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Short communication

Distribution, seasonality, lengths, and feeding behaviour of whale sharks (*Rhincodon typus*) observed in New Zealand waters

C. A. J. DUFFY
Department of Conservation
P.O. Box 112
Hamilton, New Zealand
email: cduffy@doc.govt.nz

Abstract Data from 36 whale shark (*Rhincodon typus* Smith, 1828) sightings off north-east North Island, New Zealand are summarised. Sightings were concentrated over the outer shelf and shelf break in areas influenced by the East Auckland Current at sea surface temperatures (SST) of 21–24°C. Sightings occurred from late spring to early autumn (November–April) but were most frequent in midsummer (February) when upwelling along the north-east shelf is weakest. The data indicate whale sharks occur off north-east New Zealand most summers, including those when SST is colder than usual. A cluster of sightings and three observations of whale sharks feeding on schools of anchovy (*Engraulis australis*) near Whale Island, Bay of Plenty, suggest whale sharks may aggregate seasonally in this area. Estimated total lengths (TL) of 26 whale sharks ranged from 3.5 to 15 m, with 73% between 6 and 9 m TL.

Keywords whale shark; *Rhincodon typus*; distribution; seasonality; size frequency; anchovy; East Auckland Current; New Zealand

INTRODUCTION

The whale shark (*Rhincodon typus* Smith, 1828) is generally considered to be circumglobally distributed in tropical and subtropical seas, with isolated records from warm temperate areas (Compagno 1984; Wolfson 1986; Taylor 1994; Colman 1997). It is classified as globally vulnerable on The World Conservation Union (IUCN) Red List, and is protected in a number of countries including India, the Maldives, Australia, the Philippines, Malaysia, the United States, and Honduras (Fowler & Cavanagh 2001). Recent global reviews and regional faunal lists show no records of whale sharks from New Zealand waters (Wolfson 1986; Paulin et al. 1989; Last & Stevens 1994; Colman 1997). Cox & Francis (1997) listed the whale shark among the Chondrichthyans recorded from New Zealand, describing its as a rare visitor that only appears during warm summers. Before that only five sightings in New Zealand waters had been reported in the popular angling literature (Grace 1985; Roberts 1997; Roberts et al. 1997). Between January 1991 and May 2001, I compiled 36 anecdotal records of whale shark sightings from New Zealand. This note summarises the data on the distribution, seasonality, lengths, and feeding behaviour obtained from those records.

METHODS

Details of sightings were obtained from popular magazine articles, records of the Museum of New Zealand Te Papa Tongarewa, and interviews with divers, recreational and commercial fishers, a tuna spotter plane pilot, and charter-fishing operators. Wherever possible, photographs or video were used to confirm correct species identification. Where photographic evidence was unavailable species identification was confirmed if the observer was able to describe the unique colour pattern of light spots and stripes characteristic of the whale shark (Compagno 1984). Reports provided by experienced

