

Bryde's whales (*Balaenoptera* *cf. brydei* Olsen 1913) in the Hauraki Gulf and northeastern New Zealand waters

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Cover: Bryde's whale in a feeding workup off the Northland coast.
Photo: Dr Ingrid Visser.

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ABSTRACT

Aerial surveys for Bryde's whales *Balaenoptera* cf. *brydei* were undertaken over the Hauraki Gulf and northeastern coast of New Zealand between 1999 and 2003. Whales were sighted in all months, with usually more whales seen in summer. The density of whales within the Hauraki Gulf was examined in relation to geographical location and sea surface temperatures. Whale densities were significantly higher in the inner parts of the Gulf, and in waters warmer than 14°C. Bryde's whales occurred along the entire northeastern coast from the Hauraki Gulf to North Cape, and tended to concentrate around headlands intersecting the East Australian Current. Whales were observed feeding, primarily on small fish, but crustaceans are probably also part of their local diet. The presence of calves in the survey area indicated a late winter to early spring calving season in New Zealand waters or the nearby oceanic Pacific. Short-beaked common dolphins *Delphinus delphis* and common bottlenose dolphins *Tursiops truncatus* associated with Bryde's whales in feeding workups, that were also attended by gannets *Morus serrator*, shearwaters and petrels (Procellariidae), and terns (Laridae). Bryde's whale habitat in the Hauraki Gulf coincides with shipping lanes, and a number of these whales have been struck and killed by large vessels in recent years.

Keywords: Bryde's whales, *Balaenoptera* cf. *brydei*, northeastern New Zealand, Hauraki Gulf, aerial survey, distribution, ecology

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1. Introduction

Bryde's whales are small balaenopterids found in warm temperate, subtropical, and tropical oceans around the world. Three species have been described—*Balaenoptera edeni*, *B. brydei*, and *B. omurai*—and a number of geographical populations have been identified which differ morphologically and genetically (e.g. see Best 1977, 2001; Ivashin 1980; Perrin et al. 1996; Rice 1998; Wada et al. 2003). The exact taxonomic status of the three species throughout their range is confused and remains to be resolved. A group of small-sized whales (up to 11.5 m long) that lives in the inshore coastal waters of the eastern Indian Ocean and the western Pacific is thought to represent the type species *edeni*. This is believed to be marginally sympatric with the group of larger-sized whales (up to 16.3 m long) which lives in tropical and warm temperate waters around the world, and may represent another taxon, for which the specific or subspecific name *brydei* is now available (Olsen 1913; Ivashin 1980; Wada et al. 2003), despite it earlier being described as synonymous with *B. edeni* (Junge 1950). Recent molecular analysis of mtDNA from all nominal species of 'Bryde's' whales has separated *brydei* from *edeni* and resulted in a third species—*B. omurai*—being described from specimens collected mostly in tropical waters of the western Pacific and eastern Indian oceans (Wada et al. 2003).

Bryde's whales were first recognised in southwest Pacific waters by Dr W.H. Dawbin during the late 1950s when he examined samples taken from what were previously considered by whalers and scientists to be sei whales *Balaenoptera borealis* from the Hauraki Gulf, northern North Island, New Zealand (Gaskin 1968). Dawbin had observed these whales in the Gulf while attempting to find humpback whales *Megaptera novaeangliae* to mark with Discovery tags (Dawbin 1956). A short-lived commercial whaling enterprise existed on Great Barrier Island (Aotea Island) in the Hauraki Gulf between 1956 and 1963. This focused on humpback whales, but also took 19 Bryde's whales, although the latter were not considered an economic proposition because of their low oil yield and elusive nature (Mr Charlie Heberly, former manager of the whaling station, pers. comm. August 1999; and Heberly 2004).

