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INDIGENOUS BIODIVERSITY OF TAURANGA CITY - STATE OF THE ENVIRONMENT REPORTING 2008

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1. INTRODUCTION

Section 35 of Resource Management Act (1991) requires territorial authorities to monitor and report on environmental performance. A suite of environmental performance indicators and monitoring protocols were developed in 2000 by the Tauranga City Council (TCC), then the Tauranga District Council (TDC). The extent of Tauranga City is shown in Map 1 (see Appendix 11). In 2000 Wildland Consultants was commissioned by TDC to: (1) develop methods for monitoring these indicators, (2) prepare baseline maps of landforms and vegetation and habitats, and (3) gather data for the indicators (Wildland Consultants 2000a,b,&c). In 2005 these indicators were re-measured and reported in the 2005 State of the Environment (SOE) Report (Wildland Consultants 2005).

This report describes the second re-measurement of some of these indicators. This remeasurement was primarily a mapping exercise undertaken using the 2007/08 aerial photographs. The assessment of indicators in this report has a more limited scope than in previous years, as no data on State indicators have been collected and analysed.

2. PROJECT SCOPE

The scope of this project was to:

- Review and update the boundaries of Special Ecological Sites (SES) using the latest (2007/08) aerial photographs.
- Confirm presence and category rankings of existing SES.
- Update inventory of SES to include all sites considered significant in recent survey reports (Wildland Consultants 2005, 2006, 2008).
- Update vegetation boundaries within sites as appropriate.
- Analyse GIS-based biodiversity indicators, as appropriate.

3. METHODS

3.1 Review of site category ranking

The rank of each SES was reviewed against the criteria used to identify and categorise the sites in 2000. Map 2 (see Appendix 11) shows the location of all the SES sites. There was potential for the rank of a site to change if it had become degraded (which may result in a site being placed into a 'lower' category), or if a site had been subject to restoration management (which may result in a site being assigned to a 'higher' category). However, changes would have to be significant and/or large scale to result in a rank being changed.

3.2 Review of site category ranking and site boundaries

Changes in the boundaries of each SES were made by two methods.

Firstly, aerial photographs taken in 2007/08 were compared to those taken in 2002/03, which were the basis of mapping in the 2005 SOE Report (Wildland Consultants 2005). Changes in land use were identified as either losses or gains to SESs, and attributed to either real changes ('real') or mapping errors ('artifact') associated with scale of mapping or quality of aerial photographs.

Secondly, SES boundaries were reconciled with those identified in the Tauranga Natural Areas Survey (Wildland Consultants 2008). Significant natural areas identified the Tauranga Natural Area Survey, but not in the 2005 Tauranga City SOE study, were added to the SES register for 2008 as new sites.

3.3 Vegetation mapping

For changes in vegetation type maps, aerial photographs taken in 2007/08 were visually inspected for the fit of vegetation types mapped in the 2005 SOE report (Wildland Consultants 2005). Changes in vegetation maps were made when vegetation maps obviously no longer lined up with what was present on the ground in the 2007/2008 aerial photographs.

Vegetation and habitat types were mapped and digitised using ArcGIS 9.3 at a scale of 1:1,000 for SES on sand dune landforms, and 1:3,000 elsewhere (see Map 3, Appendix 11 for a map of land forms). Changes were identified visually at these scales and in some cases were digitised at more detailed scales - down to 1:300 - to achieve accurate boundary placement. Vegetation maps are presented in Map 5, Appendix 11.

A five-level classification system was used to describe vegetation types which incorporated hydroclass, structural class, character, dynamics, and descriptors of the vegetation/habitat type. An explanation of the classification system is presented in Appendix 1, and Appendix 2 contains a description of vegetation/habitat types in Tauranga City. The attribute data associated with each vegetation type in the GIS is provided in Table 1. Maps of sites and vegetation types are presented in Appendix 3.

Table 1: Names and definitions of attributes used in the GIS data file. (Source Wildlands 2000 & 2005)

Attribute	Description
Area_ha	The area of the polygon measured in hectares.
Area_sq_metre	The area of the polygon measured in square meters.
Hydroclass	The code number for the hydroclass component of the vegetation habitat group.
Structural class	The code number for the structural class component of the vegetation habitat group.
Character	The code number for the character component of the vegetation habitat group.
Dynamics	The code number for the dynamics component of the vegetation habitat group.
Veg_habitat_group	The code for the vegetation/habitat group, comprising the individual code numbers of each component combined in sequence to provide a five digit number.
Veg_habitat_type_code	The code for the vegetation/habitat type.
Veg_habitat_type_name	The name of the vegetation/habitat type.

Attribute	Description
Description	Where a polygon consists of a mosaic of one or more vegetation types, a description of the mosaic is provided.
Notes	Notes, if any, relevant to the polygon, e.g. the vegetation has been established from plantings.
Source	Code numbers referring to the source of the information used to delineate and describe the polygon.
Poly_id	A unique number identifying each polygon.

3.4 Indigenous biodiversity indicators

3.4.1 Area of indigenous and wetland vegetation removed

The area of indigenous and wetland vegetation removed during the period 2005-2008 was derived from changes to site boundaries, as described above, and calculated using ArcGIS 9.3.

3.4.2 Habitat fragmentation and isolation

Fragmentation is a multifaceted process involving reduction in size of natural areas, changes in their shape, and increases in degree of their isolation. Landscape indices have a descriptive value in comparing spatial patterns within and between landscapes (Rutledge 2003). However, description of the three aspects of fragmented landscapes by a single metric or measure is difficult. The measurement of fragmentation is also dependent upon patch definition and patch scale. In this study, patches were defined as being equivalent to SESs and the resolution of patch boundaries is tied to differences identifiable at a scale of 1:3000. We used a different index to describe each of the three consequences of fragmentation at a landscape scale - area, shape, isolation - in relation to SESs in Tauranga City, as outlined below:

Area - Area of remaining SES is the size (in ha) of sites in raw terms.

Shape - Most measures of patch shape focus on some variation of the perimeter-to-area ratio (Krummel *et al.* 1987). Perimeter-to-area ratio is the simplest measure of shape complexity. More complex shapes will have a larger perimeter for a given area and therefore a higher perimeter-to-area ratio. However, the ratio of perimeter-to-area exhibits a negative relationship with size for patches of the same shape (Rutledge 2003). The use of a shape index can correct for this negative relationship by comparing the perimeter-to-area ratio with a standard shape of the same area. We used the Shape Index (SI) of Patton (1975), as described in Rutledge (2003), and standardised raw perimeter: area ratios against the perimeter-to-area ratio of a circle of the same size. The value of SI is equal to 1 when the patch is a circle, and increases without limit as the patch becomes more complex.

The mean perimeter-to-area ratio was calculated using the area and perimeter values. The values of these variables are provided by default for any feature created in a shape file with ArcView on the fields named "SHAPE_Length" (perimeter) and "SHAPE Area" (area). Once the features (natural site polygons) were finalised, the ratio was calculated for every polygon operating the two fields, and storing the result in a new one. To be finalised, the data base was summarized by site, calculating the

mean value of the perimeter-to-area ratio value. The same procedure was followed to calculate the shape index, varying only the equation used to operate both fields.

Isolation - To measure isolation we used the Nearest Neighbour index, based on the minimum spanning distance between sites. Minimum spanning distance is the shortest distance between the boundaries of two sites. We also calculated the average minimum spanning distance from each site to all other sites.

The procedure for calculating the minimum spanning distance can be described in three steps:

1. Generate a ***distance grid***: This was done using the Euclidean distance output raster which contains the measured distance from every cell to the nearest source (Natural Site). A single distance grid was generated for every single site in order to know the distance of any point inside the city area to a given Natural Site. This was undertaken using the *Euclidean Distance tool* of ArcGIS Spatial Analyst.

2. Calculate ***zonal statistics***: This was done using a spreadsheet which contains statistics for each zone defined by a zone dataset (Natural Sites), based on values from another dataset (***distance grid***). A single zonal statistic was generated for every single ***distance grid***. It was made using the *Zonal Statistic tool* of ArcGIS Spatial Analyst. This tool calculates several statistics per zone, but the only statistic that was needed was the "minimum", which determines the minimum value of a particular zone.

3. Create an ***output matrix***: This was done using a spreadsheet containing a matrix which describes the minimum distance between Natural Sites. Once the spreadsheet of the required fields was created (one field per Natural Site), each ***zonal statistic*** spreadsheet was joined automatically, based on the Natural Site Number, in order to populate the created fields by using a batch processing function of the '*Calculate Field tool* of ArcGis Data Management'. The fields were populated with the minimum distance value of each zone.

A similar procedure was followed to calculate the distance to built-up areas, although in this case the source of the ***distance grid*** was the built-up areas, and the final output was a column listing the minimum distance of every single site to a built-up area.

As a general setting for spatial analysis, tools were assigned a mask area based on a 2 km buffer of the Tauranga City Council boundary, and a cell size of 3 meters for the ***distance grid***. This means the minimum distance between sites was 3 meters. For the purposes of interpretation we equated this 3 m minimum distance with zero.

3.4.3 Land use and development

The minimum spanning distance between each SES boundary and the nearest urban, commercial or industrial area (excluding agricultural buildings/implement sheds, but including carparks and roads) identified in Landcover Database Version 2 (LCDB2), was measured and compared with data from 2005. Distances will decrease if new developments have been established closer to sites than previous developments. However, this measurement does not detect changes in the intensification of an

existing development, or changes that have taken place at or beyond the distance of the closest developed site.

3.4.4 Area legally protected

The area of legally protected sites was derived from GIS shapefiles supplied by TCC, and expressed as a proportion of the total area of each site (refer to Map 4, Appendix 11). This describes the area legally protected by virtue of land tenure including lands administered by TCC or DoC based upon the TCC land tenure database. It does not include areas protected by virtue of statute or provisions, such as found in district plans or the Resource Management Act (1991).

4. RESULTS

4.1 Review of special ecological site categories

On the basis of existing information, the category of only one SES site was changed. Site number 16 (Turret Road) no longer meets the criteria for SES category ranking, and was removed from the 2008 SES schedule. This was primarily due to the clearance of this site during the period 2005-2008.

4.2 Review of special ecological site boundaries

As a result of vegetation and habitat mapping, the boundaries of 31 SESs were revised (Table 2). The individual size of ten SESs, including four Category 1 sites (SES 1, 3, 5, and 9), have reduced as a consequence of habitat destruction. The total area lost was 9.2 ha. One Category 2 SES (35) increased in size as a consequence of habitat restoration work carried out over approximately 3 ha.

Boundary adjustments arising from revisions detected on higher quality aerial photographs than those available in 2005 occurred at 23 sites. Many of the revisions made to the vegetation maps prepared in 2005 are relatively minor in nature and are artefacts or corrections. In general, artefacts were identified because the mapping of vegetation in 2005 was undertaken at a scale we consider too great to effect accurate boundary location in some instances. The 2007/2008 aerial photographs are of higher quality than the photographs that were available to prepare the vegetation and habitat maps in 2005. Updated vegetation maps are presented in Appendix 3.

An increase of 12.38 ha to mangrove loamfield and shrubland has occurred around the harbour, and a gain of 10.09 ha to spinifex-pingao/*Calystegia soldanella* grassland has occurred on sand dunes along the oceanic coast. Eight hectares of artefact changes (i.e. changes to the GIS layer that were not real changes on the ground) were not individually accounted for when site boundaries associated with sand dune sites were updated.

4.3 Addition of 'new' special ecological sites

Seven new Special Ecological Sites were added to the register from sites identified within the Tauranga Natural Areas Survey (Wildland Consultants 2008). Six of the

seven SES added to the 2008 register were ranked as Category 2 SES, on the basis of information presented in the Tauranga Natural Area Survey. One SES, Elizabeth Wetland, was ranked as a Category 1 SES.

4.4 Vegetation mapping

We mapped 838.7 ha of vegetation within 36 SES in Tauranga City (refer to Appendix 4). Almost one third of the total area mapped is made up of only two vegetation/habitat types: pohuehue vineland and grey willow forest. As in 2005, the most widespread vegetation class mapped in Tauranga City was vineland, reflecting the relative abundance of pohuehue vineland along the oceanic coast.

4.5 Indigenous biodiversity indicators

4.5.1 Area of indigenous and wetland vegetation removed

Between 2005 and 2008 9.20 ha of indigenous or wetland vegetation was removed from SESs (Table 2). The vegetation type that sustained the greatest loss was grey willow forest, of which 5.21 ha was removed from wetlands in Kopurererua Stream and Wairoa River. One quarter of the area of the Kopurererua Wetland has been cleared since 2000. Despite this loss, Kopurererua Wetland remains the third largest SES within Tauranga City. One SES site (Turret Road - 0.4 ha) has been cleared completely.

Table 2: Special Ecological Sites in Tauranga City where site boundaries changed over the period 2005-2008 as a result of habitat destruction or gain, or adjustments were made as a consequence of higher quality aerial photographs.

SES Name	Type of Change						Grand Total
	Gain			Loss			
	Actual	Artifact	Total	Actual	Artifact	Total	
Hopukiore		0.53	0.53				0.53
Kaitemako Stream Mouth		0.05	0.05	0.41	1.10	1.51	-1.46
Kaituna Sand Dunes and Wetland	0.09		0.09				0.09
Kopurererua Stream Wetland		0.06	0.06	5.21	0.21	5.42	-5.36
Mangatawa					0.09	0.09	-0.09
Matua Estuary-Yorke Park	1.06	0.24	1.30		0.70	0.70	0.60
Mauao 1	0.23	0.25	0.48		0.17	0.17	0.31
Mauao 2	0.26	0.04	0.30		0.02	0.02	0.28
Motuopae Island					0.08	0.08	-0.08
Motuotau Island		0.24	0.24				0.24
Ngapeke Road		0.64	0.64		0.05	0.05	0.59
Orumatua		0.02	0.02		0.11	0.11	-0.10
Otira Sand Dunes	1.84		1.84	1.45	0.03	1.48	0.36
Papamoa Sand Dunes	2.12		2.12				2.12
Poike		0.16	0.16	0.56		0.56	-0.40
Rangataua Bay	0.27	1.03	1.30		0.57	0.57	0.73

SES Name	Type of Change						Grand Total
	Gain			Loss			
	Actual	Artifact	Total	Actual	Artifact	Total	
Ranginui Road		0.35	0.35				0.35
Shark Alley to Kaituna Spit Sand Dunes	7.48		7.48	0.86		0.86	6.62
Turret Road				0.40		0.40	-0.40
Waikareao Estuary 1		0.02	0.02	0.13	3.89	4.01	-3.99
Waikareao Estuary 2	0.33	0.27	0.61	0.04		0.04	0.57
Waimapu Estuary	7.20		7.20				7.20
Waimapu Estuary Walkway	0.72		0.72				0.72
Waipu Bay 1	1.04	0.04	1.08	0.11		0.11	0.97
Waipu Bay 2	0.63		0.63				0.63
Waipu Bay 3		0.36	0.36		0.04	0.04	0.32
Waipu Bay 4		0.95	0.95				0.95
Waipu Bay 5		0.84	0.84				0.84
Wairoa River		0.77	0.77	0.02	0.21	0.23	0.54
Waitao Stream	1.14	0.10	1.24				1.24
Welcome Bay					0.26	0.26	-0.26
Grand Total	**24.41**	**6.96**	**31.36**	**9.20**	**7.53**	**16.72**	14.64

4.5.2 Habitat fragmentation and isolation

Fragmentation indices for all SES - including perimeter-to-area ratios, shape indices, and minimum and average distances to other SES - are provided in Tables 3 and 4 below for 2005 and 2008 respectively.

All Sites in 2008 (Total 43)

Area - The area of SES in 2008 ranges from 0.2 ha to 69.2 ha, with the average across all sites being 20.3 ha (Table 3).

Shape - The 2008 shape indices range from 1.2 to 7.0, with the average across all sites being 2.2.

Isolation - The minimum distance to the nearest SES ranges from 0 to 898 m, with the average across all SES sites being 178 meters.

All Sites in 2005 (Total 38)

Area - The area of SES in 2005 ranges from 0.2 ha to 66.6 ha, with the average across all sites being 20.9 ha (Table 4).

Shape - The 2005 shape indices range from 1.3 to 7.6, with the average across all sites being 2.7.

Isolation **-** The minimum distance to nearest ranges from 0 to 634 m, with the average across all sites being 172.1 meters.

Comparison of 2005 Sites (38) in 2008

Area - The average area of the 38 SES identified in the 2005 SOE Report has increased from 20.9 to 23.2 ha.

Shape - The average shape index decreased from 2.7 to 2.3, indicating that, on average, sites have become more round than they were in 2005.

Isolation **-** The average minimum spanning distance to nearest neighbours has decreased from 172.1 to 153.7 meters.

The shape index decreased for 21 sites, increased for 12 sites, and stayed constant for five sites over this period. This has resulted in a distribution of changes which, with the exception of two outliers, is slightly left-skewed in favour of a reduction in shape indices (Figure 1).

