3. The Vertebrates

3.1 Fish

There is a rich diversity of fish fauna at the Poor Knights Islands with around 186 species recorded from within the marine reserve. Many of these species are widespread around northern New Zealand including snapper (*Pagrus auratus*), tarakihi (*Nemadactylus macropterus*), goatfish (*Upeneichthys lineatus*), red gurnard (*Chelidonichthys kumu*), red moki (*Cheilodactylus spectabilis*), leatherjacket (*Parkia scaber*), kingfish (*Seriola lalandi*), koheru (*Decapterus koheru*), and trevally (*Pseudocaranx dentex*). Conversely, a number of common coastal fishes, such as spotties (*Notolabrus celidotus*), parore (*Girella tricuspidata*), and triplefins (*Forsterygion lapillum, F. malcomi, F. varium*), are infrequent around the Poor Knights Islands. Brook (2002) suggested that the low abundance of these common coastal fish was because of the isolated offshore location and the lack of shallow, sheltered habitats at the Poor Knights Islands. There is also a distinctive subtropical group of fish that are present at the Poor Knights Islands. This group includes many colourful reef fishes such as the toadstool grouper (*Trachypoma macracanthus*), blue knifefish, (*Labracoglossa nitida*), gold ribbon grouper (*Aulacocephalus temmincki*), and the striped boarfish (*Evistias acutirostris*), which also occur around Lord Howe Island, Norfolk Island, and eastern Australia. These exotic, subtropical fishes form a conspicuous element at the Poor Knights Islands comprising around 38% of the total number of fish species recorded from the Poor Knights Islands (Brook, 2002). In recent years a number of excellent photograph references of the fish fauna of Poor Knights Islands have been published (Doak, 1991; Edney, 2001; Anthoni, 2007).

The tropical and subtropical element of the Poor Knights Islands fish fauna is continually changing. While some tropical species are able to breed and recruit around the Poor Knights Islands, other species, such as the moon wrasse (*Thalassoma lunare*), the sunset wrasse (*T. lutescens*), the long-nosed butterfly fish *(Forcipiger flavissimus)*, and the lionfish *(Pterois volitans)* appear to be transient visitors. These species are probably transported to the Poor Knights Islands as eggs or larvae via the East Auckland Current from the broad Indo-Pacific region, including Norfolk Island, Lord Howe Island, and the Kermadec Islands (Francis, 1993), and settle at the Poor Knights Islands during mid-summer, but are unable to survive over winter. Other species apparently fail to establish successful breeding populations in New Zealand, presumably relying on the continual transport of eggs and larvae from outside New Zealand to sustain population numbers at the Poor Knights Islands. Thus, the population size of these non-breeding species varies greatly at the Poor Knights Islands. For example, four species of labrids, *Anampses elegans, Coris picta,*

Pseudojuloides elongatus, and *Suezichthys arquatus*, were relatively common in the Poor Knights Islands prior to 1974, but declined to extinction within the marine reserve by 1979, and were rare or absent until 1988 when there was a strong recruitment event (Schiel, 1984; Choat *et al.*, 1988) (See Section 3.1.1 for more details). Table 1 lists all the fish species recorded from the Poor Knights Islands Marine Reserve.

Table 1 Fish species that have been recorded from the Poor Knights Islands Marine Reserve.

Family	Species	Common name	Reference
CLASS CHONDRICHTHYES			
Order Carcharhiniformes			
Carcharhinidae	*Carcharhinus brachyurus*	Bronze whaler	Ayling & Schiel (2003)
	Prionace glauca	Blue shark	Froese & Pauly (2008)
Scyliorhinidae	*Cephaloscyllium isabellum*	Carpet shark	Edney (2001)
Sphyrnidae	*Sphyrna zygaena*	Hammerhead shark	Doak (2001c)
Triakidae	*Galeorhinus galeus*	School shark	Denny *et al*. (2003)
Order Hexanchiformes			
Hexanchidae	*Notorynchus cepedianus*	Broadnose seven gill shark	D. Abbot (unpub.)
Order Orectolobiformes			
Rhincodontidae	*Rhincodon typus*	Basking whale shark	Doak (2002)
Order Lamniformes			
Alopiidae	*Alopias vulpinus*	Thresher shark	Abbott & Rousseau (2002)
Isuridae	*Isurus oxyrinchus*	Mako shark	Abbott & Rousseau (2002)
Order Myliobatiformes			
Dasyatidae	*Dasyatis brevicaudata*	Short-tailed stingray	Le Port *et al.* (2008)
	Dasyatis thetidis	Long-tailed stingray	Edney (2001)
Mobulidae	*Manta birostris*	Manta ray	Duffy & Abbott (2003)
Myliobatidae	*Myliobatis tenuicaudatus*	Eagle ray	Edney (2001)
Order Torpediniformes			
Torpedinidae	*Torpedo fairchildi*	NZ Torpedo/Electric ray	Abbott & Rousseau (2002)
CLASS ACTINOPTERYGII			
Order Anguilliformes			
Muraenidae	*Enchelycore ramosa*	Mosaic moray	Edney (2001)
	Gymnothorax nubilus	Grey moray	Edney (2001)
	Gynonthorax obesus	Speckled moray	Edney (2001)