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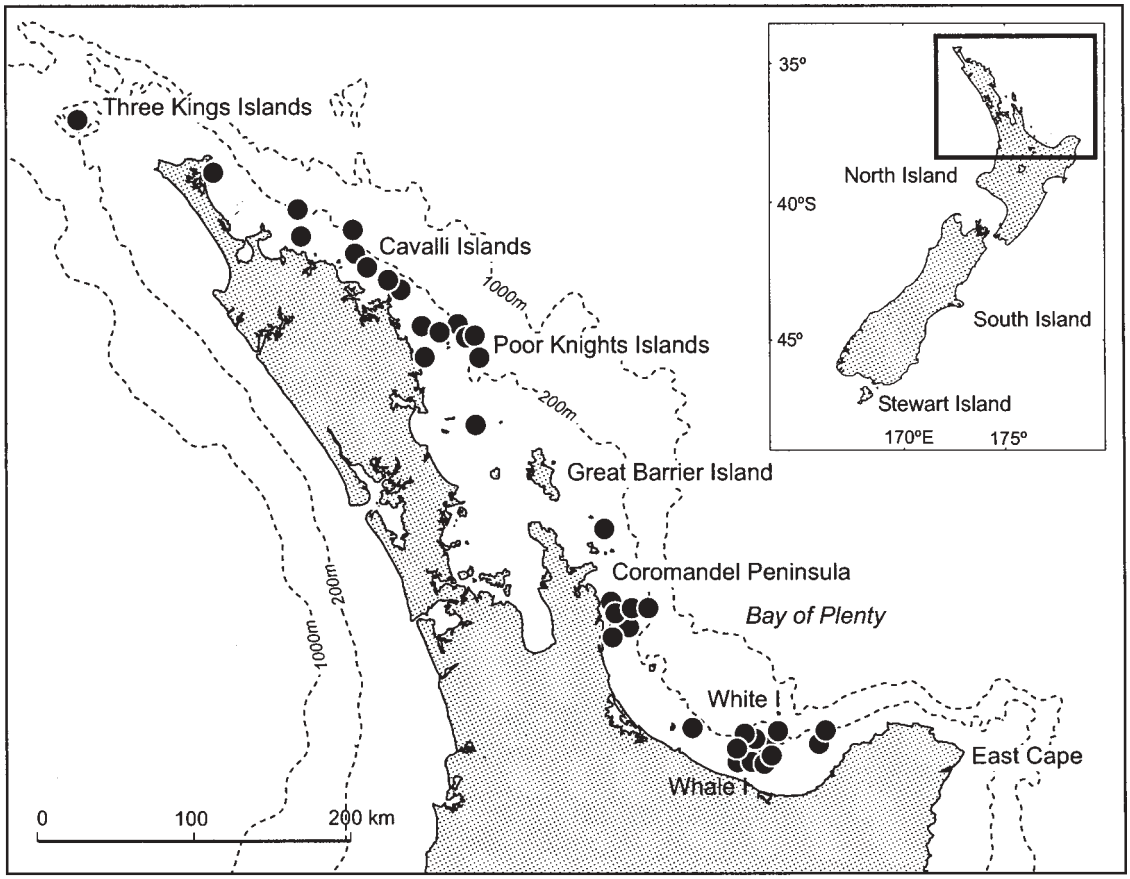

Fig. 1 Location of whale shark (*Rhincodon typus*) sightings off North Island, New Zealand.

observers of pelagic fishes were also considered reliable. Where the exact location of the sighting was not known, an indicative position was plotted on a navigational chart using information on seabed depth and/or distance from shore provided by the observer. Where seabed depth was not reported, but a distance from shore, or position relative to one or more landmarks was given, depth was estimated from the chart. Seabed depth was not estimated when only the general area of the sighting was reported.

RESULTS AND DISCUSSION

No incidental catches in fishing gear, commercial or non-commercial landings, or beach-cast whale sharks have been reported from New Zealand. The distribution of sightings is shown in Fig. 1. One sighting was from Princes Chain, Three Kings Islands (34°10′S). The remainder were made between North Cape (34°28′S) and Whale Island, Bay of Plenty (37°49′S) (Fig. 1). Seabed depths for 26 sightings ranged from 50 to 490 m, mean 155.9 m (±SE 23.5), and mode 100 m. Mean and modal depths are indicative of outer shelf and shelf-break locations, however as most sightings were reported by gamefishers there is probably a strong observer bias toward this habitat in the data. Clusters of sightings off Northland, Coromandel Peninsula, and Whale Island also correspond to popular game-fishing grounds (Fig. 1).