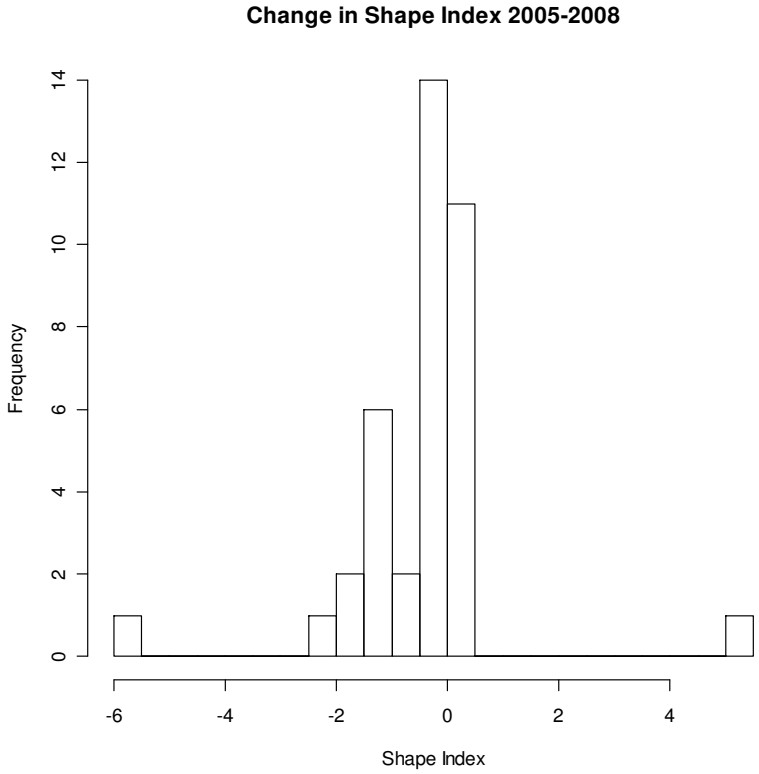

Figure 1: Distribution of changes in Shape index for the 38 sites shared between the 2005 and 2008 SES schedules, Tauranga City. Changes in the negative direction indicate that sites are becoming more rounded.

Waimapu Estuary and Waimapu Walkway have had their minimum spanning distances reduced by 120 and 166 meters respectively as a result of mangrove growth and consequent revision of site boundaries. Four other estuarine sites also contribute to the decrease in average minimum spanning distance. The minimum spanning distance for 30 sites was unchanged between 2005 and 2008.

Table 3: Fragmentation indices for SES in Tauranga City, 2005.

SES Name	Area (A) - ha	Perimeter (P) - m	MEAN_ P/A Ratio	MEAN Shape Index	Minimum Distance to Nearest	Average Distance to Nearest
Wairoa River	38.06	9,166	0.171	2.54	181	8,943
Matua Estuary-Yorke Park	49.41	9,621	0.061	2.26	181	7,483
Waikareao Estuary 1	43.10	4,141	0.010	1.77	3	6,094
Waimapu Estuary	46.24	6,455	0.014	2.66	127	6,384
Poike	31.19	6,227	0.024	2.32	127	6,532
Waitao Stream	43.65	6,296	0.098	1.83	298	5,631
Mauao 1	43.00	3,815	0.009	1.63	9	8,133
Motuotau Island	2.14	675	0.032	1.29	634	8,116
Otira Sand Dunes	57.35	9,210	0.016	3.41	3	5,992
Papamoa Sand Dunes	60.51	8,757	0.051	2.18	4	8,287
Kaituna Sand Dunes and Wetland	53.22	10,533	0.020	4.04	3	13,393
Motuopae Island	2.23	1,049	0.047	1.97	202	6,197
Waikareao Estuary 2	15.50	4,886	0.032	3.48	3	5,922
Kopurererua Stream Wetland	65.14	12,165	0.019	4.22	541	6,266
Waimapu Estuary Walkway	2.27	2,268	0.158	1.85	173	5,811
Turret Road	0.40	346	0.087	1.54	399	5,683
Waimapu Stream Wetland	0.22	219	0.101	1.31	187	7,687
Hairini	2.08	1,590	0.085	1.84	475	5,967
Kaitemako Stream Mouth	18.03	4,221	0.023	2.78	197	5,425
Welcome Bay	15.83	4,856	0.031	2.44	197	5,748
Tye Park Inlet	2.43	1,060	0.044	1.90	406	5,801
Ranginui Road	1.54	710	0.046	1.60	406	5,578
Ngapeke Road	20.14	6,179	0.031	3.86	298	5,267
Mangatawa	8.38	2,671	0.088	1.37	341	5,740
Rangataua Bay	66.64	9,036	0.014	3.10	163	4,614
Orumatua	5.49	4,098	0.075	4.90	163	4,622
Waipu Bay 1	18.87	4,121	0.022	2.66	66	4,738
Waipu Bay 2	1.38	1,110	0.081	2.65	66	4,990
Waipu Bay 3	1.24	1,390	0.113	3.50	195	4,983
Waipu Bay 4	3.42	1,431	0.042	2.17	3	5,325
Waipu Bay 5	13.88	3,932	0.065	1.96	3	5,123
Mauao 2	4.33	4,213	0.224	1.78	9	7,979
Moturiki Island	2.78	975	0.035	1.64	105	8,077
Hopukiore	1.56	1,225	0.154	2.11	79	7,838
Shark Alley to Kaituna Spit Sand Dunes	39.92	17,406	0.044	7.71	3	5,139
Kaituna River Wetlands	20.59	4,540	0.026	1.46	453	15,468
Shark Alley to Kaituna Spit Sand Dunes 1	4.28	2,759	0.064	3.73	3	8,124
Shark Alley to Kaituna Spit Sand Dunes 2	5.73	6,499	0.113	7.60	3	11,232
Shark Alley to Kaituna Spit Sand Dunes 3	3.75	1,267	0.042	1.36	3	16,174
Average	**20.92**	**4,644.04**	**0.06**	**2.68**	**172.10**	**7,089.86**

Table 4: Fragmentation indices for SES in Tauranga City, 2008.

SES Name	Area (A) - ha	Perimeter (P) - m	MEAN_ P/A Ratio	MEAN Shape Index	Minimum Distance to Nearest SES	Average Distance to All SES
Wairoa River	38.78	9,391	0.160	2.66	181	9,920
Matua Estuary-Yorke Park	50.41	8,932	0.058	2.13	181	8,429
Waikareao Estuary 1	39.61	4,562	0.012	2.03	3	6,976
Waimapu Estuary	51.78	6,701	0.013	2.61	7	7,186
Poike	30.79	6,413	0.024	2.38	127	7,314
Waitao Stream	51.18	7,878	0.083	2.14	298	6,048
Mauao 1	43.31	3,787	0.009	1.61	9	8,943
Motuotau Island	2.38	671	0.028	1.22	634	8,836
Otira Sand Dunes	57.61	9,258	0.018	2.37	3	6,223
Papamoa Sand Dunes	63.01	8,952	0.051	2.18	4	8,132
Kaituna Sand Dunes and Wetlands	69.24	20,072	0.077	2.78	3	12,529
Motuopae Island	2.16	1,040	0.048	1.98	195	7,058
Waikareao Estuary 2	16.07	5,363	0.046	2.07	3	6,798
Kopurererua Stream Wetland	62.05	11,259	0.032	1.85	541	7,150
Waimapu Estuary Walkway	6.59	3,592	0.141	1.89	7	6,617
Waimapu Stream Wetland	0.22	219	0.101	1.31	187	8,487
Hairini	2.08	1,590	0.085	1.84	475	6,728
Kaitemako Stream Mouth	16.62	4,179	0.120	1.42	197	6,162
Welcome Bay	25.45	6,628	0.025	2.51	197	6,402
Tye Park Inlet	2.43	1,060	0.044	1.90	406	6,409
Ranginui Road	1.89	758	0.040	1.55	406	6,171
Ngapeke Road	20.74	6,449	0.038	2.81	298	5,802
Mangatawa	8.29	2,729	0.088	1.39	341	6,176
Rangataua Bay	67.37	8,892	0.075	1.70	163	5,144
Orumatua	5.39	4,112	0.076	4.96	163	5,252
Waipu Bay 1	19.92	4,029	0.085	1.85	39	5,384
Waipu Bay 2	2.01	1,191	0.059	2.36	39	5,618
Waipu Bay 3	1.55	1,627	0.175	1.64	195	5,597
Waipu Bay 4	4.37	1,699	0.262	1.77	3	5,923
Waipu Bay 5	14.72	4,205	0.175	1.70	3	5,735
Mauao 2	4.61	4,507	0.242	1.73	9	8,777
Moturiki Island	2.78	975	0.035	1.64	75	8,847
Hopukiore	2.10	1,210	0.058	2.34	66	8,612
Shark Alley to Kaituna Spit Sand Dunes	45.61	19,935	0.211	1.86	3	5,630
Kaituna River Wetlands	30.78	6,933	0.026	1.77	371	14,366
Elizabeth Wetland	3.18	1,418	0.091	1.63	339	14,293
Bell Road Oxbow	3.12	1,801	0.062	1.95	898	13,267
Kaituna River Mouth	1.03	546	0.053	1.51	50	17,706
Motuopuhi Island	1.23	608	0.049	1.53	412	6,439
Waipu Bay 6	1.11	457	0.041	1.21	99	6,095
Waipu Bay 7	1.63	740	0.045	1.62	193	5,852
Shark Alley to Kaituna Spit Sand Dunes 1	4.39	3,015	0.069	2.20	3	8,207
Shark Alley to Kaituna Spit Sand Dunes 2	6.57	6,446	0.098	7.04	3	10,759
Shark Alley to Kaituna Spit Sand Dunes 3	6.54	6,182	0.095	6.77	3	15,238
Average	**20.29**	**4,818.40**	**0.08**	**2.21**	**178.00**	**8,028.8**

4.5.3 Land use and development

Average minimum spanning distance between each SES and the nearest suburban, residential or industrial areas is 259.5 meters in 2008, based on landcover information derived from LCDB2 is presented in Table 5. In 2005, the average minimum spanning distance to residential and industrial areas, on the basis of data from LCDB2, was 105.8 meters.

Table 5: Minimum spanning distance between each SES in Tauranga City and nearest suburban, residential, or industrial area, for 2005 and 2008.

SES Name	2005 Distance (m)	2008 Distance (m)
Wairoa River	97	97
Matua Estuary-Yorke Park	0	0
Waikareao Estuary 1	0	0
Waimapu Estuary	0	0
Poike	0	0
Waitao Stream	364	333
Mauao 1	103	98
Motuotau Island	739	733
Otira Sand Dunes	0	0
Papamoa Sand Dunes	0	0
Kaituna Sand Dunes and Wetlands	0	0
Motuopae Island	398	398
Waikareao Estuary 2	0	0
Kopurererua Stream Wetland	0	0
Waimapu Estuary Walkway	0	0
Turret Road	0	N/A
Waimapu Stream Wetland	101	101
Hairini	0	0
Kaitemako Stream Mouth	0	0
Welcome Bay	0	0
Tye Park Inlet	0	0
Ranginui Road	236	236
Ngapeke Road	41	41
Mangatawa	288	289
Rangataua Bay	0	0
Orumatua	517	517
Waipu Bay 1	39	34
Waipu Bay 2	73	73
Waipu Bay 3	8	8
Waipu Bay 4	514	514
Waipu Bay 5	567	567
Mauao 2	15	15
Moturiki Island	169	169
Hopukiore	0	0
Shark Alley to Kaituna Spit Sand Dunes	0	0
Kaituna River Wetlands	891	697
Elizabeth Wetland	N/A	2136
Bell Road Oxbow	N/A	1759
Kaituna River Mouth	N/A	625
Motuopuhi Island	N/A	117
Waipu Bay 6	N/A	676
Waipu Bay 7	N/A	303

SES Name	2005 Distance (m)	2008 Distance (m)
Shark Alley to Kaituna Spit Sand Dunes 1	0	0
Shark Alley to Kaituna Spit Sand Dunes 2	0	0
Shark Alley to Kaituna Spit Sand Dunes 3	1027	881
Average	**159**	**153**

4.5.4 Area legally protected

SESs cover 892.65 ha, of which 349.25 ha or 39% is legally protected by land tenure or covenant. Types of protection include DOC reserves and TCC reserves. Seventeen sites have virtually no legal protection, except as specified under district plans and provisions within the RMA (see Table 6).

Table 6: Areas and percentage of SES areas in Tauranga City with legal protection in 2008.

Site Name	Site Number	Area	Legally Protected Area	Percent Legally Protected
Wairoa River	1	38.78	0.00	0.00
Matua Estuary-Yorke Park	2	50.41	26.72	53.01
Waikareao Estuary 1	3	39.61	18.82	47.53
Waimapu Estuary	4	51.78	18.20	35.14
Poike	5	30.79	4.13	13.41
Waitao Stream	6	51.18	0.51	0.99
Mauao 1	7	43.31	41.85	96.63
Motuotau Island	8	2.38	0.00	0.00
Otira Sand Dunes	9	57.61	39.77	69.03
Papamoa Sand Dunes	10	63.01	62.80	99.66
Kaituna Sand Dunes and Wetlands	11	69.24	0.20	0.28
Motuopae Island	12	2.16	0.00	0.00
Waikareao Estuary 2	13	16.07	3.02	18.80
Kopurererua Stream Wetland	14	62.05	46.70	75.25
Waimapu Estuary Walkway	15	6.59	2.84	43.10
Waimapu Stream Wetland	17	0.22	0.00	0.00
Hairini	18	2.08	0.85	40.98
Kaitemako Stream Mouth	19	16.62	4.52	27.20
Welcome Bay	20	25.45	16.03	62.97
Tye Park Inlet	21	2.43	0.10	3.94
Ranginui Road	22	1.89	0.00	0.00
Ngapeke Road	23	20.74	0.94	1.46
Mangatawa	24	8.29	0.00	0.00
Rangataua Bay	25	67.37	1.00	0.66
Orumatua	26	5.39	0.00	0.00
Waipu Bay 1	27	19.92	0.65	3.27
Waipu Bay 2	28	2.01	0.00	0.00
Waipu Bay 3	29	1.55	0.36	23.19
Waipu Bay 4	30	4.37	0.00	0.00
Waipu Bay 5	31	14.72	0.00	0.00
Mauao 2	32	4.61	4.13	89.64
Moturiki Island	33	2.78	0.00	0.00
Hopukiore	34	2.10	2.04	97.57
Shark Alley to Kaituna Spit Sand Dunes	35	63.11	50.27	79.65

Site Name	Site Number	Area	Legally Protected Area	Percent Legally Protected
Kaituna River Wetlands	36	30.78	0.00	0.00
Elizabeth Wetland	37	3.18	0.00	0.00
Bell Road Oxbow	38	3.12	1.74	0.01
Kaituna River Mouth	39	1.03	0.00	0.00
Motuopuhi Island	40	1.23	1.08	87.49
Waipu Bay 6	41	1.11	0.00	0.00
Waipu Bay 7	42	1.63	0.00	0.00
Totals		892.65	349.2543	

5. CONCLUSIONS

5.1 Review of special ecological sites boundaries.

An increase of 12.38 ha of mangrove loamfield and shrubland around the harbour has occurred through the natural spread of mangroves onto substrate formed by the relatively recent deposition of sediment. This spread represents a transformation of one kind of natural area into another, in this case inter-tidal flats have been colonised by mangroves. However, this change has not resulted in a net gain in the area of indigenous habitats within the harbour.

An increase of 10.09 ha to spinifex-pingao/*Calystegia soladanella* grassland has occurred on sand dunes along the oceanic coast. Approximately 3 ha of this gain can be attributed to restoration activities along Mt. Maunganui Beach. The remainder of this gain is a component of natural dune dynamics. Severe storm events erode incipient and established foredunes, and reduce the vegetative cover along sand dune coasts. Recolonisation of beach sand by dune plants between severe and erosive storm events increases the vegetative cover of dune systems. The increase in the area of SES on sand dunes observed in 2008, as compared with 2005, reflects the capacity of these dune systems to express intrinsic cyclical fluctuations in the area of occupancy by dune vegetation. This process has been significantly enhanced - in Tauranga City - by the many community-based restoration and planting projects along the Mt Maunganui-Papamoa coast.

5.2 Analysis of biodiversity indicators

5.2.1 Natural area devegetated

Between 2005 and 2008, 9.2 ha of indigenous terrestrial and wetland vegetation was cleared within SESs. The largest single area lost was 5.21 ha of the Kopurererua Wetland. Tenure of all cleared land is a combination of TCC road reserve and TCC reserve. The area cleared is greater than the total area of the ten smallest SES combined. In numerical terms, most losses are small reductions due to urban encroachment into SES sites, as a result of either new housing developments or the extension of existing gardens.

This loss, considered in combination with the removal of 59 ha of indigenous or wetland vegetation during the preceeding three year interval - a total loss of 68.2 ha in

six years - is equivalent to a loss rate of 13.5% per decade. At this rate, the area of indigenous habitats within Tauranga City will halve in 50 years.

To some extent, the losses in some SES have been mitigated by the expansion of other SES. However, the areas removed are not the same character as the areas gained. Of the 841.05 ha of SES present in 2000, only 773 ha remain in 2008.

Piecemeal reductions in the areas of SESs have been offset by growth and spread of mangrove communities onto mudflats, and re-establishment of dune communities on reformed incipient foredunes. Both of these processes are natural components of estuarine and dune dynamics, respectively. This offset in area does not represent an offset in biodiversity values, when freshwater wetland communities - a nationally uncommon vegetation type - are substituted by mangrove-dominated communities within the total area encompassed by SESs. Neither is the increment in the area of sand dunes reflective of an actual gain to the area over which natural coastal processes operate, although the community-based Coastcare projects are obviously having a very positive effect.

SES site boundaries identified in this study are tied to boundaries of vegetation types. As these fluctuate along the oceanic coastal margin, so does site area. Some sites do not have the capacity to recover areas lost in one area through expansion in another, such as the Kopurererua Wetland. An assessment of this indicator must include the landscape context within which the raw values are couched, because the raw numbers - particularly total SES area in each year - do not necessarily or accurately indicate real changes.

