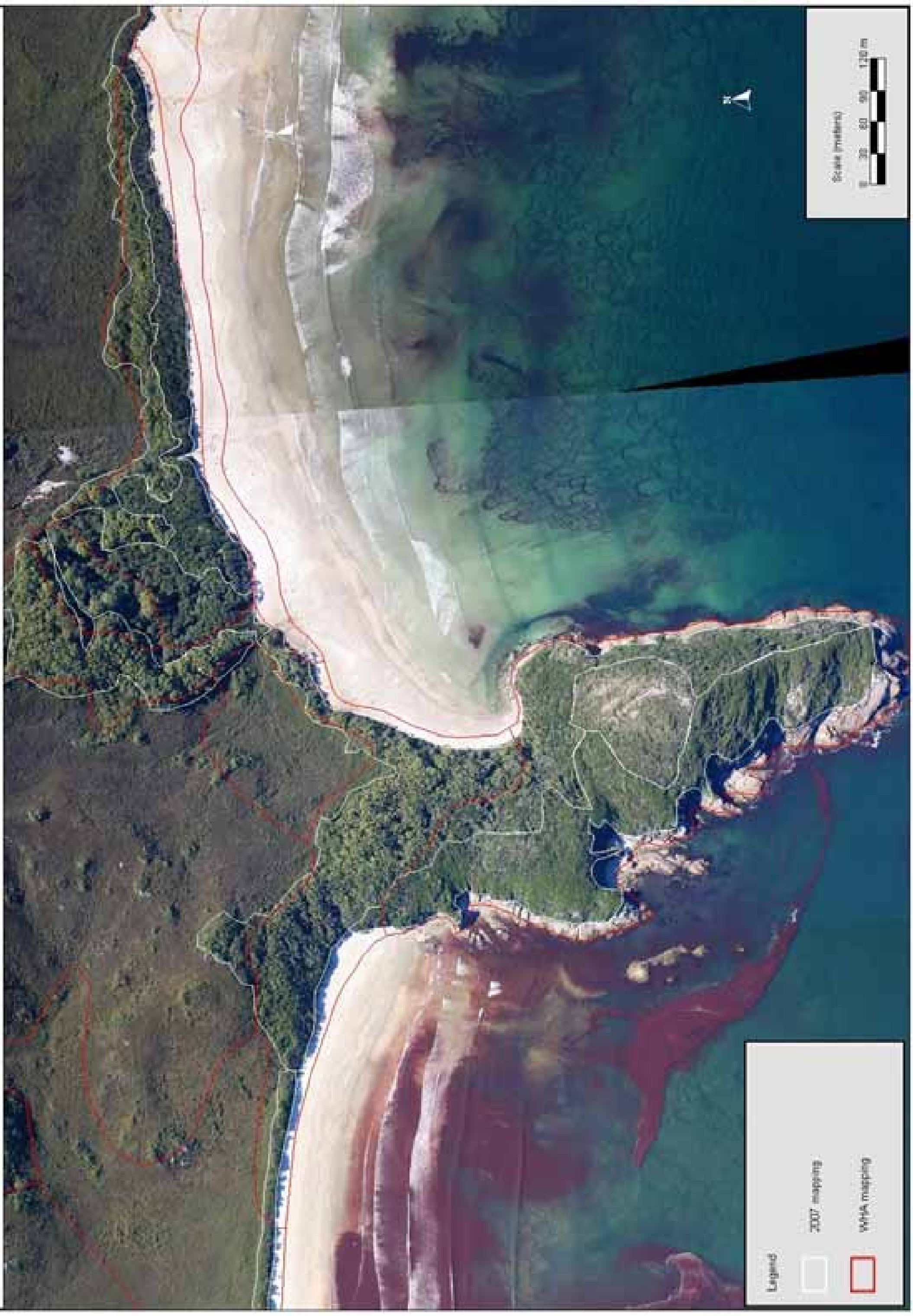


Figure 9 Comparison of TWWHA vegetation mapping and project mapping for Point Eric, Cox Bight.