Family	Species	Common name	Reference
	Gymnothorax prasinus	Yellow moray	Edney (2001)
	Gymnothorax prionodon	Motttled moray	Edney (2001)
Congridae	*Conger verreauxi*	Southern conger eel	Edney (2001)
	Conger wilsoni	Short-finned conger eel	Brook (2002)
	Gorgasia japonica	Garden eel	Ayling & Cox (1982); Doak (1991); Castle & Randall (1999)
Ophichthidae	*Ophisurus serpens*	Snake eel	Doak (2001a)
Order Aulopiformes			
Synodontidae	*Synodus doaki*	Common lizardfish	Schiel (1984)
	Synodus similis	Lavender lizardfish	Brook (2002)
Order Beloniformes			
Exocoetidae	*Cypselurus lineatus*	Flying fish	Doak (2001a)
Hemiramphidae	*Hyporhamphus ihi*	Piper	Brook (2002)
Scomberesocidae	*Scormberesox saurus*	Saurie	Kelly (1983)
Order Beryciformes			
Berycidae	*Centroberyx affinis*	Golden snapper	Edney (2001)
Trachichthyidae	*Optivus elongatus*	Slender roughy	Edney (2001)
Order Clupeiformes			
Engraulidae	*Engraulis australis*	Anchovy	Kingsford (1989)
Order Gadiformes			
Moridae	*Lotella rhacinus*	Rock cod	Brook (2002)
	Pseudophycis bachus	Morid cod	Kelly (1983)
	Pseudophycis barbata	Bastard cod	Brook (2002)
	Pseudophycis breviuscula	Red cod	Kelly (1983)
Order Gasterosteiformes			
Syngnathidae	*Hippocampus adominalis*	Seahorse	Doak (2001a)
	Hippocampus jugumus	Collared seahorse	Edney et al. (2006)
	Hippocampus sp.	Pygmy seahorse	Survey Seahorse 2000 (2005)
Order Gobiesociformes			
Gobiesocidae	*Dellichthys morelandi*	Urchin clingfish	Kelly (1983)
Order Lampriformes			
Regalecidae	*Regalecus glesne*	Oarfish	M. Conmee (unpub.)
Trachipteridae	*Trachipterus trachypterus*	Dealfish	W. Doak (unpub.)
Order Lophiiformes			
Antennariidae	*Antennarius sp.*	Frogfish	Dive Tutukaka (2008)
Order Perciformes			
Acanthuridae	*Acanthurus dussumieri*	Eyestripe surgeonfish	Francis & Evans (1992)

Family	Species	Common name	Reference
Aplodactylidae	*Aplodactylus arctidens*	Marblefish	Schiel (1984)
	Aplodactylus etheridgii	Notch-head marblefish	Schiel (1984)
Arripidae	*Arripis trutta*	Kahawai	Brook (2002)
Blenniidae	*Parablennius laticlavius*	Crested blenny	Edney (2001)
	Plagiotremus rhinorhynchos	Blue mimic blenny	Doak (2001a)
	Plagiotremus tapeinosoma	Mimie blenny	Edney (2001)
Callanthiidae	*Callanthias allporti*	Splendid sea perch	Schiel (1984)
	Callanthias australis	Magnificent splendid perch/Northern splendid perch	Brook (2002)
Carangidae	*Decapterus koheru*	Koheru	Edney (2001)
	Pseudocaranx dentex	Trevally	Edney (2001)
	Seriola lalandi	Kingfish	Edney (2001)
	Trachurus declevis	Jack mackerel	Kingsford (1989)
	Trachurus novaezelandiae	Horse mackerel	Brook (2002)
Chaetodontidae	*Amphichaetodon howensis*	Lord Howe coralfish	Schiel (1984)
	Forcipiger flavissimus	Yellow longnose butterflyfish	Francis *et al.* (1999)
Cheilodactylidae	*Cheilodactylus ephippium*	Painted moki	Edney (2001)
	Cheilodactylus fuscus	Red morwong	Kelly (1983)
	Cheilodactylus nigripes	Magpie morwong	Kelly (1983)
	Cheilodactylus spectabilis	Red moki	Choat & Ayling (1987)
	Nemadactylus douglasii	Porae	Choat & Ayling (1987)
	Nemadactylus macropterus	Tarakihi	Schiel (1984)
Chironemidae	*Chironemus marmoratus*	Hiwihiwi	Choat & Ayling (1987)
Cirrhitidae	*Cyprinocirrhites polyactis*	Lyetail hawkfish/ swallowtail hawkfish	Francis & Evans (1992)
Clinidae	*Cristiceps aurantiacus*	Crested weedfish	Battershill (1986)
	Ericentrus rubrus	Banded weedfish	D. Abbot (unpub.)
Coryphaenidae	*Coryphaena hippurus*	Mahi Mahi	Doak (2001c)
Creediidae	*Limnichthys polyactis*	longfinned sand diver	Battershill (1986)
Gemphylidae	*Thrysites atun*	Barracouta	Russell (1983)
Istiophoridae	*Makaira indica*	Black marlin	Kelly (1983)
	Makaira mazara	Pacific blue marlin	Kelly (1983)
	Tetrapturus audax	Striped marlin	Kelly (1983)
Kyphosidae	*Atypichthys latus*	Mado	Schiel (1984)
	Bathystethus cultratus	Grey knifefish	Brook (2002)
	Girella cyanea	Bluefish	Schiel (1984)
	Girella tricuspidata	Parore	Brook (2002)
	Kyphosus bigibbus	Grey seachub	Francis & Evans (1992)