5.2.2 Fragmentation and isolation

Differences in average sizes, shape indices, and isolation indices for all sites in 2008 are, in part, the result of five additional sites being included in the 2008 analysis. Specifically, the average size across all sites has decreased, the average fragmentation index has decreased, and the average minimum spanning distance has increased. When 2008 averages are calculated for these indices for the 38 sites identified in 2005, different trends are apparent. The average site size has increased, the average shape index has decreased, and the average minimum spanning distance has, decreased. This downward trend may be attributable to growth of mangrove areas, expansion of dune communities, revised site boundaries, and removal of narrow fingers of vegetation. The 14 ha increase in mapped SES boundaries between 2005 and 2008 is linked to a decrease in the average shape indices over the same period.

The decrease in average minimum spanning distance has been driven primarily by two adjacent estuarine sites - Waimapu Estuary and Waimapu Walkway - which have had their minimum spanning distances reduced by 120 and 166 meters respectively as a result of mangrove growth and revision of site boundaries. Four other estuarine sites also contribute to the decrease in average minimum spanning distance. The minimum spanning distance for 30 sites is unchanged between 2005 and 2008.

As sites become smaller, distances between sites (as a function of increasing minimum spanning distance), and area-to-perimeter ratios both increase. All three factors are components of and contribute to indices of fragmentation. Restoration

activities associated with sites may not alter minimum spanning distances between sites but may consolidate site boundaries. This will reduce the degree to which the actual sites are fragmented. Restoration activities between sites may reduce minimum spanning distances between sites, which also reduces fragmentation.

Standards need to be developed to ensure that the inclusion of potential restoration sites (PRS) into the calculation of these three indices reflects the habitat quality, and by extrapolation, the functional connectivity of those PRSs. When areas that are currently identified as "potential restoration areas" meet SES criteria, their status should be upgraded to SES, either as being established as new SES or as additions to existing SES (see Map 3, Appendix 11 for a map of existing and potential restoration sites).

5.2.3 Land use

Comparison of the recalculated distances between SES and nearest urban, suburban or industrial areas for 2005 with distances calculated for 2008 shows a small decrease in the average distance for those sites common to both years.

5.2.4 Area legally protected

Most of the 349 ha of protected areas are concentrated in the larger sites, including Kopurererua Stream Wetland, Mauao 1, Otira Sand Dunes, Papamoa Sand Dunes, and Shark Alley to Kaituna Spit Sand Dunes. Seventeen of the smaller SES have little or no legal protection. In 2005, the area with legal protection was also reported as being 39% (Wildland Consultants 2005). The proportion of SES area that is legally protected has not changed in the three year period between 2005 and 2008. This can be interpreted as a positive indicator, as the area encompassed by SES has increased from 810 ha to 892 ha over the same period, in part through the addition of several sites to the SES schedule.

6. DISCUSSION

Legislative Framework

Remeasurements of pressure and response indicators in this report were made on the basis of high resolution (pixel size 25 cm) aerial photographs. Up-to-date GIS data layers for land tenure and legal protection status were also available for the 2008 analysis and reporting. This facilitated remote assessment of indicators measuring the degree of direct human impact at each site, and the indicators presented in this 2008 report are focussed on the monitoring of human-induced impacts.

In 2003, functions of regional councils were amended within the Resource Management Act by inclusion of the following statements:

- Section 30(1)(c) of the principal Act is amended by inserting, after subparagraph (iii), the following subparagraph:

- "(iiia) the maintenance and enhancement of ecosystems in water bodies and coastal water."

- Section 30(1) of the principal Act is amended by inserting, after paragraph (g), the following paragraph:
  - "(ga) the establishment, implementation, and review of objectives, policies, and methods for maintaining indigenous biological diversity:".

This means that Environment Bay of Plenty (as well as the Department of Conservation) now also has roles relating to indigenous biodiversity within Tauranga City.

Ongoing Change

Even if all direct human impact on sites is ameliorated, mitigated, or reduced completely, biodiversity decline will continue. The ecological reality of contemporary New Zealand landscapes is that biodiversity decline and ecological degradation are multi-faceted processes. People have been major components of this process (Craig *et al*. 2000), but are no longer the primary ongoing causal agent (at least in the short term). Within a statutory framework, three landscape scale 'home truths' must be acknowledged if the objectives set out in Paragraph (ga) above are to be achieved. Firstly, ongoing impacts of invasive species continue on a day-to-day basis. Secondly, the impacts of invasive species increase from local, to regional to national scales as they spread throughout the country, up to the limits of their environmental tolerance. Thirdly, the suite of invasive species present in New Zealand continues to increase as new species arrive and others emerge and are recognised as invasive. There is already recognition of this ecological reality within the District Plan:

- *"Maintenance and enhancement of the natural character of the coastal environment, rivers, stream and wetlands."*
- *"The sustainable management of ecosystem processes and remaining indigenous vegetation, species and habitat resources."*

Snapshot in Time

State of the Environment Reporting aims to capture a snapshot of the condition of natural areas at the time of reporting. This project focuses on capturing that snapshot of state in a pragmatic and cost-effective fashion, following the methods presented in Wildland Consultants (2000b, 2005). It emphasizes some modifications to indicators that will hopefully improve the assessment of 'state'. The need for indicators capable of informing on the success of management actions that may be applied in the future with a view to improving biodiversity condition is also stressed, and options for this are explored further below.

Community Perceptions

A Community Outcomes Survey (EBOP 2006) was undertaken to assess perceptions of the community regarding the effectiveness of the outcome in the Tauranga District Plan. Most respondants expressed a *"high level of satisfaction expressed by the*

community with the District landscape", and believed that the landscape is the same or better than two years before. Seventy-nine percent rated the natural environment as good or very good. The impressions of respondents are not necessarily reflective of trends observed within SES over the period 2000-2005, when "biodiversity indices" trended downward for eight of eleven Category 1 Special Ecological Sites. This suggests that general impressions, while valuable for assessing satisfaction with city environs, should not be used as proxy indicators of the state of the environment.

Options for a More Quantitative Approach to Snapshot Reporting

Monitoring is the process of making repeatable measurements and analysing the results to detect changes. State of the Environment Monitoring involves monitoring of key indicators (from Beanland and Huser 1999) to determine:

- the environmental 'baseline' - quality and quantity;
- marked changes or gradual trends away from that baseline;
- the cause-effect relationship between human activity ('pressure'), actions ('management response'), and environmental outcomes (the 'state');
- the success and effectiveness ('performance') of resource management policy.

'State' Indices Used in 2002 and 2005

- Ecological Character

  Ecological character, in relation to indigenous species, is a measure of compositional integrity. Ecological character has been assessed qualitatively against broad criteria describing regeneration of indigenous species *in situ*, the relative frequency of exotic species at a site, and whether the vegetation is dominated by indigenous or exotic species (Wildland Consultants 2000, 2002). However, even if forests are comprised primarily or completely of indigenous species, and hence have high ecological character scores, the vegetation might not be in excellent condition. Being dominated by indigenous species means only that the vegetation contains few or no exotic species. It does not necessarily mean that communities are in good biodiversity condition, depending on the frame of reference.

- Number and Distribution of Threatened Species

  Emphasis on rarity assumes that the presence of rare species is an indicator of habitat quality. However, the causal relationship underlying the use of threatened species as indicators is tenuous, and this indicator is only useful if we have reason to link the presence of threatened species to habitat quality (Wildland Consultants 2000). In many cases the presence of rare species may not necessarily indicate habitat quality because, in New Zealand, direct predation, rather than habitat degradation or even habitat destruction, is now the primary cause of species declines for both plants and animals. New Zealand shares this somewhat unusual ecological characteristic with other oceanic island groups, including Hawai'i, Fiji, and Guam (Fritts and Rodda 1998; Craig *et al.* 2000). This is true for a number of species traditionally believed to require habitats of percieved high quality, such as

the relationship between kokako and unmodified primary forest (Lavers 1978). The fact that contemporary indigenous birds utilise exotic plantation forest habitats can call into question our preconceptions surrounding the fit between organisms, particularly threatened organisms, and their environment. So does the successful breeding of kokako on small offshore islands in vegetation established from plantings which were part of an ecological restoration project.

Furthermore, threatened species are so because they maintain small population sizes. This predisposes those populations to extinction and colonisation events due to neutral processes of death, reproduction, and dispersal which are components of functional metapopulations (Hubbell 2001), and nothing to do with patch quality.

- Presence and Abundance of Pest Animals and Pest Plants

  It is now widely acknowledged that an array of invasive species have decimated New Zealand terrestrial biodiversity (Holdaway 1989), and that their impacts are on-going (i.e. Clout *et al.* 1995; Innes *et al.* 1999; Wilson *et al.* 1998; McLennan *et al*. 1996, 2004). The logical induction from this recognition is that habitats with invasive species are experiencing adverse impacts, therefore must be undergoing biodiversity decline, whereas habitats without invasive species must be healthy because they have been relieved of the degradative pressures exerted by these organisms. Although this is an oversimplification it is a valid argument. Absence of weeds or rodents implies relief from their impacts. There is evidence correlating the recovery of populations and species with the removal of pest organisms in New Zealand, and evidence of a causal relationship for this response (O'Donnell *et al*. 1992; Clout *et al.* 1995; Innes *et al*. 1999). Likewise the decline of species and populations correlated with the expansion of pest organisms is well documented in New Zealand (Craig *et al.* 2000). Given the implementation of active pest management, the otherwise unaided recovery of species is only possible if they persist in impacted areas or are capable of returning of their own accord.

<u>Monitoring in the Best of Both Worlds</u>

Biological diversity, or "biodiversity", describes the variety of all biological life - plants, animals, fungi, and microorganisms - the genes they contain and the ecosystems on land or in water where they live. It is the diversity of life on earth (New Zealand Biodiversity Strategy 2000). The simplest way of describing community and regional diversity is simply count the number of species present (Magurran 1988). This type of count expresses how rich or poor in species a community or region is. However, the problem with a simple count is that as more individuals are sampled, the number of species detected will increase (Bunge and Fitzpatrick 1993). This means that both sample size and the density of individuals within different communities will influence the raw count of species (Hurlbert 1971; Gotelli and Colwell 2001).

Advantages of species density as indicator of biodiversity condition include:

- An objective estimate of the total number of species, and the number and diversity of indigenous and exotic species can be estimated for areas using measures of species density.

- The data upon which estimates of density are based can be obtained relatively time effectively.

- The estimation method corrects for differences in sampling effort, however sample size must be sufficient for accumulation curves to distinguish between density patterns.

Because the density of individuals varies between communities, species richness must be calculated from samples based either on area, or on the basis of a sampling unit that can be related to counts of individuals.

If sample areas are relatively small, and occurrence data recorded in the form of presence absence, an estimate of the number of species present within an SES can be obtained relatively quickly, and hence cost-effectively. If the sampling strategy is appropriately stratified, data on biodiversity can be obtained simultaneously to data on other indicators, such as abundance and distribution of pest plants. The value of data on biodiversity status, when quantified in terms of species density will, in the long term, more than outweigh costs associated with its collection.

Counts of woody species could be incorporated into measurements to assess canopy condition and health through time. Changes in rank abundance distributions can indicate changes and degradation induced by environmental weeds or browsing animals. Species richness - quantified on the basis of counts of individuals - may decline, and rank abundance distributions shift toward more uneven communities as indigenous species are usurped by browsing animals and replaced by exotic species.

This type of data would also facilitate the comparison of existing sites within Tauranga City with comparable sites elsewhere, particularly those that do not suffer the same suite of potential degradative impacts as remnants within the City.

Permanent Sample Plots

The sampling unit for an estimate of species density could be a small bounded area, say 2 × 2 meters, or slightly larger. Species occurring within a bounded area would be recorded as present only. Sampling could focus on perennial species only to avoid seasonal influence and to speed data collection. If information on canopy species richness and evenness is required, a count of the number of individuals of each species occurring within the plot area could be made.

It may be advantageous to stratify sampling by vegetation type and edge versus interior. A spatially explicit sampling strategy can also be used to monitor weed occurrence and distribution, and hence changes in both through time. However, the distribution of these sampling points need not be predetermined, nor must they be the same between sampling years. The only requirement is that a sufficient number of

samples are obtained to distinguish between density patterns at different sites. A pilot study would be necessary to estimate the number of samples needed to achieve this.

Species density is relevant, analytically robust, cost-effective, simple and easily understood and would complement assessment of ecological character as indicators of state.

8. OVERVIEW AND FUTURE DIRECTIONS

Habitat destruction continues within Tauranga City, despite the fact that less than 5.0 percent of the terrestrial area of the Tauranga Ecological District retains a cover of predominantly indigenous vegetation. More than any indicator, this is the most striking indictment on how accommodating we are of indigenous biodiversity loss within the landscapes within which we live. At face value, the area of SES has increased over the period 2005-2008, but this observation over-simplifies interactions between habitat loss and the dynamics integral to healthy indigenous systems. During the current reporting period, the rate of vegetation colonisation on mudflats and dunes has outstripped the rate of habitat destruction in other areas. In the longer term, pressures on SESs will undoubtedly increase as a consequence of current habitat destruction and requirements for future land development.

The very act of drawing boundaries around indigenous areas maintains the dichotomy between 'use' and 'preservation' within New Zealand landscapes. Cultural and natural terrestrial landscapes are both components of a single system, and both have capacity for greater integration, with mutual benefit. In the longer term, the health of remnants within Tauranga City will be improved by increasing the linkages between cultural and natural landscapes within the city.

The long term maintanence and enhancement of indigenous biodiversity within Tauranga City is dependant on the willingness of local communities to lead this. Community involvement rests upon the participation of local people, and that is a function of whether we as a people continue to value the presence of indigenous biodiversity in our cultural landscapes, or otherwise.

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VEGETATION AND HABITAT CLASSIFICATION SYSTEM

To assess the overall status of biodiversity and to monitor change, a conceptual framework is useful that identifies the components of biodiversity at several levels of organisation (Noss 1990). A system was devised for the classification of vegetation and habitats in the Tauranga District, with reference to the types of ecosystems present, the issues that the classification system could be used to address, and with reference to existing classification systems (Atkinson 1985; Environment BOP Wetland Database Categories; the Land Cover Database (LCDB); Leathwick *et al.* 1995; Wildland Consultants Ltd in prep.).

The vegetation and habitat classification system is based to a large extent on Atkinson's (1985) units. A five level classification was developed, being generally hierarchical (the two upper levels, 1 and 2, represent broader levels of organisation than the lowest level, 5), but with two descriptive levels, 3 and 4. Brief definitions of the five levels are provided in Table 1.

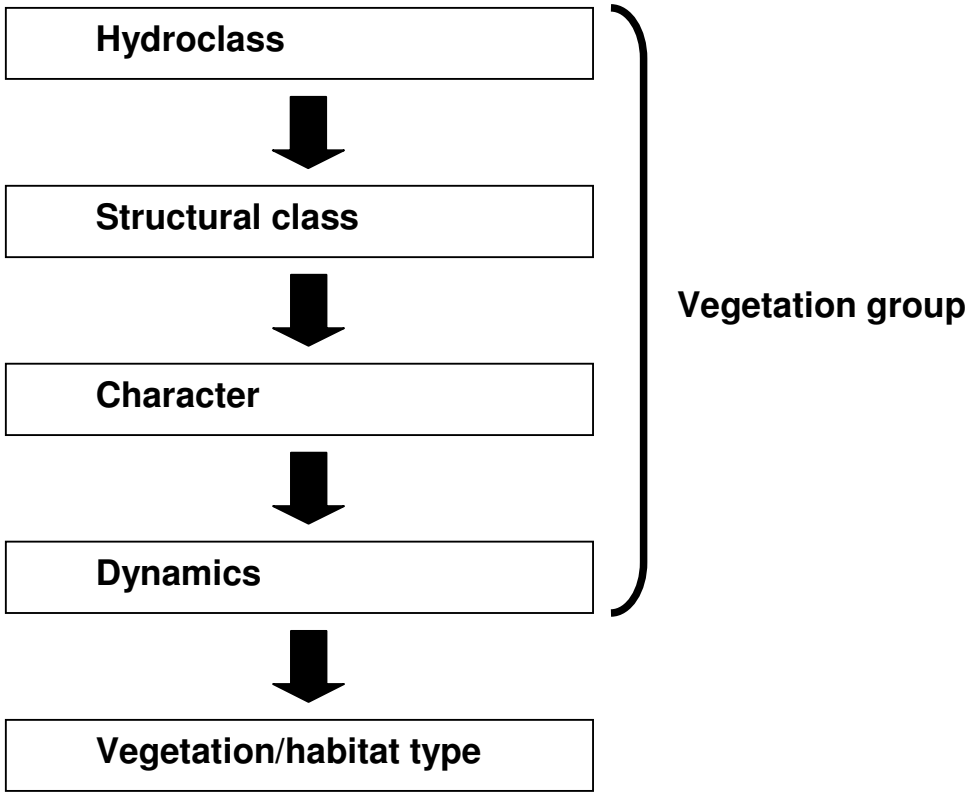
Table 1: Names and definitions of the five levels in the vegetation and habitat classification system

Level	Name	Definition
1	Hydroclass	A hydrological classification of a particular site, e.g. estuarine (refer below).
2	Structural class	The vegetation structural class (e.g. forest), following Atkinson (1985), based on the growth forms of the canopy species[1](refer below).
3	Character	The state of the vegetation in terms of the relative proportions of indigenous and exotic species in the canopy (refer below).
4	Dynamics	Essentially an assessment of the successional state of the vegetation, including a category for primary vegetation which has been modified. This was applied to scrub and forest only (refer below).
5	Vegetation/ habitat type	An abbreviated name for a vegetation/habitat type including the dominant species, following Atkinson's (1985) method for vegetation classification (refer below).

