4. Marine flora

There is a rich abundance and diversity of macroalgae at the Poor Knights Islands with 121 species of algae recorded from the islands. A thorough taxonomic survey of the macroalgae of the Poor Knights Islands has not been conducted, and therefore this is likely to be a conservative estimate of the number of macroalgal species present. Some of the lushest kelp beds in New Zealand can be found at Nursery Cove and Cleanerfish Bay and subtidal reefs are covered with the golden seawrack, *Carpophyllum angustifolium*, the strap kelp, *Lessonia variegata*, and the common kelp, *Ecklonia radiata* (Ayling & Schiel, 2003). The marine flora of the Poor Knights Islands is an unusual mixture of species common to northeastern New Zealand such as *C. angustifolium* and *Gigartina alveata*, subtropical species such as *Pedobesia clavaeformis, Microdictyon umbilicatum,* and *Palmophyllum umbracola*, and southern New Zealand species, such as *Durvillea antarctica* and *Caulerpa brownii.* Bull kelp *(D. antarctica)* is a common species in southern New Zealand, but is not found in the North Island between North Cape and East Cape with the exception of some exposed offshore islands including the Poor Knights Islands. It is possible that at high levels of wave exposure *D. antarctica* can withstand higher water temperatures (Creese & Ballantine, 1986).

Several rare species of macroalgae are found at the Poor Knights Islands. In 1994 the rare, endemic red alga, *Gelidium allanii*, was discovered with a sample of *Pterocladia capillacea* taken from the Poor Knights Islands in 1978. Prior to 1994 *G. allanii* had only been recorded from the type locality in the Bay of Islands. The alga is typically found growing in intertidal pools on calcium carbonate substrata (Nelson *et al.*, 1994). A new species of green alga, *Palmophyllum umbracola*, was found at the Poor Knights Islands in 1982 (Nelson & Ryan, 1986). This subtidal species is found at the Poor Knights Islands, the Kermadec Islands, and occasionally on the mainland in waters down to 30 m in shaded areas such as caves and overhangs (W. Nelson, NIWA, pers. comm.). An unusual green alga, *Pedobesia clavaeformis*, was discovered at Nursery Cove in 1980. This species has also been recorded from the Kermadec Islands, the Three Kings Islands, the Bay of Islands, and Cape Rodney–Okakari Point Marine Reserve (Hawkes, 1983). An undescribed species of *Rhodymenia* that has previously been reported from the Three Kings Islands has also been collected at the Poor Knights Islands (W. Nelson, NIWA, pers. comm. in Shears & Babcock, 2004).

4.1 Intertidal macroalgae

Sixty two species of intertidal macroalgae have been recorded from the Poor Knights Islands (Table 5). While there have been several studies conducted on the subtidal communities at the Poor Knights Islands no recent studies have been conducted on

intertidal communities at the islands. Published information on the intertidal macroalgal community at the Poor Knights Islands is limited to two early studies by Cranwell & Moore (1938) and Creese & Ballantine (1986). There is also some information on macroalgal species collected at the Poor Knights Islands in Battershill (1986) and Nelson & Adams (1987). Unpublished algal collections taken from the Poor Knights Islands are held at Museum of New Zealand Te Papa Tongarewa, Wellington, and the Auckland Museum Herbarium (W. Nelson, NIWA, pers. comm.).