The New Zealand population of Bryde's whales was first regarded as *Balaenoptera edeni* by Gaskin (1965, 1968), and although this attribution was not based on morphological examination of specimens, subsequent authors continued to use this name. The average and maximum total lengths of specimens taken during the whaling period in New Zealand recorded by Gaskin (1968) were 14.9 m for males and 16.3 m for females. These lengths indicate that this population should almost certainly be assigned to the larger, *brydei* size-group. Acknowledging that some confirmatory research, both morphological and genetic, remains to be done on the New Zealand population, it is referred to as *Balaenoptera* cf. *brydei* in this report.

There has been limited directed research on Bryde's whales in New Zealand. Dawbin (1956) collected whaling-related observations, Gaskin (1963, 1968) recorded sightings and measurements of caught specimens, and there are some more recent opportunistic ecological observations by O'Callaghan & Baker (2002),

Thompson et al. (2002) and researchers from Auckland University. However, there has been no concerted longer-term effort to understand the seasonal occurrence, distribution, or behaviour of the species in New Zealand waters.

The Hauraki Gulf (35°55'S - 36°55'S, 175°E), is a large (c. 1500 n.m.², < 90 m deep) embayment on the northeastern coast of the North Island of New Zealand (Fig. 1). The northern limit of the Gulf recognised for this study was the Mokohinau and Hen and Chickens islands. The Gulf is bordered on its eastern side