There is no limit to the number of individual vegetation/habitat types (Level 5) that can be recognised in the classification system. A summary of the top four levels, termed a 'vegetation group' (refer to Figure 1 below), was created by combining the numerical codes in order from Levels 1 to 4 to give a five digit summary code. Only one category can be selected for each of Levels 1-4 and only one vegetation type described in Level 5. Definitions of the categories in Levels 1-4 and the method for derivation of a vegetation/habitat type are provided below.

[1] The only variation from Atkinson's structural class classification is for *Leptocarpus similis* (oioi) which was classified as sedgeland, rather than rushland.

Figure 1: Vegetation and habitat classification hierarchy



Numerical Codes

Predefined categories were assigned to levels 1-4. Each category was also assigned a numerical code, 1 digit for hydroclass (level 1), character (level 3) and dynamics (level 4), and 2 digits for structural class (level 2). The numerical codes for each component were grouped together in order from levels 1 to 4, providing a five digit summary code referred to as a 'vegetation group'.

A five digit numerical code was used for each vegetation/habitat type, (level 5). The first two digits correspond to the structural class code (level 2) while the last three digits are a unique code for the vegetation/habitat type. There is no limit to the number of individual vegetation/habitat types that can be recognised (the current coding system only allows for 999 within each structural class, but this can be ammended to provide for a much larger number). In some cases an additional 6th decimal digit was used. This digit denotes differences between vegetation types that comprise mosaics of one or more vegetation types, where the constituent vegetation types vary only in the proportions and not in the species composition (e.g. codes 06009.1 and 06009.2 in Appendix 1).

Level 1 - Hydroclasses

1-Terrestrial All areas on land that are not wetlands (c.f. other hydroclass categories).

2-Estuarine	Tidal and non-tidal saline wetlands associated with a coastal body of water with a free connection to the open sea and where fresh water, derived from land drainage (usually rivers) is mixed with sea water (Allaby 1994).
3-Palustrine	Small open-water bodies, vegetated wet ground, and all other non-tidal wetlands not covered by riverine or lacustrine (Buxton 1991).
4-Riverine	Flowing waters contained within a channel e.g., streams, rivers and their margins (Buxton 1991).
5-Lacustrine	Dams or lakes with open water (Buxton 1991).

Level 2 - Vegetation/Habitat Structural Classes (From Atkinson 1985)

01-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 >10 cm dbh are treated as trees.
02-Treeland	Vegetation in which the cover of trees in the canopy is 20-80%, with tree cover exceeding that of any other growth form, and in which the trees form a discontinuous upper canopy above either a lower canopy of predominantly non-woody vegetation or bare ground, e.g. mahoe/bracken treeland. (Note: Vegetation consisting of trees above shrubs is classified as either forest or scrub depending on the proportion of trees and shrubs in the canopy.)
03-Vineland	Vegetation in which the cover of unsupported (or artificially supported) woody vines in the canopy is 20-100% and in which the cover of these vines exceeds that of any other growth form or bare ground. Vegetation containing woody vines that are supported by trees or shrubs is classified as forest, scrub or shrubland. Examples of woody vines occur in the genera *Actinidia, Clematis, Lonicera, Metrosideros, Muehlenbeckia, Ripogonum, Vitis* and others.
04-Scrub	Woody vegetation in which the cover of shrubs and trees in the canopy is >80% and in which shrub cover exceeds that of trees (cf forest). Shrubs are woody plants <10cm dbh.
05-Shrubland	Vegetation in which the cover of shrubs in the canopy is 20-80% and in which the shrub cover exceeds that of any other growth form or bare ground. It is sometimes useful

	to separate tussock-shrublands as a sub-class for areas where tussocks are >20% but less than shrubs. (Note: the term scrubland is not used in this classification.)
06-Tussockland	(including flaxland). 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 *Chinochloa, Poa, Festuca, Rytidosperma, Cyperus, Carex, Uncinia, Juncus, Astelia, Aciphylla* and *Celmisia*. It is sometimes useful to separate flaxland as a subclass for areas where species of *Phormium* are dominant.
07-Fernland	Vegetation in which the cover of ferns in the canopy is 20-100% and in which the fern cover exceeds that of any other growth form or bare ground. Tree ferns >10 cm dbh are excluded as trees (cf. forest).
08-Grassland	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.
09-Sedgeland	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. Included in the sedge growth form are Leptocarpus similis and many species of Carex, Uncinia, Isolepis, and Bolboschoenus. Tussock-sedges and reed-forming sedges (cf. reedland) are excluded.
10-Rushland	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. Included in the rush growth form are some species of Juncus, most species of Leptocarpus, and all species of Sporadanthus, and Empodisma. Tussock-rushes are excluded.
11-Reedland	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. 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, Schoenoplectus

	tabernaemontani, Eleocharis sphacelata, and Baumea articulata.
12-Cushionfield	Vegetation in which the cover of cushion plants in the canopy is 20-100% and in which the cushion-plant cover exceeds that of any other growth form or bare ground. Cushion plants include herbaceous, semi-woody and woody plants with short densely packed branches and closely spaced leaves that together form dense hemispherical cushions. The growth form occurs in all species of *Donatia, Gaimardia, Hectorella, Oreobolus,* and *Phyllachne* as well as in some species of *Aciphylla, Celmisia, Centrolepis, Chionohebe, Colobanthus, Dracophyllum, Drapetes, Haastia, Leucogenes, Luzula, Myosotis, Poa, Raoulia,* and *Scleranthus*.
13-Herbfield	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 separated as ferns, tussocks, grasses, sedges, rushes, reeds, cushion plants, mosses or lichens.
14-Mossfield	Vegetation in which the cover of mosses in the canopy is 20-100% and in which the moss cover exceeds that of any other growth form or bare ground.
15-Lichenfield	Vegetation in which the cover of lichens in the canopy is 20-100% and in which the lichen cover exceeds that of any other growth form or bare ground.
16-Rockland	Land in which the area of residual bare rock exceeds the area covered by any one class of plant growth-form. Cliff vegetation often includes rocklands. They are named from the leading plant species when plant cover ≥ 1%, e.g. [koromiko] rockland.
17-Boulderfield	Land in which the area of unconsolidated bare boulders (>200 mm diam.) exceeds the area covered by any one class of plant growth-form. Boulderfields are named from the leading plant species when plant cover ≥ 1%.
18-Stonefield/gravelfield	Land in which the area of unconsolidated bare stones (20-200 mm diam.) exceeds the area covered by any one class of plant growth-form. The appropriate name is given depending on whether stones or gravel form the greater area of ground surface. Stonefields and

	gravelfields are named from the leading plant species when plant cover ≥ 1%.
19-Sandfield	Land in which the area of bare sand (0.02 - 2 mm diam.) exceeds the area covered by any one class of plant growth-form. Dune vegetation often includes sandfields which are named from the leading plant species when plant cover ≥ 1%.
20-Loamfield/Peatfield	Land in which the area of loam and/or peat exceeds the area covered by any one class of plant growth-form. The appropriate name if given depending on whether loam or peat forms the greater area of ground surface. Loamfields and peatfields are named from the leading plant species when plant cover ≥ 1%.

Level 3 - Character

1-Indigenous	>50% of the plant species in the canopy are indigenous.
2-Exotic	>50% of the plants species in the canopy are exotic

Level 4 - Dynamics

1-Primary	Forest or scrub which has never been logged or cleared in any part. Applied to scrub and forest only.
2-Modified	Primary forest or scrub in which the structure or composition of the vegetation has been changed by human activities. Applied to scrub and forest only.
3-Secondary	A stage of vegetation succession characterised by the disruption (clearance) of previously existing forest or scrub leading to a marked change in the composition of the vegetation (Allaby 1994). This term was only applied to scrub and forest.
4-N/A	Not applied - all classes other than scrub and forest.

Level 5 - Vegetation/Habitat Type Names

Vegetation/habitat type names were derived using the naming system developed by Atkinson (1985). This system allows several aspects of the vegetation to be summarised in a shorthand form, including the dominant canopy species, structure of the canopy and the structural class. There are two main components to the name - (i) vegetation composition, and (ii) the structural class.

Components of a vegetation/habitat type name

(i) Composition of vegetation/habitat types

Compositional names were derived from the major canopy species and includes information on both the composition and structure of the canopy. Species that comprise 20% or more of the canopy were usually included in the type name. Where conspicuous species, such as emergent trees, comprise less than 20% of the canopy, they can be included in the compositional name as their exclusion would not convey a realistic picture of the vegetation. In cases where no species comprise 20% of the canopy, the two most abundant species are used. The range of % cover any one species contributes to the total cover is noted in the compositional name using the following notation:

tawa	over 50% cover of the double underlined species
tawa	between 25-49% cover of the underlined species
tawa	between 5-24% cover of non-underlined species
(tawa)	less than 5% cover of the bracketed species

Canopy structure is conveyed using the following approach:

rimu/tawa	indicates that rimu and tawa differ significantly in height and form separate layers, with the rimu emergent above the tawa.
rimu-tawa	indicates rimu and tawa occur in the same layer.

(ii) Structural class

This is the same term used in level 2-structural class.

Table 2: Hierarchical classification system for vegetation and habitats

Classification Levels							
1. Hydroclass		**2. Structural Class**		**3. Character**		**4. Dynamics**	
1	Terrestrial	01	Forest	1	Indigenous	1	Primary
2	Estuarine	02	Treeland	2	Exotic	2	Modified
3	Palustrine	03	Vineland			3	Secondary
4	Riverine	04	Scrub			4	N/A
5.	Lacustrine	05	Shrubland				
		06	Tussockland				
		07	Fernland				
		08	Grassland				
		09	Sedgeland				
		10	Rushland				
		11	Reedland				
		12	Cushionfield				
		13	Herbfield				
		14	Mossfield				
		15	Lichenfield				
		16	Rockland				
		17	Boulderfield				
		18	Stonefield/gravelfield				
		19	Sandfield				
		20	Loamfield/peatfield				

Set out below is an example of how the classification system can be applied to an area of estuarine saltmarsh on the margins of Tauranga Harbour, subject to tidal inundation, and made up of oioi (80% of the canopy) and searush (20% of the canopy).

- **Hydroclass = 1-estuarine** [a saline site in an estuary]
- **Structural class = 09-sedgeland** [as per Atkinson's (1985) definition, the cover of sedges (i.e. oioi) in the canopy is 20-100% and the cover of sedges exceeds that of any other growth form, c.f. searush is classified as a tussock]
- **Character = 1-indigenous** [indigenous species comprise more than 50% of the canopy]
- **Dynamics = 4-N/A** [Primary (1), modified (2) and secondary (3) classifications were only applied to the forest and scrub structural classes]
- **Vegetation group =10914**
- **Vegetation/habitat type = 09001 <u>Oioi</u>-searush sedgeland** [oioi comprises over 50% of the canopy so is double underlined, while the cover of searush is within 5-24% of the canopy so is not underlined; c.f. Atkinson 1985. Sedgeland is the structural class name. The first two digits of the code were derived from the structural class, 09, while the last three digits are the unique identifier for the vegetation types].

DESCRIPTIONS OF VEGETATION AND HABITAT TYPES

Vegetation Group[1]	Vegetation/Habitat Type		Description
	Code[2]	Name	
30122	01001	Ti kouka/grey willow-manuka forest	Grey willow in association with local manuka forms a canopy with scattered emergent ti kouka, over a generally indigenous understorey.
30122	01002	Grey willow forest	Grey willow forms a canopy over a generally indigenous understorey, often comprised of *Coprosma tenuicaulis* and *C. robusta* with scattered wheki, *Coprosma propinqua* subsp. *propinqua*, *Coprosma propinqua* subsp. *propinqua* x *C. robusta* and pampas.
30112	01003	Brush wattle-mamaku-ti kouka forest	Forest characterised by a mix of brush wattle, ti kouka and mamaku in the canopy.
10113	01004	Pohutukawa forest	Pohutukawa dominates the canopy to varying degrees and is generally the only species present
30122	01005	Grey willow/*Coprosma propinqua* subsp. *propinqua* forest	A mosaic of grey willow forest[3] (80-95%) and *Coprosma propinqua* subsp. *propinqua* shrubland (5-20%)
10113	01006	(Eucalyptus)/puriri-(rimu)-(kauri)/mamaku-makomako-hawthorn forest	Scattered eucalypts are present over a variable canopy of puriri in association with mamaku, makomako, hawthorn, and occasional kauri and mamaku.
30122	01007	Grey willow-manuka forest	Grey willow and manuka dominate the canopy over a generally indigenous understorey is a variation on Vegetation Type 01001.
30122	01008	Grey willow-manuka forest	A mosaic of Vegetation Type 01002 grey willow forest (50-80%) and Vegetation Type 01007 grey willow-manuka forest (20-50%). The understorey comprises predominantly indigenous species.
30122	01009	Grey willow/raupo forest	A mosaic of Vegetation Type 01002 grey willow forest (80-95%) and Vegetation Type 11003 raupo reedland (5-20%). The understorey comprises predominantly indigenous species.
10113	01010	Mamaku treefernland	Mamaku forms a dense almost monospecific canopy.
10122	01011	Radiata pine/pohuehue-spinifex forest	A plantation of radiata pine has been established on coastal sand dunes at the east end of SES 35.
10122	01012	she oak-wattle forest	The canopy is dominated by she-oaks and wattles.

1 Refer to Appendix 1of this report for a definition or key to 'vegetation groups'.
2 These codes are used on the site maps in this report.
3 The constituent vegetation types in each mosaic are described individually elsewhere in this section.

Vegetation Group[1]	Vegetation/Habitat Type		Description
	Code[2]	Name	
10113	02001	(Pohutukawa)-(rewarewa)/mamaku-mahoe treefernland	Emergent pohutukawa and rewarewa are thinly scattered over dense mamaku in association with mahoe.
10224	02002	Puriri/mamaku-mahoe/kawakawa treeland	Occasional puriri are emergent over an open canopy of mamaku in association with mahoe and kawakawa in the gaps. The vegetation is relatively modified and there are numerous adventive species present, particularly in the understorey. Willows are common along the toeslope and there is a small area of kahikatea.
10224	02003	Mamaku-tree privet treeland	Mamaku and tree privet are the major component of an open and modified treeland. Grey willow occurs along the toe slopes and there are scattered emergent trees including eucalyptus
10214	02004	Macrocarpa/karaka-pohutukawa treeland	Macrocarpa is emergent over a canopy of karaka in association with pohutukawa.
10214	02005	Mamaku-brush wattle-(Taiwan cherry)-(mahoe)-(hawthorn) treefernland	The canopy comprises mamaku in association with brush wattle and scattered Taiwan cherry, mahoe and hawthorn.
10214	02007	Pohutukawa treeland	Pohutukawa forms a treeland with a relatively open canopy. Occasional radiata pine are also present in some areas.
10214	02008	Pohutukawa-rewarewa/akepiro-mingimingi-hangehange-manuka-karamu-mamaku treeland.	Emergent pohutukawa and rewarewa are scattered throughout with some local dense concentrations over dense scrub comprising various mixes of akepiro, mingimingi, hangehange, manuka, karamu and mamaku.
30214	02009	Grey willow-manuka-(ti kouka)/raupo-pampas treeland	Grey willow in association with manuka and scattered ti kouka form an open canopy over raupo and pampas.
10224	02011	Brush wattle-mamaku-(mahoe) treeland	Brush wattle in association with mamaku and local mahoe form an open treeland.
10224	02012	Radiata pine-eucalyptus-(sycamore)/pohutukawa-poplar treeland	Radiata pine and eucalyptus in association with sycamore are emergent over pohutukawa and poplar.
10224	02013	Sycamore-karaka-radiata pine treeland	An open canopy of sycamore and karaka in association with radiata pine.
10214	02014	Totara treeland	Planted totara form a monospecific, dense canopy.
30224	02015	Grey willow/raupo treeland	A mosaic of Vegetation Type 01002 grey willow forest (50-80%) and Vegetation Type 11003 raupo reedland (20-50%).
30224	02016	Grey willow/manuka treeland	A mosaic of Vegetation Type 01002 grey willow forest (50%) and Vegetation Type 04008 manuka scrub (50%).
10224	02017	Exotic treeland	The canopy is very fragmented, species present include fan palm, Japanese spindle tree, woolly nightshade, brush wattle, pines, grey willow, crack willow and bamboo. Some areas have been recently cleared and planted with native species including manuka, harakeke, karamu, ngaio and taupata.
10224	02018	Mamaku-Taiwan cherry treefernland	Mamaku in association with Taiwan cherry forms a discontinuous canopy..
10224	02019	(Radiata pine)/brush wattle/mamaku-gorse-woolly nightshade treefernland	Brush wattle and scattered radiata pine are emergent over a variable canopy of mamaku in association with gorse and woolly nightshade.

