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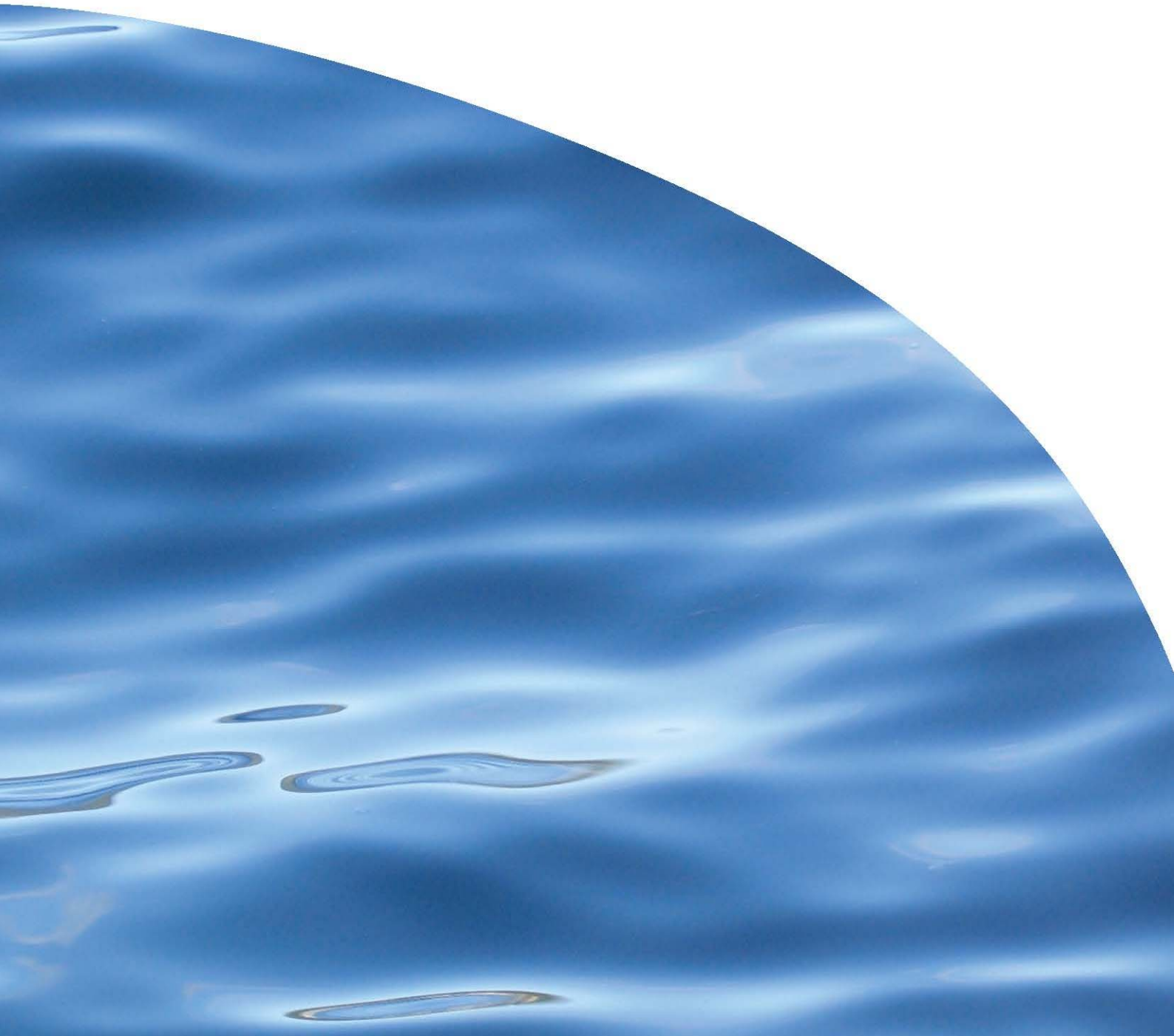
NELSON BAYS ECOSYSTEMS MAP



NELSON BAYS ECOSYSTEMS MAP

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Prepared for the Ministry of Business, Innovation and Employment for the Integrated Valuation of Marine and Coastal Ecosystem Services project —Contract No. MAUX1208

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1. BACKGROUND

The Nelson Bays ecosystem map was developed as part of the research project 'Integrated valuation of marine and coastal ecosystem services' funded by the Ministry of Business, Innovation and Employment (MBIE). The aim of this project is to develop a robust framework to characterise, quantify, map and value coastal-marine ecosystem services. In doing so, this research intends to 'make visible' coastal-marine ecosystem services that are often ignored in resource management and business decision-making. It is anticipated that this ecosystem service approach will shift thinking about coastal-marine management away from a fragmented concentration on single issues, single processes and single resources, to a more holistic appreciation of the whole-of-system ecosystem services values and processes.

Nelson Bays has been chosen as a test-bed for this research and this map represents the first step in characterising the ecosystem services in the case study area. Using ArcGIS, the map compiles existing data from a range of sources into a best estimate of the spatial coverage of coastal and marine ecosystems in the Nelson Bays region. The spatial depiction of coastal and marine ecosystems will be used to identify areas of ecosystem service provision and enable the quantification of these services.

2. STUDY AREA

The Nelson Bays coastal-marine study area used in this project is based on the Millennium Ecosystem Assessment (MA) definition of coastal ecosystems and is depicted in Figure 1. The MA defines the inland extent of coastal ecosystems as the line where land-based influences dominate up to a maximum of 100 km from the coastline or 50 m elevation (whichever is closer to the sea) with the outward extent at the 50 m depth contour (Agardy *et al.* 2005).

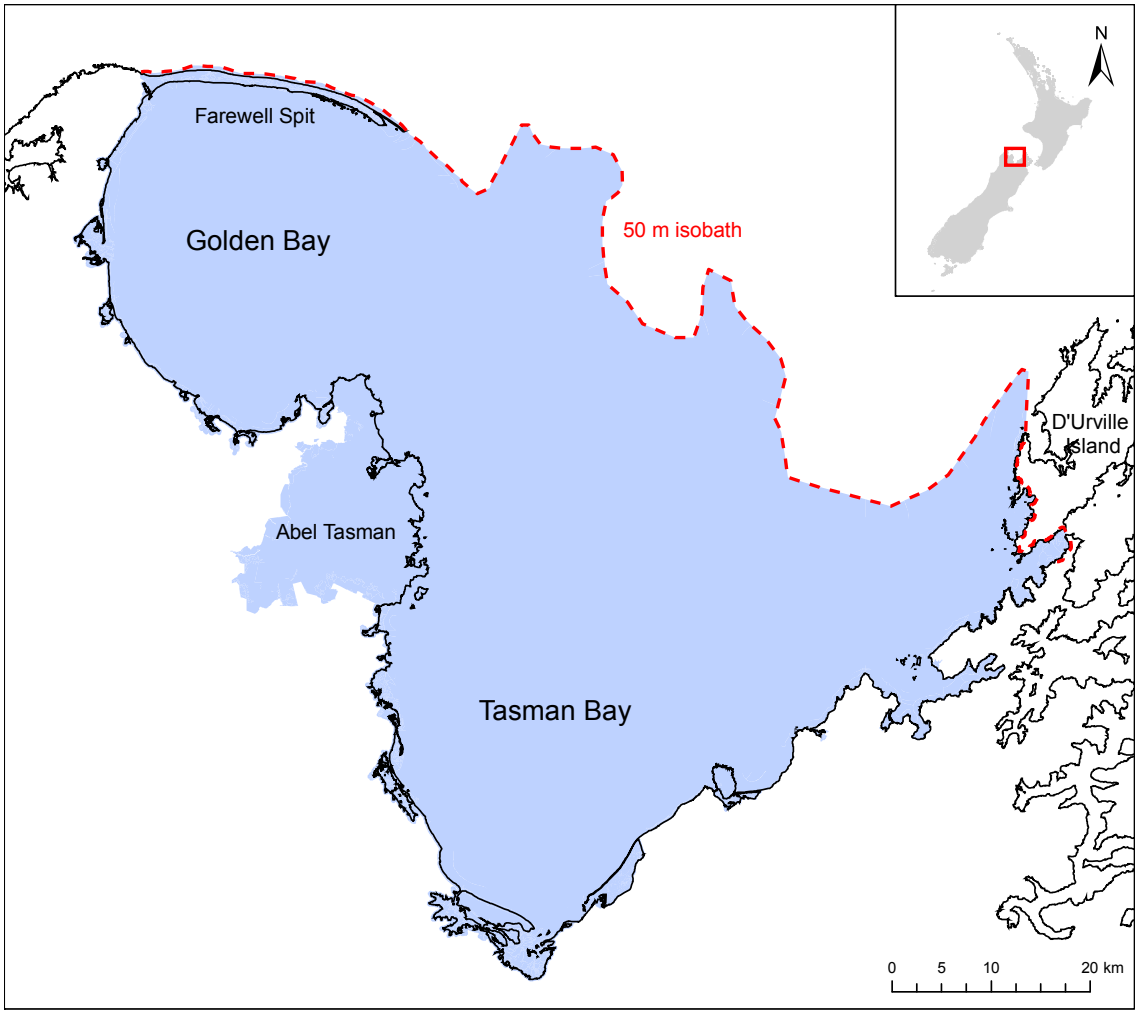

Figure 1. Nelson Bays case study area. The seaward boundary runs along the 50 m isobath (red dashed line) and the inshore boundary includes coastal features that lie within 100 km (or 50 m elevation) from the coast. The entire area of the Abel Tasman National Park and the Farewell Spit Nature Reserve are included in the case study area.

In accordance with this definition, the inshore boundary of the Nelson Bays study area encompasses all coastal features from Cape Farewell to the southern side of the entrance to Greville Harbour, D'Urville Island within 100 km (or 50 m elevation) from the coast[1]. Coastal features are defined as all parcels of land and aquatic systems that are significantly affected by coastal processes, ecology and biogeochemistry. This, for example, includes saltwater wetlands, estuaries, beaches, dune systems, brackish parts of rivers, islands and the Boulder Bank. It does not include coastal forests. In addition, the entire areas of the Abel Tasman National Park and the

[1] This is not to say that we mapped 100 km inland or up to 50 m elevation in all cases — this was only mapped if there were coastal features (*e.g.* dunes, saltmarsh, brackish parts of rivers) present within that area. The definition of coastal features excludes coastal forests. Best attempts have been made to map inshore coastal features; however, in some areas (particularly the coast north of Delaware Inlet to D'Urville Island) certain features may have been missed. Dunes systems and coastal vegetation were particularly difficult to define from aerial photos.

Farewell Spit Nature Reserve are included within the study area to capture the significant economic value of tourism activity of these features, which are largely derived from their coastal location.

The seaward boundary of the study area begins at Cape Farewell and follows the MLWS (mean low water spring) line along the northern (Tasman Sea) side of Farewell Spit. At the end of the spit, the seaward boundary runs along the 50 m isobath, a natural boundary between Nelson Bays and the Cook Strait, to a meeting point with D'Urville Island at Ragged Point on the southern side of the entrance to Greville Harbour. The boundary then follows the southern coast of D'Urville Island until it reaches Reef Point and then crosses French Pass to join up with the mainland at Channel Point. This study area is reasonably self-contained with respect to oceanic circulation patterns. It also allows the inclusion of Farewell Spit, an area with important conservation, recreation and tourism values.

3. DATA SOURCES AND LIMITATIONS

The Nelson Bays ecosystem map was based on data from a range of sources, compiled into a best estimate of the ecosystem types in Nelson Bays (Table 1). In general, modifications to areas which were previously mapped were avoided on the assumption that this data was fairly reliable. Where ecosystems from different sources overlapped, or for areas where no data was available, an educated guess was made to determine the most likely ecosystem. In some cases, the previously mapped ecosystem obviously did not match recent aerial photos[2], therefore, modifications were made. In addition to the sources listed in Table 1, sediment cores from a range of projects carried out by Cawthron Institute (Cawthron), NIWA (Tuck *et al.* 2012) and the Department of Conservation (DOC: Croisilles Harbour, Davidson & Duffy 1992) were used to help information decisions on dominant sediment cover.

The area of coastline between Waimea Inlet and Greville Harbour (excluding Nelson Haven and Delaware Bay) has not been previously mapped. Therefore, the ecosystem was primarily determined using aerial photos supplied by the Marlborough District Council (MDC). Consequently, the level of detail along this stretch of coastline, especially with regard to saltmarsh and biogenic habitats, is lower than the rest of the mapped area.