Family	Species	Common name	Reference
	Kyphosus sydneyanus	Silver drummer	Schiel (1984)
	Labracoglossa nitida	Blue knifefish	Francis *et al.* (1999)
	Scorpis aequipinnis	Sea sweep	Kingsford & MacDiarmid (1988)
	Scorpis lineolatus	Silver sweep	Edney (2001)
	Scorpis violaceus	Blue Maomao	Edney (2001)
Labridae	*Anampses elegans*	Elegant wrasse	Ward & Roberts (1986)
	Bodianus flavipinnis	NZ fox fish	Doak (1991; 2003)
	Bodianus unimaculatus[7]	Red pigfish	Edney (2001)
	Bodianus vulpinus	Pigfish	Choat *et al.* (1988)
	Coris dorsomacula	Pink-lined wrasse	Brook (2002)
	Coris picta	Combfish	Edney (2001)
	Coris sandageri	Sandager's wrasse	Ward & Roberts (1986)
	Notolabrus celidotus[8]	Paketi (spotty)	Ward & Roberts (1986)
	Notolabrus fucicola[8]	Banded wrasse	Ward & Roberts (1986)
	Notolabrus inscriptus[8]	Green wrasse	Ward & Roberts (1986)
	Pseudojuloides elongatus	Long green wrasse	Ayling & Russell (1977)
	Pseudolabrus luculentus	Orange wrasse	Ward & Roberts (1986)
	Pseudolabrus miles	Scarlet wrasse	Ward & Roberts (1986)
	Suezichthys arquatus	Rainbow fish	Francis & Evans (1992)
	Suezichthys aylingi	Crimson cleanerfish	Ward & Roberts (1986)
	Thalassoma amblycephalum	Blueheaded wrasse	Francis *et al.* (1999)
	Thalassoma lunare	Moon wrasse	Doak (2001a)
	Thalassoma lutescens	Sunset wrasse	Francis *et al.* (1999)
Latridae	*Latridopsis ciliaris*	Blue moki	Edney (2001)
	Latridopsis forsteri	Copper moki	Edney (2001)
Mugilidae	*Aldrichetta forsteri*	Yellow-eyed mullet	F. Brook (unpub.)
Mullidae	*Parupeneus spilurus*	Blackspot goatfish	Francis & Evans (1992)
	Upeneichthys lineatus	Goatfish/ red mullet	Choat & Ayling (1987)
	Upeneus francisi[9]	Bat-tailed goatfish	Randall & Gueze (1992)
Notothenidae	*Notothenia angustata*	Maori chief	Denny *et al*. (2003)
Odacidae	*Odax pullus*	Butterfish	Schiel (1984)
	Odax cyanoallix	Bluefinned butterfish	Brook (2002)
Pempheridae	*Pempheris adspersus*	Big eye	Edney (2001)
Pentacerotidae	*Evistias acutirostris*	Striped boarfish	Brook (2002)

[7] *Bodianus oxycephalus* in Ward & Roberts (1986) is believed to be *B. unimaculatus* (F. Brooks, pers. comm.).
[8] Genus previously *Pseudolabrus*
[9] Early records of *Upeneus francis* are believed to have been mis-identified as *Upeneus bensasi* (F. Brooks, pers. comm.)

Family	Species	Common name	Reference
	Paristiopterus labiosus	Giant boarfish	Doak (2001a)
	Zanclistius elevatus	Long-finned boarfish	Edney (2001)
Percichthyidae	*Polyprion moeone*	Bass	Kelly (1983)
	Polyprion oxygenios	Hapuku	Beentjes & Francis (1999)
Plesiopidae	*Acanthoclinus littoreus*	NZ rockfish	Battershill (1986)
Pinguipedidae	*Parapercis binivirgata*	Red-banded weever	Kelly (1983)
	Parapercis colias	Blue cod	Brook (2002)
Pomacentridae	*Chromis abyssicola*	Deepsea damselfish	Gregory (2008); D. Freeman, DOC, pers. comm.
	Chromis dispilus	Demoiselle	Edney (2001)
	Chromis fumea	Yellow demoiselle	Edney (2001)
	Chromis hypsilepis	One spot puller	Brook (2002)
	Chrysiptera rapanui	Easter damselfish	Francis *et al.* (1999)
	Parma alboscapularis	Black angelfish	Ward & Roberts (1986)
	Parma kermadecensis	Kermadec scalyfin	Francis *et al.* (1999)
	Parma polylepis	Banded Parma	Francis (1988)
	Stegastes gascoynei	Yellow damselfish	Doak (2001a)
Scaridae	*Leptoscarus vaigiensis*	Marbled parrotfish	Kelly (1983)
Scombridae	*Acanthocybium solandri*	Wahoo	Francis *et al.* (1999)
	Scomber australasicus	Blue mackerel	Kingsford (1989)
	Thunnus alalunga	Albacore tuna	Kelly (1983)
	Thunnus albacares	Yellow fin tuna	Kelly (1983)
	Thunnus obesus	Bigeye tuna	Kelly (1983)
	Katsuwonus pelamis	Skipjack tuna	Kelly (1983)
Serranidae	*Acanthistius cinctus*	Yellow banded perch	Edney (2001)
	Acanthistius littoreus	Black rockfish	Doak (2001a)
	Aulacocephalus temmincki	Gold-ribbon grouper	Brook (2002)
	Caesioperca lepidoptera	Butterfly perch	Schiel (1984)
	Caprodon longimanus	Pink Maomao	Edney (2001)
	Epinephelus daemelii	Saddled grouper/ Black spotted grouper	Brook (2002)
	Epinephelus lanceolatus	Giant grouper/ Queensland grouper	Francis & Evans (1992)
	Epinephelus octofasiatus	Convict grouper	D. Abbot (unpub.)
	Epinephelus rivulatus	Halfmoon grouper	Brook (2002)
	Hypoplectrodes huntii[10]	Red banded perch	Schiel (1984)
	Hypoplectrodes sp.	Half banded perch	Brook (2002)