The intertidal substratum at the Poor Knights Islands is primarily volcanic rhyolite rock, with very limited areas of sand or shell. The majority of the intertidal region consists of steep rock walls. Gently sloping rocky platforms, such as at Ramariki, Hope Point, and Bartle's Bay, account for only a very small percentage of the intertidal area (Fig. 7, Section 5.1). On rocky shorelines there is a general pattern of algal zonation down the shore. Blue-green and filamentous algae grow high up on the shore in areas of freshwater runoff or where there is sustained sea spray. In the upper littoral zone the drought resistant red alga, *Porphyra columbina,* is common. *Porphyra columbina* has a seasonal abundance, being most prolific in spring but is often absent from large areas in summer. Below the high tide mark the predominant alga is a small endemic encrusting red alga, *Apophlaea sinclairii*. This alga is extremely resistant to desiccation and wave exposure, forming a dense, deep-red crust on the rocks. Within this region, *P. columbina* occurs sparingly. In the lower limits of the *A. sinclairii* zone, around mid-tide level, two other species of red algae, *Catenellopsis oligarthra*[19] and *Catenellopsis* sp. are frequently present. On pitted rocks, especially those kept damp by brackish water from the land, *Enteromorpha* sp. and *Ulva* sp. can be found. *Apophlaea sinclairii* appears to have a high light requirement, and does not grow much lower than mid-tide level. The rocks on the lower shore are covered with thin, encrusting red algae (*Hildenbrandia* sp., *Melobesia* sp.), and various types of coralline algae. This base provides a suitable substratum for the attachment of small gelatinous algae such as *Nemalion* sp., *Trematocarpus acicularis*, and dwarfed forms of *Gigartina alveata.* In shaded areas, tufts of *Ulva* sp., *Polysiphonia* sp., *Ceramium* sp., and *Callophyllis decumbens* occur. In areas of moderate exposure the brown alga, *Xiphophora chondrophylla*, dominates the lower intertidal zone. Interspersed between *X. chondrophylla* are several other algal species including *Pleurostichidium falkenbergii, Melanthalia abscissa, Pterocladia lucida, Rhodymenia leptophylla,* and *Champia* sp. In regions were wave exposure is extreme *Durvillea antarctica* replaces *X. chondrophylla* as the dominant alga. In the lower limit of the intertidal zone *Carpophyllum ausgustifolium* forms a dense band that extends into the subtidal zone. Other algal species commonly found in this zone include *Calophyllis decumbens, Champia* sp., *Rhodymenia leptophylla, Plocamium* sp., *Pterocladia lucida, P.*

[19] Previously *Nemostoma oligarthra*

capillacea, Rhodymenia sp., *Griffithsia traversii*[20], and *Osmundaria colensoi*[21] (Cranwell & Moore, 1938).

Table 5 Intertidal macroalgae recorded from the Poor Knights Islands.

Family	Species	Reference
CLASS BRYOPSIDOPHYCEAE		
Order Bryopsidales		
Derbesiaceae	*Bryopsis plumosa*	Battershill (1986)
	Derbesia novae-zelandiae	Battershill (1986)
CLASS ULVOPHYCEAE		
Order Cladophorales		
Cladophoraceae	*Cladophora crinalis*	Battershill (1986)
	Cladophoropsis herpestica	Nelson & Adams (1987)
	Rhizoclonium riparium	Battershill (1986)
Order Codiales		
Codiaceae	*Codium convolutum*	Battershill (1986)
	Codium cranwelliae	Nelson & Adams (1987)
Order Ulvales		
Ulvaceae	*Ulva lactuca*	Nelson & Adams (1987)
CLASS PHAEOPHYCEAE		
Order Dictyotales		
Dictyotaceae	*Dictyota ocellata*	Battershill (1986)
	Padina sp.	Battershill (1986)
Order Durvillaeales		
Durvillaeaceae	*Durvillaea antarctica*	Nelson & Adams (1987)
Order Fucales		
Sargassaceae	*Carpophyllum plumosum*	Nelson & Adams (1987)
	Cystophora retroflexa	Battershill (1986)
Hormosiraceae	*Hormosira banksii*	Battershill (1986)
Fucaceae	*Xiphophora chondrophylla* var. *minus*	Nelson & Adams (1987)
Order Ralfsiales		
Ralfsiaceae	*Ralfsia verrucosa*	Battershill (1986)
Order Scytothamnales		
Splachnidiaceae	*Splachnidium rugosum*	Battershill (1986)
Order Scytosiphonales		
Scytosiphonaceae	*Hydroclathrus clathratus*	Battershill (1986)