Reliable information on some important areas of coastal ecosystems, such as horse mussel beds and brown macroalgal forests (*e.g. Ecklonia radiata* and *Carpophyllum flexuosm*), is not available within the case study region, therefore, these ecosystems

[2] Aerial photos were primarily obtained from the Nelson City Council using their Top of the South Maps (www.topofthesouth.co.nz) GIS server. The Marlborough District Council supplied aerial photos for the coastal region from Cape Soucis to Greville Harbour on D'Urville Island.

have not been mapped. Davidson (1992) reports that a horse mussel (*Atrina zelandica*) bed at Separation Point is one of the best representative beds in the Nelson / Marlborough region. As many of these communities have been significantly impacted by dredging, those which are still intact are rare and biologically important. He also notes the presence of horse mussel beds at Te Pukatea Bay, in the Abel Tasman.

Some ecosystems, such as seagrass and macroaglae, fluctuate seasonally or annually, therefore, the map provides only a snapshot in time. Other ecosystems, particularly biogenic habitats (*e.g.* oysters, mussels, worm and cockle beds), are not consistently mapped across the study area. These ecosystems are generally well defined in estuaries that have been mapped at the broad scale (Delaware, Nelson Haven, Motueka, Moutere, Motupipi, Ruataniwha, Waimea), and to a lesser extent along the coastline from Waimea to Farewell Spit (Robertson & Stevens 2012), but are not covered in other areas. Measures of the density or health of various species (*e.g.* seagrass) are not included in the ecosystem map; however, this information is available for some areas and could be requested. See Table 1 for limitations associated with each data source and Appendix 2 for further issues pertaining to the limitations associated with various ecosystem types.

Table 1. Sources of information and notes for the Nelson Bays ecosystem map.

Source	Description and notes
AbelTas (1992)	Digitised map from Davidson's (1992) report on the intertidal and shallow sub-tidal ecology of Abel Tasman. Based on 1988 aerial photos and ground-truthing in 1990–1991. Habitat classification was based on Davidson's report.
	Notes: Geo-referencing was coarse so some areas do not line up exactly with coastline. Some boundary lines were difficult to distinguish so may not be exact — especially Rf and S-Rf, Rock-B and Rock. Variations in the order of some components were not distinguished *e.g.* Rock-B *vs* B-Rock. Sub-tidal information is less reliable than intertidal information. Data is not recent but is mapped in high detail.
Asher *et al.* (2008)	Shapefiles delineating the sponge garden areas described in Asher *et al.* (2008). Data provided by Cawthron. Asher *et al.* (2008) describes two regions containing biologically diverse sponge-associated communities in Waimea Inlet (sponge gardens). The Traverse sponge garden is ~1.2 ha and consists mainly of *Mycale (Carmia) tasmani* and associated biota on a cobble / shingle substrate. The Saxton Monaco channel is ~4.8ha and also dominated by *Mycale (Carmia) tasmani*. See report for more details.
	Notes: Probably other sponge gardens within the case study area. These were the only reported sponge gardens with reliable information.
Battley *et al.* (2005)	Battley *et al.* (2005) surveyed grain-size, macrofauna and seagrass distribution at 192 sites on the intertidal flats at Farewell Spit in 2003. Along with aerial photographs[2], the sites containing seagrass were used as a guide to map the distribution of seagrass along the intertidal flats of Farewell Spit.

Source	Description and notes
	Notes: Fairly reliable data. Seagrass may vary annually so this information is only a snapshot in time.
Coastal Series Sediments (1987)	Sub-section of NIWA's Coastal Series Sediment Tasman 1987 map 1:200,000. This layer contains the digitised coastal sediments series features with *dom* and *subsidary* classes combined into one feature class (FC) layer. All sheets have been updated again into one feature class layer with features from the newer sheets replacing features from older versions. This version has been renamed (see alternative name for the source copy of this layer). However, this version is to have its attributes and feature geometries modified based on Scott Nodders QC / QC check.
	Notes: Data is not recent and sediment patterns may have changed. Data is interpolated from a limited number of sampling stations.
Delaware (2009)	Based on aerial photos (Jan 2009) and ground-truthing in 2010. Relevant report is Gillespie *et al.* (2011a). Upper boundary was set at mean high water spring (MHWS), however, in some areas supra-littoral habitat was included where it was considered integral with the upper intertidal, in which case it was included. The lower boundary was set at mean low water spring (MLWS). A 10 m wide riparian strip was also assessed visually to indicate the type of habitat surrounding the edge of the estuary. Habitat classification was in accordance with the EMP[3]. Data provided by Cawthron.
	Notes: Fairly reliable data and mapped in high detail.
DOC Reefs	Outline of reef based on Department of Conservation (DOC) shapefile of reefs around New Zealand. Primarily used for deeper reefs that were not entirely visible in aerial photos. Comparisons with aerial photographs[2] were still made.
	Notes: Reefs are mapped at a pretty coarse scale. Misses smaller reefs.
Grange *et al.* 2003	'Silt / bryozoan' areas at Separation Point were defined using data from Grange *et al*. (2003) based on side-scan sonar and ground-truthing with ROV video footage taken at Separation Point in 2002.
	Notes: Potentially other areas of bryozoans within the case study region, however, they are most likely not of significance in comparison with those at Separation Point. Evidence of scattered, small bryozoan mounds within the Tonga Island Marine Reserve and another bed off D'Urville Island that may, or may not, still exist (Grange *et al.* 2003). Side-scan sonar revealed potential bryozoan habitat along the northern boundary of the Separation Point protected area, which may extend outside of it (Grange *et al.* 2003).
Haven (2009)	Based on aerial photos (January 2009) and ground-truthing in 2011. Relevant report is Gillespie *et al.* (2011b). Upper boundary was set at MHWS, however, in some areas supra-littoral habitat was included where it was considered integral with the upper intertidal. The lower boundary was set at MLWS. A 10 m wide riparian strip was also assessed visually to indicate the type of habitat surrounding the edge of the estuary. This estuary margin included the Boulder Bank habitats up to the highest elevation point on the estuary side only and all reclamation land bordering the mapped area. Habitat classification was in accordance with the EMP. Data provided by Cawthron.
	Notes: Fairly reliable data and mapped in high detail.

[3] EMP is the Estuary Monitoring Protocol; a standardised methodology developed by Cawthron Institute for assessing and monitoring the condition of New Zealand estuaries.

Source	Description and notes
LCDB v3 (2008/09)	Landcare Research Land Cover Database version 3 (LCDB v3), using land cover in summer 2008–2009. Primarily used to map the Abel Tasman National Park and Farewell Spit.
	Notes: LCDB v3 has now been superseded by version 3.3. See www.lcdb.scinfo.org.nz for information on limitations.
Motueka (2001)	Based on aerial photos (June 2001) and ground-truthing in 2002. Relevant report is Robertson *et al.* (2003). Upper boundary was set at MHWS, however, in some areas supra-littoral habitat was included where it was considered integral with the upper intertidal, in which case it was included. The lower boundary was set at MLWS. Habitat classification was in accordance with the EMP. Data provided by Cawthron.
	Notes: Fairly reliable data and mapped in high detail.
Motupipi (2007)	Based on aerial photos (2004) and ground-truthing in 2007. Relevant report is Stevens & Robertson (2008). A 200 m terrestrial margin was included. Habitat classification was in accordance with the EMP. Data provided by Tasman District Council.
	Notes: Fairly reliable data and mapped in high detail.
Moutere (2004)	Based on aerial photos (Jan 2004) and ground-truthing. Relevant report is Clark *et al.* (2006). Upper boundary was set at MHWS, however, in some areas supra-littoral habitat was included where it was considered integral with the upper intertidal, in which case it was included. The lower boundary was set at MLWS. A 10 m wide riparian strip was also included to indicate the type of habitat surrounding the edge of the estuary. Habitat classification was in accordance with the EMP. Data provided by Cawthron.
	Notes: Fairly reliable data and mapped in high detail.
No data	For areas where there was no data, an educated guess was made as to the likely ecosystem, based on the above sources and sediment core information. Every effort was made to achieve consistency with definitions used in Cawthron's broadscale surveys, Wriggle's mapping (Stevens & Robertson 2008; Robertson & Stevens 2012) and Davidson's mapping of the Abel Tasman (Davidson 1992).
	Notes: Only an educated guess — not associated with previously recorded data.
Rob Davidson (2011)	Rhodolith shapefile associated with the rhodolith beds described in Davidson *et al.* (2011) around D'Urville Island (Coppermine and Ponganui bays). Davidson's estimate of the size of the bed was 22 ha. These were found at depths of between 6 m and 26 m and covered up to 100% of the silt and dead shells on the seafloor. Areas of reef (according to the NelBaysHab_final.shp) were excluded from the original rhodolith shapefile, slightly reducing the area. Data provided by Rob Davidson, received 29 September 2013.
	Notes: Not necessarily the only rhodolith beds in the case study region. For example, a rhodolith bed is also present in Okiwi Bay, but has not yet been mapped (pers. comm. R. Davidson. 29 September 2013).
Rob Davidson (2013)	Rhodolith shapefile associated with the rhodolith beds described in Davidson & Freeman (In prep) around Totaranui and Tonga Island. Areas of reef (according to the NelBaysHab_final.shp) were excluded from the original rhodolith shapefile, slightly reducing the area. Data provided by Rob Davidson, received 29 September 2013.
	Notes: Not necessarily the only rhodolith beds in the case study region. There may be

Source	Description and notes
	further rhodolith beds around Abel Tasman that have not yet been mapped (pers. comm. R. Davidson, 29 September 2013).
Ruataniwha (2000)	Based on aerial photos (Dec 2000) and ground-truthing. Relevant report is Tuckey and Robertson (2003). Upper boundary was set at MHWS, however, in some areas supra-littoral habitat was included where it was considered integral with the upper intertidal. The lower boundary was set at MLWS. Habitat classification was in accordance with the EMP. Data provided by Cawthron.
	Notes: Fairly reliable data and mapped in high detail.
TDC (2012)	Coastal shapefiles mapped from Waimea Inlet to the top of the west coast of the South Island. Relevant report is Robertson and Stevens (2012). Includes major estuaries / beaches plus a 200 m coastal margin. Excludes the Abel Tasman National Park and Farewell Spit. Based on 2008 aerial photos ground-truthed in 2010–2011 and previous Cawthron / Wriggle broadscale mapping. Habitat classification follows EMP. Data provided to by TDC.
	Notes: Fairly reliable data and mapped in high detail. Data outside of main estuaries may not be as accurately mapped.
Waimea-D'Urville (2013)	Mapping was carried out by Dana Clark (Cawthron) based on aerial photos supplied by the Marlborough District Council from Cape Soucis-Greville Harbour. Every effort was made to achieve consistency with definitions used in Cawthron's broadscale surveys, Wriggle's mapping (Stevens & Robertson 2008; Robertson & Stevens 2012) and Davidson's mapping of the Abel Tasman (Davidson 1992).
	Notes: Only based on aerial photos so sub-tidal areas were not very well mapped. Vegetation was hard to distinguish from aerial photos, so various saltmarsh classes were not distinguished. Hard to identify areas of seagrass without ground-truthing, so seagrass estimates are probably underestimated. No estimates of cockle, oyster or mussels beds, macroalgae or worm beds.
Waimea (2006)	Based on aerial photos (Nov 2006) and ground-truthing. Relevant report is Clark *et al.* (2008). Upper boundary was set at MHWS, however, in some areas supra-littoral habitat was included where it was considered integral with the upper intertidal, in which case it was included. The lower boundary was set at MLWS. A 10 m wide riparian strip was assessed visually to indicate the type of habitat surrounding the edge of the estuary. Habitat classification was in accordance with the EMP. Data provided by Cawthron.
	Notes: Fairly reliable data and mapped in high detail. Although cockles were detected in a number of habitats, it was not possible to provide useful estimates of the spatial extent of their occurrence because they live subsurface. Estimates of cockles are, therefore, excluded from this part of the map.
Whangamoa (2009)	Small section of the northern arm of Whangamoa Estuary was mapped by Cawthron based on aerial photos (2009) and ground-truthing. Relevant report is (Gillespie 2013). Upper boundary was set at MHWS, however, in some areas supra-littoral habitat was included where it was considered integral with the upper intertidal, in which case it was included. The lower boundary was set at MLWS. A 10 m wide riparian strip was assessed visually to indicate the type of habitat surrounding the edge of the estuary. Habitat classification was in accordance with the EMP. Data provided by Cawthron. Intention is to map the entire estuary in the near-future so habitat map could be updated at that time.

Source	Description and notes
	Notes: Fairly reliable data and mapped in high detail. Only a small section of the estuary has been properly mapped.

4. ECOSYSTEM CLASSIFICATIONS

Ecosystem classifications in Nelson Bays were primarily based on a standard set of categories from a coastal classification and mapping scheme developed by DOC/MFish (2008) to classify coastal-marine habitats in New Zealand. Classifications based on 'exposure' were not made for habitats in Nelson Bays (unlike the DOC/MFish approach) because exposure data was not obtained for this region, and most areas are relatively sheltered anyway. In addition to the categories used by DOC / MFish (2008) this classification system also includes:

- some terrestrial and artificial features (*e.g.* forest, pasture, wharves)
- a higher level saltmarsh classification
- a few extra groups to the unvegetated (*e.g.* cobble / boulder / rock, mud / sand) and biogenic habitats (*e.g.* shell bank, macroalgal bed) categories.