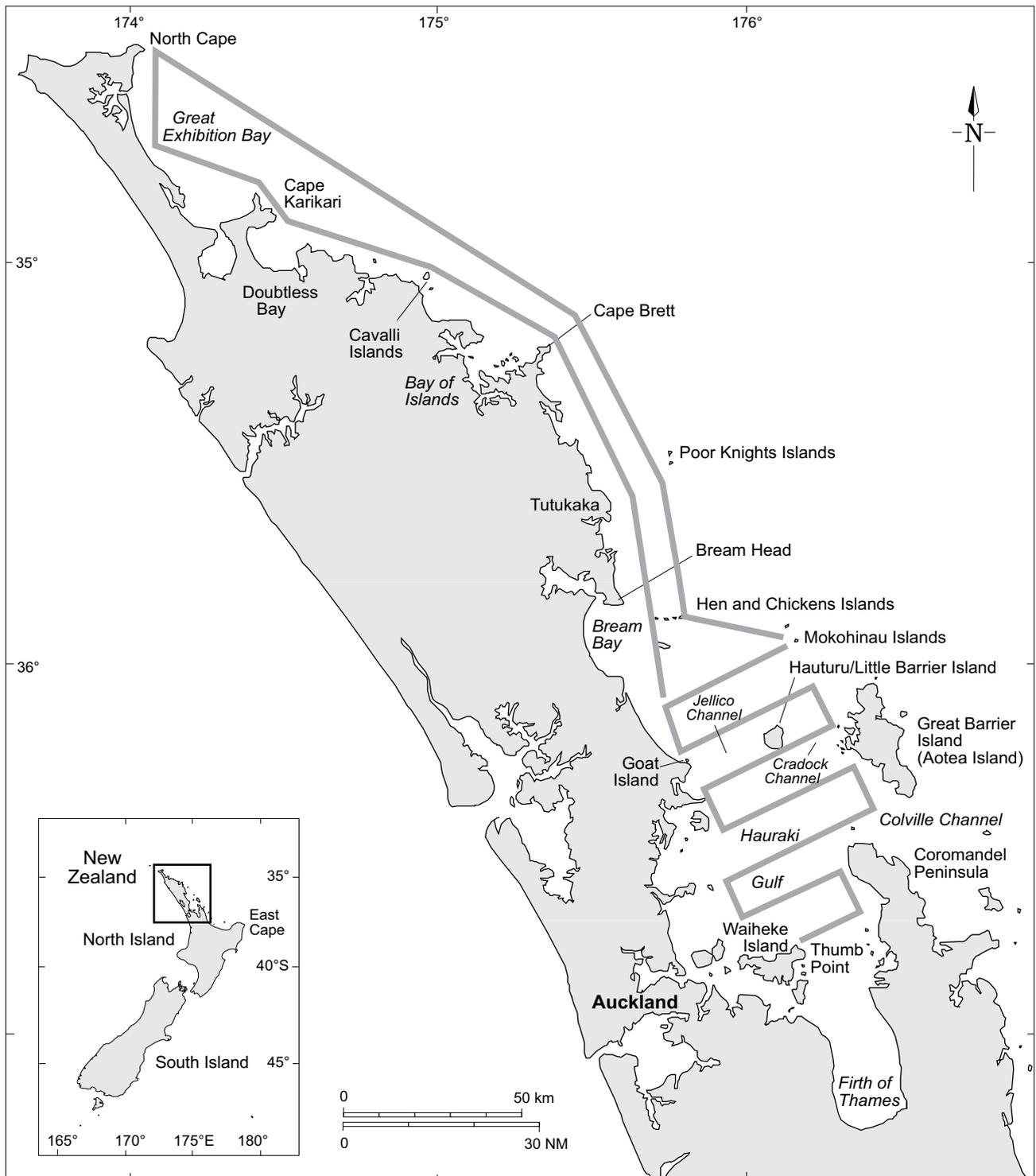


Figure 1. Map of northeast coast of New Zealand, showing flight track of Bryde's whale survey transect grid in Hauraki Gulf, flight track north of the Gulf, and whale-watching centres.

by Great Barrier Island, and its south-eastern side by the Coromandel Peninsula. The southern part of the Gulf is the relatively shallow (3–25-m-deep) Firth of Thames, and the western side is the City of Auckland and environs. Bryde's and humpback whales, along with semi-resident populations of common short-beaked dolphins *Delphinus delphis*, common bottlenose dolphins *Tursiops truncatus* and orca *Orcinus orca*, and several species of transient whales, have made the Hauraki Gulf well known for its marine mammal fauna (Gaskin 1963, 1965, 1968; Baker 1999; O'Callaghan & Baker 2002). The environment of the Gulf is strongly influenced by two climatic and oceanographic systems: onshore winds and the warm southward-flowing East Australian Current in summer, and the upwelling of cooler nutrient-rich water following periods of offshore winds in winter and spring, which helps form productive plankton-laden water in the inner Gulf (Jillett 1971; Greig 1990; Auckland Regional Council 2005). Such conditions are ideal for the growth of pelagic and benthic fishes which, in turn, probably form a large part of the diet of cetaceans living in these areas (section 3.2; Visser 1999). In 1999, the Department of Conservation (DOC) began studies of Bryde's whales in the Hauraki Gulf to obtain basic biological data that could be used to inform management of the species should the whale-watching tourist industry develop further.

The aims of the study were to investigate the seasonal distribution of Bryde's whales within the Hauraki Gulf and, if possible, to obtain some indication of the population density or abundance of the whales in the Gulf. An abundance estimation was not attempted as the survey area would only cover a portion of the total Bryde's whale population on the northeastern coast of New Zealand, and the possible seasonal movement of whales in and out of the Gulf would have biased any assessment of numbers. However, the transect design was representative of the whole Hauraki Gulf, so numbers of whales recorded in aerial surveys could be used to estimate Bryde's whale density in the Gulf. While the density estimates may be an under estimate, analysis should be able to show seasonal changes in density including estimating a CI for the density estimate (Eberhart et al. 1979; Burnham et al. 1980; Seber 1986). As well as determining the seasonal density and occurrence of Bryde's whales within the Gulf, an attempt would be made at correlating sightings with particular locations, sea surface temperatures (SST), and feeding localities.

2. Methods

A pilot study was carried out to investigate whether Bryde's whales could be readily identified from the air and distinguished from other baleen whales known to be occasionally in the area (e.g. antarctic minke *Balaenoptera acutorostrata*, dwarf minke *B. bonarensis*, fin *B. physalus*, sei *B. borealis*, and the blue whale *B. musculus intermedia*).