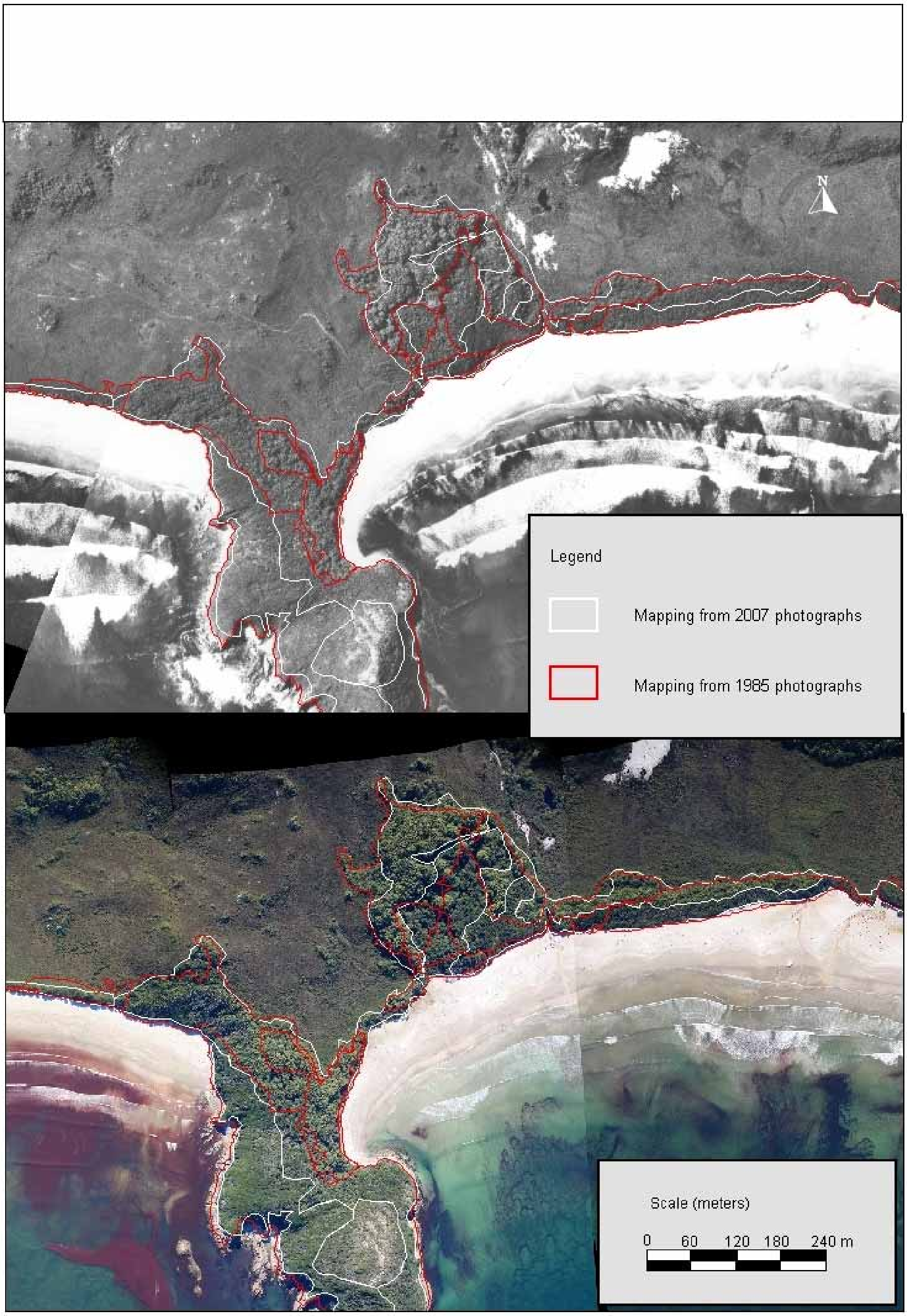


Figure 10 Comparison of vegetation mapping based on 1985 (top) and 2007 (below) aerial photographs.

Furthermore, by comparing the vegetation communities present and the distribution of each on the 1980's historic photos to those of 2007, it is clear that an obvious change in vegetation has occurred over a 20-year period. The time scale of significant vegetation change that is interpretable from aerial photographs is likely to be 10 years or more. Though vegetation loss due to erosion can occur rapidly, it is known to be cyclic and longer term monitoring will be needed to identify trends.

Currently, this method will enable vegetation community changes to be detected only qualitatively. Limitations to determining vegetation change occur due to differences in aerial photo resolution between the current photos and historic photos (higher resolution allows better interpretation and mapping). This limitation will reduce in the future as photographic resolution has now reached an adequate level for this type of monitoring. Detecting vegetation change is also limited by the geo-referencing of the photographs. Because spatial errors are large and each photo has been rectified independently, actual quantitative community change, ie the actual size or distribution of each community type, cannot be calculated. As geo-rectification improves, this limitation will be removed and spatial quantitative analysis of vegetation change, including changes in size of patches, shifts in the distribution of communities along the coast, and calculations of the total area of the community along the coast of the TWWHA, will be possible.

4.3 TWWHA coastal floristic values

Four of the vegetation communities of conservation significance, marsupial lawn, coastal rainforest, coastal shrubland and coastal grassland were identified using both field surveys and aerial photo interpretation.