The hierarchal structure of the ecosystem classifications and equivalent DOC / MFish classifications are displayed in Table 2. Appendix 1 contains a comprehensive ecosystem classification table and further issues pertaining to classification can be found in Appendix 2. Appendix 3 contains detailed descriptions with reference photos of the structural classes used in the ecosystem classification.

Table 2. Hierarchal structure of ecosystem classifications used in the Nelson Bays ecosystem map with equivalent DOC / MFish classifications displayed.

Coastal classification			
Category	**Structural class**	**Dominant cover**	**Equivalent DOC / MFish (2008, 2011) classification**
Saltmarsh	Estuarine shrubland	Various sp.	Biogenic Saltmarsh
	Tussockland	Various sp.	Biogenic Saltmarsh
	Grassland	Various sp.	Biogenic Saltmarsh
	Sedgeland	Various sp.	Biogenic Saltmarsh
	Rushland	Various sp.	Biogenic Saltmarsh
	Reedland	Various sp.	Biogenic Saltmarsh
	Herbfield	Various sp.	Biogenic Saltmarsh
	Saltmarsh	Saltmarsh	Biogenic Saltmarsh
Duneland	Duneland	Various sp.	Biogenic Saltmarsh
Unvegetated	Mud *(~ < 63 um)*	Estuarine mud *(within estuary / delta)*	Estuarine Mud
		Shallow mud *(< 30 m depth)*	Shallow Mud High Current Shallow Mud
		Deep mud *(30–200 m depth)*	Deep Mud High Current Deep Mud
	Mud / sand	Estuarine mud / sand *(within estuary/delta)*	n/a
		Shallow mud/sand *(> 30 m depth)*	n/a
		Deep mud/sand *(30–200 m depth)*	n/a
	Sand *(~ > 63 um - < 2 mm)*	Estuarine sand *(within estuary / delta)*	Estuarine Sand
		Shallow sand *(< 30 m depth)*	Sheltered Shallow Sand Moderate Shallow Sand Exposed Shallow Sand High Current Shallow Sand

Coastal classification			
Category	**Structural class**	**Dominant cover**	**Equivalent DOC / MFish (2008, 2011) classification**
Unvegetated (*continued*)	Sand *(~ > 63 um - < 2 mm) (continued)*	Deep sand*(30–200 m depth)*	Deep Sand High Current Deep Sand
	Gravel *(~2–60 mm)*	Estuarine gravel *(within estuary/delta)*	Estuarine Gravel
		Shallow gravel *(< 30 m depth)*	Sheltered Shallow Gravel Moderate Shallow Gravel Exposed Shallow Gravel High Current Shallow Gravel
		Deep gravel *(30–200 m depth)*	Deep Gravel High Current Deep Gravel
	Cobble / Boulder / Rock	Estuarine cobble *(~60-250mm, within estuary/delta)*	n/a
		Cobble *(~60 –250 mm)*	n/a
		Estuarine boulder *(~> 250mm, within estuary/delta)*	n/a
		Boulder *(~> 250 mm)*	n/a
		Estuarine rock *(> boulder, within estuary/delta)*	n/a
		Rock *(> boulder)*	n/a
	Reef	Estuarine reef *(within estuary/delta)*	Estuarine Reef
		Shallow reef *(< 30 m depth)*	Sheltered Shallow Reef Moderate Shallow Reef Exposed Shallow Reef High Current Shallow Reef
		Deep reef (*30–200 m depth)*	Deep Reef High Current Deep Reef
	Shoreline soft sediment	Estuarine beach *(within estuary/delta)*	Estuarine Beach

Coastal classification			
Category	**Structural class**	**Dominant cover**	**Equivalent DOC / MFish (2008, 2011) classification**
Unvegetated (*continued*)	Shoreline soft sediment (*continued*)	Beach	Sheltered Beach Moderate Beach Exposed Beach High Current Beach
	Shoreline rocky substrate	Estuarine rocky shore *(within estuary/delta)*	Estuarine Rocky Shore
		Rocky shore	Sheltered Rocky Shore, Moderate Rocky Shore, Exposed Rocky Shore High Current Rocky Shore
		Boulder bank	n/a
Biogenic Habitats	Seagrass	Seagrass	Biogenic Seagrass Biogenic Seagrass Above MHW[4]
	Macroalgal bed	Various sp.	n/a
	Bryozoan areas	Silt / bryozoan mounds	Biogenic Silt / Bryozoan Mounds
	Shellfish bed	Shell bank (area that is dominated by dead shells)	n/a
		Oyster bed	n/a
		Mussel bed	Biogenic Mussel
		Cockle bed	n/a
	Worm bed	Sabellid field	n/a
	Rhodolith bed	Rhodolith bed	Biogenic Rhodoliths
	Sponge garden	Sponge garden	Biogenic Low-Relief Biogenic Reef
Water	Water	Water	n/a

[4] Although biogenic seagrass above MHW is listed as a category in the DOC / MFish classification, in reality seagrass will not occur above MHW.

Coastal classification			
Category	**Structural class**	**Dominant cover**	**Equivalent DOC / MFish (2008, 2011) classification**
Artificial Structure	Artificial structure	Bridge	n/a
		Man-made structure	n/a
		Ramp	n/a
		Seawall / rockwall (man-made)	n/a
		Wharf	n/a
Terrestrial-type Features	Terrestrial shrub / scrub / forest	Various sp.	n/a
	Terrestrial grassland	Terrestrial grassland	n/a
	Introduced Weeds	Unidentified introduced weeds	n/a
	Industrial	Industrial	n/a
	Residential	Residential	n/a
	Pine debris	Pine debris	n/a
	Road	Road	n/a
	Pasture	Pasture	n/a
	Maintained park/amenity area	Maintained park / amenity area	n/a

Terrestrial classification			
Category	**Structural class**	**Dominant cover**	**Equivalent DOC / MFish (2008, 2011) classification**
Terrestrial Shrub / Scrub / Forest	Terrestrial shrub / scrub / forest	Various sp.	n/a
Terrestrial Grassland	Terrestrial grassland	Terrestrial grassland	n/a
Horticulture	Horticulture	Horticulture	n/a
Industrial	Industrial	Industrial	n/a
Residential	Residential	Residential	n/a
Pine Debris	Pine debris	Pine debris	n/a
Road	Road	Road	n/a
Pasture	Pasture	Pasture	n/a
Introduced Weeds	Introduced weeds	Unidentified introduced weeds	n/a
Maintained Park / Amenity Area	Maintained park / amenity area	Maintained park / amenity area	n/a
Artificial Structure	Artificial structure	Man-made structure	n/a

5. MAP ATTRIBUTES

The attribute table contains the hierarchal classification of each feature as well as a range of other information (Table 3). Cawthron also holds information from the attribute tables of the source data used to construct this Nelson Bays ecosystems map. This source data may be requested if a user requires more detail than the level provided in the map.

Table 3. Information contained in the attribute table of the Nelson Bays ecosystem map.

Column	Description
Feat_type	**Feature type:** Hierarchal classification of feature. See Table 2 and Appendix 1 for details.
Category	**Category:** Hierarchal classification of feature. See Table 2 and Appendix 1 for details.
Struc_clas	**Structural class:** Hierarchal classification of feature. See Table 2 and Appendix 1 for details.
Dom_cover	**Dominant cover**. Hierarchal classification of feature. See Table 2 and Appendix 1 for details.
Sed_layer	**Sediment layer:** Probable sediment type for each coastal feature. Sediment type was not determined for Terrestrial features. For Unvegetated features the sediment layer was the same as the dominant cover. For other features, sediment cover was assigned on the sub-dominant categorisations from the original data source or, when this was not available, an educated guess was made based on surrounding sediments. Refer Appendix 4 for more information.
Beach_popu	**Beach popularity:** Ranking of beaches and rocky shore as low, medium, high or very high in terms of their popularity for recreation. Based on a report assessing important areas for contact recreation (Forrest *et al.* 1994) and a survey of Nelson locals. Refer Appendix 5 for more information.
Refugia	**Refugia / nursery habitat:** Identifies features that provide refugia or nursery habitat services. A feature was included if any of the dominant or sub-dominant ecosystems[5] contained biogenic habitat. These biogenic habitats include bryozoan areas, macroalgal beds, mussel beds, oyster beds, rocky reefs, rhodolith beds, saltmarsh, seagrass, sabellid reefs and sponge gardens. Refer Appendix 6 for more information.
Abel_Tas	**Abel Tasman:** Denotes whether the feature is part of the Abel Tasman national park according to the Department of Conservation's Public Conservation Areas shapefile. 'Yes' indicates the features is part of the national park, 'Within' indicates the feature is within the national park boundaries but not actual part of the park (*i.e.* private land).
ES_Biome	**Ecosystem service biomes:** Classifies features into ES biomes used in a Rapid Ecosystem Service Assessment (refer Cole *et al.* In press). These

[5] Saltmarsh was only included if it was the dominant habitat because it was assumed the refugia habitat function provided by saltmarsh would only function when saltmarsh was the dominant cover.

Column	Description
	biomes include coastal lagoons, coastal waters, estuary, intertidal reef, saltmarsh, sand beach / dunes and seagrass. Refer Appendix 7 for definitions of each biome.
Zone	**Geographic zone:** Classifies features into geographic zones. Refer Appendix 8 for definitions of each zone.
NB_Region	**Nelson Bays region:** Indicates the region of the case study area that the feature is contained within. Golden Bay extends from the tip of Farewell Spit to Separation Point. Tasman Bay extends from Separation Point to Cape Soucis. The Cape Soucis north section extends north from Cape Soucis to the entrance to Greville Harbour on D'Urville Island. Refer Appendix 9 for a map of the three regions.
NB_Area_ha	**Area:** Area of feature in hectares. In order to keep these area values up to date, the geometry will need to be re-calculated if any changes are made to the features.
Source	**Source:** Primary source of the data. Refer Table 1.
Comment	**Comment:** Details justification for why changes were made to original polygons or for the classification used in areas for which there was no data. It also includes uncertainties / assumptions made when making the map[6].

6. CLEANING AND CHECKS

Once the data had been collated the map was 'cleaned' to minimise errors in the spatial depiction and area calculations of marine and coastal ecosystems. This removed erroneous gaps and overlaps that may have arisen as a result of merging data from a number of data sources. These steps are listed below:

1. Duplicate polygons were identified by checking for identical centroid coordinates; none were identified.
2. Significant unmapped gaps were identified by overlaying the map onto bright background and looking for areas displaying that colour. Adjacent polygons were extended to fill unmapped gaps.
3. The ET Geo Wizards Clean Polygon Layer tool was used to remove overlaps and gaps smaller than the 'fuzzy tolerance' and identify larger overlaps between adjacent polygons (slivers). The area of each sliver was calculated using the Calculate Geometry tool to identify large accidental overlaps. Slivers larger than 250 m^2 were removed.

[6] A comment that might not be self-explanatory is 'smooth transition between coast / terres' or something similar. This was put in the comments when part of a terrestrial feature was listed as coastal so that the coastal study area could have a smooth boundary, *e.g.* a road cutting through an estuary. If the part of the road that cuts through the estuary remained as a terrestrial feature then the study area would be intersected by a terrestrial feature, although it's in the coastal zone. So that part of the road was deemed to be coastal with the associated comment, 'smooth transition between coast / terres'.

4. Small slivers (*i.e.* less than 250 m^2) were removed using the ET Geo Wizards Eliminate tool, which eliminates unwanted slivers by merging them into the neighbouring polygons (Elimination method: join neighbour with the same attribute. Attribute used was Dom_cover).
5. Small gaps between polygons and holes within polygons were identified using the ET Geo Wizards Clean gaps tool. Once identified the ET Geo Wizards Eliminate tool was used to merge them into neighbouring polygons (Elimination method: join longest common boundary).
6. The total area of each Structural Class was calculated for both the original map and the cleaned map to ensure the cleaning process did not significantly alter coastal ecosystem area values. In most cases differences in area were less than 1 ha or 0.1%, with the exception of Shoreline rocky substrate, which was 1.4 ha larger once cleaned. A significant proportion of the Shoreline rocky substrate was mapped by hand; therefore, it was expected to contain a number of gaps and overlaps.
7. A comparison of total area values was also undertaken to check that the total study area was equivalent to the sum of the individual polygons comprising the study area. The total study area values were determined by merging the polygons using the Dissolve tool. In all cases the dissolved areas were equivalent to the sum of individual polygons within that area.