[20] Previously *Pandorea traversii*
[21] Previously *Vidalia colensoi*

Family	Species	Reference
Order Sphacelariales		
Stypocaulaceae	*Stypocaulon paniculatum*	Nelson & Adams (1987)
CLASS RHODOPHYCEAE		
Order Bangiales		
Bangiaceae	*Bangia atropurpurea*	Battershill (1986)
	Porphyra columbina	Cranwell & Moore (1938)
CLASS FLORIDEOPHYCEAE		
Order Ceramiales		
Ceramiales	*Centroceros clavulatum*	Nelson & Adams (1987)
	Ceramium sp.	Cranwell & Moore (1938)
	Cladhymenia oblongifolia	Battershill (1986)
	Griffithsia traversii	Cranwell & Moore (1938)
	Microcladia novae-zelandiae	Battershill (1986)
Rhodomelaceae	*Aphanocladia delicatula*	Battershill (1986)
	Laurencia distichophylla	Battershill (1986)
	Osmundaria colensoi	Nelson & Adams (1987)
	Polysiphonia sp.	Cranwell & Moore (1938)
Order Corallinales		
Corallinaceae	*Arthrocardia corymbosa*	Nelson & Adams (1987)
	Corallina officialis	Battershill (1986)
	Haliptilon rosea	Nelson & Adams (1987)
	Jania micrarthrodia	Battershill (1986)
	Jania novae-zelandiae	Nelson & Adams (1987)
	Melobesia sp.	Cranwell & Moore (1938)
Order Gelidiales		
Gelidiaceae	*Gelidium allanii*	Nelson *et al.* (1994)
	Gelidium caulacantheum	Battershill (1986)
	Gelidium pusillum	Battershill (1986)
	Pterocladia capillacea	Nelson & Adams (1987)
	Pterocladia lucida	Nelson & Adams (1987)
Order Gigartinales		
Areschougiaceae	*Placentophora colensoi*	Nelson & Adams (1987)
Catenellopsidaceae	*Catenellopsis oligarthra*	Cranwell & Moore (1938)
	Catenellopsis sp.	Cranwell & Moore (1938)
Caulacanthaceae	*Caulacanthus ustulatus*	Nelson & Adams (1987)
Gigartinaceae	*Gigartina alveata*	Cranwell & Moore (1938)
	Gigartina chapmanii	Battershill (1986)
Halymeniaceae	*Pachymenia lusoria*	Battershill (1986)
Kallymeniaceae	*Callophyllis decumbens*	Cranwell & Moore (1938)
Plocamiaceae	*Plocamium* sp.	Cranwell & Moore (1938)

Family	Species	Reference
Sarcodiaceae	*Trematocarpus acicularis*	Cranwell & Moore (1938)
Order Gracilariales		
Gracilariaceae	*Curdiea coriacea*	Nelson & Adams (1987)
	Melanthalia abscissa	Nelson & Adams (1987)
Order Hildenbrandiales		
Hildenbrandiaceae	*Apophlaea sinclairii*	Nelson & Adams (1987)
	Hildenbrandia sp.	Cranwell & Moore (1938)
Order Nemaliales		
Galaxauraceae	*Nothogenia pulvinata*	Battershill (1986)
Liagoraceae	*Liagora harveyana*	Battershill (1986)
	Nemalion sp.	Cranwell & Moore (1938)
Order Rhodymeniales		
Champiaceae	*Champia laingii*	Battershill (1986)
Lomentariaceae	*Lomentaria* sp.	Battershill (1986)
Rhodymeniaceae	*Rhodymenia australis*	Nelson & Adams (1987)
	Rhodymenia leptophylla	Nelson & Adams (1987)

4.2 Subtidal macroalgae

Seventy nine species of subtidal macroalgae have been recorded from the Poor Knights Islands (Table 6). Distribution of subtidal macroalgae around the Poor Knights Islands is greatly influenced by wave exposure and light intensity. On the exposed eastern side of the islands the sublittoral fringe (<2 m) is dominated by *Carpophyllum augustifolium* and red turfing and foliose algae including *Pterocladia lucida, Rhodymenia* sp., *Osmundaria* sp., and *Pachymenia crassa. Lessonia variegata*, coralline turf, and red turfing algae dominate the 4–6 m region, and coralline turf and red turfing algae dominate the deeper waters (<18 m).

