eventual aim is to provide a single, comprehensive document on the Poor Knights Islands Marine Reserve that can be used to assist managers of the reserve to make appropriate management decisions. However, owing to funding constraints the document will be written in stages as time and funding allows. This first report covers the physical environment of the reserve, marine vertebrates, marine macroalgae, subtidal habitats, and biosecurity aspects.

2. The physical environment

2.1 Seabed geology and bathymetry

The Poor Knights Islands are located on New Zealand's northeastern continental shelf at 35°28'S, 174°44'E. The volcanic origin of the Poor Knights Islands is obvious in the geology of the islands and the seabed. The islands are extremely steep, with cliffs reaching over 200 m above and extending over 100 m below sea level. The seabed drops sharply away from the coastline along much of the island, reaching depths of over 100 m within the 800 m radius of the marine reserve. A shallow region joins Tawhiti Rahi Island and Aorangi Island, with depths typically less than 30 m (Fig. 4). Shallow, gently sloping rocky reefs exist at South Harbour, Maroro Bay, Nursery Cove, Bartle's Bay, Cleanerfish Bay, and Lighthouse Cove (Fig. 2). Away from the steep gradient of the islands the continental shelf is predominantly regular and flat, with the occasional peak rising sharply from the sea floor. The continental shelf edge occurs approximately 10 km offshore of the islands at approximately 150–180 m depth (Eade, 1967; Stewart, 2001).

Medium to coarse shelly sand is the predominant sediment type on the inner shelf around the Poor Knights Islands. Finer sand is present in areas of Maroro Bay and Skull Bay. The sediment is predominately bioclastic[2] with a small lithic[3] component and almost no mud. The bioclastic component of the sediment primarily consists of skeletal debris from bryozoans and molluscs, with smaller percentages of barnacle, brachiopod, echinoid, and scleractinian coral skeletons (Brook *et al.*, 2001). Further out towards the continential slope, the grain size of sediments differs significantly north and south of the Poor Knights Islands. North of the islands, coarse, shelly sands graduate into well-sorted fine sands on the shelf and upper slope down to about 500 m, which graduate into progressively finer deposits in deeper water. South of the islands, coarse shelly sands grade rapidly into sandy mud and mud deposits on the central

[2] Skeletal carbonate sands
[3] Rock/stone

shelf. On the outer shelf fine sands graduate into finer deposits in deeper water (Eade, 1967).

Most of the sediment on the continental shelf of northeastern New Zealand has a carbonate content of less than 40%. However, carbonate concentrations close inshore around the Poor Knights Islands are higher than average owing to the high proportion of bioclastic sands. East of the Poor Knights Islands, a region beyond the shelf edge at 300–500 m depth has an usually low percentage (<20%) of carbonate in the sediment owing a high percentage of volcanic glass (Eade, 1967).