Table 4 lists the overall areas of each section of the map. In general, the coastal study area is defined as the coastal section of the study area and Farewell Spit. The Abel Tasman National Park is included in the overall case study area, but the rest of the terrestrial section is usually excluded from any area estimates.

Table 4. Summary of total areas (ha) for the Nelson Bays ecosystem map.

Section of map	**Area (ha)**
Terrestrial section of study area (excluding Farewell Spit and Abel Tasman National Park)	6,531
Coastal section of study area (excluding Farewell Spit and Abel Tasman National Park)	400,122
Farewell Spit[7]	2,242
Abel Tasman National Park[7]	23,606
Total area mapped	**432,501**

[7] Based on Land Cover Database version 3 (LBDB v3) estimates of land cover, therefore, primarily includes terrestrial or terrestrial-type features. Coastal features are largely included in the coastal section of the study area.

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Appendix 1. Comprehensive ecosystem classification structure including corresponding classifications used in the source data.

Feature type: Coastal			
Category	**Structural class**	**Dominant cover**	**Corresponding classification in source data**
Saltmarsh	Estuarine shrubland	*Muehlenbeckia complexa*	*Muehlenbeckia complexa* (Delaware 2009, Haven 2009)
		Plagianthus divaricatus (Saltmarsh ribbonwood)	*Plagianthus divaricatus* (Waimea 2006, Mouteka 2001, Moutere 2004, Delaware 2009, Haven 2009, Ruataniwha 2000, TDC 2012, Whangamoa 2009)
			Plagianthus divaricatus-Cortaderia sp. (Ruataniwha 2000)
			Plagianthus divaricatus-Leptocarpus similis (Ruataniwha 2000)
			Plagianthus divaricatus-Phormium tenax (Ruataniwha 2000)
			Plagianthus divaricatus-Ulex europaeus (Ruataniwha 2000)
	Tussockland	*Carex* spp. (Sedge)	*Carex* spp. (Waimea 2006, Motuere 2004)
			Carex pumila (Abel Tas 1992)
		Cortaderia jubata (Purple pampas grass)	*Cortaderia jubata* (Delaware 2009)
		Cortaderia sp. (Toetoe)	*Cortaderia* sp. (Haven 2009, TDC 2012)
		Phormium tenax (New Zealand flax)	*Phormium tenax* (Motupipi 2007, Delaware 2009, Haven 2009, Ruataniwha 2000, TDC 2012)
			Flaxland (LCDB v3)
		Stipa stipodes	*Stipa stipodes* (Waimea 2006, Haven 2009)
		Tussockland	Tussockland (Waimea 2006, Delaware 2009)
	Grassland	*Festuca* spp	*Festuca* spp. (Abel Tas 1992)
			Festuca arundinacea (Waimea 2006, Motuere 2004, Motueka 2001, Motupipi 2007, Haven 2009, Delaware 2009, Ruataniwha 2000, TDC 2012, Whangamoa 2009)
	Sedgeland	*Cyperus eragrostis* (Umbrella sedge)	*Cyperus eragrostis* (Waimea 2006, Delaware 2009)
		Schoenoplectus pungens (Three-square)	*Schoenoplectus pungens* (Motupipi 2007, Haven 2009, Delaware 2009, TDC 2012, Abel Tas 1992)
		Isolepis cernua (Slender clubrush)	*Isolepis cernua* (Motueka 2001, Delaware 2009, Abel Tas 1992)
	Rushland	*Apodasima similis* (Jointed wirerush)	*Apodasima similis* (TDC 2012)

Feature type: Coastal			
Category	**Structural class**	**Dominant cover**	**Corresponding classification in source data**
Saltmarsh *continued*	Rushland *continued*	*Apodasima similis* (Jointed wirerush) *continued*	*Leptocarpus similis* (Waimea 2006, Motuere 2004, Motueka 2001, Motupipi 2007, Haven 2009, Delaware 2009, Ruataniwha 2000, TDC 2012, Abel Tas 1992, Whangamoa 2009)
		Isolepis nodosa (Knobby clubrush)	*Isolepis nodosa* (Waimea 2006, Motuere 2004, Motueka 2001, Haven 2009, Delaware 2009)
		Juncus kraussii (Searush)	*Juncus kraussii* (Waimea 2006, Motuere 2004, Motueka 2001, Motupipi 2007, Haven 2009, Delaware 2009, Ruataniwha 2000, TDC 2012)
			Juncus kraussii-Leptocarpus similis (Ruataniwha 2000)
			Juncus kraussii-Samolus repens (Ruataniwha 2000)
		Juncus maritimus	*Juncus maritimus* (Abel Tas 1992)
		Juncus pallidus (Pale rush)	*Juncus pallidus* (Ruataniwha 2000, Abel Tas 1992)
		Juncus planifolius	*Juncus planifolius* (Abel Tas 1992)
	Reedland	*Typha orientalis* (Raupo)	*Typha orientalis* (Motuere 2004, Motueka 2001, Motupipi 2007, Delaware 2009, TDC 2012, Abel Tas 1992, Whangamoa 2009)
	Herbfield	*Calystegia sepium* (Pink bindweed)	*Calystegia sepium* (Delaware 2009)
		Carpobrotus edulis (Ice Plant)	*Carpobrotus edilus* (Waimea 2006, Motupipi 2007, haven 2009, TDC 2012, Abel Tas 1992)
		Cotula coronopifolia (Brass buttons)	*Cotula coronopifolia* (Abel Tas 1992)
		Disphyma australe (NZ Ice Plant, Horokaka)	*Disphyma australe* (Motuere 2004, Delaware 2009)
		Mimulus repens	*Mimulus repens* (Delaware 2009, Abel Tas 2012)
		Plantago coronopus (Buck's horn plantain)	*Plantago coronopus* (Abel Tas 1992)
		Samolus repens (Primrose)	*Samolus repens* (Motueka 2001, Motupipi 2007, Delaware 2009, Ruataniwha 2000, TDC 2012, Abel Tas 1992)
		Sarcocornia quinqueflora (Glasswort)	*Sarcocornia quinqueflora* (Motuere 2004, Motueka 2001, Motupipi 2007, Haven 2009, Delaware 2009, Ruataniwha 2000, TDC 2012, Abel Tas 1992)
			Sarcocornia quinqueflora-Samolus repens (Ruataniwha 2000)
		Selliera radicans (Remuremu)	*Selliera radicans* (TDC 2012, Abel Tas 1992)

Feature type: Coastal			
Category	**Structural class**	**Dominant cover**	**Corresponding classification in source data**
Saltmarsh *continued*	Herbfield *continued*	*Suaeda novae–zelandiae* (Sea blite)	*Suaeda novae-zelandiae* (Waimea 2006, Motuere 2004, Motupipi 2007, Haven 2009, Delaware 2009,TDC 2012, Abel Tas 1992)
	Saltmarsh	Saltmarsh	Used when a more specific structural class could not be defined
			Herbaceous saline vegetation (LCDB v3)
Duneland	Duneland	*Ammophila arenaria* (Marram grass)	*Ammophila arenaria* (Waimea 2006, Motupipi 2007, Delaware 2009, TDC 2012, Abel Tas 1992)
		Spinifex sericeus (Silvery grass)	*Spinifex sericeus* (Motupipi 2007, TDC 2012)
		Desmoschoenus spiralis (Pingao)	*Desmoschoenus spiralis* (TDC 2012, Abel Tas 1992)
		Spinifex hirsutus	*Spinifex hirsutus* (Abel Tas 1992)
		Duneland	Used when a more specific structural class could not be defined
Unvegetated	Mud *(~ < 63 um)*	Estuarine mud *(within estuary / delta)*	Mud (Abel Tas 1992)
			Soft mud (TDC 2012, Motupipi 2007)
		Shallow mud *(< 30 m depth)*	Mud (Abel Tas 1992)
			Clay (Coastal Series Sediment 1987)
			Silt (Coastal Series Sediment 1987)
			Soft mud (TDC 2012)
			Shelly mud (Abel Tas 1992)
			Mud / shell / coarse sand (Abel Tas 1992)
		Deep mud *(30–200 m depth)*	Clay (Coastal Series Sediment 1987)
			Silt (Coastal Series Sediment 1987)
	Mud / sand	Estuarine mud / sand *(within estuary / delta)*	Mud / sand (Ruataniwha 2000, Abel Tas 1992)
			Fine sand (Abel Tas 1992)
			Firm mud / sand (Waimea 2006, Motueka 2001, Motuere 2004, Motupipi 2007, Haven 2009, Delaware 2009, TDC 2012)
			Soft mud / sand (Waimea 2006, Motueka 2001, Motuere 2004, Motupipi 2007, Haven 2009, Delaware 2009, TDC 2012, Whangamoa 2009)

Feature type: Coastal			
Category	**Structural class**	**Dominant cover**	**Corresponding classification in source data**
Unvegetated *continued*	Mud / sand *continued*	Estuarine mud / sand *(within estuary / delta) continued*	Very soft mud / sand (Waimea 2006, Motuere 2004, Motupipi 2007, Haven 2009, Delaware 2009, TDC 2012)
		Shallow mud / sand	Firm mud / sand (Motueka 2001, TDC 2012)
			Soft mud / sand (Motueka 2001, TDC 2012)
			Very soft mud / sand (TDC 2012)
		Deep mud / sand	Mud / sand (Ruataniwha 2000, Abel Tas 1992)
			Fine sand (Abel Tas 1992)
			Firm mud / sand (Waimea 2006, Motueka 2001, Motuere 2004, Motupipi 2007, Haven 2009, Delaware 2009, TDC 2012)
			Soft mud / sand (Waimea 2006, Motueka 2001, Motuere 2004, Motupipi 2007, Haven 2009, Delaware 2009, TDC 2012)
			Very soft mud / sand (Waimea 2006, Motuere 2004, Motupipi 2007, Haven 2009, Delaware 2009, TDC 2012)
	Sand *(~ > 63um - < 2mm)*	Estuarine sand *(within estuary / delta)*	Sand (Abel Tas 1992)
			Coarse sand (Abel Tas 1992)
			Coarse sand / sand (Abel Tas 1992)
			Firm sand (Waimea 2006, Motueka 2001, Motuere 2004, Motupipi 2007, Delaware 2009, Haven 2009, Ruataniwha 2000, TDC 2012)
			Firm shell / sand (Motueka 2001, Delaware 2009, Haven 2009)
			Mobile sand (Waimea 2006, Motueka 2001, Motuere 2004, Motupipi 2007, Delaware 2009, Haven 2009, TDC 2012)
			Sand mix (Abel Tas 1992)
			Coarse sand / pebble / cobble (Abel Tas 1992)
			Fine sand / pebbles / cobbles (Abel Tas 1992)
		Shallow sand *(< 30 m depth)*	Sand (Abel Tas 1992, Coastal Series Sediment 1987)
			Coarse sand (Abel Tas 1992)
			Firm sand (Motueka 2001, TDC)

Feature type: Coastal			
Category	**Structural class**	**Dominant cover**	**Corresponding classification in source data**
Unvegetated *continued*	Sand *(~ > 63 um–< 2 mm) continued*	Shallow sand *(< 30 m depth) continued*	Firm shell / sand (Motueka 2001)
			Mobile sand (Motueka 2001, Motupipi 2007, TDC)
			Sand mix (Abel Tas 1992)
			Muddy broken and dead shell with coarse sand (Abel Tas 1992)
			Sand / boulders (Abel Tas 1992)
			Sand / reef (Abel Tas 1992)
		Deep sand *(30–200 m depth)*	Sand (Coastal Sediment Series 1987)
	Gravel *(~2-60mm)*	Estuarine gravel *(within estuary / delta)*	Gravel field (Waimea 2006, Motueka 2001, Motuere 2004, Motupipi 2007, Delaware 2009, Haven 2009, TDC 2012, Whangamoa 2009)
		Shallow gravel *(< 30 m depth)*	Gravel (Coastal Series Sediment 1987)
			Gravel field (TDC 2012)
		Deep gravel *(30–200 m depth)*	Gravel (Coastal Series Sediment 1987)
	Cobble / Boulder / Rock	Estuarine cobble *(~60-250mm, within estuary / delta)*	Pebbles / cobbles (Abel Tas 2012)
			Cobble field (Waimea 2006, Motueka 2001, Motuere 2004, Motupipi 2007, Delaware 2009, Haven 2009, Ruataniwha 2009, TDC 2012)
		Cobble *(~60-250mm)*	Pebbles / cobbles (Abel Tas 2012)
			Cobble field (Motueka 2001, TDC 2012)
			Coarse sand / sand / boulder (Abel Tas 1992)
		Estuarine boulder *(~>250mm, within estuary / delta)*	Boulder field (Motupipi 2007)
		Boulder *(~>250mm)*	Boulders (Abel Tas 1992)
			Boulder field (Haven 2009, TDC 2012)
			Boulder / coarse sand (Abel Tas 1992)
			Sand / boulders (Abel Tas 1992)
			Sand / rock (Abel Tas 1992)
			Sand / reef (Abel Tas 1992)