Short closed herbfields were surveyed at New Harbour and Cox Bight. A well-developed patch of marsupial lawn is located near the creek at New Harbour with smaller patches occurring at the beach/vegetation interface. The composition of this community was very similar to other published accounts of the community (Harris 1991, Kirkpatrick and Harris 1995). An interesting component of the small patches at New Harbour was the presence of the terrestrial alga, *Nostoc* sp. Patches of marsupial lawn were also found along Cox Bight, although these tended to be small, and represent early stages of the community. They were found on the interface between the beach and vegetation. Marsupial lawns could also be identified from the aerial photographs. These patches tended to be larger in size and not covered by overhanging vegetation. Well-developed (older) and larger patches of closed herbfield were observed at Nye Bay, Mulcahy Bay, Wreck Bay, Towterer Beach, Hannant Inlet, New Harbour and Louisa Bay. Some small patches were evident around New Harbour Lagoon. It is these large, well-developed patches of marsupial lawn, rather than the small patches that are of high conservation value and should be incorporated into the long-term monitoring program.

Littoral rainforest was also identified at both New Harbour and Cox Bight. Field data was collected from New Harbour rainforest but not from Cox Bight. This community can be distinguished in aerial photographs due to its dark green canopy colour and large crown sizes. Using the aerial photography, small patches of rainforest were detected at most of the western and southern beaches. An extensive area of coastal rainforest was identified on the dunefield running north east from Towterer Beach. It appears to be an unusual version of littoral rainforest with *Phyllocladus aspleniifolius* and *Dicksonia antarctica* as more common species than expected. The interesting floristic composition and the large extent of this coastal rainforest make it not only unique but of high conservation value.

Coastal shrubland is the most widely distributed community along the TWWHA coastline. This community was surveyed at New Harbour and Cox Bight. There appears to be much variation in the species composition within this vegetation type. In many cases coastal shrublands are mixed communities that included *Leptospermum scoparium*, *Leucopogon parviflorus* and *Correa backhouseana*. From the aerial photo interpretation this community type has a large distribution along the TWWHA coastline occurring at the back of nearly every sandy beach.

Coastal grassland was detected through field-work at both New Harbour and Cox Bight. This grassland was mostly had a sparse cover of *Austrofestuca littoralis* as well as *Poa poiformis* and *Hierochloe redolens*. Coastal grassland can be difficult to identify from aerial photographs where its has a sparse cover and limited distribution. Where it can be recognised from aerial photographs it has a mid green colour (different from marsupial lawn, which has a bright apple green colour). Patches of coastal grassland were seen at most of the western beaches with the most well developed occurring at Nye Bay and Towterer Beach.

Although rookery and wetland vegetation types were identified as having conservation significance, and do occur at New Harbour or Cox Bight, they were not specifically targeted for surveying. The marsupial lawn on the estuary at New Harbour was surveyed and does fall within the definition of a wetland community. These communities are found within the coastal environment of the TWWHA but photographs were not interpreted specifically for these two communities during this pilot project.

Two species listed under the *Threatened Species Protection* Act 1995 (TSPA), *Ranunculus acaulis* and *Lachnagrostis scabra* ssp *scabra*, were recorded during the field work at both New Harbour and Cox Bight. The Tasmanian endemic species, *Correa backhouseana,* was sampled a number of times in coastal heath and scrub communities at New Harbour and Cox Bight. Individual species are not easily recognised from aerial photo interpretation.

4.4 Geomorphology classification and mapping

Geomorphic processes appear to be highly dynamic at Cox Bight and New Harbour (Figures 11 and 12). Trends in geomorphic process were apparent using the geomorphic classification system in this study. Most of the Cox Bight beach to the west of Point Eric, appeared to be stable. To the east of Point Eric, geomorphological processes change over small distances up to the eastern end of Cox Bight beach where erosion was very active (Figure 11). At New Harbour beach, there was a clearer trend in geomorphological processes. At the western end of the beach, the shoreline was stable, toward the centre the shore is depositional and to the east the shore is eroding (Figure 12).

Aerial photographs were not a good tool for assessing geomorphology as much of the shoreline and the interface between the beach and dunes are obscured by vegetation. On ground observations indicated that much of the shoreline of Cox Bight was eroding at the time. The development of a more rigorous system to record and monitor erosion and other gemorphological processes should be established.

4.5 Coastal geomorphology values

Coastal geomorphology values are currently inadequately identified in the TWWHA. Linking geomorphic values with vegetation values in risk assessments may facilitate improved focus on sites at lower risk of loss of values where management for the protection of those values may be most feasible. Value mapping was not within the scope of this study. Prion Bay is an area of interest as the area contains many geomorphic features in association with a range of vegetation types potentially at risk from climate induced changes.