The study was divided into two areas for the surveys proper: the Hauraki Gulf and Northland east coast (Fig. 1). A flight transect was mapped across the Gulf, beginning at Thumb Point, Waiheke Island (36°41'S 175°09'E) and ending at Navire Rock, Mokohinau Islands (35°57'S 175°08'E). The grid had a 4 n.m. observation

swathe from 800 ft in a high-winged Cessna 172 cruising at 90 knots. The width of the observation swathe was determined by pre-study in-flight experiments using GPS waypoints. North of the Hauraki Gulf, two longitudinal search flight tracks were flown between the Mokohinau Islands and North Cape—one inshore (water < 50 m deep) and one slightly more offshore (water 50–200 m deep)—in order to examine areas north of the Gulf where Bryde’s whales might be present, to place the Gulf whale population in the full coastal context, and ascertain if there was any along-shore migration (Fig. 1). All flights followed these tracks using a GPS ‘Route’ and were carried out when winds were < 12 knots, to maximise the chance of observers seeing whales or their ‘footprint’—a large surface swirl caused by a whale’s swimming movements.

For all of the aerial surveys, two observers (not including the pilot) scanned the ocean each side of the aircraft below a black tape on the wing struts, which indicated the margin of the swathe area. Sightings were recorded on a GPS following verification, which was done by the aircraft leaving the flight track temporarily and descending to 500 ft for closer observation. The GPS waypoint was recorded as close as possible to directly above the whale when first sighted, at which time the survey became ‘off-search’ and remained so while the plane descended and the whale species was confirmed. The flight track was then resumed.

Original data from this survey are on file in DOC’s Marine Conservation Unit, Wellington.

2.1 CALCULATING THE DENSITY OF BRYDE’S WHALES IN THE HAURAKI GULF

Because single whales were most often observed travelling, and could be easily sighted by their prominent blow, surfacing behaviour (Fig. 2), or submerging ‘footprint’, it was assumed that they would have a detection probability close to 1 in the area observed. Small pods of whales were most often seen associated with dolphins, gannets *Morus serrator* and shearwaters (Procellariidae); indeed, they were usually detected in feeding ‘workups’ through the disturbance caused by the feeding dolphins, and the congregation and diving activity of the birds (Fig. 3). The detection probability of small groups was also assumed to be 1 in the observation swathe, although this is likely to be an over estimate.

Figure 2. A travelling Bryde’s whale from 500 ft.



Figure 3. Typical feeding workup of gannets and shearwaters, from 500 ft.



The density of Bryde's whales in the Hauraki Gulf was calculated as follows:

The conventional line transect estimator of density D is

$$D = n/2L\mu$$

where n is the number of animals detected, L the sum of the lengths of the transects and μ the estimated effective swathe half-width (swathe half-width is the observation swathe from each side of the aircraft) (Buckland et al. 2004),

$$\text{and } d_{ij} = c_{ij}/A_i$$

where i = the transect number (1,...,13), j = the day of sampling (1,...,33), d_{ij} is the density on transect i for day j , c_{ij} is the sum of the whales seen on transect i on day j and A_i is the area of transect i (note that area or length of transect can be used in this calculation).

Then the weighted mean density for each sampling day (D_j) was obtained by summing the d_{ij} weighted by the area of each transect i :

$$D_j = \Sigma d_{ij} * w_i / \Sigma w_i$$

Where w_i = the weight of transect i and is equal to the area of transect i (A_i) divided by the total area (A_T) (A_i/A_T), and $A_T = 1201.8 \text{ n.m.}^2$.

2.2 TESTS FOR SIGNIFICANCE

A mixed model analysis of variance was performed to test for significance of the factors 'day', 'season', 'year' and 'location' on the density of Bryde's whales at the 95% level of significance. A mixed model was used where the factor 'day' was random and nested within factors 'year' and 'location' that are fixed and crossed with each other.