Feature type: Coastal			
Category	**Structural class**	**Dominant cover**	**Corresponding classification in source data**
Unvegetated *continued*	Cobble / Boulder / Rock *continued*	Estuarine rock *(> boulder, generally exposed from water, within estuary / delta)*	Bedrock (Delaware 2009, Haven 2009)
			Rockfield (Delaware 2009, Haven 2009)
		Rock *(> boulder, generally exposed from water)*	Rock (Abel Tas 1992)
			Rock / boulders (Abel Tas 1992)
			Limestone (Abel Tas 1992)
			Sand / reef (Abel Tas 1992)
	Reef *(generally sub-tidal)*	Estuarine reef *(within estuary / delta)*	Reef (Abel Tas 1992)
		Shallow reef *(< 30 m depth)*	Reef (Abel Tas 1992)
			Coarse sand / rock (Abel Tas 1992)
			Sand / rock (Abel Tas 1992)
			Sand / reef (Abel Tas 1992)
			Rockfield (TDC 2012)
		Deep reef (*30–200 m depth)*	
	Shoreline soft sediment	Estuarine beach *(within estuary / delta)*	Fine sand / pebbles / cobbles (Abel Tas 1992)
			Sand / boulders (Abel Tas 1992)
			Sand (Abel Tas 1992)
			Coarse sand (Abel Tas 1992)
			Coarse sand / sand (Abel Tas 1992)
			Sand mix (Abel Tas 1992)
			Firm shell / sand (Delaware 2009, Motueka 2001)
			Mobile sand (Delaware 2009, Motupipi 2007, Waimea 2006)
			Soft sand (Delaware 2009, Waimea 2006)

Feature type: Coastal			
Category	**Structural class**	**Dominant cover**	**Corresponding classification in source data**
Unvegetated *continued*	Shoreline soft sediment *continued*	Estuarine beach *(within estuary / delta) continued*	Firm sand (Delaware 2009, Motueka 2001, Motupipi 2007, Moutere 2004, Waimea 2006, TDC 2012)
			Firm mud / sand (Moutere 2004, TDC 2012)
			Very soft mud / sand (TDC 2012)
			Coastal sand and gravel (LCDB v3)
		Beach	Firm sand (Motueka 2001, Motupipi 2007, TDC)
			Mobile sand (Motueka 2001, Motupipi 2007, TDC)
			Coarse sand (Abel Tas 1992)
			Coarse sand-sand (Abel Tas 1992)
			Sand (Abel Tas 1992)
			Sand mix (Abel Tas 1992)
			Sand / rock (Abel Tas 1992)
	Shoreline rocky substrate	Estuarine rocky shore *(within estuary / delta)*	Sand / boulders (Abel Tas 1992)
			Cobble field (Delaware 2009, Haven 2009, Motupipi 2007, Moutere 2004, Waimea 2006)
			Bedrock (Delaware 2009, Haven 2009)
			Boulder field (Delaware 2009, Haven 2009)
			Gravel field (Delaware 2009, Haven 2009, Moutere 2004, Waimea 2006)
			Rockfield (Delaware 2009, Haven 2009, Motupipi 2007)
			Boulder (Abel Tas 1992)
			Pebble / cobble (Abel Tas 1992)
		Rocky shore	Coarse sand / rock (Abel Tas 1992)
			Sand / boulders (Abel Tas 1992)
			Sand / rock (Abel Tas 1992)
			Sand / reef (Abel Tas 1992)

Feature type: Coastal			
Category	**Structural class**	**Dominant cover**	**Corresponding classification in source data**
Unvegetated *continued*	Shoreline rocky substrate *continued*	Rocky shore *continued*	Cobble field (Haven 2009, Motueka 2001)
			Rockland (Motueka 2001)
			Boulder (Abel Tas 1992)
			Boulder / coarse sand (Abel Tas 1992)
			Rock (Abel Tas 1992)
			Rock / boulder (Abel Tas 1992)
			Limestone (Abel Tas 1992)
		Boulder bank	Boulder field (Haven 2009)
Biogenic habitatts	Seagrass	Seagrass	*Zostera* sp. (Waimea 2006, Motuere 2004, Delaware 2009, Ruataniwha 2000)
			Zostera muelleri (Haven 2009, Delaware 2009)
			Data from Battley *et al.* 2005
	Macroalgal bed	*Enteromorpha* sp.	*Enteromorpha* sp. (Waimea 2006, Motueka 2001, Delaware 2009, Haven 2009)
		Gelidium caulacantheum	*Gelidium caulacantheum* (Delaware 2009, Haven 2009)
		Gracilaria chilensis	*Gracilaria chilensis* (Waimea 2006, Moutere 2004)
		Gracilaria secundata	*Gracilaria secundata* (Delaware 2009, Haven 2009)
		Ulva sp. (Sea lettuce)	*Ulva* sp. (Waimea 2006, Motupipi 2007)
			Ulva lactuca (Haven 2009, Delaware 2009)
	Bryozoan areas	Silt / bryozoan mounds	Grange *et al*. 2003
	Shellfish bed	Shell bank (area that is dominated by dead shells)	Shell bank (Waimea 2006, Motuere 2004, Motupipi 2007, Delaware 2009, Haven 2009, TDC 2012)
		Oyster bed	Oyster reef (Waimea 2006, Motupipi 2007, Delaware 2009, Haven 2009, TDC 2012)
		Mussel bed	Mussel reef (Waimea 2006, Delaware 2009, TDC 2012)
		Cockle bed	Cocklebed (Delaware 2009)
	Worm bed	Sabellid field	Sabellid Field (Waimea 2006, Moutere 2004)
	Rhodolith bed	Rhodolith bed	Data from Rob Davidson
	Sponge garden	Sponge garden	Data from Asher *et al.* 2008

Feature type: Coastal			
Category	**Structural class**	**Dominant cover**	**Corresponding classification in source data**
Water	Water	Water	Water (Waimea 2006, Motuere 2004, Motupipi 2007, Delaware 2009, Haven 2009, Ruataniwha 2000, TDC 2012)
			Lake and pond (LCDB3)
			Estuarine open water (LCDB v3)
Artificial structure	Artificial structure	Bridge	Bridge (TDC 2012)
		Man-made structure	Man-made structure (Waimea 2006, Delaware 2009, Haven 2009)
		Ramp	Ramp (TDC 2012)
		Seawall / rockwall (man-made)	Man-made seawall (Haven 2009)
			Seawall man-made (TDC 2012)
			Rock wall man-made (Waimea 2006, Delaware 2009, Haven 2009)
			Boulder-field (man-made) (Motupipi 2007, TDC 2012)
			Rock field man-made (Motupipi 2007, TDC 2012)
		Wharf	Wharf (Moutere 2004, Delaware 2009, TDC 2012)
Terrestrial-type feature	Terrestrial shrub / scrub / forest	*Casuarina* spp.	*Casuarina* spp. (Haven 2009)
		Chamaecytisus palmensis (Tree lucerne, Tagasaste)	*Chamaecytisus palmensis* (Motupipi 2007)
		Coprosma acerosa (Sand coprosma)	*Coprosma acerosa* (Haven 2009)
		Cordyline australis (Cabbage tree)	*Cordyline australis* "Cabbage tree" (Ruataniwha 2000)
		Cupressus macrocarpa	*Cupressus macrocarpa* (Motupipi 2007)
		Dodonea viscosa (Akeake)	*Dodonea viscosa* (Delaware 2009)
		Exotic shrub / scrub / forest	Exotic forest (TDC 2012)
			Exotic scrub (TDC 2012)
			Exotic scrubs / shrubs / trees (Waimea 2006)
			Exotic forest (LCDB v3)
		Knightia excelsa (Rewarewa)	*Knightia excelsa* (Motuere 2004)

Feature type: Coastal			
Category	**Structural class**	**Dominant cover**	**Corresponding classification in source data**
Terrestrial-type feature *continued*	Terrestrial shrub / scrub / forest *continued*	*Leptospermum* spp.	*Leptospermum scoparium* (Waimea 2006, Motuere 2004, Haven 2009)
		Lichen	Lichen (Haven 2009)
		Metrosideros excelsa (Pohutukawa)	*Metrosideros excelsa* (Haven 2009)
		Mixed native and exotic shrub / scrub / forest	Mixed native and exotic scrub (TDC 2012),
			Mixed native and exotic scrub / forest (TDC 2012)
			Classification used for some blank coastal areas
		Myoporum laetum (Ngaio)	*Myoporum laetum* (Haven 2009)
		Native shrub / scrub / forest	Native scrub (Motupipi 2007, TDC 2012)
			Native scrub / shrub / trees (Haven 2009)
			Manuka and / or kanuka (LCDB v3)
			Broadleaved indigenous hardwoods (LCDB v3)
			Indigenous forest (LCDB v3)
			Fernland (LCDB v3)
		Oxalis rubens (native oxalis)	*Oxalis rubens* (Haven 2009)
		Pinus radiata (Pine tree)	*Pinus radiata* (Waimea 2006, Motupipi 2007, Haven 2009, TDC 2012)
			Classification used in Waimea-Durville & for some blank coastal areas
		Ulex europaeus (Gorse)	*Ulex europaeus* (Waimea 2006, Motupipi 2007, Delaware 2009, Ruataniwha 2000, TDC 2012)
			Gorse and / or broom (LCDB v3)
		Terrestrial shrub / scrub / forest	Used when specific species could not be determined
			Herbaceous freshwater vegetation (LCDB v3)
			Forest — harvested (LCDB v3)
			Matagouri or grey scrub (LCDB v3)
	Terrestrial shrub / scrub / forest	Terrestrial grassland	Grassland (Waimea 2006, TDC 2012)

Feature type: Coastal			
Category	**Structural class**	**Dominant cover**	**Corresponding classification in source data**
Terrestrial-type feature *continued*	Terrestrial shrub / scrub / forest	Terrestrial grassland *continued*	Unidentified grass (Waimea 2006)
			Unmaintained introduced grass (TDC 2012)
			Classification used in some blank coastal areas
			High producing exotic grassland (LCDB v3)
			Low producing grassland (LCDB v3)
	Introduced weeds	Unidentified introduced weeds	Unidentified introduced weeds (Moutere 2004, Delaware 2009)
	Industrial	Industrial	Classification used in some blank coastal areas
	Residential	Residential	Residential (Haven 2009, TDC 2012)
			Classification used in some blank coastal areas
	Pine debris	Pine debris	Pine debris (Delaware 2009)
	Road	Road	Road (Motupipi 2007, TDC 2012)
			Classification used in some blank coastal areas
	Pasture	Pasture	Classification used in some blank coastal areas
	Maintained park / amenity area	Maintained park / amenity area	Maintained park / amenity area (TDC 2012)
			Classification used in some blank coastal areas
			Urban parkland / open space (LCDB v3)

Feature type: Terrestrial			
Category	**Structural class**	**Dominant cover**	**Corresponding classification in source data**
Terrestrial shrub / scrub / forest	Terrestrial shrub / scrub / forest	*Cordyline australis* (Cabbage tree)	Use as classification for some blank terrestiral areas
		Cupressus macrocarpa	Cupressus macrocarpa (Motupipi 2007)
		Eucalyptus spp. (Gum tree)	*Eucalyptus* spp. (Motupipi 2007, TDC 2012)
		Exotic shrub / scrub / forest	Exotic forest (Motupipi 2007, TDC 2012)
			Exotic scrub / forest (Motupipi 2007)
			Exotic scrub (TDC 2012)
			Exotic forest (LCDB v3)
		Leptospermum spp.	*Leptospermum* spp. (Abel Tas 1992)
			Leptospermum scoparium (Motupipi 2007, TDC 2012)
		Melicytus ramiflorus (Mahoe)	*Melicytus ramiflorus* (Motupipi 2007)
		Metrosideros excelsa (Pohutukawa)	*Metrosideros excelsa* (TDC 2012)
		Mixed native and exotic shrub / scrub / forest	Mixed native and exotic forest (Motupipi 2007, TDC 2012)
			Mixed native and exotic scrub (TDC 2012, Motupipi 2007),
			Mixed native and exotic scrub / forest (TDC 2012, Motupipi 2007)
		Myoporum laetum (Ngaio)	*Myoporum laetum* (Delaware 2009, TDC 2012)
		Native shrub / scrub / forest	Native forest (TDC 2012)
			Native scrub (Motupipi 2007, TDC 2012)
			Native scrub / forest (TDC 2012, Motupipi 2007)
			Native scrub / shrub / trees (Delaware 2009, Haven 2009)
			Manuka and / or kanuka (LCDB v3)
			Broadleaved indigenous hardwoods (LCDB v3)
			Indigenous forest (LCDB v3)
			Fernland (LCDB v3)