[10] Previously *Ellerkeldia huntii*

Family	Species	Common name	Reference
	Trachypoma macracanthus	Toadstool grouper	Edney (2001)
Sparidae	*Pagrus auratus*	Snapper	Schiel (1984)
Sphyraenidae	*Sphyraena* cf. *acutipinnis*	Sharp-finned barracuda	Francis *et al.* (1999)
Tripterygiidae	*Forsterygion flavonigrum*	Yellow-black triplefin	Edney (2001)
	Forsterygion lapillum	Common triplefin	Brook (2002)
	Forsterygion malcolmi	Mottled triplefin	Brook (2002)
	Forsterygion varium	Striped triplefin	Brook (2002)
	Gilloblennius tripennis	Tripenny	Kelly (1983)
	Grahamina capito	Spotted robust triplefin	Battershill (1986)
	Bellapiscis medius[11]	Twister	Kelly (1983)
	Karalepis stewarti	Scaly-head triplefin	Edney (2001)
	Notoclinops caerulepunctus	Blue-dot triplefin	Edney (2001)
	Notoclinus fenestratus	Topknot	Battershill (1986)
	Notoclinops segmentatus[12]	Blue-eyed triplefin	Edney (2001)
	Notoclinops yaldwyni	Yaldwyn's triplefin	Edney (2001)
	Obliquichthys maryannae	Oblique-swimming triplefin	Edney (2001)
	Ruanoho decemdigitatus	Long-finned triplefin	Battershill (1986)
	Ruanoho whero	Spectacled triplefin	Edney (2001)
Uranoscopidae	*Kathetostoma giganteum*	Giant banded stargazer	Doak (2001a)
Xiphiidae	*Xiphias gladius*	Broadbill swordfish	Kelly (1983)
Order Pleuronectiformes			
Rhombosoleidae	*Rhombosolea plebeia*	Flounder	Doak (1991)
Soleidae	*Aseraggodes bahamondei*	South Pacific sole	Francis *et al.* (1999)
Order Scorpaeniformes			
Scorpaenidae	*Helicolenus percoides*	Reef ocean perch	Brook (2002)
	Pterois volitans	Red lionfish	Francis & Evans (1992)
	Scorpaena cardinalis	Scorpion fish	Schiel (1984)
	Scorpaena papillosus	Dwarf Scorpionfish	Brook (2002)
Triglidae	*Chelidonichthys kumu*	Red gurnard/ Bluefin gurnard	Battershill (1986)
Order Syngnathiformes			
Fistulariidae	*Fistularia* cf. *commersonii*	Bluespotted cornetfish	Francis *et al.* (1999)
Syngnathidae	*Leptonotus norae*	Longsnout pipefish	Battershill (1986)
	Stigmatopora macropterygia	Long-snouted pipefish	Battershill (1986)
Order Tetraodontiformes			
Diodontidae	*Allomycterus pilatus*[13]	Porcupine fish	Brook (2002)

[11] Previously *Helcogramma medium*
[12] Previously *Tripterygion bucknilli*
[13] Previously *Allomycterus jaculiferus*, referred to as *Allomycterus whitleyi* in Russell (1971)

Family	Species	Common name	Reference
Molidae	*Mola mola*	Ocean sunfish	Doak (1991)
	Ranzania laevis	Oblong sunfish	W. Doak (unpub.)
Monacanthidae	*Parika scaber*	Leatherjacket	Choat & Ayling (1987)
	Thamnaconus analis	Triggerfish/ morsecode leatherjacket	Francis & Evans (1992)
Ostraciidae	*Ostracion solorensis*	Striped boxfish	Doak (2001c)
Tetradontidae	*Canthigaster callisterna*	Sharp-nosed pufferfish	Schiel (1984)
Order Zeiformes			
Zeidae	*Zenion leptolepis*	Elongate dory	Kelly (1983)
	Zeus faber[14]	John dory	Edney (2001)

3.1.1 Fish monitoring

One of the aims of the Poor Knights Islands Marine Reserve is to protect the reef fish population around the islands from overfishing, particularly those species that are long-lived or have low reproductive rates. When the reserve was first established in 1981 recreational fishing of snapper, kingfish, trevally, mackerel, kahawai, shark, billfish, tuna, and pink maomao was permitted in 95% of the reserve. At the time it was thought that these species were pelagic and thus, were not a permanent part of the reserve's fish population (Denny, 2008). However, recent studies have found that trevally, snapper, pink maomao, and kingfish are largely or partially resident around reefs (Saul & Holdsworth, 1992; Willis *et al.*, 2001; Francis, 2002; Parsons *et al.*, 2003). The abundance of a number of common, conspicuous fish species at the Poor Knights Islands has been monitored since the establishment of the marine reserve.

Planktivorous fish

Planktivorous fish are the most conspicuous and abundant fish at the Poor Knights Islands with schools numbering in the hundreds commonplace. Accurate monitoring of planktivorous fish is difficult because of the schooling nature of these fish. Two studies on planktivorous fish at the Poor Knights Islands have been conducted by Kingsford & MacDiarmid (1988) and Kingsford (1989). The most abundant planktivorous reef fish in the upper 30 m of the water column was *Chromis dispilus* (Demoiselle), which had a mean density of 1125 $\pm$ 181 S.E. per 9000 m^3 and accounted for 85% of all planktivorous reef fish sampled at the Poor Knights Islands. Densities of *C. dispilus* were relatively stable between sites and times as the fish have a strong association with reefs and do not venture far from the reef during daytime.

[14] Previously *Zeus japonicus*

Scorpis violaceus (Blue maomao), *Caprodon longimanus* (Pink maomao), and *Decapterus koheru* (Koheru) were also common, but typically travelled around the reserve in large schools, and thus, their abundance varied greatly between sites and times, with mean densities ranging between 0 and 436 fish per 9000 m^3. All other planktivorous reef fish sampled[15] were found at low densities.

The localised distribution of planktivorous fish was influenced by current direction, with higher abundances of fish always present on the incurrent side of archways. The feeding activity of these dense schools of fish was capable of causing a significant reduction in zooplankton numbers directly downstream of the school. Diurnal planktivorous fish were absent from the reef at night, seeking shelter in deeper waters away from the islands (Kingsford & MacDiarmid, 1988).