Vegetation Group[1]	Vegetation/Habitat Type		Description
	Code[2]	Name	
30224	02020	Grey willow/raupo-harakeke-purei treeland	An open canopy of grey willow is present over varying mixes of raupo, harakeke and purei. In some areas the grey willow canopy is absent.
10224	02021	Pine-eucalyptus/tree privet-brush wattle/woolly nightshade-gorse treeland	Scattered pine and eucalyptus species are emergent over a canopy dominated by tree privet in association with brush wattle. Woolly nightshade and gorse are present on margins and in canopy gaps. There are small areas of mamaku along stream margins.
10224	02022	Mamaku-brush wattle/gorse treefernland	Mamaku in association with brush wattle form an open canopy, with gaps generally dominated by gorse. The vegetation is highly modified
	02023	Mamaku-brush wattle-(Taiwan cherry)-(mahoe)-(hawthorn) treefernland	Mamaku, brush wattle, Taiwan cherry, mahoe, and hawthorn form the canopy. There are emergent raiata pines at the top of the bank. Other species include kawakawa, woolly nightshade, Chinese privet, and grape.
10314	03003	*Muehlenbeckia complexa*-spinifex vineland	The present day vegetation cover is a mosaic of communities dominated by either indigenous or exotic species, or both. The vegetation mosaic reflects both the disturbance history, the degree of exposure, and the proximilty to weed sources experienced by the dunes. Spinifex and pingao are common on the foredune, with scattered *Calystegia soldanella* and local sea rocket (*Cakile maritima* subsp. *maritima*). Behind the foredune indigenous species dominate in many places, however the proportion of adventive species to indigenous changes in association with the intensity of dune development along the dunes. Common native species are *Muehlenbeckia complexa,* spinifex, *Carex testacea*, perehia, and *Ficinia nodosa*. A combination of these species generally form the vegetation cover behind the foredune, with varying densities of adventive species such as introduced ice plant, harestail (*Lagurus ovatus*), catsear (*Hypochaeris radicata*), purple groundsel (*Senecio elegans*), lupin (*Lupinus arboreus*), gizania, arctotis (*Arctotis stoechadifolia*) and ripgut brome (*Bromus diandrus*). Bracken iincreases in abundance on transgressive dunes further back from the beach, and is common in a couple of areas. Evergreen buckthorn (*Rhamnus alaternus*) and *Acacia sophorae* are present locally.
10324	03005	Japanese honeysuckle/*Carex geminata* vineland	Mats of Japanese honeysuckle on swards of *Carex geminata* and blackberry.
10413	04001	(Pohutukawa)-(kanuka)-(rewarewa)-(totara)/mahoe-whauwhaupaku-manuka-karamu-hawthorn-mingimingi scrub	Occasional pohutukawa, kanuka, totara and rewarewa are emergent over a variable canopy generally comprising mahoe, manuka, whauwhaupaku, karamu, hawthorn and mingimingi.
30423	04002	Manuka-gorse scrub	Scrub dominated by manuka and gorse. The two species tend to form monospecific stands within the vegetation type, most probably a reflection of previous clearance.

Vegetation Group[1]	Vegetation/Habitat Type		Description
	Code[2]	Name	
10423	04003	Gorse-manuka-Spanish heath-pampas scrub	Highly modified scrub dominated by gorse in association with manuka, Spanish heath and pampas. Occasional karamu, sapling pohutukawa and akepiro are also present in the canopy.
10423	04004	Gorse-Spanish heath-pampas-bracken-smilax scrub	A highly modified dense scrub of relatively low stature. The canopy is dominated by gorse in association with Spanish heath, pampas, bracken and smilax.
10413	04005	Kawakawa-whau-mamaku scrub	A local area of scrub dominated by kawakawa in association with whau and mamaku.
10413	04006	Mahoe-karamu-mamaku-hangehange scrub	Secondary scrub dominated by a mix of mahoe, mingimingi, hangehange and karamu. There are a few scattered large emergent pohutukawa.
20411	04007	Mangrove scrub	Mangrove forms extensive monospecific stands of low staured scrub on mud flats.
30411	04008	Manuka scrub	Manuka dominates the canopy and is generally the only canopy species present. Occasionally there are low numbers of ti kouka.
10413	04009	Manuka-kanuka-mingimingi-(pohutukawa) scrub	Secondary scrub dominated by manuka in association with kanuka, mingimingi and occasional young pohutukawa.
10413	04010	Mapou-mingimingi-mahoe-karamu scrub	Secondary scrub dominated by mapou in association with mingimingi, mahoe and karamu.
10413	04011	Ngaio scrub	Planted ngaio. Pohutukawa forms a minor component of the canopy at some sites.
10423	04012	Pohutukawa/gorse-pampas scrub	Gorse in association with pampas forms dense scrub with occasional emergent pohutukawa.
10413	04013	Pohutukawa/mingimingi-akepiro-hangehange scrub	Scattered large pohutukawa are emergent over a dense canopy of mingimingi, akepiro and hangehange. Other minor canopy components include mamaku, whauwhaupaku and mahoe.
10413	04014	Totara-mahoe-hawthorn scrub	Totara in association with mahoe and hawthorn form a dense scrub of variable height. Other minor canopy components include mamaku, mapou and whauwhaupaku.
30412	04015	Grey willow/manuka-raupo scrub	A mosaic of Vegetation Type 04008 manuka scrub (>50%), Vegetation Type 11003 raupo reedland (20-30%) and Vegetation Type 01002 grey willow forest (20-30%).
20411	04016	Mangrove-oioi-searush scrub	A mosaic of Vegetation Type 04007 mangrove scrub (>50%), Vegetation Type 09009 oioi sedgeland (30-45%) and Vegetation Type 06002 searush tussockland (5-20%).
10413	04017	Pohutukawa scrub	A planted area dominated by pohutukawa.
10413	04018	Pohutukawa-karo-taupata-*Melicytus novae-zelandiae*-ngaio scrub	Pohutukawa in association with karo, taupata, *Melicytus novae-zelandiae* and ngaio form a variable canopy. Much of this vegetation has originated from plantings and there have been recent plantings of these species within this vegetation type.

Vegetation Group[1]	Vegetation/Habitat Type		Description
	Code[2]	Name	
10423	04019	(Brush wattle)-mamaku/gorse-woolly nightshade-mahoe-hangehange scrub	Mamaku and occasional brush wattle are emergent over a dense low canopy of gorse in association with woolly nightshade, mahoe and hangehange.
10423	04020	(Wattle)/mamaku-Japanese honeysuckle-gorse scrub	A highly modified area comprising a variable and open canopy of mamaku-Japanese honeysuckle and gorse with scattered emergent wattle. Mamaku, Japanese honeysuckle and gorse tend to occur as a mosaic of monospecific patches.
10423	04021	Tree privet-(mamaku)/gorse-woolly nightshade scrub	Tree privet and scattered mamaku are emergent over gorse in association with woolly nightshade. This vegetation is highly modified.
10423	04022	Brush wattle-mamaku scrub	Brush wattle with a component of mamaku forms a thick scrub.
10423	04023	Gorse-woolly nightshade scrub	Gorse in association with woolly nightshade forms a dense low scrub. There are occasional emergent mamaku, brush wattle, pines and tree privet.
10413	04024	Akeake-manuka-tarata-kohuhu-ti kouka-ngaio-koromiko-harakeke scrub	Secondary scrub established through plantings. Composition varies from area to area, but generally comprises mixes of akeake, manuka, tarata, kohuhu, ti kouka, ngaio, koromiko and harakeke. Other species present at lower abundance include pohutukawa, whau, karo, karaka and puriri.
10412	04025	Mamaku-tarata-Taiwan cherry-kohuhu-titoki-karaka-makomako scrub	A very diverse canopy, common elements including mamaku, tarata, Taiwan cherry, kohuhu, titoki, karaka and makomako
30514	05001	*Coprosma propinqua* subsp. *propinqua* shrubland	Shrubland dominated by *Coprosma propinqua* subsp. *propinqua* in association with locally common harakeke, toetoe and raupo. There are occasional manuka and a few individuals of *Olearia solandri* and *Coprosma propinqua* subsp. *propinqua* x *C. robusta.*
30514	05002	*Coprosma propinqua* subsp. *propinqua*-manuka-pampas shrubland	*Coprosma propinqua* subsp. *propinqua* is the common canopy dominant in association with scattered manuka, harakeke and local pampas and gorse. Marsh ribbonwood is common adjacent to the salt marsh.
30514	05003	Manuka-grey willow/harakeke-*Baumea juncea*- marsh ribbonwood shrubland	Manuka in association with grey willow are emergent over harakeke, *Baumea juncea* and marsh ribbonwood, which tend to occur towards the shoreline. Sea rush occurs locally next to the shore.
30524	05004	Grey willow-raupo-harakeke-Japanese honeysuckle shrubland	Grey willow in association with raupo and to a lesser extent harakeke and Japanese honeysuckle characterise this type.
10524	05005	Gorse-pampas tussock-shrubland	A highly modified vegetation type dominated by gorse in association with pampas. Occasional akeake and pohutukawa are present within this vegetation type on Mauao.
20514	05006	Marsh ribbonwood shrubland	Marsh ribbonwood dominant shrubland, with oioi and searush occasionally present on seaward margin.
30514	05007	Grey willow/gorse-*Coprosma propinqua* subsp. *propinqua*-manuka-harakeke shrubland	Scattered grey willow are emergent over an open canopy of gorse, *Coprosma propinqua* subsp. *propinqua*, manuka and harakeke shurbland.

Vegetation Group[1]	Vegetation/Habitat Type		Description
	Code[2]	Name	
10514	05008	Kawakawa-pohuehue/pohuehue-blackberry shrubland	Shrubland comprising kawakawa with pohuehue surrounded by low statured pohuehue and blackberry.
10524	05009	Whau-karamu-taupata-manuka-karo-harakeke shrubland	A recently cleared and planted area. Species planted include whau, karamu, taupata, manuka, karo and harakeke.
20514	05010	Mangrove shrubland	Extensive areas of open shrubland comprised almost solely of mangrove on mudflats.
10514	05011	Mamaku/kawakawa shrubland	Numerous mamaku are emergent over an open canopy of kawakawa. The open nature of the kawakawa canopy is the result of recent clearings of exotic species. Native species planted in canopy gaps includes manuka, karamu, kawakawa, mahoe, whau and puriri.
30514	05012	Manuka shrubland	Manuka dominates a variable canopy, which includes components of *Coprosma tenuicaulis*, *C. robusta*, grey willow, harakeke and local toetoe and/or ti kouka.
10514	05013	Manuka-(pohutukawa)-(akeake)-(mingimingi) shrubland	A partially cleared area previously dominated by gorse. The resultant vegetation comprises scattered manuka with a few pohutukawa, akeake and mingimingi.
30514	05014	Grey willow/manuka-raupo shrubland	A mosaic of Vegetation Type 01002 grey willow forest (20-50%), Vegetation Type 04008 manuka scrub (20-50%) and Vegetation Type 11003 raupo reedland (20-50%).
30514	05015	Manuka-harakeke-toetoe shrubland	Shrubland of variable height, comprising manuka in association with harakeke, toetoe and *Baumea juncea* with scattered oioi. Raupo is common is some areas.
30514	05016	Manuka-harakeke-ti kouka-(raupo)-(oioi) shrubland	A mosaic of Vegetation Type 05021manuka-harakeke-ti kouka shrubland (>90%), Vegetation Type 11003 raupo reedland (<5%) and Vegetation Type 09009 oioi sedgeland (<5%).
30514	05017.1	Manuka-(raupo) shrubland	A mosaic of Vegetation Type 04008 manuka shrubland (>95%) and Vegetation Type 11003 raupo reedland (<5%).
30514	05017.2	Manuka-raupo shrubland	A mosaic of Vegetation Type 04008 manuka shrubland (50-80%) and Vegetation Type 11003 raupo reedland (20-50%).
30514	05018	Whau-karamu-ngaio-(tarata)-(manuka)-(pohutukawa)-(taupata)/kikuyu grass-cocksfoot shrubland	A planted area comprising whau, karamu and ngaio in association with tarata, manuka, pohutukawa and taupata.
10514	05019	Pohutukawa/mahoe-mingimingi-hawthorn-kawakawa-gorse shrubland	Mahoe, mingimingi, hawthorn, kawakawa and gorse form an open canopy of variable composition. There are several large emergent pohutukawa present and several dense patches of bracken.
20514	05020	*Olearia solandri*-harakeke-marsh ribbonwood-oioi-*Baumea juncea*-pampas-grey willow shrubland	Shrubland commonly comprising a mix of *Olearia solandri*, harakeke, marsh ribbonwood, *Baumea juncea*, pampas and grey willow. *Baumea articulata*, manuka and raupo are locally common.

Vegetation Group[1]	Vegetation/Habitat Type		Description
	Code[2]	Name	
10523	05022	Pampas/gorse-Spanish heath-manuka-harakeke/exotic grasses shrubland rockland	Parts of Mauao burned in 2003. Scattered pampas on the steepest slopes. Low stature shrubs (average height approximately 0.5 m). Occasional boneseed, ngaio (possibly planted), karamu etc.
10513	05023	Manuka-harakeke-ngaio-pohutukawa/exotic grasses shrubland	Areas on Mauao planted in 2005.
10513	05024	dead pohutukawa/dead small trees/bracken-gorse-hangehange-pampas-woolly nightshade shrubland	Pohutukawa forest on Mauao that was burned in 2003.
20614	06001	Mangrove-searush shrub-tussockland	Mangrove and searush form the vegetation cover, with local areas dominated by searush.
20614	06002	Searush tussockland	Tussockland generally comprised of dense monospecific stands of searush.
30614	06004	Pohutukawa-taupata/*Ficinia nodosa* tree-tussockland	A rock outcrop characterised by pohutukawa, taupata and *Ficinia nodosa*.
20614	06005	Brush wattle-grey willow/harakeke-pampas tussockland	Harakeke in association with pampas dominate this vegetation type with numerous emergent brush wattle and grey willow.
10614; 30614	06006	Harakeke-pampas-manuka-marsh ribbonwood/searush-oioi tussockland	Harakeke, pampas, manuka and marsh ribbonwood are emergent over searush and oioi.
20614	06007	Harakeke flaxland	Harakeke dominates these areas forming a dense cover.
20614	06008	Searush-oioi-(pasture) tussockland	A mosaic of Vegetation Type 06002 searush tussockland (20-50%), Vegetation Type 09017 searush-oioi sedgeland (20-50%), Vegetation Type 06014 searush-(pasture) tussockland (5-20%), and Vegetation Type 09009 oioi sedgeland (5-20%).
20614	06009.1	Searush-oioi tussockland	A mosaic of Vegetation Type 06002 searush tussockland (80-95%) and Vegetation Type 09017 searush-oioi sedgeland (5-20%).
20614	06009.2	Searush-oioi tussockland	A mosaic of Vegetation Type 06002 searush tussockland (50-80%) and Vegetation Type 09017 searush-oioi sedgeland (20-50%).
20614	06010	Searush-oioi tussockland	A mosaic of searush tussockland (50-80%) and oioi sedgeland (20-50%).
20614	06011	Searush-oioi-mangrove tussockland	A mosaic of Vegetation Type 09002 searush tussockland (>60%), Vegetation Type 09009 oioi sedgeland (5-20%) and Vegetation Type 05010 mangrove shrubland (5-20%).
20614	06012	Searush-*Samolus repens*-marsh ribbonwood-*Baumea juncea*-oioi tussockland	A mosaic of Vegetation Type 19001 sandfield (25%), Vegetation Type 09022 marsh ribbonwood-*Baumea juncea*-oioi-searush sedgeland (25%), Vegetation Type 06002 searush tussockland (25%) and Vegetation Type 13004 *Samolus repens* herbfield (25%).
20614	06013	Searush-oioi tussockland	A mosaic of Vegetation Type 06002 searush tussockland (>50%) and Vegetation Type 09009 oioi sedgeland (<50%).

Vegetation Group[1]	Vegetation/Habitat Type		Description
	Code[2]	Name	
20614; 30614	06014	Searush-(pasture) tussockland	Searush tussockland with pasture grasses locally present between searush tussocks.
30624	06015	Grey willow/pampas-harakeke tussockland	Grey willow and are emergent over pampas and harakeke tussockland. Composition is variable between areas, and in some places *Baumea articulata* is a significant component of the vegetation
30614	06016	Pampas-harakeke-manuka-*Coprosma propinqua* subsp. *propinqua*/raupo-bracken-(*Baumea articulata*) shrub-tussockland	Shrub-tussockland characterised by pampas, harakeke, manuka and *Coprosma propinqua* subsp. *propinqua* with lower statured raupo, bracken and *Baumea articulata*.
20614	06017	Harakeke-pampas-raupo-gorse-*Coprosma propinqua* subsp. *propinqua*/searush-oioi-(marsh ribbonwood)-(*Baumea articulata*) shrub-tussockland	Harakeke, pampas, raupo, gorse and *Coprosma propinqua* subsp. *propinqua* are emergent over searush and oioi in association with marsh ribbonwood and *Baumea articulata*.
20614	06018	Searush-harakeke-marsh ribbonwood-*Coprosma propinqua* subsp. *propinqua* tussockland	Searush dominates this tussockland in association with harakeke, marsh ribbonwood and *Coprosma propinqua* subsp. *propinqua*.
20614	06019	Searush-mangrove-oioi-marsh ribbonwood tussockland	Tussockland comprising searush in association with mangrove, oioi and marsh ribbonwood.
20614	06020	Raupo-pampas-harakeke-*Baumea articulata*/oioi-mangrove-searush sedge-tussockland	A highly variable vegetation type generally comprising raupo, pampas, harakeke and *Baumea articulata* emergent over oioi, mangrove and searush.
30624	06021	Pampas tussockland	Pampas dominated tussockland. Other minor elements include manuka and harakeke.
30624	06022	Ti kouka/pampas tussockland	Tussockland comprising pampas with scattered emergent ti kouka.
20614	06023	Marsh ribbonwood/searush-*Ficinia nodosa*/*Samolus repens-Sarcocornia quinqueflora* tussockland	A mosaic of Vegetation Type 06024 marsh ribbonwood/searush-*Ficinia nodosa* tussockland (50-80%) and Vegetation Type 13005 *Samolus repens-Sarcocornia quinqueflora* herbfield (20-50%). The herbfield tends to occur along the seaward margins of the tussockland.
20614	06024	Marsh ribbonwood/searush-*Ficinia nodosa* tussockland	Marsh ribbonwood are emergent over a dense cover of searush and *Ficinia nodosa*.
20614	06025	*Ficinia nodosa*-searush/*Samolus repens-Sarcocornia quinqueflora* tussockland	A mosaic of Vegetation Type 06027 *Ficinia nodosa*-searush tussockland (50-80%), and Vegetation Type 13005 *Samolus repens-Sarcocornia quinqueflora* herbfield (20-50%). The herbfield tends to occur along the seaward margins of the tussockland.
20614	06026	Gorse-pampas-harakeke-marsh ribbonwood/searush-oioi-mangrove tussockland	Gorse, pampas, harakeke and marsh ribbonwood are emergent over searush, oioi and mangrove. The three lower statured species tend to occur on the seaward margin.
20614	06027	*Ficinia nodosa*-searush tussockland	Tussockland dominated by *Ficinia nodosa* in association with searush.