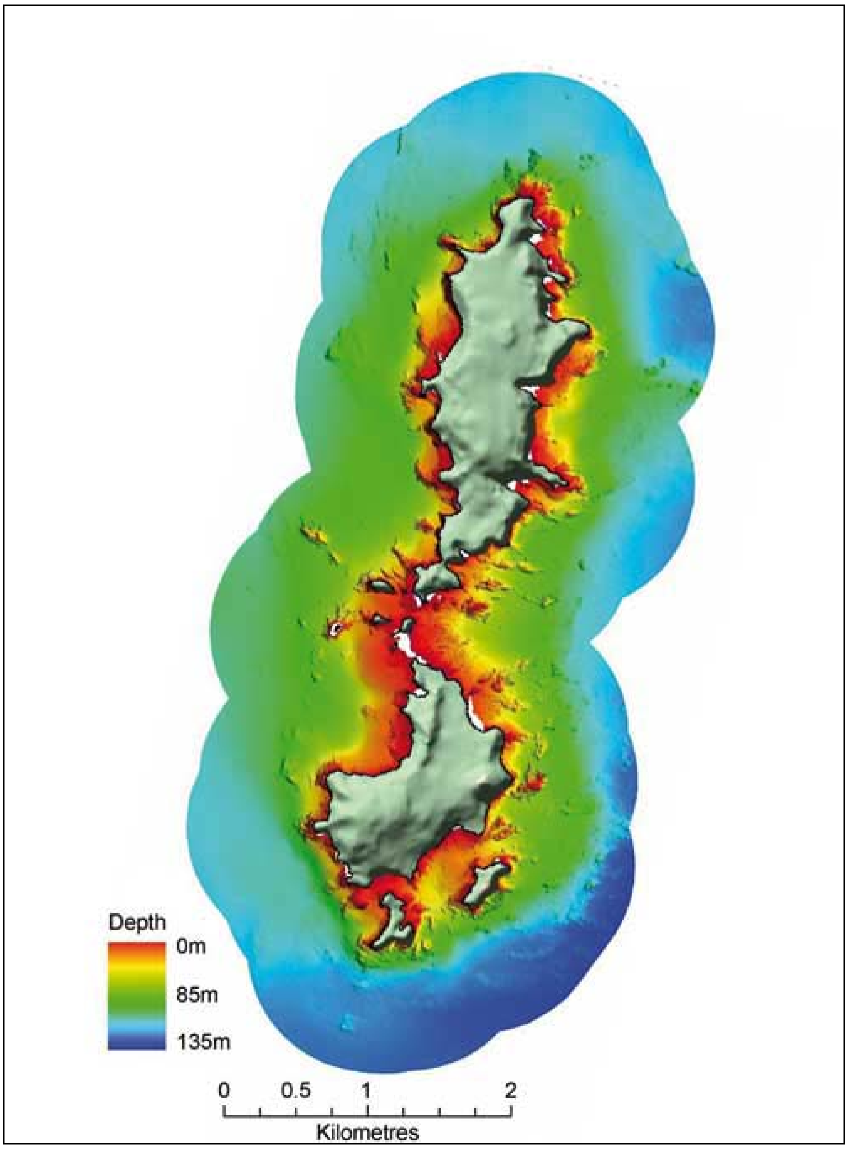

Figure 4 **Bathymetry map of Poor Knights Islands produced by high resolution multi-beam sonar. The edge of the coloured area aligns with the reserve boundary (Map reproduced with permission from Morrison *et al.*, 2007).**

2.2 Hydrology of the area

The East Australian Current forms the principle southward flowing current along the east coast of Australia. This very strong current, originating in the Coral Sea travels south to approximately Brisbane where a major branch turns eastward across the Tasman Sea towards New Zealand. The current, now called the East Auckland Current, passes north of New Zealand and flows down the northeastern coastline of New Zealand to East Cape following approximately the edge of the continental shelf (Fig. 5), at speeds of between 0.18–0.3 m/s (Harris, 1985). This current of warmer oceanic waters is usually held offshore by topographic trapping over the continental shelf (Sharples, 1997). Thus, a band of 'resident' hydrologically different coastal water usually exists between the mainland and the East Auckland Current. On occasions during periods of intense stratification in spring–summer, strong southeasterly winds may drive the clear, warm oceanic waters of the East Auckland Current closer towards the mainland resulting in a rapid increase in water temperatures (~2°C) and salinity (Sharples, 1997). This summer event, known by local communities as "the blue water coming in", transports oceanic plankton and planktonic life-stages of subtropical species closer towards the northeastern coastline of New Zealand (Zeldis *et al.*, 1995; Sharples, 1997).