The distribution patterns of planktivorous fish at the Poor Knights Islands differs from other nearby locations (Hen and Chickens Islands, Goat Island, Mokohinau Islands, Needles, Kawau Island, Little Barrier Island, and Whangarei Heads). The Poor Knights Islands had significantly higher numbers of *C. dispilus, S. violaceus, D. koheru*, and *C. longimanus* than other sites, but significantly lower numbers of *Scorpis aequipinnis* (sea sweep) than Goat Island, and significantly lower numbers of *Arripis trutta* (Kahawai) than the Mokohinau Islands (Kingsford, 1989). However, these results need to be interpreted with care as there is limited temporal data for many of the locations.

Labrids and other families

More labrid species have been recorded at the Poor Knights Islands than anywhere else in New Zealand (Ward & Roberts, 1986), with 18 wrasse species recorded at the Poor Knights Islands. All these wrasses are sex-changing hermaphrodites, starting life as females and later changing sex to become males. Labrids are especially abundant around tropical coral reefs, and some of these warm water species such as *Thalassoma lunare* (Moon wrasse), *Thalassoma amblycephalum* (Blueheaded wrasse), and *Suezichthys arquatus* (Rainbow fish) are uncommon at the Poor Knights Islands and may only be transient visitors. These species arrive in northeastern New Zealand, and particularly around the Poor Knights Islands, at the end of summer but do no appear to survive the cold winter months well and populations gradually dwindle (Doak, 2001a).

[15] *Caesioperca lepidoptera, Pseudocaranx dentex, Scorpis aequipinnis, Chromis hypsilepsis, Trachurus novaezelandiae, Labracoglossa nitida*, and *Scomber australasicus.*

One notable labrid found at the Poor Knights Islands is the rare *Suezichthys aylingi,* (Crimson cleanerfish), which is restricted to eastern Australia, the Three Kings Islands, and northeastern New Zealand. *Suezichthys aylingi* is only abundant at the Three Kings Islands and it is most likely that the Poor Knights Islands populations are derived from there (Choat *et al.*, 1988).

Choat *et al*. (1988) monitored 12 labrid species and 4 other fish species at the Poor Knights Islands over a period of 12 years from 1975 to 1986. The fish species were divided into three distributional groups; 1) widespread coastal species that are also found in southern temperate waters, 2) northern coastal species that are abundant on offshore islands, and 3) subtropical species that are normally rare in New Zealand (Table 2).

Table 2 **Species of fish monitored by Choat *et al*. (1988) at the Poor Knights Islands.**

Distributional grouping and species	Common name
1. Widespread coastal species with southern distribution	
Cheilodactylus spectabilis	Red moki
Nemadactylus douglasii	Porae
Parika scaber	Leatherjacket
Notolabrus celidotus	Spotty
Notolabrus fucicola	Banded wrasse
Pseudolabrus miles	Scarlet wrasse
2. Northern coastal species abundant on offshore islands	
Bodianus vulpinus	Pigfish
Coris sandageri	Sandager's wrasse
Parma alboscapularis	Black angelfish
Notolabrus inscriptus	Green wrasse
Pseudolabrus luculentus	Orange wrasse
Suezichthys aylingi	Crimson cleanerfish
3. Transient species of subtropical origin	
Anampses elegans	Elegant wrasse
Coris picta	Combfish
Pseudojuloides elongatus	Long green wrasse
Suezichthys arquatus	Rainbow fish

Results from the study showed distinct patterns in both temporal and spatial abundance. Temporal patterns in fish abundance at Nursery Cove varied between the three groups. Total mean abundance of the subtropical group gradually decreased from

approximately 13 fish per 500 m^2 in 1975 to 0 fish per 500 m^2 in 1979, and did not increase for the remainder of the study period. These subtropical species appear to be unable to successfully reproduce in New Zealand waters and thus populations at the Poor Knights Islands are dependent on recruitment from populations outside of New Zealand. Size structures of sampled fish indicate that populations at the Poor Knights Islands were derived from a single large recruitment event that occurred prior to 1975. The northern coastal group showed a similar decline in abundance between 1975 and 1982. Total mean abundance of *P. luculentus*, *C. sandageri*, and *S. aylingi* declined from >100 fish per 500 m^2 in 1975 to ~20 fish per 500 m^2 in 1982. However, abundance of all three species increased slightly between 1982 and 1985 suggesting recruitment to the local population. In contrast, the mean abundance of the widespread coastal species showed no consistent temporal pattern over the study period.

Distinct, localised spatial patterns also existed between sites and habitats. For example, high numbers of *S. aylingi* and *C. sandageri* were recorded at Nursery Cove, whereas the nearby Bartle's Bay had very low numbers of *S. aylingi* and *C. sandageri,* but high numbers of *P. alboscapularis.* Species abundances were also strongly influenced by habitat. *Coris sandageri* was most abundant in shallow, sandy reefs, *P. alboscapularis* was most abundant on exposed shores amongst algal stands, and *Parika scaber* was more abundant over *E. radiata* beds in waters deeper than 10 m. These variations in spatial distribution were emphasized, not masked, by temporal variations in abundances. The results of the study by Choat *et al.* (1988) showed that fish abundances vary greatly on both a temporal and spatial scale, and that temporal patterns can sometimes span several years. Management decisions based on fish abundance counts need to take into careful consideration the numerous factors that affect fish counts including species sampled, habitat, location, season, and sampling method.