Sites of moderate exposure such as Cleanerfish Bay are dominated by *C. angustifolium* and red turfing algae in shallow waters (<2 m). Red turfing algae (e.g. *Gigartina macrocarpa*), red foliose algae (*Osmundaria, Placentophora colensoi, P. crassa, Nesophila hoggardii*), *Ulva lactuca*, and *E. radiata* dominate the 4–6 m region, while deeper regions are predominately covered by an *E. radiata* forest interspersed with patches of *Caulerpa flexilis*.

In the more sheltered locations such as Nursery Cove, Skull Bay, Landing Bay, and Labrid Channel, a mixture of species is present in the shallow region (> 2 m) including; *Carpophyllum maschalocarpum, C. angustifolium, L. variegata, E. radiata*,

coralline turf, red turfing algae, red foliose algae (*Osmundaria, P. lucida, Pterocladia capillacea, Rhodymenia* sp.), and *Melanthalia abscissa* (Shears & Babcock, 2004). *Carpophyllum angustifolium* reaches a mean density of > 130 plants/m^2 in the shallows, but is quickly replaced by *L. variegata* and *E. radiata* at 4–6 m depths (Choat & Schiel, 1982). *Ecklonia radiata* dominates the deeper regions reaching densities of >70 plants/m^2 (Ayling & Schiel, 2003). Occasionally dense stands of *Carpophyllum flexuosum* can be found at depths between 10–20 m (Choat & Schiel, 1982). Underneath the *E. radiata* canopy a diverse assemblage of other species is present including *Distromium skottsbergii, Carpomitra costata, Phacelocarpus labillardieri, Delisea elegans, Plocamium* sp., and *Curdiea coriacea* (Shears & Babcock, 2004).

In deeper waters light intensity is the major environmental factor determining the distribution of macroalgae. Light penetration in the clear waters of the Poor Knights Islands is at least three times deeper than at nearby inshore coastal regions, and as a result algae can survive at more than twice the depth they are normally limited to in inshore coastal waters (Ayling, 1968). For example, light intensity governs the lower limit of *E. radiata* and in areas where light intensity is reduced, such as on a vertical rock face, the lower limit of *E. radiata* is around 28 m. However, on more gently angled rock slopes *E. radiata* can be found at 48 m depth at the Poor Knights Islands, whereas, the lower limit of *E. radiata* in the Hauraki Gulf is around 12 m (Doak, 1971). Ocassionally, in depths of 30 m and more, towering tangled 3 m high columns of *Sargassum sinclairii* can be found (Ayling, 1974c).

Shears and Babcock (2004) conducted a survey of nine shallow subtidal sites[22] (≤18 m depth) around the Poor Knights Islands (Fig. 1 in Shears & Babcock, 2004). Total average algal biomass was 475.6 g/m^2. The three most dominant species in terms of biomass were *E. radiata* (52.8 g/m^2), *C. angustifolium* (18.2 g/m^2), and *Lessonia variegata* (5.7 g/m^2). The most abundance algae in terms of percentage occurrence were crustose coralline algae (mixed species) (99.4%), red turfing algae (mixed species) (90%), coralline turfing algae (mixed species) (79.4%), and *E. radiata* (66.7%) (Table 7).

[22] Lighthouse Bay, Rocklily Inlet, Nursery Cove, Cleanerfish Bay, Skull Bay, Bartle's Bay, Matt's Crack, Frasers Bay, and Labrid Channel (see Fig. 2 for locations).