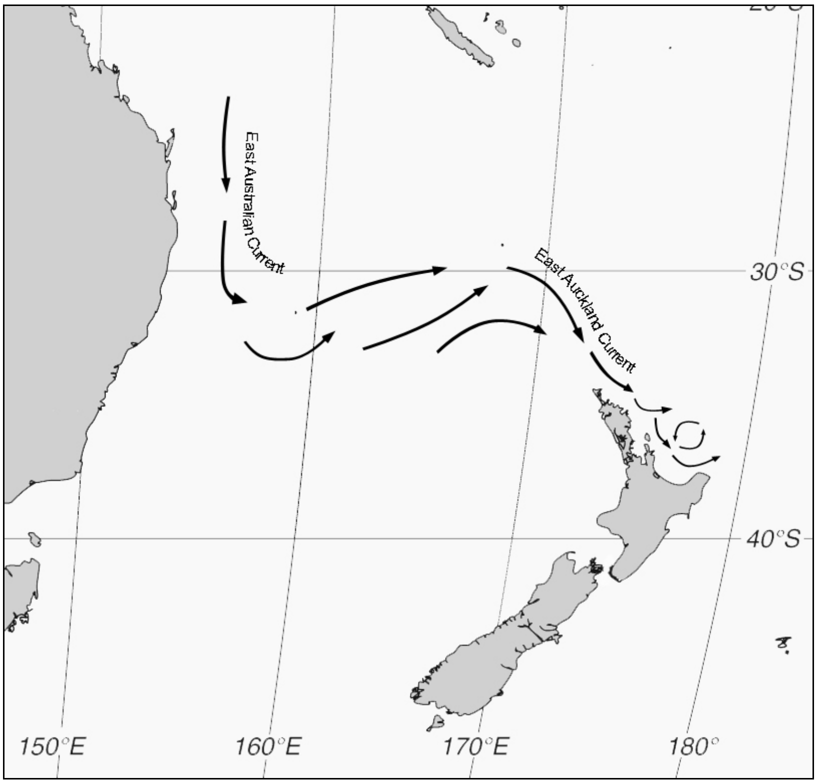

Figure 5 Generalised path of the East Australian and East Auckland currents.

The Poor Knights Islands are situated 5–10 km west of the shelf-break sea surface temperature front that separates the cooler coastal waters from the East Auckland Current (Stewart, 2001), and thus, the islands are more frequently influenced by waters of higher temperature, salinity, and clarity[4] than the waters around the mainland or at other islands on the northeastern coastline[5]. On certain days sea surface temperature (SST) at the Poor Knights Islands can be 2°C higher than on the adjacent coastline (Grace, 1983), but long-term SST data collected by satellite mounted Advanced Very High Resolution Radiometer shows much smaller differences in average SST between the Poor Knights Islands and the adjacent coastline. Comparison of the average monthly SST for the Poor Knights Islands and the Tutukaka coastline between 1993 and 2007 show a that the SST around the Poor Knights Islands is, on average, only 0.2°C higher than the SST of the Tutukaka coastline (NIWA Satellite Data Services[6], unpublished data). The largest temperature differences between the two regions appears to be during the winter months (July–September), when average SST at the Poor Knights Islands are 0.5–0.8°C higher than along the Tutukaka coastline (Fig. 6). Maximum SST of around 22°C occur in February at the Poor Knights Islands and minimum SST of around 13°C occur in September (NIWA Satellite Data Services, unpublished data). The water is thermally stratified with surface temperatures typically 5°C higher than temperatures at 100 m depth. The depth of the surface mixed layer varies but typically ranges between 30–50 m (Stewart, 2001).

[4] Water clarity at the Poor Knights can exceed 30 m (Grace, 1983)
[5] It should be noted that pronounced cold water upwellings at North Cape and the Three Kings Islands override the strong subtropical influence of the East Auckland Current that one might expect in these more northern regions (Kelly, 1983).
[6] http://www.niwascience.co.nz/services/paid/sat