4.6 Links between geomorphology and vegetation

There appeared to be no obvious correlation between geomorphic process along the foredune of sampled beaches and the vegetation. This may be due to the limited geomorphology information that was collected and truncation of vegetation communities that may occur in an erosional environment. Field observations suggest that closed herbfield communities often occur on eroding scarps at the back of the beach, but they are not restricted to this location. Incipient dunes supported sparse sedgeland or grassland. More geomorphic mapping is required to investigate correlations between geomorphic processes, such as erosion, and different vegetation communities than was possible in this study.

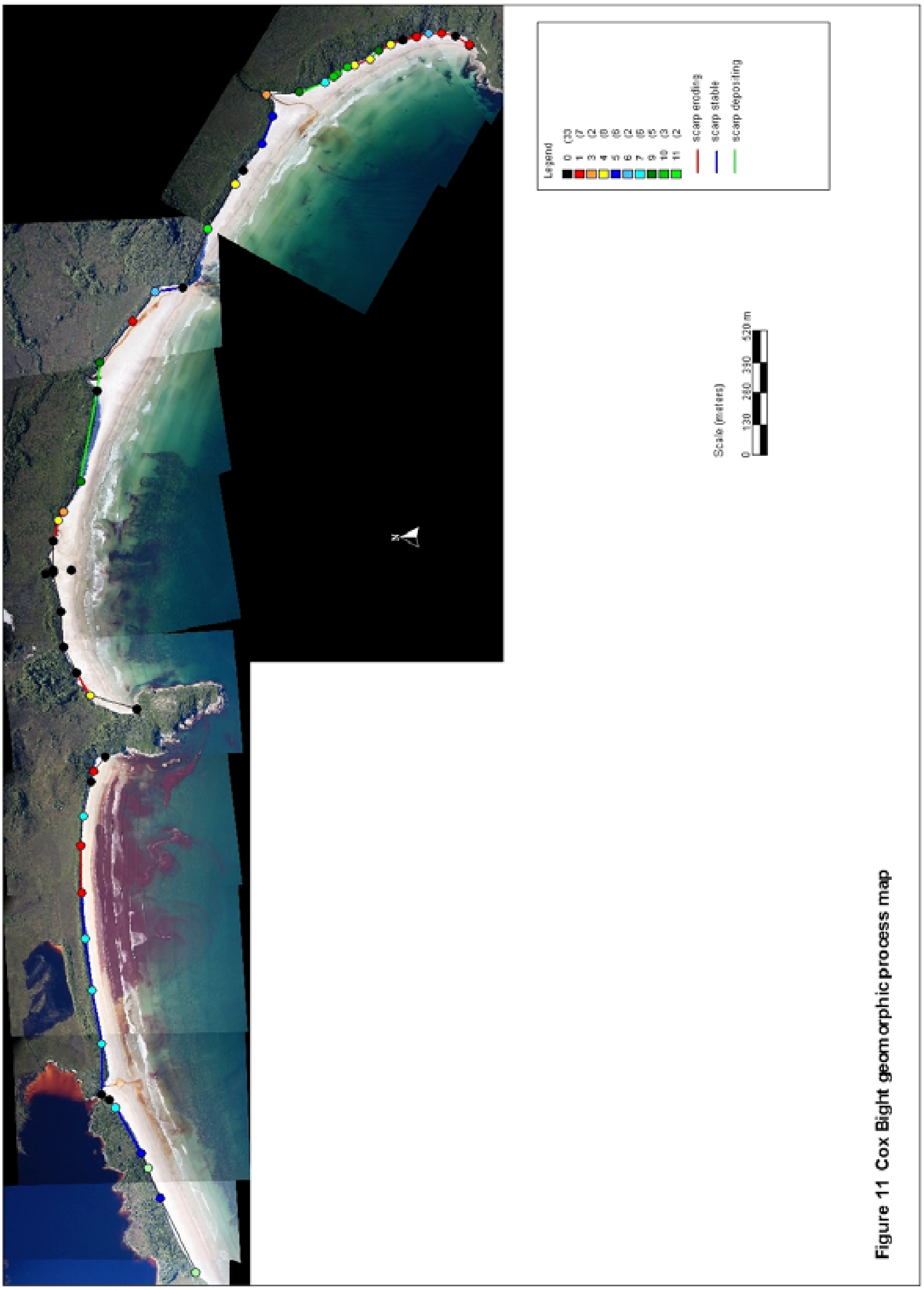


Figure 11 Cox Bight geomorphic process map

Figure 12 New Harbour geomorphic process map