

Appendix S1. Assignment of LCDB4 land cover classes to ‘indigenous’ or ‘exotic’

Class no.	Class name	Assignment
1	Built-up Area (settlement)	Exotic
2	Urban Parkland / Open Space	Exotic
5	Transport Infrastructure	Exotic
6	Surface Mines and Dumps	Exotic
10	Coastal Sand and Gravel	Indigenous
12	Landslide	Indigenous
14	Permanent Snow and Ice	Indigenous
15	Alpine Grass / Herbfield	Indigenous
16	Gravel and Rock	Indigenous
20	Lake and Pond	Indigenous
21	River	Indigenous
22	Estuarine Open Water	Indigenous
30	Short-rotation Cropland	Exotic
33	Orchard Vineyard and Other Perennial Crops	Exotic
40	High Producing Exotic Grassland	Exotic
41	Low Producing Grassland	Exotic
43	Tall-Tussock Grassland	Indigenous
44	Depleted Grassland	Indigenous
45	Herbaceous Freshwater Vegetation	Indigenous
46	Herbaceous Saline Vegetation	Indigenous
47	Flaxland	Indigenous
50	Fernland	Indigenous
51	Gorse and/or Broom	Exotic
52	Mānuka and/or Kānuka	Indigenous
54	Broadleaved Indigenous Hardwoods	Indigenous
55	Sub-Alpine Shrubland	Indigenous
56	Mixed Exotic Shrubland	Exotic
58	Matagouri or Grey Scrub	Indigenous
64	Forest – Harvested	Exotic
68	Deciduous Hardwoods	Exotic
69	Indigenous Forest	Indigenous
70	Mangrove	Indigenous
71	Exotic Forest	Exotic

Appendix S2. Protected area information

The protected areas dataset reflecting the status in 2012 and used for our analysis is incomplete and has limitations. Some errors will tend to overestimate the protected area in threatened environments. For example, we have made considerable effort to identify and exclude Crown land managed by the Department of Conservation (DOC) for purposes other than conservation (e.g. buildings, gravel reserves, racecourses, cemeteries, marginal strips), but may not have been able to identify all of these. A further caveat is that the type and strength of protection provided by the legislation and conditions for different areas of land vary widely. A range of extractive and habitat-destroying activities are permitted and carried out in some areas of public and private land that in the database are deemed to be protected. On the other hand, there are likely to be additional protected areas that do not appear in any of the spatial databases that we were able to source and collate for either protected area dataset. For example, the dataset excludes council-protected areas in many districts and some regions, and certain types of privately-protected land (including biodiversity sanctuaries such as the ecological island at Maungatautari in the Waikato, and small-scale private conservation covenants). Furthermore, our database likely excludes some areas where biodiversity is protected but the legal designation does not reveal this (e.g. some recreation reserves, marginal strips, Crown-administered riverbeds). Such omission errors will lead to underestimates of area of indigenous vegetation protected.

We attempted to minimise unintended omission errors in the databases provided to us, by overlaying past and present protected areas in GIS and enquiring about any sizeable polygons that were previously included and not present in the more recent data. We found three parts of the Catlins Conservation Park in the Southland Conservancy had been excluded from the current DOC GIS layer of public conservation land (July 2012, downloaded from Koordinates.com). Our enquiries suggest these omissions are erroneous, but they were not corrected for this study. Other exclusions may or may not be justified. For example, the protected areas dataset used by Walker et al. (2006) included some sizeable scenic reserves that no longer appear in the public conservation land data (e.g. Lake Okataina Scenic Reserve (4,388 ha, Bay of Plenty), Pukeamaru Scenic Reserve (3,264 ha, East Coast), and Raukumara Conservation Area (1,896 ha, East Coast)).

The protection dataset supplied by DOC for previous analyses (Rutledge et al. 2004; Walker et al. 2006) included some areas that were legally protected by organisations other than DOC, Queen Elizabeth II Trust and councils that are not included in the latest public conservation land database made available by DOC on Koordinates.com. These areas apparently remain protected by other organisations; for example, the largest area is Hinewai Reserve on Banks Peninsula, which remains owned and managed for conservation by the Maurice White Trust. We did not include these privately owned protected areas in the 2012 dataset because of the difficulty of (1) tracing the multiple private and community organisations that legally protect land, (2) establishing whether or not these areas remain legally protected for biodiversity conservation purposes, and (3) sourcing up-to-date spatial data depicting boundaries for these areas. There may also be errors in the boundaries of land parcels in the GIS data with which we were supplied. This source of error could either inflate or decrease the areas of indigenous vegetation estimated to be protected.

Appendix S3. Rasterising and re-projecting of GIS data layers

We first converted the vector layers of land cover (all four time steps in LCDB4, 1996/97, 2001/02, 2007/08, 2011/12) and our new protected areas spatial data (2012) to 25-m GIS integer raster files ('grids') registered to the 25-m LENZ raster layer in the NZMG projection. This decreased (by 836,630 ha) the area of LCDB included in the analysis, mainly due to the polygons of water (mainly riverbeds, lakes and harbour areas) that are not included in LENZ. It almost totally excludes some associated cover classes (94.6% of Lake and Pond, 92.5% of Estuarine Open Water and 90.0% of Mangrove in the vector LCDB4 2011/12 imagery), while substantially decreasing others (51.3% of River, 8.5% of Coastal Sand and Gravel, 4.9% of Gravel and Rock, 4.5% of Deciduous Hardwoods and 2.6% of Herbaceous Saline Vegetation). All other LCDB classes decreased by $\leq 2\%$ of their original size, due to the combination of re-projecting and turning the polygon shapes into 25×25 m cells.

For consistency, we excluded areas classified 'Null' in LENZ Level IV (Leathwick et al. 2003b) from all tabulations and analyses. Null LENZ pixels mainly surround water bodies (especially braided and other riverbeds). Their exclusion further reduces the area we recognise as terrestrial New Zealand by 211,100 ha, mainly of land in the LCDB4 2011/12 cover classes Gravel and Rock (74,840 ha), High Producing Exotic Grassland (29,480 ha), Low Producing Grassland (26,920 ha), Deciduous Hardwood (15,760 ha, predominantly willows along rivers), River (15,300 ha), and Gorse and Broom (13,920 ha).

For completeness, we note that we made several attempts at performing this analysis using the NZTM projection and different types of spatial files. First, as protected area and LCDB data are now provided in the NZTM projection, we attempted to project the LENZ Level 4 layer (originally in NZMG) to NZTM. However, the scale distortion related to this re-projection is not uniform across the country (Ollivier 2009). Although minimised in the most populated areas of New Zealand, there is more scale distortion (maximum 0.5%) with a NZTM projection at the extremities (north of the North Island and south of the South Island). This distortion means that when re-projecting the 25×25 m grid cells of LENZ, the cells at the extremities present a larger area than they did in NZMG. Over the whole of the country these changes are substantial and result in a much more complex analysis as cells cannot be simply counted because their variable size must also be taken into account.

We also attempted to combine the protected area information and LCDB in their original vector (polygon) dataset with a vectorised LENZ layer, to maintain the integrity of the boundary details identified in the LCDB and protected area vector information. This approach failed, apparently because the computational requirements of the analysis were beyond the capacity of ArcGIS at this time. Given these difficulties, we chose to rasterise and project the protected area and LCDB NZTM data into NZMG to be compatible with the LENZ layer; this also allowed direct comparison to previous versions of the threatened environment classification.

Reference

- Ollivier K 2009. Frequently asked questions on NZ projections. <http://www.ollivier.co.nz/projection/faq.shtm#q6>, updated September 2009 (accessed October 2014).