Daily sea surface temperatures (SST) were obtained from the Auckland University Marine Laboratory at Goat Island, Leigh, throughout the study. The weighted mean counts (C_j) for each day (j) were obtained using the formula:

$$C_j = \Sigma C_{ij} * w_i / \Sigma w_i$$

Because more than one pod of whales might have been seen on each transect on each day, the number of whales seen on each transect on each day was summed. The weight of each transect was the ratio of the length of each transect to the length of the whole flight survey (i.e. the sum of the 13 transects). Weighted counts were obtained by multiplying the number of whales seen on each transect on each day by the weight of the transect.

3. Results

The pilot survey was flown along the entire northeastern coast north of the Coromandel Peninsula in September 1999. It was found that Bryde's whales could be readily identified from the air by their size (10–16 m) compared with the larger fin, sei and blue whales, and smaller minke whales that were also seen in the survey area; and three specifically diagnostic rostral ridges, which are evident when the whales surface to breathe. The pilot study also provided some indication of where Bryde's whales could be found in the Hauraki Gulf at that time of the year (spring) and showed that the whales in the Gulf formed only part of a wide-ranging population of this species along the whole northeastern coast of New Zealand.

Over the period October 1999 to February 2003, 21 survey flights were undertaken over the Hauraki Gulf transect grid, and 12 search flights were made along the Northland east coast between the Mokohinau Islands and North Cape.

3.1 OCCURRENCE OF BRYDE'S WHALES IN THE HAURAKI GULF

Bryde's whales were encountered throughout the entire area of the Hauraki Gulf surveyed, and in all seasons, but generally in small numbers. The locations of all sightings of Bryde's whales during the survey are shown in Fig. 4. The total numbers of sightings per season during the survey are shown in Fig. 5. Feeding locations over the same area are shown in Fig. 6. The frequency of group sizes of travelling and feeding¹ Bryde's whales are shown in Fig. 7.

Over the survey period (1999–2003), more whales were seen in the Gulf in summer than in winter (Figs 5 & 8). Figure 8 shows daily sea surface temperatures (SST) plotted against weighted mean whale counts. On average, six whales were sighted during each survey of the Gulf transects. The most individuals sighted on one survey of the Gulf transects was 18 in October 2001, and one survey flight failed to locate any whales (May 2001). The analysis of density showed no detectable difference between days ($P > 0.05$) within each season and year, between years ($P > 0.05$) or between season ($P = 0.1361$); but the densities in the upper and inner Hauraki Gulf were significantly different ($P = 0.0342$), with more whales recorded in the inner part of the Gulf.

3.2 TRAVELLING AND FEEDING BRYDE'S WHALES IN THE HAURAKI GULF

Most single Bryde's whales were sighted travelling, whereas pods of whales were often congregated around feeding workups (Fig. 3). Such activity was often observed in the Jellicoe Channel and the area west of Great Barrier Island (Aotea Island) (Figs 1 & 4). The maximum group size of whales seen in a feeding

¹ The only behaviours observed during the survey—i.e. no mating or sleeping were observed.