Table 6 **Subtidal macroalgae recorded from the Poor Knights Islands.**

Family	Species	Reference
CLASS BRYOPSIDOPHYCEAE		
Order Bryopsidales		
Caulerpaceae	*Caulerpa brownii*	Schiel (1984)
	Caulerpa flexilis	Nelson & Adams (1987)
	Caulerpa geminata	Nelson & Adams (1987)
Derbesiaceae	*Pedobesia clavaeformis*	Nelson & Adams (1987)
CLASS ULVOPHYCEAE		
Order Cladophorales		
Anadyomenaceae	*Microdictyon umbilicatum*	Nelson & Adams (1987)
Order Codiales		
Codiaceae	*Codium convolutum*	Shears & Babcock (2004)
	Codium cranwelliae	Nelson & Adams (1987)
Order Tetrasporales		
Palmellopsidaceae	*Palmophyllum umbracola*	Nelson & Ryan (1986)
Order Ulvales		
Ulvaceae	*Ulva lactuca*	Nelson & Adams (1987)
CLASS PHAEOPHYCEAE		
Order Dictyotales		
Dictyotaceae	*Distromium skottsbergii*	Nelson & Adams (1987)
	Glossophora kunthii	Schiel (1984)
	Taonia australasica	Battershill (1986)
	Zonaria turneriana	Shears & Babcock (2004)
Order Ectocarpales		
Chordariaceae	*Leathesia difformis*	Schiel (1984)
Ectocarpaceae	*Ectocarpus* sp.	Schiel (1984)
Order Ralfsiales		
Ralfsiaceae	*Ralfsia verrucosa*	Battershill (1986)
Order Sporochnales		
Sporochnaceae	*Carpomitra costata*	Nelson & Adams (1987)
Order Fucales		
Cystoseiraceae	*Landsburgia quercifolia*	Nelson & Adams (1987)
Fucaceae	*Xiphophora chondrophylla* var. *minus*	Nelson & Adams (1987)
Sargassaceae	*Carpophyllum angustifolium*	Nelson & Adams (1987)
	Carpophyllum maschalocarpum	Shears & Babcock (2004)
	Carpophyllum plumosum	Nelson & Adams (1987)
	Cystophora torulosa	Battershill (1986)
	Sargassum sinclairii	Ayling (1974c)

Family	Species	Reference
Order Laminariales		
Alariaceae	*Ecklonia radiata*	Nelson & Adams (1987)
Lessoniaceae	*Lessonia variegata*	Shears & Babcock (2004)
Order Scytosiphonales		
Scytosiphonaceae	*Colpomenia sinuosa*	Shears & Babcock (2004)
	Hydroclathrus clathratus	Battershill (1986)
Order Sphacelariales		
Stypocaulaceae	*Halopteris paniculata*	Nelson & Adams (1987)
CLASS FLORIDEOPHYCEAE		
Order Balliales		
Balliaceae	*Ballia callitricha*	Battershill (1986)
	Ballia scoparia	Battershill (1986)
Order Bonnemaisoniales		
Bonnemaisoniaceae	*Delisea compressa*	Nelson & Adams (1987)
	Delisea elegans	Shears & Babcock (2004)
	Delisea pulchra	Battershill (1986)
	Ptilonia mooreana	Schiel (1984)
Order Ceramiales		
Ceramiaceae	*Antithamnion* sp.	Battershill (1986)
	Callithamnion sp.	Battershill (1986)
	Euptilota formosissima	Nelson & Adams (1987)
	Spyridia sp.	Battershill (1986)
Delesseriaceae	*Abroteia orbicularis*	Nelson & Adams (1987)
	Hymenena sp.	Battershill (1986)
	Phycodrys profunda	Nelson & Adams (1987)
	Platyclinia purpurea	Nelson & Adams (1987)
Rhodomelaceae	*Aphanocladia delicatula*	Battershill (1986)
	Dasyclonium bipartitum	Nelson & Adams (1987)
	Dasyclonium incisum	Nelson & Adams (1987)
	Laurencia distichophylla	Battershill (1986)
	Osmundaria colensoi	Nelson & Adams (1987)
Order Corallinales		
Corallinaceae	*Amphiroa anceps*	Nelson & Adams (1987)
	Arthrocardia corymbosa	Nelson & Adams (1987)
	Cheilosporum sagittatum	Nelson & Adams (1987)
	Haliptilon rosea	Nelson & Adams (1987)
Order Gelidiales		
Gelidiaceae	*Pterocladia capillacea*	Shears & Babcock (2004)
	Pterocladia lucida	Nelson & Adams (1987)