Vegetation Group[1]	Vegetation/Habitat Type		Description
	Code[2]	Name	
30612	06028	harakeke-*Coprosma propinqua* subsp. *propinqua*/raupo-*Baumea articulata* flax-reedland	Harakeke and *Coprosma propinqua* subsp. propinqua are emergent above swards of raupo and *Baumea articulata*. Other species include reed sweetgrass (Glyceria maxima), watercress, pohuehue, and occasional ti kouka.
10714	07001	Pohutukawa/bracken fernland	Occasional pohutukawa are emergent over a dense cover of bracken.
10824	08001	(Manuka)/cocksfoot-paspalum-bidibid grassland	An open grassy clearing dominated by cocksfoot and paspalum in association with bidibid. Scattered manuka are present throughout, and *Paesia scaberula*, bracken and kiokio are locally dominant.
10824	08004	(Ngaio)-(harakeke)-(pohutukawa)/introduced ice plant-Indian doab-kikuyu grass grassland	Scattered ngaio, harakeke and pohutukawa have been planted on the old leisure land site, with the majority of the vegetation cover comprising introduced ice plant, Indian doab and kikuyu grass.
10824	08005	*Ficinia nodosa-Muehlenbeckia complexa*/ratstail-cocksfoot-*Poa anceps* grassland	Grassland characterised by exotic species including ratstail, cocksfoot and *Poa anceps* with scattered *Isolepis* nodosa and *Muehlenbeckia complexa*.
30824	08006	(Grey willow)/reed sweet grass grassland	Scattered grey willow occur over reed sweet grass dominated grassland.
20824	08007	Spartina grassland	Grassland dominated by spartina.
10812	08008	Spinifex-pingao grass-sedgeland	Planted areas on sand dunes that also include shore spurge.
20914	09001	Oioi-mangrove-searush-raupo shrub-sedgeland	A variable vegetation type, generally comprising oioi in association with mangrove, searush and raupo.
20914	09002	Oioi-*Baumea articulata*-marsh ribbonwood sedgeland	A mosaic of Vegetation Type 09010 oioi-*Baumea articulata* sedgeland (>50%), Vegetation Type 09012 oioi-marsh ribbonwood shrub-sedgeland (20-45%), and Vegetation Type 09009 oioi sedgeland (5-20%).
20914	09003	Marsh ribbonwood/oioi-searush sedgeland	A mosaic of Vegetation Type 09017 searush-oioi sedgeland (50%) and Vegetation Type 09023 marsh ribbonwood/oioi sedgeland (50%).
20914	09004	*Coprosma propinqua* subsp. *propinqua*/oioi sedgeland	*Coprosma propinqua* subsp. *propinqua* is the dominant canopy component with oioi forming a dense cover between and beneath the shrubs. Other minor components of the canopy include marsh ribbonwood, toetoe and *Olearia solandri*.
20914	09005	Oioi-searush sedgeland	A mosaic of Vegetation Type 09009 oioi sedgeland (50%), and Vegetation Type 06002 searush tussockland (50%).
20914	09006	*Baumea juncea*-harakeke-oioi sedgeland	*Baumea juncea* in association with harakeke and oioi characterise this vegetation.
20914	09007	Mangrove/*Schoenoplectus pungens* sedgeland	*Schoenoplectus pungens* comprises the majority of the vegetation cover in association with mangrove.
20914	09008	Manuka/oioi-searush-marsh ribbonwood sedgeland	A mosaic of Vegetation Type 06002 searush tussockland (20-50%), Vegetation Type 09009oioi sedgeland (20-50%), Vegetation Type 09012 oioi-marsh ribbonwood shrub-sedgeland (5-20%), and Vegetation Type 04008 manuka shrubland (5-20%).

Vegetation Group[1]	Vegetation/Habitat Type		Description
	Code[2]	Name	
20914	09009	Oioi sedgeland	Oioi forms extensive monospecific stands, however in some areas a variety of other species form a minor component of the canopy. These species include searush, marsh ribbonwood, mangrove, *Baumea articulata* and *B. juncea* amongst others.
20914	09010	Oioi-*Baumea articulata* sedgeland	Oioi dominant sedgeland with *Baumea articulata* common.
20914	09011	Oioi-*Baumea juncea* sedgeland	Sedgeland comprising about equal proportions of oioi and *Baumea juncea*.
20914	09012	Oioi-marsh ribbonwood shrub-sedgeland	Oioi in association with marsh ribbonwood are generally the only canopy species and are present in varying proportions.
20914	09013	Oioi-marsh ribbonwood-harakeke-*Baumea juncea* sedgeland	Sedgeland dominated by oioi with scattered marsh ribbonwood, *Baumea juncea* and harakeke. Occasional *Coprosma propinqua* subsp. *propinqua*, tall fescue and searush are also present.
20914	09014	(Grey willow)/(manuka)/oioi-searush-(raupo) sedgeland	A mosaic of Vegetation Type 09009 oioi sedgeland (>50%), Vegetation Type 06002 searush tussockland (20-50%), Vegetation Type 11003 raupo reedland (<5%), Vegetation Type 04008 manuka shrubland (<5%), and Vegetation Type 01002 grey willow forest (<5%).
20914	09015	(Manuka)/oioi-searush-marsh ribbonwood sedgeland	A mosaic of Vegetation Type 09009 oioi sedgeland (>50%), Vegetation Type 06002 searush tussockland (20-45%), Vegetation Type 09012 oioi-marsh ribbonwood shrub-sedgeland (5-20-%), and Vegetation Type 04008 manuka scrub (<5%).
20914	09016	*Schoenoplectus pungens* sedgeland	*Schoenoplectus pungens* forms monospecific stands below the mean high tide level.
20914	09017	Searush-oioi sedgeland	This vegetation type has been modified by drainage and/or grazing and has a canopy comprised of searush and oioi with local marsh ribbonwood, batchelor's button and *Samolus repens*.
20914	09018	Oioi-searush-(marsh ribbonwood) sedgeland	A mosaic of Vegetation Type 09009 oioi sedgeland (80-95%), Vegetation Type 06002 searush tussockland (5-20%), and Vegetation Type 09012 oioi-marsh ribbonwood shrub-sedgeland (<5%).
20914	09019	Oioi-*Bolboschoenus fluviatilis* sedgeland	A mosaic of Vegetation Type 09009 oioi sedgeland (80-95%) and Vegetation Type 11004 *Bolboschoenus fluviatilis* reedland (5-20%)
20914	09020.1	Oioi-searush sedgeland	A mosaic of Vegetation Type 09009 oioi sedgeland (80-95%) and Vegetation Type 06002 searush tussockland (5-20%).
20914	09020.2	Oioi-searush sedgeland	A mosaic of Vegetation Type 09009 oioi sedgeland (50-80%) and Vegetation Type 06002 searush tussockland (20-50%).
20914	09021	Oioi-marsh ribbonwood sedgeland	A mosaic of Vegetation Type 09009 oioi sedgeland (50%) and Vegetation Type 09012 oioi-marsh ribbonwood shrub-sedgeland (50%).

Vegetation Group[1]	Vegetation/Habitat Type		Description
	Code[2]	Name	
31024	10001	*Juncus effusus*-(harakeke) rushland	Scattered *Juncus effusus* and occasional harakeke (planted) are emergent over a dense cover of dead paspalum (probably sprayed).
31013	10002	ti kouka/*Juncus edgariae*/pasture rushland	scattered ti kouka emergent above grazed *Juncus edgariae* and pasture.
41114	11001	Raupo-*Baumea articulata* reedland	Raupo and *Baumea articulata* form dense stands on river margins.
31114	11002	*Baumea articulata* reedland	*Baumea articulata* is the dominant species in this type and forms a tall, dense cover. Other species often present as minor components include raupo and oioi.
31114	11003	Raupo reedland	Reedland comprised almost solely of raupo, but often with a minor component of *Baumea articulata*.
31114; 41114	11004	*Bolboschoenus fluviatilis* reedland	*Bolboschoenus fluviatilis* forms monospecific stands on channel margins.
31114	11005	Raupo-oioi-*Baumea articulata* reedland	A mosaic of Vegetation Type 09010 oioi-*Baumea articulata* sedgeland (50%) and Vegetation Type 11003 raupo reedland (50%).
31114	11006	*Baumea articulata*-*Muehlenbeckia complexa* reedland	Reedland comprising *Baumea articulata* in association with *Muehlenbeckia complexa* on estuarine margins.
31114	11007	Grey willow/raupo-harakeke-pampas reedland	Numerous scattered grey willow are emergent over raupo in association with harakeke and pampas.
31114	11008	*Baumea articulata*-harakeke-raupo reedland	*Baumea articulata* in association with harakeke and raupo characterise this reedland.
41114	11009	*Baumea articulata*-*Bolboschoenus fluviatilis*-raupo reedland	Reedland comprising *Baumea articulata* and *Bolboschoenus fluviatilis* in association with raupo.
31112	11010	Raupo-flax reedland	Reedland dominated by raupo and flax, with makaka (marsh ribbonwood), grey willow, manuka, *Olearia solandri*, karamu, *Baumea articulata*, and pampas.
21314	13001	Arrow grass herbfield	Small herbfields comprised solely of arrow grass occurring on mudflats.
21314	13002	(*Coprosma propinqua* subsp. *propinqua*)-(manuka)/*Baumea articulata*-mangrove-oioi-(searush)/arrow grass herbfield	*Baumea articulata*, mangrove, oioi and occasional searush are scattered over arrow grass herbfield. Occasional *Coprosma propinqua* subsp. *propinqua* and manuka are present on the margins.
11614	16002	(*Ficinia nodosa*)-(pohutukawa)-(*Coprosma acerosa* x *C. repens*) rockland	Scattered *Ficinia nodosa*, pohutukawa and *Coprosma acerosa* x *C. repens* are present on mussel rock
11614	16003	(Taupata)-(pohutukawa)/(oioi)/(*Sarcocornia quinqueflora*)-(*Senecio lautus*) rockland	Scattered taupata, pohutukawa, oioi, *Sarcocornia quinqueflora* and *Senecio lautus* are present on the rock faces on the margin of Moturiki Island.
21914	19001	Sandfield	Small sandy spits and beaches dominated by sand with a wide range of species present at low abundance. Species present include *Ficinia nodosa,* spinifex, *Carex pumila, Austrostipa stipoides* and harakeke amongst others.
21914	19002	*Sarcocornia quinqueflora* sandfield	A mosaic of Vegetation Type 19001sandfield (80-95%) and Vegetation Type 13003 *Sarcocornia quinqueflora* herbfield (5-20%).
22014	20001	Mangrove loamfield	Scattered mangrove at of low abundance on mudflats.

SCIENTIFIC NAMES OF SPECIES REFERRED TO IN THE TEXT

Indigenous Plants

akeake	*Dodonaea viscosa*
bracken	*Pteridium esculentum*
clubrush, wiwi	*Ficinia nodosa*
coastal mahoe	*Melicytus novae-zelandiae*
Cook's scurvy grass	*Lepidium oleraceum*
harakeke, flax	*Phormium tenax*
houpara, coastal five-finger	*Pseudopanax lessonii*
kahikatea	*Dacrycarpus dacrydioides*
karo	*Pittosporum crassifolium*
mahoe	*Melicytus ramiflorus*
mangrove	*Avicennia marina* subsp. *australasica*
manuka	*Leptospermum scoparium*
marsh ribbonwood, makaka	*Plagianthus divaricatus*
New Zealand spinach	*Tetragonia tetragonioides*
ngaio	*Myoporum laetum*
oioi	*Apodasmia similis*
pingao	*Desmoschoenus spiralis*
panahi	*Calystegia soldanella*
pohuehue	*Muehlenbeckia complexa*
pohutukawa	*Metrosideros excelsa*
sand daphne	*Pimelea arenaria*
sand tussock	*Austrofestuca littoralis*
searush	*Juncus kraussii* subsp. *australiensis*
shore spurge	*Euphorbia glauca*
spinifex	*Spinifex sericeus*
swamp maire, maire tawake	*Syzygium maire*
tauhinu	*Ozothamnus leptophylla*
taupata	*Coprosma repens*
ti kouka, cabbage tree	*Cordyline australis*
toetoe	*Cortaderia fulvida*

Adventive Plants

arum lily	*Zantedeschia aethiopica*
banana passionfruit	*Passiflora tripartita* var. *mollissima*
black wattle	*Racosperma mearnsii*
blackberry	*Rubus fruticosus* agg.
blue morning glory	*Ipomoea indica*
boneseed	*Chrysanthemoides monolifera*
boxthorn	*Lycium ferocissimum*
brush wattle	*Paraserianthes lophantha*
Cape ivy	*Senecio angulatus*

caper spurge	*Euphorbia lathyris*
Chinese privet	*Ligustrum sinense*
climbing asparagus	*Asparagus scandens*
climbing dock	*Rumex sagittatus*
cotoneaster	*Cotoneaster* spp.
dimorphotheca	*Osteospermum fruticosum*
evergreen buckthorn	*Rhamnus alaternus*
gazania	*Gazania* spp.
German ivy	*Senecio mikanoides*
ginger	*Hedychium* spp.
gorse	*Ulex europaeus*
grey willow	*Salix cinerea*
harestail	*Lagurus ovatus*
Japanese honeysuckle	*Lonicera japonica*
Japanese spindle tree	*Euonymus japonicus*
loquat	*Eriobotrya japonica*
lupin	*Lupinus arboreus*
maritime pine	*Pinus pinaster*
marram	*Ammophila arenaria*
mignonette vine, Madeira vine	*Andredera cordifolia*
moth plant	*Araujia sericifera*
nasturtium	*Tropaeolum majus*
Norfolk pine	*Araucaria heterophylla*
pampas	*Cortaderia selloana*
periwinkle	*Vinca major*
pink bindweed	*Calystegia silvatica*
plectranthus	*Plectranthus ciliatus*
radiata pine	*Pinus radiata*
reed sweetgrass	*Glyceria maxima*
she oak	*Casuarina* sp.
silver poplar	*Populus alba*
smilax	*Asparagus asparagoides*
South African iceplant	*Carpobrotus edulis*
Spanish heath	*Erica lusitanica*
spartina	*Spartina* sp.
Taiwan cherry	*Prunus campanulata*
tradescantia (wandering Jew)	*Tradescantia fluminensis*
tree privet	*Ligustrum lucidum*
tuber ladder fern	*Nephrolepis cordifolia*
woolly nightshade	*Solanum mauritianum*

Indigenous Fauna

banded rail	*Rallus philippensis*
fernbird, matata	*Bowdleria punctata*

CRITERIA FOR THE SELECTION OF SPECIAL ECOLOGICAL SITES
(from Wildland Consultants 2000a)

An assessment of the relative significance of natural areas was undertaken following the completion of baseline information documentation. The following criteria were used for the selection of Significant Ecological Sites (SES):

1. Representativeness. The primary criterion, based on a comparison of present vegetation cover vs past extent, diversity and pattern, naturalness, and size.

2. Diversity and pattern. The diversity of ecological and physical features, and the patterns that exist within an area under consideration.

3. Naturalness. The degree to which the vegetation and habitats reflect likely natural character. Most mainland ecosystems are modified but the degree of naturalness is an important consideration.

4. Size and shape. Areas which are relatively large (*i.e.* compared to the mean size of remaining areas of indigenous vegetation in an Ecological District) are preferred to small areas. Small areas can be affected strongly by edge effects. A compact single area is generally preferable to long narrow areas or small separate remnants.

5. Rarity and special features. The relative rarity of physical landscape features, vegetation, habitats and species within an ecological region or district or on a national basis.

6. Buffering and connectivity. The degree to which a natural area is protected or buffered by the surrounding landscape, or provides a buffer to other areas. A site may play an important role by connecting other areas of indigenous vegetation or habitat, or providing a riparian buffer.

7. Viability. The likelihood of an area remaining ecologically viable over time. Larger areas are generally more likely to remain viable with lower levels of management input.

Each Significant Ecological Sites (SES) was assigned to a significance category. These are defined below. The highest ranking category is Category 1.

Category 1 SES

These sites are the best quality or only remaining unprotected representative examples of indigenous vegetation or wildlife habitats on particular landform units within the coastal or semi-coastal bioclimatic zone in the Tauranga District. This category also includes intact altitudinal or geographic sequences across the Tauranga District, or diverse assemblages of landform unit, vegetation, and bioclimatic character.