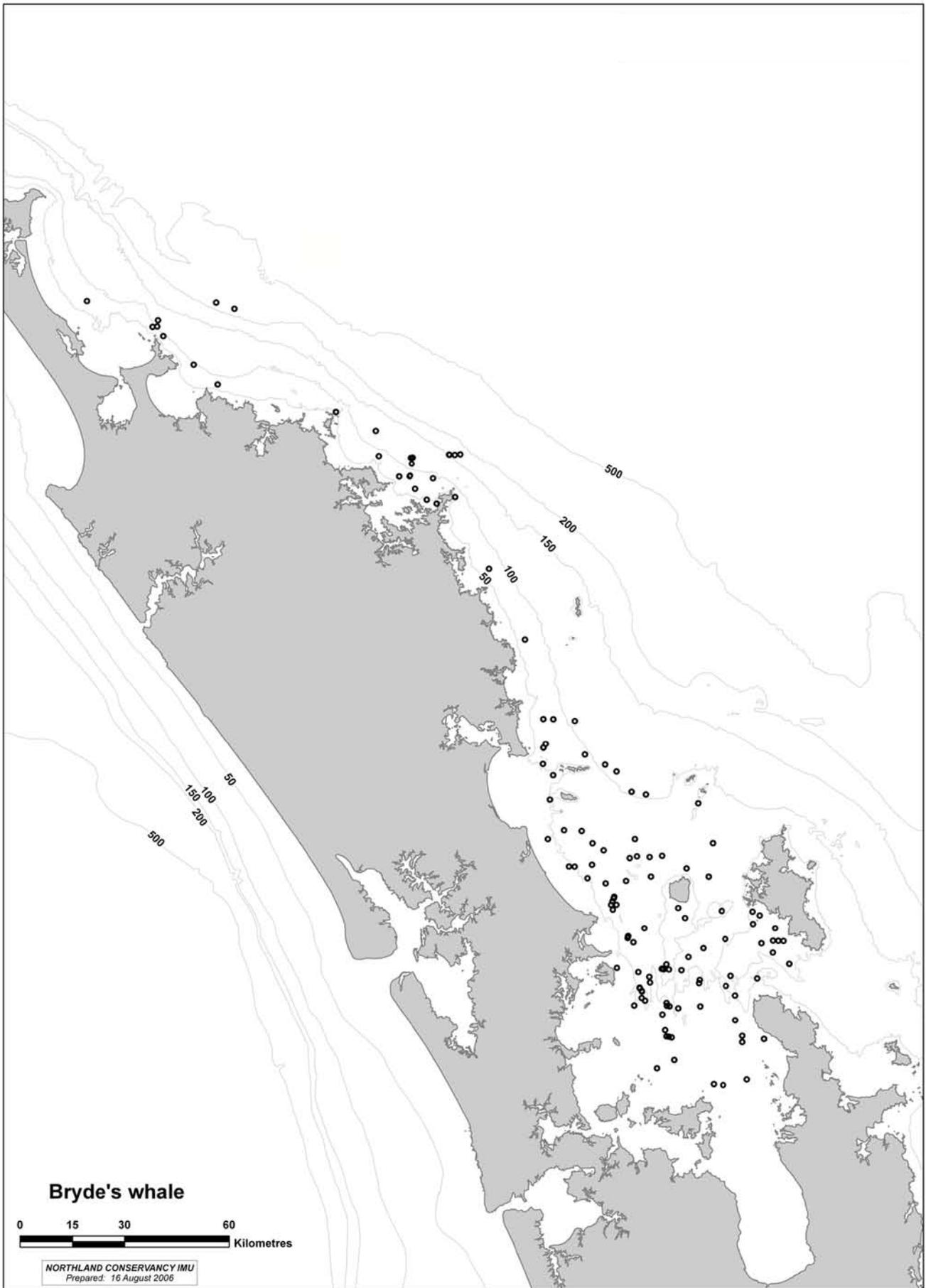
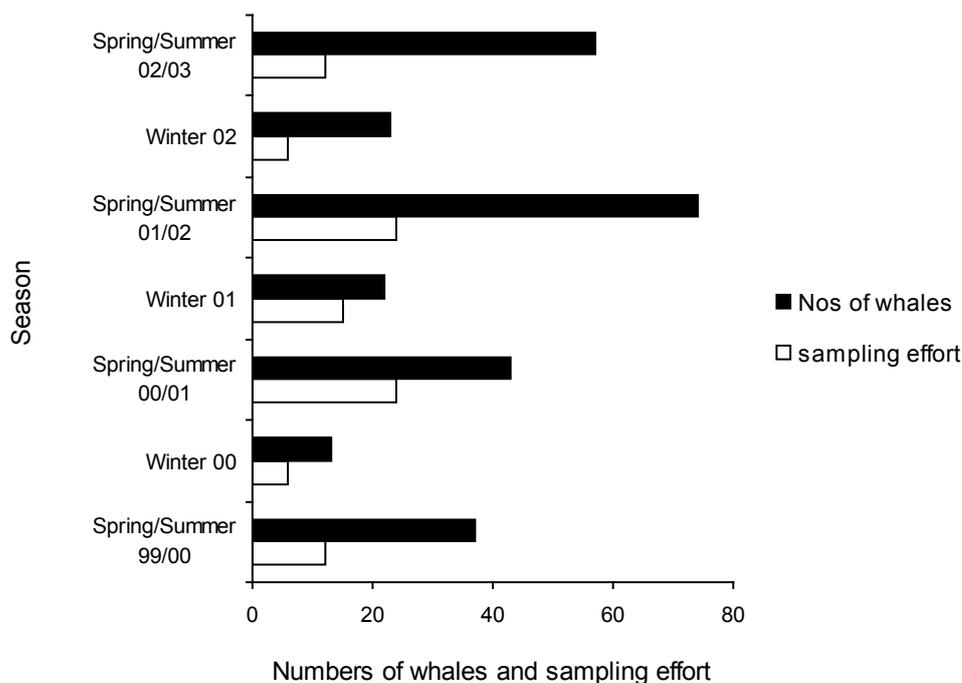