Snapper (*Pagrus auratus*) and other reef fish species

Snapper are the most abundant demersal predatory fish in northeastern New Zealand and are thought to have an impact on the structure of coastal marine ecosystems (Shears & Babcock, 2002). Snapper are also heavily fished, both commercially and recreationally, and prior to implementation of full marine reserve status in October 1998 recreational fishing of snapper was permitted within the Poor Knights Islands Marine Reserve, with the exception of two small areas around Nursery Cove Reef/Bartle's Bay and Frasers Bay (~100 ha). Snapper abundances were monitored at the Poor Knights Islands biannually from September 1998 to September 2002 (Denny *et al.*, 2004). Two further surveys were conducted in autumn 2004 (Denny & Shears, 2004) and autumn 2007 (Denny, 2008). In 1998 there was no difference in snapper

density between the small fully protected areas and partially protected areas where snapper could be fished within the reserve, indicating that full protection of small areas is of little value for protecting targeted fish species. Four years after the implementation of full marine reserve status snapper abundance at the Poor Knights Islands had increased by nearly seven times, whereas snapper abundance at the nearby Mokohinau Islands and Cape Brett were unchanged. Abundances of snapper continued to increase until autumn 2004[16] but there was no significant change in snapper abundances between autumn 2004 and autumn 2007[17].

Although snapper abundance at the Poor Knights Islands appears to have reached a plateau, the mean size of snapper within the reserve appears to have steadily increased since the implementation of full marine reserve status. Mean fork length of snapper at the Poor Knights Islands increased from 274 ± 9 mm (S.E.) in 1999, to 324 ± 5 mm in 2001, to 354 ± 5 mm in 2004, to 384 ± 5 mm in 2007 (Denny *et al.*, 2003; Denny, 2008). The difference in the mean size of snapper between 1999 and 2001 is too large to be attributed to growth alone, and thus adult snapper must have immigrated into the reserve. It should be noted that it is possible that the increase in mean size between 2004 and 2007 may not be an accurate estimate of the real change in size between the two sampling dates owing to different methods being used to measure snapper size in 2004 and 2007 (see Denny, 2008 for more details).

A number of other species showed significant abundance changes of more than 100% in the four years following implementation of full marine reserve status at the Poor Knights Islands. Abundance of orange wrasse (*Pseudolabrus lucentus*), blue maomao, and pink maomao, were significantly higher in 2002 than in 1998, whereas abundances of banded wrasse (*Notolabrus fucicola*), butterfish (*Odax pullus*), crimson cleanerfish (*Suezichthys aylingi*), goatfish (*Upeneichthys lineatus*), red moki (*Cheilodactylus spectabilis*), and scarlet wrasse (*Pseudolabrus miles*) were significantly lower[18]. These results show that the reef fish community at the Poor Knights Islands changed rapidly following the establishment of a full marine reserve. Fish species targeted by recreational fishers such as snapper and pink maomao (Denny & Shears, 2004) increased significantly, whereas most non-target species showed no significant increase in abundance, with the exception of orange wrasse and blue maomao (Denny *et al.*, 2003). However, by 2007 snapper was the only monitored species at the Poor Knights Islands to show a significant increase in abundance in comparison to 1998 abundance levels. Four species (banded wrasse, butterfish, crimson cleanerfish, and pigfish (*Bodianus vulpinus*)), had significantly decreased in

[16] Taking into account the seasonal fluctuations in abundances of snapper
[17] Note that snapper abundances in 2007 may have been underestimated owing to a change in sampling method.
[18] These changes were not seen in the control sites (Mokohinau Islands and Cape Brett).

abundance since 1998, and 19 other species showed no significant change. Denny (2008) suggested that the lack of any long-term significant increase in fish densities, with the exception of snapper, nine years after implementation of full marine reserve status at the Poor Knights Islands may be explained by several reasons: 1) the large increase in snapper numbers may have caused a decrease in abundances of prey species or competiting species, 2) high snapper abundances may have caused habitat changes, 3) different divers used in different surveys had different fish estimates, and/or 4) long-term climatic changes many affect recruitment and subsequent survival of subtropical species to the Poor Knights Islands. Choat *et al*. (1988) recorded similar long-term declines in labrid abundances prior to implementation of full marine reserve status at the Poor Knights Islands (see above).

Hapuku (*Polyprion oxygeneios*)

Adult hapuku are deep water (50–350 m), demersal fish that are typically found near caves and other rocky reliefs. Juvenile fish are pelagic for a number of years and are rarely caught (Roberts, 1986; Paul, 2002). Schools of around 30 huge hapuku used to frequent waters < 40 m deep around the Poor Knights Islands, but the majority of the Poor Knights Islands hapuku population was caught prior to establishment of the full marine reserve (Doak, 1991). A tagging study conducted in 1988 around the vicinity of the Poor Knights Islands found that the median size of hapuku in deep waters around the reserve was 81.5 cm total length (TL), greater than the median size of fish from South Island (64.2 cm TL) or the Cook Strait (67.0 cm TL). Hapuku captured from around the Poor Knights Islands were largely residentiary, with fish recaptured within 51 km of their release location after a period of up to 3 years. In comparison, fish from South Island populations travelled distances of up to 1389 km before recapture. There was no evidence of mixing between the northeast Northland hapuku population and South Island populations suggesting that the northeast Northland hapuku population may be genetically distinct from South Island populations (Beentjes & Francis, 1999). Anecdotal reports state that the hapuku population around the Poor Knights Islands may be recovering with diver sightings of hapuku becoming more frequent (Grace, 2006).

Seasonal abundances

Snapper have a strong seasonal abundance at the Poor Knights Islands with higher abudance in autumn than in spring. It is thought that the snapper population at the Poor Knights Islands consists of ‘resident’ fish that are present all year round, and migratory fish that move in and out of the reserve seasonally. The influx of these

migratory fish can clearly been seen in the high autumn abundances at the Poor Knights Islands (Denny, 2008).