Although the year-of-sighting was unknown for eight records, all sightings were made between 1980 and 2001. Only three recorded sightings were made before 1991, one from c. 1981, one from January 1985 (Grace 1985), and one from c. 1988. As some Northland charter operators spoken to do not consider sightings of whale sharks particularly

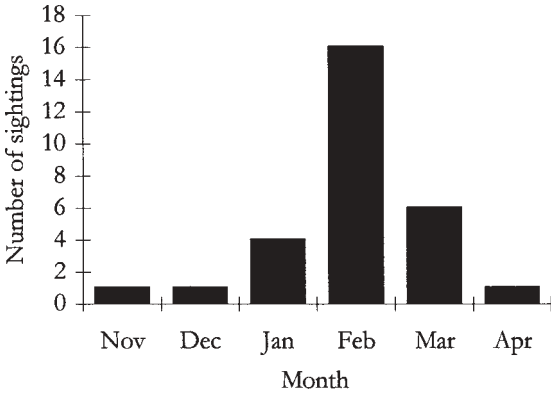

Fig. 2 Seasonality of whale shark sightings off North Island, New Zealand.

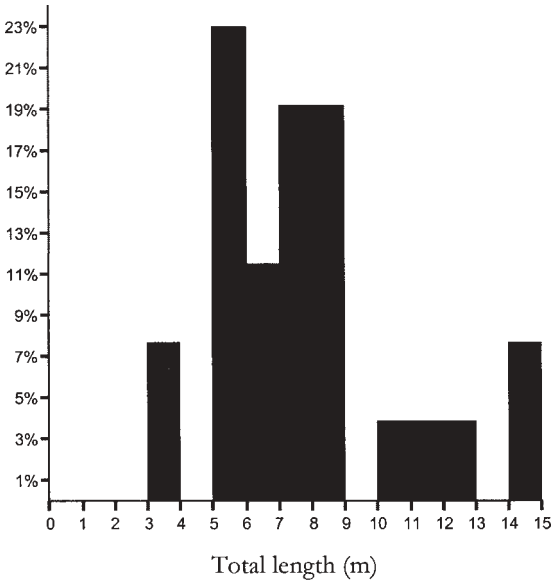

Fig. 3 Length frequency of whale sharks observed off north-east North Island, New Zealand.

unusual, the low number of sightings recorded before 1991 probably reflects an absence of research, rather than an increase in the abundance of whale sharks in New Zealand waters during the 1990s. Whale shark sightings were reported every year from 1991 to March 2001 inclusive, except 1993 and 1994 (one sighting was reported from c. 1994). Sixteen sightings (48%) were reported from 1996 to 1999 inclusive. During this period, the annual number of reported sightings ranged from three in 1997, to five in 1998. The month-of-sighting was known for 20 records. All occurred between November and April inclusive. Most (89.6%) were reported from January to March inclusive, with 55% reported in February (Fig. 2). Sea surface temperature (SST) reported for eight sightings ranged from 21 to 24°C, mean 22.04°C (±SE 0.24).

The estimated total length (TL) of 26 sharks ranged from 3.5 to 15 m, mean 8.15 m (SE 0.58). Only two sharks were less than 6 m TL. Most (73%) were between 6 and 9 m TL (Fig. 3). No sharks were sexed. Most sightings were of individual sharks swimming at or near the surface. A single pair of whale sharks was observed off the Cavalli Islands. The largest shark in the pair, c. 15 m TL, was swimming at the surface. The second shark, c. 7.5 m TL, was swimming several metres below it (T. Lay pers. comm.). On three separate occasions individual sharks were observed hanging vertically in the water suction-feeding on schools of anchovy (*Engraulis australis*) near Whale Island, Bay of Plenty (Fig. 4). These were the only observations of feeding reported.