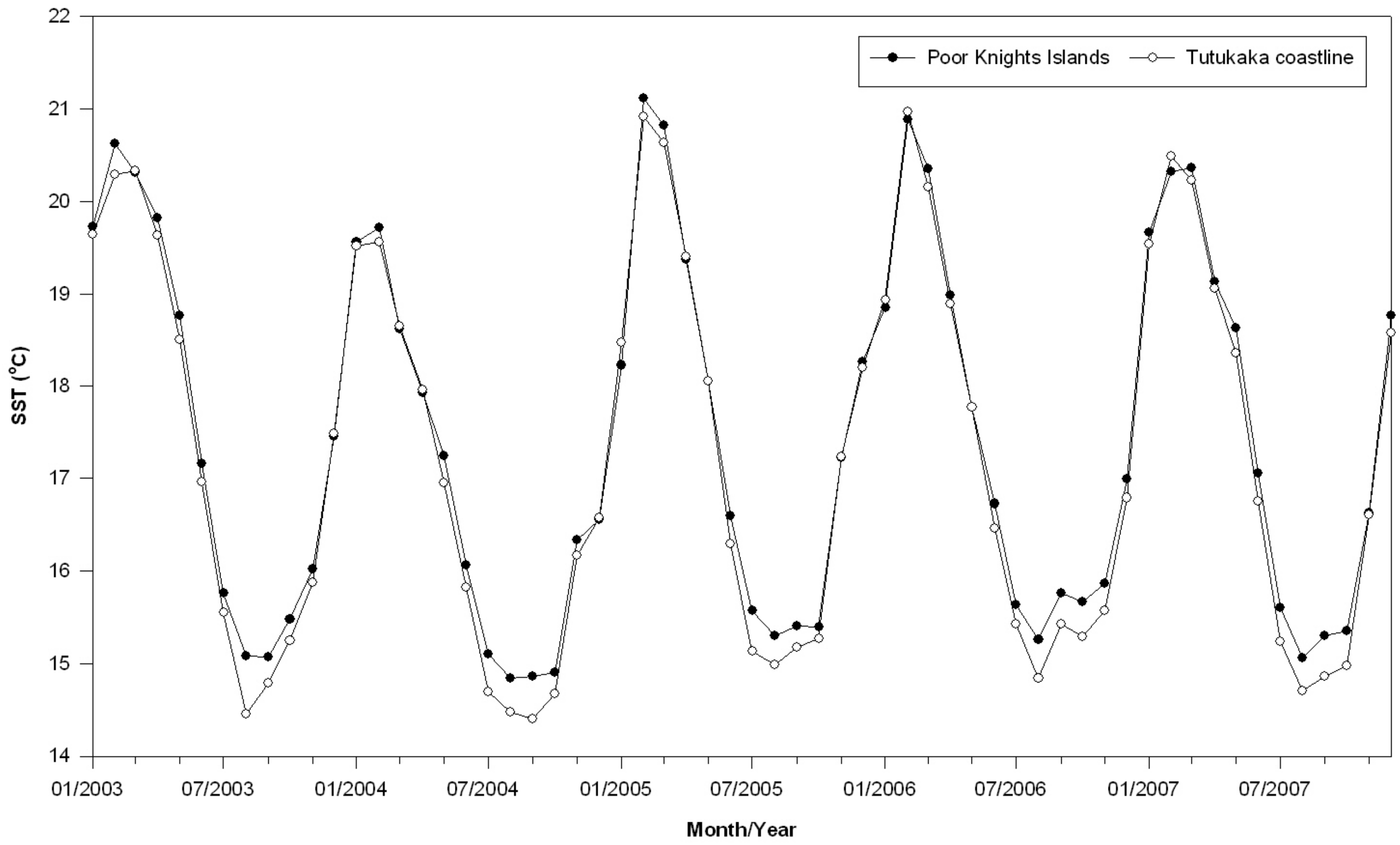

Figure 6 **Average monthly Sea Surface Temperatures (SST) for the Poor Knights Islands and the Tutukaka coastline between 2003 and 2007 (Data from NIWA Satellite Services).**

The East Auckland current is the main non-tidal current that affects the Poor Knights Islands, flowing predominantly southeast with a mean speed of 0.2 m/s (Sharples & Greig, 1998). Waters around the Poor Knights Islands are also affected by onshore internal waves and a strong north–south tidal current, which reverses direction depending on the state of the tide (Kingsford & MacDiarmid, 1988). Internal waves are generated by the interaction of tides, stratification, and bathymetry at the continental shelf edge. These waves facilitate vertical mixing of the water column drawing nutrients from deeper waters to the surface, and may provide a mechanism for the shoreward transport of larvae and plankton. The main tide-driven internal wave travels towards the Poor Knights Islands at a mean speed of 0.3 m/s and has a minimum travel time of 30 hours from the closest generation region (Stevens & Abraham, 2005).

Spring tides at the Poor Knights Islands have a maximum range of around 2 m and neap tides have a range of around 1 m (Stevens & Abraham, 2005).