Annual distribution of *Pterocladia lucida* lineage

In New Zealand the red seaweed *Pterocladia lucida* (Turner) J.Agardh (agar weed) is found on the Three Kings, North, South, and Chatham Islands (Adams 1994, Neale & Nelson 1998, Nelson et al. 2002). It is also found around southern Australia, from Perth to New South Wales (Coff's Harbour), and including Tasmania (Womersley 1994). *Pterocladia* has been harvested in New Zealand for the cell wall polysaccharide agar since the 1940s (Moore 1946, Nelson 1986, Luxton & Courtney 1987, Schiel & Nelson 1990, Hurd et al. 2004). There are proposals to include *Pterocladia* in the quota management system (Nelson 2003).

1. Literature sources

   The literature was searched for distributional information for the red seaweed *P. lucida*.

   a. A search was carried out of the following databases: Te Puna using the keywords "*Pterocladia lucida* + Zealand +geograph? (+distribut?" Keyword Relevance Search = "*Pterocladia lucida"* +thesis (16/09/2005); Aquatic Sciences and Fisheries Abstracts "*Pterocladia lucida* and zealand and (geograph* or distribut*)" (16/09/2005); Web of Science "TS = (*Pterocladia lucida* and zealand and (geograph* or distribut*))" (15/09/2005); Scopus "title-abs-key ("*Pterocladia lucida"* and zealand and (geograph* or distribut*))" (16/09/2005); Google Scholar "zealand geographic or distributed or distribution '*Pterocladia lucida'"* (19/09/2005). From all these sources 1 thesis, a number of paper citations were located (INNZ = 2; Google scholar = 28).
   b. Using subject indices, *Seafood New Zealand* was checked for articles dealing with *Pterocladia lucida* and research.
   c. A search of NIWACAT in September 2005 produced no records that contributed additional distribution information for this species.

2. Ministry of Fisheries electronic databases

   In the Ministry of Fisheries databases there are data held for seaweeds grouped under the name *Pterocladia* (PTE). This includes two species, now placed in different genera, *Pterocladia lucida* and *Pterocladiella capillacea* (previously *Pterocladia capillacea*), both of which belong to the red algae family Gelidiaceae in the order Gelidiales. Members of this order contain the cell wall polysaccharide agar. Approximately 95% of the harvest is reported to consist of *P. lucida* with the rest *P. capillacea* (Luxton & Courtney 1987).

   In the 1980s the *Pterocladia* harvest was composed of ca. 69–75% drift or beach-cast weed and 25–31% picked attached thalli (Nelson 1986, Luxton & Courtney 1987). The proportions of the harvest that were drift or picked

varied significantly between regions. Schiel & Nelson (1990) reported that 96% of the harvest in the sheltered and warm waters of the Bay of Islands was from attached thalli whereas on the exposed coasts of the Wairarapa 95% was harvested from shore cast thalli.

Recent reports (Gerring et al. 2001) suggest that only 15% of the total harvest is presently taken by diving (although they found only negligible quantities of beachcast *Pterocladia* during the two years of their study in the Waihau Bay area of the Bay of Plenty). However, it is not possible to conclude that the remainder is drift. Three collection methods are presently used and they are not distinguished in the statistics: handpicking attached thalli from the shore, diving to hand-pick from deeper populations, and collection of beachcast material. From the seaweed database it is not possible to distinguish whether drift or attached thalli were collected.

3. Museum holdings

Holdings of *P. lucida* were examined at WELT (herbarium of the Museum of New Zealand Te Papa Tongarewa), 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. Summary

Pterocladia lucida is a richly branched robust alga reaching 20–50 cm in height. It is primarily a subtidal reef species and is found on open, exposed coasts. (Adams 1994) at depths of 1–7 m relative to high water, depending on locality. There is a great deal of variation among individuals in the appearance of thalli, largely owing to variation in the degree of branching and the width of axes, to such an extent that at various times a number of varieties have been described. It is generally accepted that these are environmental or strain variants that are not worth recognition at a higher taxonomic rank. This has been substantiated by recent molecular sequencing data (Nelson et al. in press).

There have been two research studies into the assessment of stocks of *P. lucida*. McCormick (1990) compared a variety of survey techniques at sites in the Leigh Marine Reserve in the northeast of the North Island and at Ngawihi on the south Wairarapa coast. McCormick found that the biomass of *P. lucida* at Leigh was highly variable along and down the reef. Much of the variation was explained by differences between depths although there was even greater variation between quadrats. Thus although there was a general trend with depth, there was very significant patchiness in distribution. This contrasts with the pattern of distribution found at Ngawihi where much of the variability in *P. lucida* biomass was attributable to differences between quadrats and there was no depth trend in the biomass data. McCormick considered that these differences were at least in part attributable to the differing reef topography, with steeply

sloping, short reef structure at Leigh and long and gradually sloping reefs at Ngawihi. These differences in topography will affect the influence of wave exposure and light penetration, two key environmental factors influencing macroalgal distribution. He concluded that a semi-systematic design with replicate quadrats at fixed depths with regularly spaced sites was the preferred approach as it was less time consuming than other methods tried and allowed statistical comparisons of biomass between depths, sample sites, and geographic locations as well as an acceptable ability to estimate standing crop.

Gerring et al. (2001) assessed biomass of *P. lucida* at Waihau Bay in the eastern Bay of Plenty using two approaches and obtained estimates for both summer/autumn and for winter. Gerring et al. (2001) found that thalli harvested in summer either by plucking or by cutting recovered to their initial biomass within 12 months, whereas when harvested in winter, the cut and the plucked thalli remained smaller than the control thalli and did not recover biomass within a year. They concluded that sustainable harvest of the resource was possible if the removal occurred in summer—but cautioned that this conclusion needed to be tested at larger physical scales, over longer time periods, and at other sites.

Although various figures have been published describing productivity of the *Pterocladia* resources, these estimates are very locally focused and somewhat difficult to compare. For example, Luxton & Courtney (1987) stated 'relatively small areas have sustainable yields in excess of 10 t dry wt.yr^{-1}. McCormick (1990) gave a standing crop estimate for a 3 km stretch of coast in northeast North Island as between 25,336 ± 9159 kg and 32,980 ± 5081 kg depending on which method was used for surveying the populations. Gerring et al. (2001) recorded 146–200 t wet weight in a 436,556 m^2 area sampled in summer/autumn and a winter biomass of 119–121 t wet weight for the same area. They converted this to an estimated figure of 173 t wet weight over the 4.4 km of coastline studied. McCormick (1990) calculated a wet weight to dry weight regression equation (dry weight = 0.116 + 0.316 x wet weight) and thus at the Waihau Bay study site there was ca. 55 t dry weight of *P. lucida.* Gerring et al. (2001) cautioned that there is likely to be significant interannual variability in the abundance of *P. lucida* and that this limits the extent to which results from a specific site/time can be generalised to other places and times. Populations of *P. lucida* and *Pterocladiella capillacea* have been sustainably harvested for more than 60 years. But because of the patchy distribution of these species there is potential for over-harvest and resource damage unless a locally focussed management regime is in place.

The 90% distribution has been overlaid on the 100% distribution and has been extended to link headlands or subtidal reef areas where this species has been recorded and/or where equivalent habitats occur.

The above information on the distribution of *P. lucida* derived primarily from herbarium collections, was reviewed by Dr Murray Parsons, former

Keeper Landcare Herbarium, and then integrated by hand onto a large-scale map of New Zealand. The rounded lines 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.

5. References

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

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