Category 2 SES

These sites are also good quality representative examples of vegetation and/or wildlife habitat which complement Category 1 areas, and existing protected areas. They include :

(a) relatively small sites with vegetation types or plant taxa under-represented or not represented in protected natural areas;
(b) relatively large areas with features which are represented in protected areas or Category 1 but which are nevertheless worthy of protection;
(c) sites containing vegetation types which would once have been more common in the ecological district and are under-represented in protected natural areas or Category 1, but which have been degraded by weed invasion, animal damage, or other similar agents.
(d) relatively small sites which still retain their indigenous character or support indigenous fauna populations.

APPENDIX 5

INDIGENOUS BIODIVERSITY INDICATORS

(Source: Wildland Consultants 2000a)

Pressure-State-Response Model

The Pressure-State-Response model is a conceptual model that has been used by planners and ecologists in a number of studies and investigations (e.g. OECD 1993, Northland Regional Council 2002). The 'Pressure' component is concerned with the stresses operating at a site and may include factors such as habitat destruction, pest animals, weeds, and degraded water quality. 'State' is the condition of a site as a result of the pressures that are operating, and may include such factors as the vegetation types and species that are present and the areal extent of the site. The final part of the model, 'Response', is based on remedies for the 'Pressure' and 'State' components and may include such things as the level of legal protection, and management actions such as weed and animal pest control. The indicators that are being measured in this study follow the Pressure-State-Response model.

Pressure Indicators

Area of Wetland and Indigenous Vegetation Removed

The area of wetland and indigenous vegetation that has been removed is indicative of land use pressures such as vegetation removal to enable agricultural or horticultural production, or urban development. In most instances changes in land use results in habitat destruction, which impacts biota and ecosystem processes (such as maintenance of water quality, or erosion prevention). Data for the analysis of this indicator is derived from field observations and detailed vegetation maps.

Habitat Fragmentation and Isolation

Fragmentation and isolation relates to the size and connectivity of natural areas. Generally, large natural areas with connections to other natural areas are more sustainable than small areas surrounded by exotic vegetation or urban development, and which therefore are more vulnerable to edge effects, particularly invasion by pest plants. Data for the analysis of this indicator can be derived from vegetation and habitat maps that facilitate analysis of the spatial extent of each natural area and its proximity to other natural areas.

Abundance and Distribution of Pests

New Zealand landscapes are invaded by a range of pest animals and plants whose impacts, like the process of invasion itself, are insidious, pervasive, and ongoing. Pest animals and plants pose serious threats to indigenous vegetation and fauna. Pests animals in New Zealand are known to cause local and global extinction of indigenous species (both plants and animals) through predation and competition. Pest plants can precipitate collapse of entire forest stands through disruption of gap-phase regeneration, by either preventing gap-phase regeneration or by outcompeting and replacing indigenous species in gaps. The role of pest animals in facilitating this replacement through the suppression of palatable indigenous species such as kohekohe and kotukutuku is unquantified, but cannot be discounted. The abundance and distribution of pests indicates the degree to which sites are under pressure from known negative impacts associated with pest animals and plants.

Land Use and Development

Changes in land use and development have on-site impacts and potential off-site impacts. Off-site impacts can include pollution, increased runoff, and decreased water quality that perturb natural areas. In addition, changes in land use (e.g. from agricultural to urban use) adjacent to a site increase human impacts within a site, such as dumping of waste, establishment of exotic plants from gardens, and incursions of domestic animals/predators, such as cats and dogs.

State Indicators

Biodiversity Condition and Trend

Biodiversity condition and trend provides a measure of 'ecological integrity' that is not necessarily reflected in data relating to the extent of indigenous vegetation. It includes factors such as the impacts of weeds, animal pests, and human activities. Data to measure this indicator can be derived from empirical measurements and/or standardised observations.

Biodiversity condition and trend ('status of natural area') – specific assessments of selected vegetation/habitat types of species (including weeds and animal pests). This could be done by sampling at selected representative sites within selected natural areas. Appropriate ecological units would need to be selected, based on consideration of landform/hydroclasses/vegetation classes or vegetation types. Monitoring visits would be undertaken annually to collect simple information on vegetation/habitat condition (Wildland Consultants 2000). This could include the following elements, depending on the characteristics of the site:

- pre-selected monitoring sites
- simple habitat descriptors
- selection of specific condition and trend indicators for a site/area
- assessment of canopy cover and composition
- assessment of vegetation condition
- assessment of vegetation trend
- assessment of regeneration
- presence of special plants
- general fauna assessment
- special fauna
- threat agents and effects

The presence of a range of single species is not reflective of community level biodiversity trends. An appropriate response variable should be sensitive to real changes in biodiversity condition at a community and site level.

Community diversity, evenness, and rank abundance distributions for different species can be reflective of biodiversity trends through time, for the trophic communities from which data are derived. These trends may be extrapolated over all biodiversity components.

Number and Distribution of Threatened Species

Threatened and uncommon plants of New Zealand are identified by de Lange et al. (2004), and indigenous animals identified in the New Zealand threat classification lists (Hitchmough 2002). The presence of a threatened species at a site can indicate that habitat at the site is less degraded than other similar habitats. An increase in the size or extent of a population of a

threatened species generally indicates an improvement in habitat condition at that site (reflecting a lower level of threat from a threatening agent or process or an increase in available habitat). However, the absence of threatened species from a site does not indicate that the site is of poorer quality than those with threatened species.

Response Indicators

Area Legally Protected

The area (ha) of legally protected indigenous vegetation and habitats is a measure of public (and political) attitudes to the value of indigenous biodiversity and natural areas. Legal protection is important because it provides impetus to prevent site destruction. However, habitat loss is not the only threatening process causing biodiversity decline and environmental degradation. New Zealand landscapes are invaded by a range of pest animals and plants whose impacts are insidious, pervasive, and on-going. Legal protection does not prevent degradation of sites by pests and weeds. In New Zealand legal protection of habitats is insufficient to effect conservation of biological diversity and maintenance of our indigenous natural heritage due to the extensive impacts of pest animals and plants.

Location, Area, and Type of Pest and Weed Control

New Zealand landscapes are invaded by a range of pest animals and plants whose impacts, like the process of invasion itself, are insidious, pervasive, and on-going. Pest animals and plants pose serious threats to indigenous vegetation and fauna. In the absence of active management pest animals and plants have negative impacts on indigenous species. Therefore, the locations and extent of pest animal and weed control is an important indicator, not only of public and agency attitudes and priorities, but also of the degree to which sites are under pressure from known negative impacts associated with pest animals and plants.

ABUNDANCE AND DISTRIBUTION OF PESTS

(Source: Wildland Consultants 2005)

Weed species present within SES 1 (Wairoa River) which have increased in abundance and distribution since 2000 include brush wattle, she-oak, and possibly black wattle (Table 12). Grey willow, pampas, and tree privet are all widespread but there has been no detectable change in their distribution and abundance since 2000. This is probably a reflection of the fact that they were widespread in 2000 and already occupied almost all suitable habitats and micro-sites. Other invasive weed species on the margins of SES 1 include smilax, woolly nightshade, gorse, cotoneaster, and blackberry.

Table 12: Distribution of selected weed species in SES 1 (Wairoa River) in 2000, 2002, and 2005.

Weed species	Weed Distribution Code*		
	2000**	2002***	2005
grey willow	-4	-4	-4
brush wattle	-2	-4	-4
pampas	-3	-3	-3
tree privet	-2	-2	-2
back wattle		-4	-4
she-oak		-4	-4
smilax			-1

* -8 common throughout SES; -7 patches throughout SES; -6 scattered throughout SES; -5 local patches in two or more vegetation/habitat types; -4 local patches confined to one vegetation/habitat type; -3 locally scattered in two or more vegetation/habitat types;
-2 locally scattered in one vegetation/habitat type; -1 one small infestation; 1 infestation not present; X species not observed

** Wildland Consultants Ltd 2000c

*** Wildland Consultants Ltd 2002

SES 2 comprises Matua Saltmarsh and Yorke Park. The northern end of Matua Saltmarsh is the subject of a community restoration project which has carried out weed control and reduced the distribution and abundance of pampas and ginger (and also probably of other species) (Table 13). Ginger, gorse, and brush wattle are present on the railway embankment and on the margins of the drains, especially towards the centre of the saltmarsh. In contrast, weed control does not appear to have been undertaken in Yorke Park and grey willow and pampas remain common. Other invasive species in SES 2 include Japanese honeysuckle, she-oak, and blackberry.

Table 13: Distribution of selected weed species in SES 2 (Matua Estuary-Yorke Park) in 2000, 2002, and 2005.

Weed species	Weed Distribution Code*		
	2000**	2002***	2005
grey willow	-4	-4	-4
pampas	-7	-7	-5
ginger	-4	-4	-2
dimorphotheca			-1
she-oak			-1
Japanese honeysuckle			-5

* -8 common throughout SES; -7 patches throughout SES; -6 scattered throughout SES; -5 local patches in two or more vegetation/habitat types; -4 local patches confined to one vegetation/habitat type; -3 locally scattered in two or more vegetation/habitat types; -2 locally scattered in one vegetation/habitat type; -1 one small infestation; 1 infestation not present; X species not observed.
** Wildland Consultants 2000c.
*** Wildland Consultants 2002.

In SES 3 (Waikareao Estuary), the distribution of ginger and tradescantia has increased (Table 14). Grey willow and Taiwan cherry remain abundant and widespread, and are canopy dominants on the northern, landward, side of the site (Vegetation Types 01002, 02009, and 04025). Invasive weeds present on the margin of the wetland and at the base of the hillslope include pampas, Japanese honeysuckle, tuber ladder fern, Chinese privet, arum lily, and reed sweetgrass. Additional species on the hill slope include Taiwan cherry, plectranthus, ginger, and climbing asparagus.

Table 14: Distribution of selected weed species in SES 3 (Waikareao Estuary) in 2000, 2002, and 2005.

Weed species	Weed Distribution Code*		
	2000**	2002***	2005
grey willow	-4	-4	-4
pampas	-3	-3	-3
spartina	1	1	X
ginger	-2	-2	-3
tradescantia	-2	-2	-3
Japanese honeysuckle	-2	-2	-2
moth plant	-2	0	X
Taiwan cherry			-4

* -8 common throughout SES; -7 patches throughout SES; -6 scattered throughout SES; -5 local patches in two or more vegetation/habitat types; -4 local patches confined to one vegetation/habitat type; -3 locally scattered in two or more vegetation/habitat types; -2 locally scattered in one vegetation/habitat type; -1 one small infestation; 1 infestation not present; X species not observed.
** Wildland Consultants 2000c.
*** Wildland Consultants 2002.

In SES 4 (Waimapu Estuary), the abundance and distribution of brush wattle and Japanese honeysuckle has increased since 2000 (Table 15). No change was detected in the abundance and distribution of grey willow, tree privet, and pampas Other invasive species at this site include Taiwan cherry, woolly nightshade, Chinese privet, arum lily, ginger, and blackberry.

Table 15: Distribution of selected weed species in SES 4 (Waimapu Estuary) in 2000, 2002, and 2005.

Weed species	Weed Distribution Code*		
	2000**	2002***	2005
grey willow	-4	-4	-4
brush wattle	-2	-3	-4
Japanese honeysuckle	-2	-2	-3
tree privet	-2	-2	-2
pampas	-6	-6	-6
arum lily			-2
Taiwan cherry			-2
ginger			-1

* -8 common throughout SES; -7 patches throughout SES; -6 scattered throughout SES; -5 local patches in two or more vegetation/habitat types; -4 local patches confined to one vegetation/habitat type; -3 locally scattered in two or more vegetation/habitat types; -2 locally scattered in one vegetation/habitat type; -1 one small infestation; 1 infestation not present; X species not observed.
** Wildland Consultants 2000c.
*** Wildland Consultants 2002.

The abundance and distribution of pampas and Japanese honeysuckle have increased in SES 5 (Poike) (Table 16). Grey willow, tree privet, and radiata pine may also have spread. Other invasive species include woolly nightshade, blackberry, and Chinese privet.

Table 16: Distribution of selected weed species in SES 5 (Poike) in 2000, 2002, and 2005.

Weed species	Weed Distribution Code*		
	2000**	2002***	2005
grey willow	-6		-7
pampas	-5	-5	-7
tree privet	-1	-3	-2
Japanese honeysuckle	-1	-2	-3
pink bindweed	-1		
radiata pine			-1

* -8 common throughout SES; -7 patches throughout SES; -6 scattered throughout SES; -5 local patches in two or more vegetation/habitat types; -4 local patches confined to one vegetation/habitat type; -3 locally scattered in two or more vegetation/habitat types; -2 locally scattered in one vegetation/habitat type; -1 one small infestation; 1 infestation not present; X species not observed.
** Wildland Consultants 2000c.
*** Wildland Consultants 2002.

There has been no detectable increase in the abundance of grey willow, pampas, or pines in SES 6 (Waitao Stream) during 2000-2005 (Table 17). Pampas is present on the margins of the site and on raised areas, such as where spoil from drains has been dumped. Grey willow is common in one vegetation type and pines remain uncommon at the site. However, she-oak is established in the searush tussockland. Other weeds within this SES include black wattle, gorse, woolly nightshade, moth plant, and banana passionfruit.

Table 17: Distribution of selected weed species in SES 6 (Waitao Stream) in 2000, 2002, and 2005.

Weed species	Weed Distribution Code*		
	2000**	2002***	2005
grey willow	-4	-4	-4
pampas	-3	-2	-3
Pinus spp.		-2	-2
She-oak			-2

* -8 common throughout SES; -7 patches throughout SES; -6 scattered throughout SES; -5 local patches in two or more vegetation/habitat types; -4 local patches confined to one vegetation/habitat type; -3 locally scattered in two or more vegetation/habitat types; -2 locally scattered in one vegetation/habitat type; -1 one small infestation; 1 infestation not present; X species not observed.
** Wildland Consultants 2000c.
*** Wildland Consultants 2002.

Weed distribution codes were not recorded for SES 7 (Mauao 1) in 2000 and 2002 (Table 18). However, weed control has reduced the distribution and/or abundance of ginger, pampas, gorse, and boneseed (refer to Section 5.5.8 below). Pampas and gorse remain widespread but are less dominant than they were in 2000. Other invasive species that have not been controlled include climbing asparagus, Japanese honeysuckle, smilax, ginger, evergreen buckthorn, mignonette vine, blue morning glory, and Spanish heath. Two seedling loquat trees were observed.

Table 18: Distribution of selected weed species in SES 7 (Mauao 1) in 2000, 2002, and 2005.

Weed species	Weed Distribution Code*		
	2000**	2002***	2005
pampas			-5
gorse			-5
boneseed			-3
climbing asparagus			-3
woolly nightshade			-3
Japanese honeysuckle			-4
loquat			-2

* -8 common throughout SES; -7 patches throughout SES; -6 scattered throughout SES; -5 local patches in two or more vegetation/habitat types; -4 local patches confined to one vegetation/habitat type; -3 locally scattered in two or more vegetation/habitat types; -2 locally scattered in one vegetation/habitat type; -1 one small infestation; 1 infestation not present; X species not observed.
** Wildland Consultants 2000c.
*** Wildland Consultants 2002.

No change in weed abundance and distribution was detected in SES 9 (Otira Sand Dunes) during 2000-2005 (Table 19). In part this may be due to the fact that weeds are scattered throughout the SES at relatively low densities, and it would take a large change for any variation to be detected in the abundance and distribution scores. Pampas, evergreen buckthorn, Japanese spindle tree, marram, South African iceplant, exotic grasses, and smilax are present throughout the SES but are more common towards its western end. Lupins are scattered on the foredune. This species has a potentially high negative impact because it is a

nitrogen-fixer, which alters the nutrient status of the substrate and may create habitat suitable for other adventive species.

Table 19: Distribution of selected weed species in SES 9 (Otira Sand Dunes) in 2000, 2002, and 2005.

Weed species	Weed Distribution Code*		
	2000**	2002***	2005
climbing dock	-3	-3	-3
Japanese spindle tree	-2	-3	-2
pampas	-2	-2	-2
blackberry		-2	-2
moth plant		-2	-2
evergreen buckthorn		-3	-2
lupins			-4
marram			-2

* -8 common throughout SES; -7 patches throughout SES; -6 scattered throughout SES; -5 local patches in two or more vegetation/habitat types; -4 local patches confined to one vegetation/habitat type; -3 locally scattered in two or more vegetation/habitat types; -2 locally scattered in one vegetation/habitat type; -1 one small infestation; 1 infestation not present; X species not observed.
** Wildland Consultants 2000c.
*** Wildland Consultants 2002.

The abundance and distribution of pampas and Japanese spindletree has decreased in SES 10 (Papamoa Sand Dunes), and climbing dock may have increased (Table 20). Other invasive species present on the dunes include pines, Japanese honeysuckle, lupins, exotic grasses, evergreen buckthorn, and South African iceplant. There is a wide variety of exotic species within the parts of the site that are adjacent to the road including Norfolk pine, freesia, caper spurge, Taiwan cherry, nasturtium, periwinkle, and tradescantia.

Table 20: Distribution of selected weed species in SES 10 (Papamoa Sand Dunes) in 2000, 2002, and 2005.

