Annual distribution of seagrass lineage

The angiosperm *Zostera capricorni* Asch. (1876) is endemic to Australasia, being found in New Zealand throughout the mainland coast, from Parengarenga Harbour to Stewart Island (Inglis 2003, Turner & Schwarz 2006). It is not known from the Chatham Islands or from any of the subantarctic islands. Whereas it was previously thought there were two species of *Zostera* in New Zealand, *Z. capricorni* and *Z. novazelandica*, recent work has shown them to be conspecific (Les et al. 2002).

1. Literature sources

   The literature was searched for distributional information for the seagrass *Zostera capricorni* and *Z. novazelandica*.

   a. A search was carried out in September/October 2005 of the following databases: Te Puna using the keywords "zostera capricorni", "zostera cap", and "thesis zostera nov."; Aquatic Sciences and Fisheries Abstracts using "(zostera capricorn or zostera novazelandica) and zealand and (geograph* or distribut*)"; Scopus using ("Zostera capricorni" and "Zost novazelandica"); Google Advanced Scholar using "zealand geographic OR distributed OR distribution "zostera novazelandica" and "zealand geographic OR distributed OR distribution "zostera capricorni", and Google using "seagrasses". Relevant papers and reports were reviewed for information on the distribution of *Zostera* in New Zealand waters.
   b. Using subject indices, *Seafood New Zealand* was checked for articles dealing with *Z. capricorni* and *Z. novazelandica* distribution and research.
   c. A search of NIWACAT in October 2005 produced no records that contributed additional distribution information for this species.

2. Ministry of Fisheries electronic databases

   There are no data held for *Z. capricorni* that extend the distributions derived in more detail from the other data sources.

3. Museum holdings

   Holdings of *Z. capricorni* were examined at WELT, the herbarium of the Museum of New Zealand Te Papa Tongarewa, CHR (Landcare Research herbarium), AK (Auckland Museum herbarium, including the herbarium of Auckland University), and in the algal research collections at NIWA. Data were used to help estimate presence/absence.

4. Regional councils

Regional councils having jurisdiction over shores not well represented in the above collections were contacted in March 2006 for information on the presence/ absence of seagrass. This information was integrated into the distribution maps.

5. Summary

Zostera capricorni is a geographically widespread and in places locally common or abundant plant. It is found predominantly between mid and low tide levels in estuaries and sheltered harbours (Inglis 2003, Turner & Schwarz 2006). However, it can also be found permanently submerged in sheltered places (most often—but not exclusively—around offshore islands), and on intertidal reef platforms in some more exposed localities (e.g., Arnold 2004). Its depth distribution relative to high water is 0.5–6.0 m, according to location. The largest persistent stands are in relatively clear, tidal waters away from major urban centres (Inglis 2003).

Zostera capricorni stands support a diverse and abundant assemblage of invertebrates that is often richer than unvegetated habitats nearby (Inglis 2003). They may also be important nursery habitats for fish such as snapper (Morrison & Francis 2001, Turner & Schwarz 2006).

Almost certainly seagrass was much more abundant and widespread in earlier times than it is now; in the late 19th century, it was apparently so abundant in places that there were proposals for harvesting and exporting it for mattress and furniture stuffing (see Inglis 2003). The causes of the declines are not always readily apparent, cycles in abundance being a feature of the species (e.g., Ramage & Schiel 1999), but estuarine degradation is almost certainly implicated (Turner & Schwarz 2006). Sedimentation remains a widespread problem in New Zealand estuaries, which together with turbidity, and nutrient enrichment in urban estuaries in particular, is probably a major cause of contractions in beds. 'Slime mold' and 'wasting disease' have also been implicated in New Zealand die-offs, but it remains unknown whether there is any link between the prevalence of the pathogens involved and loss of water quality.

Seagrass meadows are slowly returning in some areas from which they had been lost; for example, improvements in water quality over the past 2 decades in Whangarei Harbour and the Avon-Heathcote Estuary have led to the re-establishment of seagrass in areas from which it had disappeared, or general re-growth (Inglis 2003).

Mapping the distribution of seagrass in New Zealand waters is not straightforward. Although mainly intertidal estuarine and theoretically, therefore, easy to map, recording of distributions has not been completed universally. Further, plants are perennial with the total biomass varying seasonally (e.g., Schwarz 2004); there are the natural interannual cycles in patch size; there are the recoveries in certain areas; patches may be small and easily overlooked; and the species can exist in insignificant

patches in quite a wide range of coastal situations wherever there are fine sediments and some shelter—all of which lead to uncertainty in the current distribution. According to Inglis (2003), seagrass habitats have been mapped in only 22 of the 300-plus New Zealand estuaries; mapped areas typically represent <3% of the total intertidal area of each estuary. (But this assessment does not necessarily take into account mapping that has not been formally published, such as that undertaken by regional councils.) Exceptions include tidally dominated embayments such as Whanganui Inlet and Whangamata, where seagrass meadows cover up to 31% and 18% of the intertidal area respectively.

Seagrass occurs more extensively than just in estuaries, however, and the non-estuarine habitat is probably more widely colonised by seagrass than is immediately apparent. On open shores such as those of Gisborne/Hawkes Bay, the intertidal reef platform occurrences are likely to be widespread (Arnold 2004). Even offshore islands may have backwaters containing *Zostera* (e.g., Great Mercury Island—Grace & Grace 1976) or submerged beds (Slipper Island— Grace & Whitten 1974), which may exist even on otherwise the most rugged open coasts (e.g., east side of Great Barrier Island—Deng et al. 2004). Also Fiordland harbours small quantities, at the heads of inlets. Seagrass is likely to be least widespread or absent on the very exposed rocky coastlines such as those of the West Coast of the South Island (although it is present in the intermediate estuaries) and on alluvial shores such as those of Canterbury Bight.

Seagrass is very widespread, even if not necessarily locally common. It is concluded that seagrass is distributed all round mainland New Zealand and Stewart Island, except for extensive open sand/shingle beaches and the most exposed of the more extensive rock/cliff shores. The 90% distribution takes in the many estuaries noted by Inglis (2003), and others with significant stands. Hotspots of distribution are the estuaries associated with the greatest areas of seagrass (Inglis 2003): Parengarenga Harbour (42 km^2), Houhora (10 km^2), Rangaunu Harbour (74 km^2), Tauranga Harbour (29 km^2), Farewell Spit ('large areas of seagrass'), Whanganui Inlet (8 km^2), and Karamea Estuary, Akaroa Harbour, and Toetoes Harbour (each with 'extensive area(s) of seagrass'). This definition of hotspot is based on the estimated extent of the beds, rather than on density.

The above information on the distribution of *Z. capricorni*, derived primarily from recent field surveys, museum holdings, and local knowledge, was reviewed by Dr Peter Heenan, Landcare Research, and then integrated by hand onto a large-scale map of New Zealand. The shoreline distributions were then digitised and imported into a GIS software package as layers. The areas of each distribution class were calculated and the layers were linked to attribute and metadata files. The map, because of its scale, cannot be taken to accurately define the local distribution of this species.

6. References

The following publications were the key references and/or the ones most useful in describing the annual distribution of *Z. capricorni*. The list is not intended to be an exhaustive bibliography of publications about this species.

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