Family	Species	Reference
Order Gigartinales		
Acrosymphytaceae	*Acrosymphyton firmum*	Nelson & Adams (1987)
Areschougiaceae	*Placentophora colensoi*	Nelson & Adams (1987)
Caulacanthaceae	*Taylorophycus filiformis*	Shears & Babcock (2004)
Gigartinaceae	*Gigartina macrocarpa*	Shears & Babcock (2004)
	Melanthalia abscissa	Nelson & Adams (1987)
Halymeniaceae	*Pachymenia crassa*	Nelson & Adams (1987)
Kallymeniaceae	*Callophyllis dichotoma*	Nelson & Adams (1987)
	Kallymenia berggrenii	Shears & Babcock (2004)
Peyssonneliaceae	*Peyssonnelia sp.*	Nelson & Adams (1987)
Phacelocarpaceae	*Phacelocarpus labillardieri*	Nelson & Adams (1987)
Plocamiaceae	*Plocamium costatum*	Nelson & Adams (1987)
Pseudoanemoniaceae	*Hummbrella hydra*	Nelson & Adams (1987)
Rhizophyllidaceae	*Nesophila hoggardii*	Nelson & Adams (1996)
Order Gracilariales		
Gracilariaceae	*Curdiea codioides*	Shears & Babcock (2004)
	Curdiea coriacea	Shears & Babcock (2004)
Order Halymeniales		
Halymeniaceae	*Cryptonemia latissima*	Nelson & Adams (1987)
Order Nemaliales		
Liagoraceae	*Liagora harveyana*	Battershill (1986)
Galaxauraceae	*Scinaia* sp.	Battershill (1986)
Order Rhodymeniales		
Champiaceae	*Champia novae-zelandiae*	Shears & Babcock (2004)
Faucheaceae	*Gloioderma saccatum*	Nelson & Adams (1987)
	Gloiodermatopsis setchellii	Nelson & Adams (1987)
Rhodymeniaceae	*Rhodymenia australis*	Nelson & Adams (1987)
	Rhodymenia leptophylla	Nelson & Adams (1987)
	Rhodymenia sp. aff. *R. hancockii*	Nelson & Adams (1987)
	Rhodymenia sp.	Nelson & Adams (1987)

Table 7 **Percentage occurrence of subtidal macroalgal species recorded from the waters of the Poor Knights Islands ≤ 18 m deep (Table adapted from Shears & Babcock, 2004).**

Species	% occurrence	Species	% occurrence
Large brown algae		**Foliose red algae**	
Ecklonia radiata	66.7	*Nesophila hoggardii*	40.0
Xiphophora chondrophylla	23.9	*Osmundaria colensoi*	32.8
Carpophyllum angustifolium	20.0	*Pterocladia lucida*	26.1
Lessonia variegata	20.0	*Plocamium* sp.	25.0
Carpophyllum maschalocarpum	18.3	*Euptilota formosissima*	21.7
Sargassum sinclairii	16.7	*Curdiea coriacea*	21.1
Carpophyllum plumosum	8.9	*Pachymenia crassa*	16.1
Carpophyllum flexuosum	7.8	*Rhodymenia* undescr. sp.	13.3
Landsburgia quercifolia	5.6	*Placentophora colensoi*	10.6
		Rhodymenia sp.	8.3
Small brown algae		*Delisea compressa*	8.3
Zonaria turneriana	21.7	*Melanthalia abscissa*	6.7
Brown encrusting algae*	8.9	*Phacelocarpus labillardieri*	2.8
Distromium scottsbergii	7.8	*Callophyllis* sp.	2.2
Carpomitra costata	4.4	*Kallymenia berggrenii*	1.7
Halopteris sp.	3.9	*Taylorophycus filiformis*	1.7
Colpomenia sinuosa	1.7	*Plocamium costatum*	1.1
Brown turfing algae*	0.6		
		Red turfing algae (<5 cm)	
Green algae		Red turfing algae*	90.0
Ulva sp.	58.9	Coralline turfing algae*	79.4
Codium convolutum	42.8	*Gigartina macrocarpa*	10.0
Codium cranwelliae	8.9	*Champia novae-zelandiae*	3.3
Caulerpa flexilis	7.2		
Caulerpa geminata	7.2	**Encrusting red algae**	
Pedobesia clavaeformis	1.1	Crustose coralline algae*	99.4
Green turfing algae	0.6	Red encrusting algae*	46.7
		Curdiea codioides	7.2

* Mixed species.