Feature type: Terrestrial			
Category	**Structural class**	**Dominant cover**	**Corresponding classification in source data**
Terrestrial shrub / scrub / forest *continued*	Terrestrial shrub / scrub / Forest *continued*	*Oxalis rubens* (native oxalis)	None found in terrestrial areas of Nelson Bays
		Pinus radiata (Pine tree)	*Pinus radiata* (Waimea 2006, Motupipi 2007, Delaware 2009, Haven 2009, TDC 2012)
		Salix sp. (Willow - species not identified)	*Salix* sp. (TDC 2012)
			Salix fragilis (Delaware 2009)
		Ulex europaeus (Gorse)	*Ulex europaeus* (Waimea 2006, Moutere 2004, Motupipi 2007, Delaware 2009, Ruataniwha 2000, TDC 2012)
			Gorse and / or broom (LCDB v3)
		Terrestrial shrub / scrub / forest	Used when specific species could not be determined
			Herbaceous freshwater vegetation (LCDB v3)
			Forest – harvested (LCDB v3)
			Matagouri or grey scrub (LCDB v3)
Terrestrial grassland	Terrestrial grassland	Terrestrial grassland	Grassland (TDC 2012, Waimea 2006, Motupipi 2007)
			Unidentified grass (Waimea 2006)
			Classification used in Waimea-Durville and some blank terrestrial areas
			High producing exotic grassland (LCDB v3)
			Low producing grassland (LCDB v3)
Horticulture	Horticulture	Horticulture	Horticulture (TDC 2012)
Industrial	Industrial	Industrial	Industrial (TDC 2012)
Residential	Residential	Residential	Residential (Motupipi 2007, Haven 2009, TDC 2012)
Pine debris	Pine debris	Pine debris	Pine debris (Waimea 2006)
Road	Road	Road	Road (Motupipi 2007, Haven 2009)
Pasture	Pasture	Pasture	Pasture (TDC 2012)
Introduced weeds	Introduced weeds	Unidentified introduced weeds	Unidentified introduced weeds (Motupipi 2007, Delaware 2009)

Feature type: Terrestrial			
Category	**Structural class**	**Dominant cover**	**Corresponding classification in source data**
Maintained park / amenity area	Maintained park / amenity area	Maintained park / amenity area	Maintained park / amenity area (TDC 2012)
			Urban parkland / open space (LCDB v3)
Artificial structure	Artificial structure	Man-made structure	Classification used in some blank terrestrial areas

Appendix 2. Specific issues pertaining to the Nelson Bays ecosystem classification.

General

- DOC / MFish (DOC / MFish 2008; 2011) classification classified habitats according to exposure. Information on exposure has not been obtained, therefore, a distinction between sheltered, moderate, exposed, and high current habitats has not been made in this classification. Most areas are relatively sheltered anyway.

Saltmarsh

- DOC / MFish (2011) classification separated out saltmarsh as Biogenic Saltmarsh and Biogenic Saltmarsh Above MHW. Accurate information on MHW is not available at this stage but it can be separated out later if needed.

- Davidson's Abel Tasman study (1992) identified a range of saltmarsh species in one polygon, rather than identifying it by the dominant saltmarsh species. In order to classify such polygons into 'Structural classes' the structural class to which most of the saltmarsh species belonged was used. If a given polygon contained an equal number of species from two different Structural Classes (*e.g.* two herbfield species and two rushland species) then the structural class was classified based on the first listed species from the two equal classes. To classify the dominant cover, the first species listed was used, unless it did not match the structural class chosen, in which case the first species listed in the correct structural class was used. Some species are identified but are not displayed on the map, using this system. These species (*Juncus planifolius, Cotula coronopifolia, Plantago coronopus*) are still listed in the 'Ecosystem classification' column.

- In some cases (*e.g.* along Tasman Bay's northeast coastline), the 'Saltmarsh' ecosystem was mapped using only aerial photographs. The dominant cover category of 'Saltmarsh' was applied in thess situations where the exact saltmarsh species could not be accurately confirmed. The 'Source' for most of these is 'No data' or 'Waimea-D'Urville'. For the other sources of information (*e.g.* Waimea, Delaware), ground-truthing was undertaken to identify different classes / species of saltmarsh.

- Along Farewell Spit, where 'Herbaceous Saline Vegetation' overlapped with areas of seagrass (as determined by Battley *et al.* [2005]), the area was classified as 'Seagrass' not 'Saltmarsh' Battley's seagrass results were deemed to be more accurate as they were obtained from field surveys, whereas the areas of saltmarsh along Farewell Spit were only derived from satellite information (LCDB).

Duneland

- In some cases (*e.g.* along Tasman Bay's northeast coastline) the duneland ecosystem was mapped using only aerial photos. The dominant cover category of Duneland was applied in these situations where the exact duneland species could not be accurately confirmed. The source for most of these is 'No data' or 'Waimea-D'Urville'. For the other sources of information (*e.g.* Waimea, Delaware) ground-truthing was undertaken to identify different dominant covers of Duneland.

- Duneland is not well mapped across the case study region as it is difficult to determine the extent of dunes from aerial photos, especially if they have been stabilised by terrestrial forms of vegetation.

Unvegetated

- DOC / MFish (2011) classification used Mudflat as a habitat type. It was not clear what distinguished this category from Estuarine Mud, so the Mudflat category was not used.

- DOC / MFish (2011) has categories for volcanic habitat and lower / mid / upper slope habitat. These features are not present in our study area, so were not included in the classification. They could be an addition in the future, if the study area is extended.

Biogenic Habitats

- DOC / MFish (2011) classification separated seagrass as: Biogenic Seagrass and Biogenic Seagrass Above MHW. Accurate information on MHW is not currently available but could be separated out in the future, if required. However, it would not be expected to find seagrass above MHW as the New Zealand species is predominantly intertidal.

- Seagrass was primarily defined for estuaries that have been mapped at a broad scale (Delaware, Haven, Motueka, Motupipi, Moutere, Ruataniwha, Waimea). However, the mapping in the Abel Tasman (Davidson 1992), at Farewell Spit (Battley *et al.* 2005) and along coastline from Waimea to Farewell Spit (Robertson & Stevens 2012) captured additional seagrass areas.

- There may be other rhodolith beds around Abel Tasman that have not yet been mapped (pers. comm. R. Davidson, 29 September 2013). For example, a rhodolith bed is also present in Okiwi Bay, but has not yet been mapped (pers. comm. R. Davidson, 29 September 2013).

- No Biogenic Bryozoan areas, as classified by DOC / MFish (2011), were identified in our study area. The only bryozoan area identified was at Separation Point, but because the bryozoan mounds were interspersed with silt, they were classified as Biogenic Silt / Bryozoan Mounds. Any other bryozoan areas, not included in the map, are unlikely to be as significant as the Separation Point area. For example, there is evidence of scattered, small bryozoan mounds within the Tonga Island Marine Reserve and another bed off D'Urville Island that may, or may not, still exist (Grange *et al.* 2003). Side-scan sonar revealed potential bryozoan habitat along the northern boundary of the Separation Point protected area, which may extend outside of it (Grange *et al.* 2003).

- DOC / MFish (2011) classification has Serpulid Patch Reefs *Galeolaria hystrix* as a category. No such areas were identified in our study area. We used the category Sabellid Field to indicate biogenic tubeworm reefs. Worm beds / reefs were only spatially defined for estuaries that have been mapped at a broad scale (Delaware, Haven, Motueka, Motupipi, Moutere, Ruataniwha, Waimea) and to a lesser extent along the coastline from Waimea to Farewell Spit (excluding the Abel Tasman; Robertson & Stevens 2012).

- DOC / MFish (2011) classification has Biogenic Dog Cockles as a category. No significant dog cockle beds were identified in our study area.

- It was not clear in the DOC / MFish (2011) classification what constitutes a Biogenic Low-Relief Biogenic Reef and a Biogenic High-Relief Biogenic Reef. It is assumed these are biogenic reefs composed of species other than those mentioned elsewhere in the classification. Our study area has two sponge gardens in Waimea Inlet, which have been listed as a separate form of dominant

cover. Otherwise there were no other features that would be categorised in these two classes.

- The distribution of horse mussel communities throughout the case study area is poorly documented. For this reason horse mussel beds were not included as a separate ecosystem category. Davidson (1992) reports that a horse mussel bed at Separation Point is one of the best representative beds in the Nelson / Marlborough region. As many of these communities have been significantly impacted by dredging, those which are still intact are rare and biologically important. He also notes the presence of horse mussel beds at Te Pukatea Bay.

- Two references to mangroves located within an estuary in Golden Bay were made in the TDC 2012 dataset (Robertson & Stevens 2012). As mangroves are not known to grow this far south and an anomaly, this information was removed. Even if these two references to mangroves do exist, they are small enough to be insignificant to the wider purpose of the study. DOC / MFish (2011) classification has Biogenic Mangroves and Biogenic Mangroves Above MHW as categories. These categories could be added to our classification system under Biogenic Habitats in the future, to include any confirmed areas of mangroves.

- The distribution of brown algae is not well documented in the Nelson Bays region. Davidson (1992) reports that the distribution of *Ecklonia radiata* in Golden and Tasman Bays is restricted to six known localities, with as few as three plants from one location. Areas that do support large macroalgae are rare and biologically important. *Carpophyllum flexuosm* was recorded at two points along the Abel Tasman coastline (Davidson 1992). Large brown algae form extensive, highly productive, biogenic habitats that support distinctive, diverse assemblages of other organisms and have a strong structural influence on coastal ecosystems (see references in DOC / MFish 2011). Brown algal species are not included in the Macroalgae Ecosystem category. Rather the Macroalgae category is dominated by red algae (*Gelidium caulacantheum, Gracilaria chilensis* and *Gracilaria secundata*) and the nuisance green algae *Enteromorpha* and *Ulva*.

- Clark *et al.* (2008) mention in their report on Waimea Inlet that "…although cockles were detected in a number of habitats, it was not possible to provide useful estimates of the spatial extent of their occurrence. Due to their sub-surface location they were not visible on aerial photographs. Therefore this incomplete data layer was deleted from the map." This inability to properly detect cockles is probably the case for all broad-scale mapping in the region. As a result, the spatial extent of cockles should be regarded with caution.

- Oyster beds / reefs; mussel beds / reefs, and shell banks were only spatially defined for estuaries that have been mapped at a broad scale (Delaware, Haven, Motueka, Motupipi, Moutere, Ruataniwha, Waimea) and to a lesser extent along the coastline from Waimea to Farewell Spit (excluding the Abel Tasman; Robertson & Stevens 2012).

- Macroalgal beds were only spatially defined for estuaries that have been mapped at a broad scale (Delaware, Haven, Motueka, Motupipi, Moutere, Ruataniwha, Waimea), the Abel Tasman region (Davidson 1992) and the coastline from Waimea to Farewell Spit (Robertson & Stevens 2012). Macroalgal beds refer to areas dominated by red algae (*Gelidium caulacantheum, Gracilaria chilensis* and *Gracilaria secundata*) and the nuisance green algae *Enteromorpha* and *Ulva*.

Water

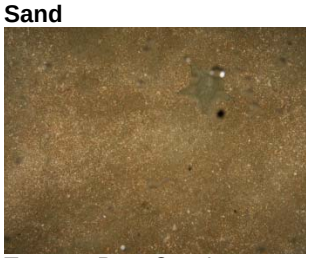
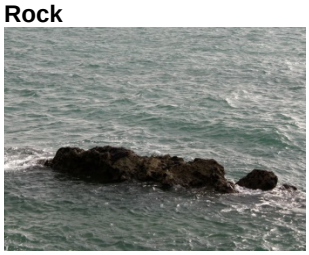
- Water refers to areas of water on land, although these may be considered coastal features if

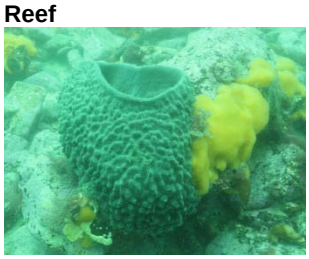
located, for example, on an island or Farewell Spit. Estuarine areas classified as Water in the source data were generally re-classified according to the surrounding ecosystem in this ecosystem classification.
Terrestrial-type features • These are terrestrial features (*e.g.* terrestrial shrub / scrub / forest or a residential area) that are located on islands or within an estuary. In these cases the feature falls under the Terrestrial-type Features category so that it can still be included in area estimates of the coastal zone. Otherwise, the total coastal area would not include such features (*e.g*. island) although they are obviously part of the coastal landscape. Includes terrestrial features on Farewell Spit.
Terrestrial grassland • The term Grassland is used twice. Once to denote a structural class of saltmarsh, which includes *Festuca* spp. It is also denotes Terrestrial Grassland as a Terrestrial category that includes grassland areas that cannot be distinguished as pasture or maintained park / amenity area and are not saltmarsh. The latter is generally a terrestrial feature but may be considered coastal when located on islands or along coastal shores.