A number of other fish species show seasonal abundance patterns at the Poor Knights Islands. Scorpionfish (*Scorpaena cardinalis*), orange wrasse, Sandager's wrasse (*Coris sandageri*), pigfish, and spotties are significantly more abundant in autumn than spring, whereas porae, tarakihi (*Nemadactylus macropterus*), banded wrasse, and red moki are significantly more abundant in spring than in autumn (Denny *et al.*, 2003). Sting rays, eagle rays, and manta rays are common in the shallow waters around the Poor Knights Islands during summer and early autumn but are absent during winter (Doak, 2001c; Duffy & Abbott, 2003). There is some evidence that short-tailed stingrays (*Dasyatis brevicaudata*) do not travel far from the islands (<25 km) during winter, but spend increasing amounts of time in deeper waters (150–200 m) (Le Port *et al.*, 2008).

3.1.2 Fish diet

Russell (1983) examined the stomach contents of 50 species of fish common to northeastern New Zealand to provide information on their diet. Dietary information on fish species present at the Poor Knights Islands is given in Table 3. More detailed information on prey species and numerical percentage occurrence can be found in the original paper.

Table 3 **Percentage occurrence (by volume) of food in the stomachs of common fish at the Poor Knights Islands (Data summarised from Russell (1983).**

Fish species	Common name	Food	% Volume
Carnivorous fish			
Arripis trutta	Kawahai	Fish	66.6
		Euphausiids	33.3
Cheilodactylus spectabilis	Red moki	Amphipods	39.7
		Polychaetes	16
		Ophuriods	13
		Crabs	12.6
		Echinoids	8
		Molluscs	6.9
Chironemus marmoratus	Hiwihiwi	Molluscs	57.7
		Crabs	23.4
		Amphipods	6.6
		Hermit crabs	5.3
		Echinoids	4.3
Conger wilsoni	Short-finned conger eel	Crabs	95
		Hermit crabs	5
Dellichthys morelandi	Urchin clingfish	Echinoids	91.7
		Amphipods	8.3
Gilloblennius tripennis	Tripenny	Amphipods	30.8
		Hermit crabs	19.5
		Molluscs	19.4
		Crabs	7.5
		Polychaetes	6.3
		Barnacles	5.9
		Opiuroids	5.8
		Isopods	4.2
Gymnothorax prasinus	Yellow moray	Crab	86
		Fish	14
Helcogramma medium	Twister	Amphipods	57.1
		Molluscs	35.5
		Sandflies	4.3
Hypoplectrodes huntii	Red banded perch	Fish	58
		Crabs	24
		Hermit crabs	12
		Bivalves	2
		Amphipods	2
		Ophuroids	2
Latridopsis ciliaris	Blue moki	Amphipods	37.5
		Crabs	31
		Molluscs	9.9
		Corallina fragments	7.2
		Echinoids	5.7
		Polychaetes	5.0
		Isopods	3.5

Fish species	Common name	Food	% Volume
Lotella sp.	Rock cod	Crabs	50
		Fish	50
Myliobatis tenuicaudatus	Eagle ray	Gastropods	33.3
		Crabs	33.3
		Hermit crabs	30
		Shrimps	3.3
Nemadactylus douglasii	Porae	Polychaetes	19.5
		Ophuroids	19.4
		Amphipods	16.4
		Cephalochordates	16.4
		Echinoids	10.0
		Corallina fragments	6.2
		Crabs	5.0
		Molluscs	5.2
Notoclinops segmentatus	Blue-eyed triplefin	Amphipods	59.0
		Barnacles	25.3
		Polychaetes	5.3
		Rhabdocoels	4.7
		Ostracods	2.7
Notolabrus celidotus	Spotty	Molluscs	47.9
		Crabs	30.5
		Hermit crabs	12.8
		Amphipods	5.6
Notolabrus fucicola	Banded wrasse	Crabs	40.6
		Hermit crabs	30.6
		Molluscs	28.8
Optivus elongatus	Slender roughy	Shrimps	53.3
		Crustaceans	43.3
		Amphipods	3.3
Pagrus auratus	Snapper	Crabs	30.9
		Molluscs	30.6
		Echinoids	28.3
		Fish	3.3
		Polychaetes	2.7
		Ophuroids	2.6
Parablennius laticlavius	Crested blenny	Copepods	28.6
		Mollusc eggs	27.2
		Hydrozoans	17.4
		Barnacles	9.3
		Molluscs	8.3
		Cyanophyceae	6.4
		Amphipods	2.1
Parapercis colias	Blue cod	Fish	39.6
		Hermit crabs	35.8
		Crabs	15.4
		Molluscs	7.5

Fish species	Common name	Food	% Volume
Parika scaber	Leatherjacket	Sponges	36.8
		Ascidians	28.8
		Rhodophyceae	11.8
		Echinoids	9.4
		Bryozoans	6.9
		Hydrozoans	3.1
Paristiopterus labiosus	Giant boarfish	Holothurians	24
		Crabs	20
		Amphipods	15
		Echiuroids	12
		Ophiuroids	12
		Polychaetes	9
		Bivalves	8
Pempheris adspersus	Big eye	Polychaetes	78.3
		Gastropods & *Corallina* fragments	9.4
		Isopods	7.6
		Amphipods	2.8
Pseudolabrus miles	Scarlet wrasse	Hermit crabs	58.9
		Crabs	15.1
		Ophuroids	12.9
		Barnacles	7.9
		Molluscs	4.0
Pseudophycis breviuscula	Red cod	Amphipods	40
		Hermit crabs	20
		Barnacles	16.6
		Crabs	13.3
		Shrimps	10
Scorpaena cardinalis	Scorpion fish	Crabs	66.6
		Hermit crabs	16.7
		Shrimps	16.7
Seriola lalandii	Kingfish	Fish	100
Thrysites atun	Barracouta	Fish	100
Upeneichthys lineatus	Goatfish	Crabs	66.6
		Amphipods	30.0
		Bivalves	1.3
Zeus faber	John dory	Fish	100
Planktivorous fish			
Caesioperca lepidoptera	Butterfly perch	Copepods	70.5
		Paguran larvae	9.5
		Chaetognaths	8.0
		Euphausiid larvae	5.3
		Other plankton	6.7
Chromis dispilus	Demoiselle	Copepods	97.3
		Other plankton	2.7