These data suggest that although they are infrequently observed, whale sharks probably migrate annually to New Zealand waters during spring and summer like many other subtropical pelagic fishes (Ayling & Cox 1982; Grace 1985; Francis et al. 1999). However, although the midsummer peak in sightings is consistent with records of whale sharks from other temperate regions there is little direct evidence that whale sharks undertake regular seasonal migrations (Gudger 1952; Whitley 1965; Beckley et al. 1997; Colman 1997; Wilson et al. 2001). Francis et al. (1999) observed that although influxes of tropical and subtropical marine species occur around northern New Zealand during warmer than usual summers, some probably also arrive in average and cool summers. This is certainly the case for whale sharks. Of the years with the highest number of whale shark sightings, 1996, 1998, and 1999 were warmer than usual, whereas 1997 was colder than the long-term average for north-east North Island (Francis et al. 1999). Whale sharks were also reported in 1991, 1992, 1994, and 1995, all years that were colder than usual (Francis et al. 1999).

The distribution and abundance of whale sharks is generally considered to be influenced by oceanographic features such as upwelling, boundary currents, and fronts that enhance pelagic productivity (Iwasaki 1970; Taylor 1996; Colman 1997; Eckert & Stewart 2001; Wilson et al. 2001). Off north-east New Zealand the distribution of whale shark sightings reflects the path of the East Auckland

Fig. 4 A 7.6 m total length whale shark (*Rhincodon typus*) feeding on anchovy (*Engraulis australis*) near Whale Island, Bay of Plenty, New Zealand, February 1999. Two large remora (Echeneidae) are visible on the dorsal surface of the shark's head.

Current (EAUC) (Stanton et al. 1997). The EAUC is a boundary current, derived mainly from part of the East Australian Current that meanders east across the Tasman Sea at c. 31°S (Heath 1985). This flow gives rise to the EAUC north-east of North Cape, and from there it flows south-east along the east coast of North Island to East Cape (Heath 1985; Ridgway & Greig 1986; Stanton et al. 1997). Consequently, SSTs during autumn, winter, and early spring are generally 1°C warmer off the north-east North Island than at the corresponding latitude on the west coast (Chiswell 1994). Iwasaki (1970) found that whale shark sightings in the western north Pacific Ocean tended to be associated with the path of the Kuroshio Current, and were most common at SSTs between c. 21 and 25°C. In the New Zealand region, mean summer SST generally ranges from 20 to 23°C north of 38°S (Chiswell 1994; Anon. 2000, 2001).

It is thought that whale sharks may time their movements to coincide with localised productivity events or behavioural changes in their prey, such as schooling, that allow for more efficient exploitation (Wilson et al. 2001). However, the environmental cues they might use to achieve this are largely unknown. Wilson et al. (2001) found that indices of whale shark abundance off Ningaloo Reef, Western Australia, were only weakly to moderately correlated with the Southern Oscillation Index, SST, and an index of the strength of the Leeuwin Current. As already noted, the occurrence of whale sharks off north-east New Zealand does not appear to be determined by summer SST. Similarly, physical signals of upwelling do not appear to directly influence their distribution in New Zealand waters. Upwelling along the north-east shelf and western Bay of Plenty is wind-driven and therefore tends to be weakest during spring and summer when stratification of the water column is strongest and whale shark sightings are most frequent (Chang et al. 1996; Sharples & Greig 1998). Also, whale sharks were

present during late 1998 and 1999 when the La Niña phase of the Southern Oscillation shut down upwelling and suppressed the 1999 spring bloom on the north-east shelf (Zeldis et al. 2001).

Compared with the north-east shelf, the inner shelf waters of the Bay of Plenty are relatively dilute and nutrient-rich (Chang et al. 1996). Anchovy aggregate to breed in such areas (Palomera 1992; Hoedt & Dimmlich 1995), and from about January to mid March large schools of anchovy are the focus of intense pelagic feeding activity in the eastern Bay of Plenty (Ayling & Cox 1982). As anchovy are an energy rich prey (Takahashi et al. 2001), whale sharks may aggregate in this area to feed on them. Elsewhere, whale sharks are known to aggregate seasonally to feed on small schooling fishes, fish spawn, squid, and planktonic crustaceans, including copepods and euphausids (Gudger 1941; Hoffman et al. 1981; Taylor 1994, 1996; Clark & Nelson 1997; Colman 1997; Heyman et al. 2001).

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