Figure 4. Northeastern New Zealand showing all sighting locations of Bryde's whales 1999–2003. Circles may represent more than one individual at that location.

Figure 5. Numbers of Bryde's whales sighted per season in the Hauraki Gulf and off the northeastern coast of New Zealand, 1999–2003. Sampling effort is percentage of total number of survey and search flights.



situation was five. Although small silvery fish could sometimes be seen leaping from the water during Bryde's whale/short-beaked common dolphin/gannet feeding activity (workups), it was not possible to identify the prey fish from the air. Given that gannets dive for fish of a size that they can readily swallow, it seems likely that small varieties, such as saury *Scomberesox saurus*, pilchards *Sardinops sagax*, anchovies *Engraulis australis*, or jack mackerels *Trachurus novaezelandiae* are the likely targets. All of these species are common in the waters of the Hauraki Gulf and northeastern New Zealand (Paul 2000; Kendrick & Francis 2002). Gaskin (1972) reported Bryde's whales feeding on fish in the Hauraki Gulf, and Bryde's whales in South Africa, northwestern Australia, and Peru are known to feed on similar species (Best 1960, 2001; Chittleborough 1961; Ramírez 1992). Cephalopods and pelagic crustaceans such as euphausiids have also been recorded from Bryde's whale stomachs in other parts of its range (Olsen 1913; Omura 1962; Best 1974, 2001; Ramírez 1992). A sample of faecal matter discharged from a Bryde's whale near Tutukaka, Northland, and provided to us by Dr Ingrid Visser, contained separated euphausiid setae. Several Bryde's whales were observed in the Hauraki Gulf lunge-feeding on their sides, with their throats and abdomens widely extended (Fig. 9). On these occasions, only shearwaters (*Puffinus* spp.) were also present, and small fish were not detected, suggesting that the whales may have been feeding on other small marine animals such as crustaceans. The detection of feeding whales was assisted by associated bird activity and because the feeding aggregations typically involved more than one whale with consequent greater ocean disturbance; whereas travelling whales, which were mostly singletons, were harder to detect. Given that whales can remain submerged for between 1 and 16 minutes, it was therefore easier to miss individuals than groups, although submerged whales could often be detected by the 'footprint' left by tail flexing or the expulsion of air bubbles, and they could sometimes be seen swimming just beneath the surface (Figs 10 & 11).



Figure 6. Northeastern New Zealand showing feeding locations of Bryde's whales 1999-2003. Circles may represent more than one individual at that location.