Fish species	Common name	Food	% Volume
Decapterus koheru	Koheru	Copepods	42.2
		Mysids	20
		Euphausiid larvae	16.6
		Crab larvae	10.5
		Larvaceans	9.5
		Other plankton	0.9
Hyporhamphus ihi	Piper	Mysids	40
		Crab larvae	23
		Paguran larvae	15
		Polychaete larvae	13
		Ostracods	5
		Copepods	3
		Cumaceans	1
Scorpis aequipinnis	Sea sweep	Larvaceans	53
		Copepods	25
		Mysids	12.6
		Chaetognaths	4.5
		Paguran larvae	2.9
Herbivorous fish			
Aplodactylus arctidens	Marblefish	Rhodophyceae	80
		Phaeophyceae	15
		Chlorophyceae	5
Kyphosus sydneyanus	Silver drummer	Phaeophyceae	95
		Rhodophyceae	5
Odax pullus	Butterfish	Phaeophyceae	100
Parma alboscapularis	Black angelfish	Rhodophyceae	80
		Chlorophyceae	20

3.2 Sea snakes and turtles

Seven marine reptiles have been recorded from New Zealand; the loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), olive ridley turtle (*Lepidochelys olivacea*), leathery turtle (*Dermochelys coriacea*), yellow-bellied sea snake (*Pelmis platurus*), and the banded sea snake (*Laticauda colubrina*) (Gill, 1997). All these tropical species have been found around northeastern New Zealand, but they only occur incidentally and do not reside or breed in New Zealand waters. Most of the sightings of marine reptiles in New Zealand occur during the summer months as most species, with the exception of the leathery turtle, are likely to die or move out of New Zealand waters during winter. For example, the lower temperature limit for the yellow-bellied sea snake is 17°C (Whitaker, 2002). While turtles have occassionally been reported from around the Poor Knights Islands very few of the turtles are identified or recorded, therefore actual abundances are unknown. The green turtle, leathery turtle, loggerhead turtle, and hawksbill turtle have

been reported from the Poor Knights Islands (J. Choat, pers. comm. in Kelly, 1983; Gill, 1997; Abbott & Rousseau, 2002; Doak, 2008).

3.3 Marine mammals

Ten marine mammal species have been recorded from the waters around the Poor Knights Islands consisting of five species of baleen whales, four species of toothed whales/dolphins, and the New Zealand fur seal (Table 4). Six other marine mammal species have been recorded from the Tutukaka coastline and may also utilise the waters around the Poor Knights Islands (Kelly, 1983). The most common marine mammals at the Poor Knights Islands are the common dolphin (*Delphinus delphis*), the bottlenose dolphin (*Tursiops truncatus*), and the New Zealand fur seal (*Arctocephalus forsteri*). Common dolphins are most abundant at the Poor Knights Islands during spring and travel in pods ranging from a few individuals to hundreds (Doak, 2001b). Northern New Zealand populations are known to eat jack mackerel (*Trachurus novaezelandiae*), kahawai (*Arripis trutta*), yellow-eyed mullet (*Aldrichetta forsteri*), flying fish (*Cypselurus lineatus*), parore (*Girella tricuspidata*), and garfish (*Hyporamphus ihi*) (Neumann & Orams, 2003). Bottlenose dolphins are most abundant at the Poor Knights Islands during winter, but they are also common during January. Pods of up to 200 bottlenose dolphins have been encountered at the Poor Knights Islands. Both common and bottlenose dolphins frequently interact with divers and boats (Doak, 2001b). New Zealand fur seals are frequently visitors to the High Peak Rocks (Pinnacles) during winter and up to 45 seals have been sighted hauling out on the High Peak Rocks (Northland Regional Council, 2003). Individual fur seals are commonly seen in the waters around the Poor Knights Islands, and on occasion on the wave platform on the northeastern side of Aorangi Island (K. Hawkins, DOC, pers. comm.).

Table 4 **Marine mammals recorded from around the Poor Knights Islands (PK) or the Tutukaka (T) coastline.**

Family	Species	Common name	Recorded from PK or T	Reference
CLASS MAMMALIA				
Order Cetacea				
Balaenidae	*Eubalaena australis*	Southern right whale	PK	Patenaude (2003)
	Eubalaena glacialis	Northern right whale	T	Kelly (1983)
Balaenopteridae	*Balaenoptera acutorostrata*	Minke whale	PK	Doak (2001c)
	Balaenoptera borealis	Sei whale	PK	Doak (2001c)
	Balaenoptera edeni	Brydes whale	PK	Abbott & Rousseau (2002)
	Megaptera novaeangliae	Humpback whale	PK	Doak (2001c)
Delphinidae	*Delphinus delphis*	Common dolphin	PK	Abbott & Rousseau (2002)
	Globicephala melas	Long-finned pilot whale	PK	Abbott & Rousseau (2002)
	Grampus griseus	Risso's dolphin	T	Kelly (1983)
	Orcinus orca	Orca	PK	Abbott & Rousseau (2002)
	Pseudorca crassidens	False killer whale	T	Kelly (1983)
	Tursiops truncatus	Bottlenose dolphin	PK	Abbott & Rousseau (2002)
Kogiidae	*Kogia sima*	Dwarf sperm whale	T	Kelly (1983)
Physeteridae	*Physeter catodon*	Sperm whale	T	Kelly (1983)
Ziphiidae	*Mesoplodon* sp.		T	Kelly (1983)
Order Carnivora				
Otariidae	*Arctocephalus forsteri*	NZ fur seal	PK	Abbott & Rousseau (2002)