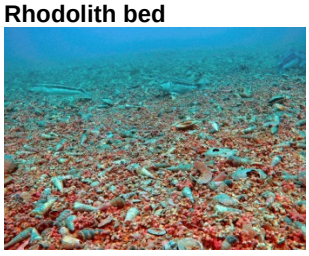
Appendix 3. Descriptions of Structural Classes used in the Nelson Bays ecosystem classification.

Structural class	Description	Source
Estuarine shrubland  Saltmarsh ribbonwood (*Plagianthus divaricatus*), Waimea Estuary: Allan Smith	Vegetation in which the cover of estuarine shrubs in the canopy is 20%–100% and in which estuarine shrubland cover exceeds that of any other growth form or bare ground. Estuarine shrubland includes *Muehlenbeckia complexa* and *Plagianthus divaricatus*.	
Tussockland  Needle sedge (*Stipa stipodes*), Waimea Estuary: Allan Smith	Vegetation in which the cover of tussocks in the canopy is 20%–100% and in which the tussock cover exceeds that of any other growth form or bare ground. Tussocks include all grasses, sedges, rushes, and other herbaceous plants with linear leaves (or linear non-woody stems) that are densely clumped and > 10 cm height. Examples of the growth form occur in all species of *Cortaderia, Gahnia*, and *Phormium*, and in some species of *Chionochloa, Poa, Festuca,Rytidosperma, Cyperus, Carex, Uncinia, Juncus, Astelia, Aciphylla*, and *Celmisia*.	Robertson *et al.* (2002)
Grassland  Tall fescue (*Festuca arundinacea*): Deric Charlton	Vegetation in which the cover of grass in the canopy is 20%–100%, and in which the grass cover exceeds that of any other growth form or bare ground. Tussock-grasses are excluded from the grass growth-form. *Festuca* spp. is the only species present in the Nelson Bays case study area.	Robertson *et al.* (2002)
Sedgeland  Slender clubrush (*Isolepis cernua*): Jon Sullivan	Vegetation in which the cover of sedges in the canopy is 20%–100% and in which the sedge cover exceeds that of any other growth form or bare ground. Sedges vary from grass by feeling the stem. If the stem is flat or rounded, it is probably a grass or a reed, if the stem is clearly triangular, it is sedge. Included in the sedge growth form are many species of *Carex, Uncinia*, and *Scirpus*. Tussock-sedges and reed-forming sedges are excluded.	Robertson *et al.* (2002)
Rushland  Sea rush (*Juncus kraussi*), Waimea Estuary: Allan Smith	Vegetation in which the cover of rushes in the canopy is 20%–100% and in which the rush cover exceeds that of any other growth form or bare ground. A tall grass-like, often hollow stemmed plant. Included in the rush growth form are some species of *Juncus* and all species of *Sporadanthus, Apodasimilis,* and *Empodisma*. Tussock-rushes are excluded.	Robertson *et al.* (2002)

Structural class	Description	Source
Reedland  Raupo (*Typha orientalis)*, Whangamoa Estuary: Cawthron	Vegetation in which the cover of reeds in the canopy is 20%–100% and in which the reed cover exceeds that of any other growth form or open water. If the reed is broken the stem is both round and hollow — somewhat like a soda straw. The flowers will each bear six tiny petal-like structures — neither grasses nor sedges will bear flowers, which look like that. Reeds are herbaceous plants growing in standing or slowly-running water that have tall, slender, erect, unbranched leaves or culms that are either hollow or have a very spongy pith. Examples include *Typha, Bolboschoenus, Scirpus lacutris, Eleocharis sphacelata,* and *Baumea articulata*. Some species, covered by Rushland or Sedgeland classes (above), are excluded. *Typha orientalis* is the only species present in the Nelson Bays case study area.	Robertson *et al.* (2002)
Herbfield  Sea blite (*Suaeda novaezelandae*) on Glasswort (*Sarcocornia quinqueflora*) bed, Waimea Estuary: Allan Smith	Vegetation in which the cover of herbs in the canopy is 20%–100% and in which the herb cover exceeds that of any other growth form or bare ground. Herbs include all herbaceous and low growing semi-woody plants that are not identified as ferns, tussocks, grasses, sedges, rushes, reeds, cushion plants, mosses or lichens.	Robertson *et al.* (2002)
Saltmarsh  Waimea Estuary: Allan Smith	A community of halophytic (salt-tolerant), emergent vegetation rooted in soils alternately inundated and drained by tidal action. Includes estuarine shrubland, tussockland, grassland, sedgeland, rushland, reedland and herbfield. This class was used when the saltmarsh species could not be identified down to a more specific structural class (*e.g.* when identifying it from aerial photos without ground-truthing).	
Duneland  Tahunanui Beach: Dana Clark	Vegetated sand dunes in which the cover of vegetation in the canopy (commonly *Spinifex* spp., *Ammophila arenaria* or *Desmoschoenus spiralis*) is 20%–100% and in which the vegetation cover exceeds that of any other growth form or bare ground.	Robertson and Stevens (2012)
Mud  Tasman Bay: Cawthron	Combination of silts and clays with a grain-size < 63 µm. Usually appears brown on the surface with a shallow black anaerobic layer. When rubbed between the fingers it appears soft and non-granular. May contain dead shell material at times.	Modified from Davidson (1992)

Structural class	Description	Source
Mud / sand  Nelson Haven: Cawthron	A mixture of mud and sand, the surface appears brown, and may have a black anaerobic layer below. Used as a default class within the estuaries for areas where data on sediment type was unavailable.	Modified from Robertson *et al.* (2002)
Sand  Tasman Bay: Cawthron	Grain-size > 63 µm–2 mm. May be mud-like in appearance but granular when rubbed between the fingers. May have a thin layer of silt on the surface making identification from a distance impossible. May contain dead shell material at times as well as occasional patches of cobbles, boulders or reef.	Modified from Robertson *et al.* (2002)
Gravel  Cawthron	Dominant benthic cover is unconsolidated gravel (2 mm–20 mm diameter) and exceeds the area covered by any one class of plant growth-form. Unless estuarine, this class is sub-tidal, and is often an extension of substrates located intertidally.	Robertson *et al.* (2002)
Cobble  Cawthron	Dominant benthic cover is unconsolidated cobble (20 mm–200 mm diameter) and exceeds the area covered by any one class of plant growth-form. Unless estuarine, this class is sub-tidal, and is often an extension of substrates located intertidally.	Robertson *et al.* (2002)
Boulder  Tasman Bay: Cawthron	Dominant benthic cover is unconsolidated boulders (> 200 mm diameter) and exceeds the area covered by any one class of plant growth-form. Unless estuarine, this class is sub-tidal, and is often an extension of substrates located intertidally.	Robertson *et al.* (2002)
Rock  Nelson: Dana Clark	Dominant benthic cover is larger than a boulder (often solid slab of rock) and generally partially exposed from the water. Includes limestone formations.	

Structural class	Description	Source
Reef  Reef with sponge and ascidians: Cawthron	Sub-tidal stable hard substratum, not separated into boulders or smaller sediment units. Biogenic reefs (*e.g.* those made of shellfish, bryozoans or sabellid worms) are not included in this class.	
Shoreline soft sediment  Abel Tasman: Ben Knight	Sandy area lying between the extremes of high and low tides. Benthic cover can range from mud / sand to sand and may occasionally include cobbles, boulders or rock. Includes shorelines within estuaries.	
Shoreline rocky substrate  Rabbit Island: Allan Smith	Rocky area lying between the extremes of high and low tides. Benthic cover can range from gravel to rock and may occasionally include patches of sand. Includes shorelines within estuaries and the boulder bank.	
Seagrass  Nelson Haven: Cawthron	Seagrasses (sometimes called eelgrass) are flowering plants that colonize shallow marine and estuarine habitats. *Zostera muelleri* is the most common species of seagrass in New Zealand. It primarily grows in the intertidal zone with limited populations growing in sheltered sub-tidal areas with clear water.	
Macroalgae  Sea lettuce (*Ulva* sp.) and *Gracilaria* sp., Waimea Inlet: Allan Smith	Algae are relatively simple plants that live in freshwater or saltwater environments. In the marine environment, they are often called seaweeds. Although they contain chlorophyll, they differ from many other plants by their lack of vascular tissues (roots, stems, and leaves). Many familiar algae fall into three major divisions: Chlorophyta (green algae), Rhodophyta (red algae), and Phaeophyta (brown algae). Macroalgae are algae observable without using a microscope. While brown algae (*e.g. Ecklonia radiata*) are present in the Nelson Bays case study area, they are not well represented in the ecosystem map due to a lack of data.	Robertson *et al.* (2002)

Structural class	Description	Source
Bryozoan areas  *Smittoidea* and *Cinctipora* spp. Ken Grange	Bryozoans are a phylum of marine invertebrates. In the Nelson Bays case study area only one area of bryozoans is identified, at Separation Point, however, others may exist. This area consists of bryozoan mounds interspersed with mud and silt. Bryozoan community is dominated by *Celleporaria agglutinans*, which form mounds up to 40 cm tall and 50 cm wide. The mounds are associated with many other bryozoan species as well as brachiopods, sponges, hydroids and horse mussels. The Separation Point bryozoan area may contain the alien bryozoan species, *Biflustra grandicella* (Gordon & Grange 2004).	Grange *et al.* (2003)
Shellfish bed  Pacific oyster (*Crassotrea giganta*) bed, Waimea Inlet: Allan Smith	Area that is dominated by one or more species of shellfish. Includes oysters, mussels, cockles and mussels. Also include shellbanks, which are areas dominated by dead shells. May not be comprehensive across the study area.	Modified from Robertson *et al.* (2002)
Sponge garden  Sponge garden, Waimea Estuary: Cawthron	Biologically diverse sponge-associated communities. In the Nelson Bays case study area both of the documented regions of sponge gardens are located within Waimea Inlet. The Traverse sponge garden is ~1.2 ha and consists mainly of *Mycale (Carmia) tasmani* and associated biota on a cobble / shingle substrate. The Saxton Monaco channel is ~4.8 ha and also dominated by *Mycale (Carmia) tasmani*. It is likely that sponges gardens occur in other areas of the Nelson Bays region, for example within the Horoirangi Marine Reserve (NCC 2003), but these have not been well documented.	Asher *et al.* (2008)
Worm bed  *Galeolaria hystrix*: Rob Davidson	Area that is dominated by raised beds of sabellid polychaete tubes. May not be comprehensive across the study area.	Robertson and Stevens (2012)
Rhodolith bed  Rhodolith bed, Totaranui: Rob Davidson	Discrete assemblages of rhodolith algae. Rhodoliths are red algae that resemble coral.	

Structural class	Description	Source
Water  = Coastal lagoon, Farewell Spit: Helen Tribe	In the Nelson Bays case study region the only areas of water are the coastal lagoons on Farewell Spit. These are shallow stretches of water separated from the ocean by coastal land.	
Artificial structure  Bridge, Rabbit Island: Dana Clark	Introduced natural or man-made materials that modify the environment. Includes bridges, miscellaneous man-made structures, boat ramps, seawalls / rockwalls and wharfs. Could potentially include 'natural' materials such as sand replenishment but not in this case study area.	Robertson and Stevens (2012)
Terrestrial shrub / scrub / forest  Nelson: Dana Clark	Includes terrestrial species of plants, which may be considered as shrub, scrub or forest and also lichen. Shrubland: Cover of shrubs in the canopy is 20%–80%. Shrubs are woody plants < 10 cm diameter at breast height (dbh). Commonly sub-grouped into native, exotic or mixed shrubland. Scrub: Cover of shrubs and trees in the canopy is > 80% and in which shrub cover exceeds that of trees (*c.f.* forest). Shrubs are woody plants < 10 cm dbh. Forest: Woody vegetation in which the cover of trees and shrubs in the canopy is > 80% and in which tree cover exceeds that of shrubs. Trees are woody plants ≥ 10 cm dbh. Tree ferns ≥ cm dbh are treated as	Robertson *et al.* (2002)

	trees. Lichenfield: vegetation in which the cover of lichens is 20%–100% and where lichen cover exceeds that of any other growth form or bare ground.	
Terrestrial grassland  Nelson: Dana Clark	Land dominated by grass cover but not used for pasture and not obviously a maintained park / amenity area. Does not include the saltmarsh grassland vegetation *Festuca* spp.	
Introduced weeds  Massey University	Vegetation in which the cover of introduced weeds in the canopy is 20%–100% and in which the weed cover exceeds that of any other growth form or bare ground. Not comprehensive across the study area and occasionally some areas may have been classified as 'Terrestrial shrub / scrub / forest'.	