Weed species	Weed Distribution Code*		
	2000**	2002***	2005
Japanese spindle tree	-3	-3	-2
pampas	-3	-3	-1
radiata and maritime pine	-3	-3	-3
marram	-2	-2	X
Japanese honeysuckle		-3	-3
blackberry		-2	-2
climbing dock		-3	-4
Exotic grasses			-8

* -8 common throughout SES; -7 patches throughout SES; -6 scattered throughout SES; -5 local patches in two or more vegetation/habitat types; -4 local patches confined to one vegetation/habitat type; -3 locally scattered in two or more vegetation/habitat types; -2 locally scattered in one vegetation/habitat type; -1 one small infestation; 1 infestation not present; X species not observed.
** Wildland Consultants 2000c.
*** Wildland Consultants 2002.

SES 11 (Kaituna Sand Dunes and Wetland) is less weed-infested than the other Category 1 sites on dunes, and there has been no detectable change in weed distribution or abundance

within the site (Table 21). However, South African iceplant, gazania, and an unidentified succulent plant are present on the dunes near the houses (at the east end of the site), and there is potential that they will spread further if left unchecked.

Table 21: Distribution of selected weed species in SES 11 (Kaituna Sand Dunes and Wetland) in 2000, 2002, and 2005.

Weed species	Weed Distribution Code*		
	2000**	2002***	2005
gorse	-2	-2	-2
Japanese spindle tree	-2	1	X
grey willow	-4	-4	-4
evergreen buckthorn		-3	-2
blackberry		-1	-1
mothplant		-4	X
lupins			-2
South African iceplant**			-2

* -8 common throughout SES; -7 patches throughout SES; -6 scattered throughout SES; -5 local patches in two or more vegetation/habitat types; -4 local patches confined to one vegetation/habitat type; -3 locally scattered in two or more vegetation/habitat types; -2 locally scattered in one vegetation/habitat type; -1 one small infestation; 1 infestation not present; X species not observed.

** Wildland Consultants 2000c.

*** Wildland Consultants 2002.

**** At the east end of the site only.

Pampas is present in all ten Category 1 SESs that were surveyed (Table 22). The other most widely distributed species are gorse, woolly nightshade, blackberry, and grey willow. In addition, Japanese spindle tree, lupins, South African iceplant, and evergreen buckthorn are present at all sand dune sites (i.e. SESs 9, 10, and 11). Lupin is a nitrogen-fixer, which alters the nutrient status of the substrate and may create habitat suitable habitat for other introduced species. The site inspections undertaken for this study were not comprehensive weed surveys, so it is almost certainty that the suite of invasive species is even larger and more widely distributed than this study suggests, particularly relatively inconspicuous and/or sub-canopy species.

Table 22: Recorded occurrences of weed species at Category 1 Special Ecological Sites in Tauranga City.

Weed species	SES Number											Number of Occurrences
	1	2	3	4	5	6	7	8	9	10	11	
banana passionfruit						✓						1
boneseed							✓					1
Cape ivy									✓			1
German ivy										✓		1
mignonette/Madeira vine							✓					1
plectranthus			✓									1
reed sweetgrass			✓									1
tuber ladder fern			✓									1
boxthorn									✓	✓		2
climbing asparagus			✓				✓					2
climbing dock									✓	✓		2
marram									✓	✓		2
periwinkle									✓	✓		2
silver poplar			✓							✓		2
arum lily		✓	✓	✓								3
Japanese spindletree									✓	✓	✓	3
lupin									✓	✓	✓	3
smilax	✓						✓		✓			3
South African iceplant									✓	✓	✓	3
evergreen buckthorn							✓		✓	✓	✓	4
ginger		✓	✓	✓			✓					4
moth plant			✓			✓			✓		✓	4
she-oak	✓	✓	✓			✓						4
Taiwan cherry		✓	✓	✓						✓		4
tradescantia		✓	✓						✓	✓		4
black wattle	✓	✓	✓	✓		✓						5
Pinus spp.					✓	✓	✓		✓	✓		5
tree privet	✓		✓	✓	✓		✓					5
Chinese privet	✓	✓	✓	✓	✓				✓			6
Japanese honeysuckle		✓	✓	✓	✓		✓			✓		6
woolly nightshade	✓			✓	✓	✓	✓				✓	6
grey willow	✓	✓	✓	✓	✓	✓					✓	7
blackberry	✓	✓		✓	✓	✓			✓	✓	✓	8
brush wattle	✓	✓	✓	✓	✓	✓	✓		✓			8
gorse	✓	✓	✓	✓	✓	✓	✓		✓		✓	9
pampas	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	10

BIODIVERSITY CONDITION AND TREND

(Source: Wildlands Consultants 2005)

Since 2000, Biodiversity Condition has trended downwards at eight Category 1 sites (SES numbers 1, 3, 4, 5, 6, 9, 10, and 11). Biodiversity condition has improved at SES 2 (Matua Estuary-Yorke Park) and SES 7 (Mauao 1) (Table 24). Biodiversity condition was not assessed for Motuotau (SES 8) in 2005 but it trended downwards during 2000-2002.

Table 24: Biodiversity condition scores out of a maximum score of 500, attained by Category 1 Special Ecological Sites in 2000, 2002, and 2005.

Special Ecological Site		Biodiversity Condition Scores		
No.	**Name**	**2000***	**2002****	**2005**
1	Wairoa River	400	354	349
2	Matua Estuary-York Park	453	453	457
3	Waikareao Estuary 1	420	420	401
4	Waimapu Estuary	435	412	412
5	Poike	362	362	307
6	Waitao Stream	466	466	460
7	Mauao 1	335	367	367
8	Motutau Island	480	400	
9	Otira Sand Dunes	415	405	375
10	Papamoa Sand Dunes	375	360	360
11	Kaituna Sand Dunes and Wetland	411	408	384

* Wildland Consultants 2000c.
** Wildland Consultants 2002.

Human activities have caused direct negative impacts at nine Category 1 SESs during the period 2000-2005 (refer to Table 25). Negative impacts include pedestrian tracks (SES 7), vehicle tracks (SESs 9, 10, and 11), vegetation clearance (SESs 5, 6, and 11), rubbish dumping (SESs 4, 5, 9, and 10), fire (SES 7), drainage (SESs 2, 3, 4, 5 and 6), and erosion (SES 7).

Positive impacts were evident at five sites, including planting (SESs 2, 3, 7, and 10), restoration works (SESs 2 and 7), and weed control (SESs 2, 4, 7, and 9). There is a lack of information available about the impacts of domestic pets and animal pest control, though it is known that pest animal control has been undertaken in SESs 7, 9, and 10 (refer to Section 5.5.9). It is important to note that the activities that are being considered are only those that had direct impacts during the five-year period from 2000 to 2005 and not modifications that have occurred at a site in the more distant past, e.g. historic vegetation clearance.

Table 25: Impacts of activities in Category 1 Special Ecological Sites (-3 major negative impact; -2 moderate negative impact, -1 minor negative impact, 0 neutral, 1 minor positive impact, 2 moderate positive impact, 3 major positive impact, X impact unknown)

Activity	Category 1 Special Ecological Sites										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Recreation (tracks)	0	0	X	0	X	X	-2		-1	-2	-1
vegetation clearance	0	0	0	0	-2	-1	0		0	0	-2
Dumping of inorganic waste	X	X	0	X	-1	0	0		-1	-1	-1
Dumping of organic waste	X	X	X	-1	-1	X	0		-1	-2	X
Domestic stock	X	0	0	0	0	X	X		0	0	X
Planting	0	1	1	X	0	0	2		0	1	X
Fire	0	0	0	0	0	0	-3		0	0	0
Domestic pets	X	X	X	X	X	X	X		X	X	X
Drainage	0	-1	-1	-2	-1	-1	0		0	0	X
Restoration works	0	2	0	X	0	0	1		0	0	X
Weed control	0	2	X	1	0	0	2		1	X	X
Animal pest control	X	X	X	X	X	X	1		1	1	X
Other							-2*				

* Erosion

NUMBER AND DISTRIBUTION OF THREATENED SPECIES

(Source: Wildlands Consultants 2005)

Threatened species have been recorded at eight Category 1 SESs and one Category 2 SES (Table 26). It is not possible to compare these observations between years because there is no empirical or methodological basis for such a comparison. However, it is almost definite that the populations of pingao, shore spurge, and sand tussock have increased during the period 2000-2005 as a result of plantings established by Coast Care. Additionally, swamp maire is being planted at Carmichael Reserve in Bethlehem and in Kopurererua Valley (SES 14) (S. Moohan, TCC, pers. comm.). Swamp maire is not included in the national list of threatened and uncommon plants but it is regionally uncommon and has been greatly reduced in extent within Tauranga Ecological District.

Table 26: Sites in Tauranga City where threatened species of plants and birds have been recorded since 2000.

Site No.	Site Name	Threatened species	Date(s) recorded by SOE monitoring*
1	Wairoa River	fernbird	2000, 2002
3	Waikareao	fernbird	2002
4	Waimpau Esturay	fernbird	2002
5	Poike	fernbird	2002
6	Waitao Stream	fernbird	2002
		banded rail	2002
9	Otira Sand Dunes	pingao	2000, 2002, 2005
		shore spurge	2005
10	Papamoa Sand Dunes	pingao	2000, 2005
		sand tussock	2000, 2005
		sand daphne	2000, 2005
11	Kaituna Sand Dunes	pingao	2000, 2002, 2005
		sand tussock	2000, 2002
35	Shark Alley to Kaituna Spit Sand Dunes	pingao	2005

* Wildland Consultants 2000c, Wildland Consultants 2002.

The population of sand daphne in SES 10 is located on the foredune (GPS coordinates E2803120 N6382757), and can be reached from a beach access route a short distance west of the end of Kirkpatrick Road. The population comprises two patches. The largest patch encompasses an area of *c.*4 m x 4 m with *c.*70% cover. Approximately 3 m away from this patch, towards the beach, is a plant that measures 1.2 m x 0.9 m. Photographs of the population are presented in Appendix 7 (as are images of other SESs). The measurements and photographs can be repeated in future years to detect any change in the size or condition of the population. To the south, the population abuts a track that is used by both walkers and quad bikes, so the plant(s) are unlikely to be able to spread in this direction.

LOCATION, AREA, AND TYPE OF PEST AND WEED CONTROL
(Source: Wildlands Consultants 2005)

Weed control has been undertaken at SES 2 (Matua saltmarsh), SES 7 (Mauao), and SES 14 (Kopurererua Valley) in concert with restoration projects (refer to Sections 5.4 and 5.5.3, above). Weed control in SESs 9, 10, and 35 (the sand dunes between Mauao and the east end of Papamoa) is also being undertaken, funded through Environment BOP EEF funding.

TCC's annual budget for weed control, excluding that associated with planting projects is $18,000 (G. Phee, pers. comm., TCC). This enables TCC to respond to some complaints but does not enable site-specific or species-specific control programmes that would achieve ecological outcomes. Unlike natural areas, planted areas do have weed control plans. For example, approximately $30-35,000 has been spent on weed control in the Kopurererua Valley, including control of gorse, wattles, pampas, blackberry, and grey willow around the old hospital ponds, and a suite of weeds on "Smith's Bank", adjacent to Route K. Control of species such as Japanese honeysuckle, blackberry, and gorse has been undertaken in Johnson Reserve, Welcome Bay, by a community group supported by TCC and Environment BOP.

Apparently small-scale, localised weed control was identified during site visits, including observations of dead and live pampas and woolly nightshade near College Place (SES 5, Waimapu Estuary), dead gorse, pampas, and blackberry near Fraser Cove (SES 5), and recently sprayed pampas on the verge of SH 29 (SES 25 Rangataua).

Rabbit control has been carried out on publicly-owned land in the sand dunes of SESs 9, 10, and 35. It is undertaken "as-needed", and upon the advice of Environment BOP pest control officers (Suzy O'Neill, Environment BOP, pers. comm.). Rabbit control is undertaken more frequently at sites where reinvasion rates are high (for example, at Harrison's Cut) than at sites where reinvasion rates are lower. Animal pest control has been sporadic on Mauao (SES 7) in the past, but rats are now controlled regularly during four months of every year. There are no plans to control mustelids or cats, and possums are only present at low levels (Glenn Ayo, TCC, pers. comm.).

Construction of fences to exclude domestic stock from natural areas can also be regarded as a form on pest control. In 2000, SES 35 (Kaituna River Wetlands) was grazed throughout. Field inspections in 2005 revealed that parts of this SES have now been fenced, and indigenous vegetation is regenerating.

SITE PHOTOGRAPHS

Plate 1: A restored/created wetland and associated plantings on the northern edge of Matua Saltmarsh (SES 2). The boardwalk is visible in the mid-ground, with saltmarsh in the background. Photograph taken in 2005.

Plate 2: A view across (manuka)/oioi-searush-marsh ribbonwood sedgeland (Vegetation Type 09015) towards willow forest (Vegetation Type 01002) at Waikareao Estuary (SES 3). Photograph taken in 2005.

Plate 3: Waimapu Estuary (SES 4) viewed from near College Road. The estuary margin in the foreground includes pampas, brush wattle, and mahoe. Across the open water of the estuary is a large expanse of searush-oioi tusockland (Vegetation Type 06013) with mangroves on the margins. Photograph taken in 2005.

Plate 4: A small stand of kahikatea at the north end of SES 4 (Waimapu Estuary), near Fraser Cove. Baumea articulata is in the foreground.
Photograph taken in 2005.

Plate 5: An infestation of wild ginger, pampas, arum lily, and Japanese honeysuckle in ES 4. Photograph taken in 2005.

Plate 6: Willow wetland (Vegetation Type 01002) south of SH29, in SES 5 (Poike). Photograph taken in 2005.

Plate 7: Part of SES 6 (Waitao Stream) that has been cleared of oioi-searush sedgeland (Vegetation Type 09020.1) and searush tussockland (Vegetation Type 06002), drained, and excavated to create ponds. Photograph taken in 2005.

Plate 8: A view of SES 6 (Waitao Stream) from Asher Road, showing mangrove loamfield Vegetation Type 20001), mangrove shrubland (Vegetation Type 05010), and clumps of pampas on the landward margin. Photograph taken in 2005.

Plate 9: A small part of the area on Mauao (SES 7) that was destroyed by fire in 2003. Photograph taken in 2005.

Plate 10: Pampas/gorse-Spanish heath-manuka-harakeke shrubland-rockland (Vegetation Type 05022) on Mauao (SES 7), which has established following the fire of 2003 and replaced vegetation types dominated by various mixtures of pampas and gorse (Vegetation Types 06003, 05005, 16001, and 08002). Photograph taken in 2005.

Plate 11: Foredune in SES 9 (Otira Sand dunes), showing pingao in the foreground and spinifex dominant higher on the dune, with a patch of pingao. Photograph taken in 2005.

Plate 12: Pingao that has been severely browsed, probably by rabbits, in SES 9 (Otira Sand Dunes). Photograph taken in 2005.

Plate 13: Spinifex-pohuehue vineland (Vegetation Type 03003) in SES 9 (Otira Sand Dunes), with a few shrubs of tauhinu in the foreground, and, in the background at left of frame, evergreen buckthorn. Clubrush is also a component of this vegetation type. Photograph taken in 2005.

Plate 14: Sand daphne, a threatened species, flowering in the Papamoa Sand Dunes (SES 10) between the ends of Parton and Kirkpatrick Roads (GPS location E2803120 N6382757). There is one large, n-shaped patch at centre of frame, adjacent to the track. A smaller patch is located below the brow of the dune, to the right of centre-frame. Photograph taken in 2005.

Plate 15: Flowering sand daphne in the Papamoa Sand Dunes (SES 10, GPS location E2803120 N6382757). This photo can be repeated in future by using Motiti Island, which is on the horizon, as a reference point. Photograph taken in 2005.

Plate 16: A small patch of sand daphne (0.9m x 1.2 m) in SES 10 (Papamoa Sand Dunes). Photograph taken in 2005.

Plate 17: A close-up view of flowering sand daphne amongst harestail, other exotic grasses, panahi, and the native grass Lachnagrostis billardierei. Photograph taken in 2005.

Plate 18: Spinifex and pingao in SES 11 (Kaituna Sand Dunes) that has been damaged by vehicle tracks (a track is visible at lower right of frame). Photograph taken in 2005.

Plate 19: Johnson Reserve, in Welcome Bay, is a restoration site. A community group is involved and weed control and planting have been undertaken (although some of the species that have been planted are not indigenous). Photograph taken in 2005.

Plate 20: A view of the Kaitemako Stream valley, immediately north of Welcome Bay Road, dominated by swards of reed sweetgrass - it is a potential restoration site. Photograph taken in 2005.

Plate 21: The banks of Kaitemako Stream, immediately north of the Welcome Bay Road Bridge, are a restoration site and have been planted with indigenous species. The site contrasts strongly with the adjacent part of the stream bank that has not been subjected to weed control or planting (see above). Photograph taken in 2005.

Plate 22: Part of a potential restoration site in a gully above Welcome Bay and SES 19 (Kaitemako Stream Mouth). Photograph taken in 2005.

Plate 23: Rotary Park, Mangatapu, is a potential restoration site - the foreshore could be planted with indigenous sedges and rushes which would buffer it from wave action. Photograph taken in 2005.

Plate 24: SES 20 (Welcome Bay) is dominated by mangroves, with patches of harakeke and manuka. Photograph taken in 2005.

Plate 25: Tye Park (SES 21) viewed from Ranginui Road, showing a suite of weeds on the margin and an inlet dominated by mangroves. The ridge in the rearground is a potential restoration site. Photograph taken in 2005.

MAPS

1. Tauranga City Council (TCC) boundary
2. Special ecological sites in Tauranga City
3. Special ecological sites, and actual and potential restoration sites in Tauranga City
4. Landforms of Tauranga City
5. Legally protected areas in Tauranga City
6. Index Map - Special Ecological Sites (SES) and vegetation/habitat types