Structural class	Description	Source
Industrial  Waimea: Dana Clark	Land dominated by industrial activities.	
Residential  Nelson: Dana Clark	Land dominated by residential housing.	

Pine debris  Rabbit Island: Dana Clark	Debris originating from pine trees forestry areas.	
Road  Rocks Road, Nelson: Dana Clark	Gravel or sealed roads. Not comprehensive — needs further updating if all roads are to be separated out.	
Maintained park / amenity area  Tahunanui: Dana Clark	Area of terrestrial grassland maintained and used for recreation. Some areas that might fit into this class may have been categorised in the 'Terrestrial grassland' class.	
Horticulture  Appleby: Dana Clark	Land dominated by horticulture activities.	
Structural class	**Description**	**Source**
Pasture  Appleby: Dana Clark	Land dominated by pasture. When it was unclear if the land-use activity was pasture it was assigned to the 'Terrestrial grassland' category.	

Appendix 4. Sediment Layer.

The Sediment Layer (Sed_layer) column in the attribute table of the Nelson Bays ecosystem classification map denotes the probable sediment type for each coastal feature. This allows the underlying sediment cover to be captured even when the dominant ecosystem cover is saltmarsh, duneland, biogenic habitat or an artificial structure. For example, the sediment type for a seagrass bed growing on an estuarine sandflat would be estuarine sand.

For 'Unvegetated' features the Sediment Layer was the same as the dominant cover. For other features, sediment cover was assigned on the sub-dominant categorisations from the original data source or, when this was not available, an educated guess was made based on surrounding sediments. The term 'Not sediment' was used when the feature did not appear to have an underlying coastal sediment, for example a road cutting through an estuary, reclaimed land or islands. The table below outlines specific issues pertaining to the Sediment Layer classification. Sediment type was not determined for 'Terrestrial' features.

Saltmarsh The dominant surrounding ecosystem was used, unless sub-dominant categorisation was available. Saltmarsh along the boulder bank was classified as Boulder Bank. All saltmarsh was reclassified as a sediment type.
Duneland Duneland was classified as Beach.
Estuarine rocky shore and rocky shore The sediment type for these features reflected the size of the substrate along the rocky shore (*e.g.* gravel, cobble, boulder, rock).
Seagrass and macroalgal beds The dominant surrounding ecosystem was used, unless sub-dominant categorisation was available. Preference was given to soft sediment ecosystems and generally, Estuarine Mud / Sand was chosen in preference to Estuarine Sand. In a few instances Seagrass was completely surrounded by Estuarine Rock or Estuarine Cobble or Estuarine Gravel with no sub-dominant categorisation — the seagrass patches were classified as Estuarine Gravel in this case, as seagrass would not grow on cobble or rock.
Shellfish Shell Hash was the sediment type assigned to features that were within the Shellfish Structural Class (*e.g.* shell bank, oyster bed, mussel bed).
Sabellid reef Sabellid reef was classified according to the sub-dominant categorisation or surrounding sediment. This classification may not reflect the unique characteristics of sabellid reefs.
Seawall / rockwall Categorised as Estuarine Rock or Rock unless sub-dominant categorisation was different.
Ramp Categorised as Rock or Estuarine Rock unless sub-dominant categorisation was different.

Appendix 5. Beach popularity.

Beaches and rocky shores were ranked as low, medium, high or very high in terms of their popularity for recreation (Beach_popu column in attribute table). These rankings were based on a report assessing important areas for contact recreation (Forrest *et al.* 1994) and a survey of Nelson locals. Beaches in Abel Tasman National Park were generally classified as medium or higher except those past Totaranui / Anapai. It should be noted that this general classification may not hold true for smaller beaches, especially if they have no track access. The table below shows the beach popularity rankings, with bold text indicating rocky shorelines.

Very high (beach 181 ha; rocky shore none)	
• Kaiteriteri Beach • Tahunanui Beach • Rabbit Island Main Beach	• Pohara Beach • Tata Bay • Totaranui
High (beach 13 ha; rocky shore 3.6 ha)	
• Ligar Bay • **Cable Bay** • Little Kaiteriteri	• Marahau • Bark Bay • Anchorage
Medium (beach 122 ha; rocky shore 114 ha)	
• Okiwi Bay • Wainui • Split Apple Bay • **Schnappers** • Mapua • Stephen's Bay • Anapai • Torrent Bay • Apple Tree Bay • Onekaka • **The Glen** • Whawharangi Bay • Tonga Bay • Onetahuti	• Pakawau • Parapara • **Kina** • **Ruby Bay** • Paton's Rock • Awaroa • Collingwood • Goat Bay • Waiharakeke • Beaches that look as though they have a significant settlement along them and are not classified as being high or very high
Low (beach 1,427 ha; rocky shore 622 ha)	
• Pepin Island • Taupo Point • Mutton Cove • Delaware Beach • Hori Bay • Whangamoa (Kokorua)	• Honey Bay • Breaker Bay • Ngaio Bay • Motueka Spit • Farewell Spit • All other beaches and rocky shores not previously mentioned

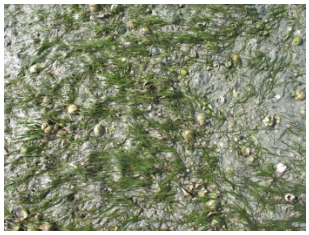
Appendix 6. Refugia

The Refugia column in the attribute table identifies features that provide refugia or nursery habitat services. A feature was included if any of the dominant or sub-dominant ecosystems contained biogenic habitat. These biogenic habitats include bryozoan areas, macroalgal beds, mussel beds, oyster beds, rocky reefs, rhodolith beds, saltmarsh, seagrass, sabellid reefs and sponge gardens. This captures, for example, seagrass that was present when the dominant cover was an Unvegetated category such as sand. Cockle beds were not included in the Refugia column because it was known they were unevenly mapped across the estuaries. Saltmarsh was only included if it was the dominant ecosystem because it was assumed the refugia habitat function provided by saltmarsh would only function when saltmarsh was the dominant cover.

Appendix 7. Ecosystem service (ES) biomes.

ES Biome	Definition	Dominant cover within biome
Coastal lagoon (261 ha)  = Coastal lagoon, Farewell Spit: Helen Tribe	Shallow stretches of water separated from the ocean by coastal land. Contains all coastal features with a dominant cover of water. Note that all coastal lagoons occur on Farewell Spit.	Water
Coastal waters (368,705 ha)  Tasman Bay: Dana Clark	The seabed and water column of the open coast. Contains all coastal features located outside of estuaries and the intertidal area but excludes reefs, seagrass, saltmarsh, sand beaches and dunes.	Boulder Cobble Shallow & deep gravel Shallow & deep mud Shallow mud / sand Shallow & deep sand Rhodolith bed Rock Silt / bryozoan mounds Wharf
Estuary (7,628 ha)  Abel Tasman: Dana Clark	A partially enclosed body of water, which is either permanently or periodically open to the sea. There is a measurable variation of salinity due to the mixture of seawater and freshwater derived from land drainage. contains all macroalgal beds, shellfish beds, worm beds, artificial structures and unvegetated features within estuaries. Also includes estuarine rocky shores and estuarine beaches. Does not include seagrass, saltmarsh or dunes.	Bridge Cockle bed *Enteromorpha* sp. Estuarine beach Estuarine boulder Estuarine cobble Estuarine gravel Estuarine mud Estuarine mud / sand Estuarine rock Estuarine rocky shore Estuarine sand *Gelidium caulacantheum* *Gracilaria chilensis* *Gracilaria secundata* Man-made structrure Mussel bed Oyster bed Ramp Sabellid field Seawall / rockwall (man-made) Shell bank

ES Biome	Definition	Dominant cover within biome
		Sponge garden *Ulva* sp. Wharf
Intertidal (10,353 ha)  Ruby Bay: Dana Clark	The area of land at the land-sea interface. It is marine in character and influenced periodically by the rise and fall of twice-daily tides, of bimonthly spring and neap tides, or by ebb and flow in tidal reaches of rivers. This ES biome is only a rough approximation of the intertidal area and is based primarily on the Land Information New Zealand (LINZ) depth contour polyline (hydro, 1:90k–1:350k) layer. The intertidal biome includes all areas shallower than the 0 m isobath of this layer but does not include areas assigned to the ES biomes of estuary, seagrass, saltmarsh, sand beach / dune and reef or terrestrial features. Along the Farewell Spit tidal flats the edge of the tidal flats, as defined by Battley *et al.* (2005), was used as a boundary rather than the 0 m isobath. As beaches are included in the sand beach / dune biome, the main area of exposed beach is excluded from the Intertidal biome but this is not the case for rocky shores. Rocks obviously protruding from the water (*i.e.* surrounded by reef or bathy of < 0 m) were classified as intertidal. Seawalls / rockwall (man-made) outside of the estuary biome were classified as Intertidal. The Boulder Bank was classified as Intertidal.	Boulder Boulderbank Cobble *Enteromorpha* sp. Man-made structure Mussel bed Ramp Rhodolith bed Rock Rocky shore Seawall / rockwall (man-made) Shallow gravel Shallow mud Shallow mud / sand Shallow sand Shell bank Wharf
Reef (1,271 ha)  Reef with sponge and ascidians: Cawthron	Sub-tidal stable hard substratum, not separated into boulders or smaller sediment units. Contains all features within the Reef Structural class.	Shallow reef Deep reef
Saltmarsh (1,491 ha)	A community of halophytic (salt-tolerant), emergent vegetation rooted in soils alternately inundated and drained by tidal action. Contains all features with the Saltmarsh category, regardless of location. Does not include features with a sub-	Various saltmarsh species

ES Biome	Definition	Dominant cover within biome
 Waimea Estuary: Allan Smith	dominant classification of Saltmarsh.	
Sand beach / Dune (3,008 ha)  Tahunanui Beach: Dana Clark	Sandy area lying between the extremes of high and low tides and vegetated sand dunes. Contains all features with a dominant cover of Beach or those within the Duneland category. Beach areas were primarily delineated by the main area of beach exposed in aerial photos. Some intertidal parts of beaches may not be captured in this category and will instead be included in the Intertidal biome. Farewell Spit was assumed to be primarily composed of sand beach and dune. As the dunes were often covered in saltmarsh and terrestrial species, the land cover did not reflect this dominance of dunes. Therefore, for the Sand Beach / Dune Biome classification, terrestrial shrub / scrub / forest, terrestrial grassland and saltmarsh ecosystems were classified as Dunes where they occurred on the land section of Farewell Spit.	*Ammophila arenaria* Beach *Desmoschoenus spiralis* Duneland Exotic shrub / scrub / forest Maintained park / amenity area Native shrub / scrub / forest *Phormium tenax* Saltmarsh *Spinifex sericeus* Terrestrial grassland Terrestrial shrub / scrub / forest *Ulex europaeus*
Seagrass (7,405 ha)  Nelson Haven: Cawthron	Flowering plants that colonise shallow marine and estuarine habitats. Contains all features with a dominant cover of seagrass, regardless of location. Does not include features with a sub-dominant classification of Seagrass.	Seagrass
N / a (2,348 ha)  Nelson: Dana Clark	ES biome categories are not available for terrestrial features, including terrestrial features within the coastal area (terrestrial-type features). The exception was terrestrial shrub / scrub / forest and terrestrial grassland features along Farewell Spit, which were classified as Sand Beach / Dunes.	Various terrestrial shrub / scrub / forest species Industrial Pasture Pine debris Residential Road Terrestrial grassland Unidentified introduced weeds

Appendix 8. Zones

The ‘Zone’ column in the attribute table classifies the features into different geographic zones.

Zone	Definition
Barrier island	Barrier islands are long narrow islands built of wave transported sand, separated from the mainland by an estuary. Includes rocky shorelines and beaches. In general, saltmarsh is not considered to be part of a barrier island unless it is completely surrounded by barrier island features.
Estuary	Any feature located within an estuary. Includes estuarine beaches and rocky shores. Excludes estuary islands and barrier islands. Also includes the Motueka River delta intertidal area.
Estuary island	Features on islands within estuaries, with the exception of barrier islands. Includes rocky shorelines and beaches. In general, saltmarsh is not considered to be part of an estuary island unless it is completely surrounded by estuary island features.
Farewell Spit	Section of Farewell Spit mapped by LCDB version 3.
Island	Features on islands, with the exception of barrier islands and islands located within estuaries. Includes rocky shorelines and beaches.
Spit	Narrow strip of land, commonly consisting of sand deposited by longshore currents, that has one end attached to the mainland and the other terminating in open water. Includes rocky shorelines and beaches. Excludes areas of Farewell Spit mapped by LCDB version 3.
Tidal flat	Delineates the Farewell Spit tidal flats as indicated in (Battley *et al.* 2005).

Appendix 9. Nelson Bays regions.

Map showing the three regions used to divide up the Nelson Bays case study area.