Summer cetacean community, with particular reference to Bryde's whales, in the Hauraki Gulf, New Zealand

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ABSTRACT

A pilot study was undertaken from 13 November 2000 to 16 February 2001 to investigate the distribution, behaviour, and individual identification of Bryde's whales (*Balaenoptera edeni*) in the Hauraki Gulf, New Zealand. Cetaceans were observed from a commercial marine mammal tour vessel on 125 survey trips over a 47-day sampling period. In addition, sightings of cetaceans were recorded by the vessel's crew from 7 October 2000 to 16 February 2001, during 167 trips over 118 days. On 144 trips where cetaceans were sighted, we recorded six cetacean species. Bryde's whales were encountered 29 times, often seen feeding (90.9% of encounters) singly or in small, loose aggregations. Eighteen Bryde's whales were individually identified from photographs of the dorsal fin. Common dolphins (*Delphinus delphis*) were by far the most common cetacean in terms of animal number and sighting frequency, with 91.7% of all encounters including this species. Common dolphin schools of 150 animals were not uncommon, with larger congregations recorded on occasion. Other species recorded include bottlenose dolphins (*Tursiops truncatus*), long-finned pilot whales (*Globicephala melas*), killer whales (*Orcinus orca*) and Arnoux's beaked whales (*Berardius arnouxii*). We recorded 25 schools of mixed species, predominantly Bryde's whales and common dolphin associations.

Keywords: Cetacean distribution, Bryde's whale, *Balaenoptera edeni*, common dolphin, *Delphinus delphis,* cetacean community, Hauraki Gulf, New Zealand.

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1. Introduction

This research was conducted as a feasibility study, to assess the viability of conducting a long-term study of Bryde's whales (*Balaenoptera edeni*), and the general cetacean community, aboard the commercial marine mammal tour vessel, *Dolphin Explorer,* within the Hauraki Gulf, New Zealand. This report presents a summary of the cetacean community structure, seasonality and distribution within the Gulf over the summer period of 7 October 2000 to 16 February 2001. Recommendations are made for further study into the cetacean community of the Gulf, and in particular, into the Bryde's whale population.

The Hauraki Gulf Marine Park, on the east coast of the greater Auckland area, is utilised by a number of cetacean species. Some species pass through the Gulf intermittently or while on migration, whilst other species appear to be resident or semi-resident in the Gulf. The Hauraki Gulf (Fig. 1) extends from Bream Head to Cape Colville, approximately latitude 36°10′S to 36°60′S.

Forty-six cetacean species have been recorded from the Australasian region (Baker 1983). Regular incidental sighting reports and stranding records suggest the Hauraki Gulf is frequented by a large number of these species.

2. Methods

The field season ran from 13 November 2000 to 16 February 2001. The study area encompassed the inner Hauraki Gulf from Little Barrier Island to the north, Great Barrier Island to the east, and the Coromandel Peninsula and eastern coast of Auckland on the southern and western sides, respectively. The permit conditions of the vessel limited interactions with dolphins to waters greater than 10 m depth, and with whales to waters greater than 20 m depth.

A total of 167 survey trips were conducted aboard the research platform, a commercial marine mammal tour vessel, the 19.9 m catamaran *Dolphin Explorer,* from 7 October 2000 to 16 February 2001. Consequently, sampling periods were limited to those times when the vessel was operating under this commercial capacity.

Over this summer period, the vessel generally ran two 5-hour trips per day, a morning trip from 0600 h, and an afternoon trip from 1200 h. Trips were occasionally cancelled due to adverse weather and/or sea conditions, or due to lack of patronage.

The vessel surveyed a total of 835 hours during 167 trips over 118 days. Cetaceans were encountered on 144 of these (encounter rate of 86%). One of us (TMO) accompanied 56 trips (280 hours) over 47 days from 13 November to 16 February. On the remaining trips, the vessel crew collected survey data. Generally, the photographic data collection was performed on the morning trips, when sea conditions and visibility were more favourable.

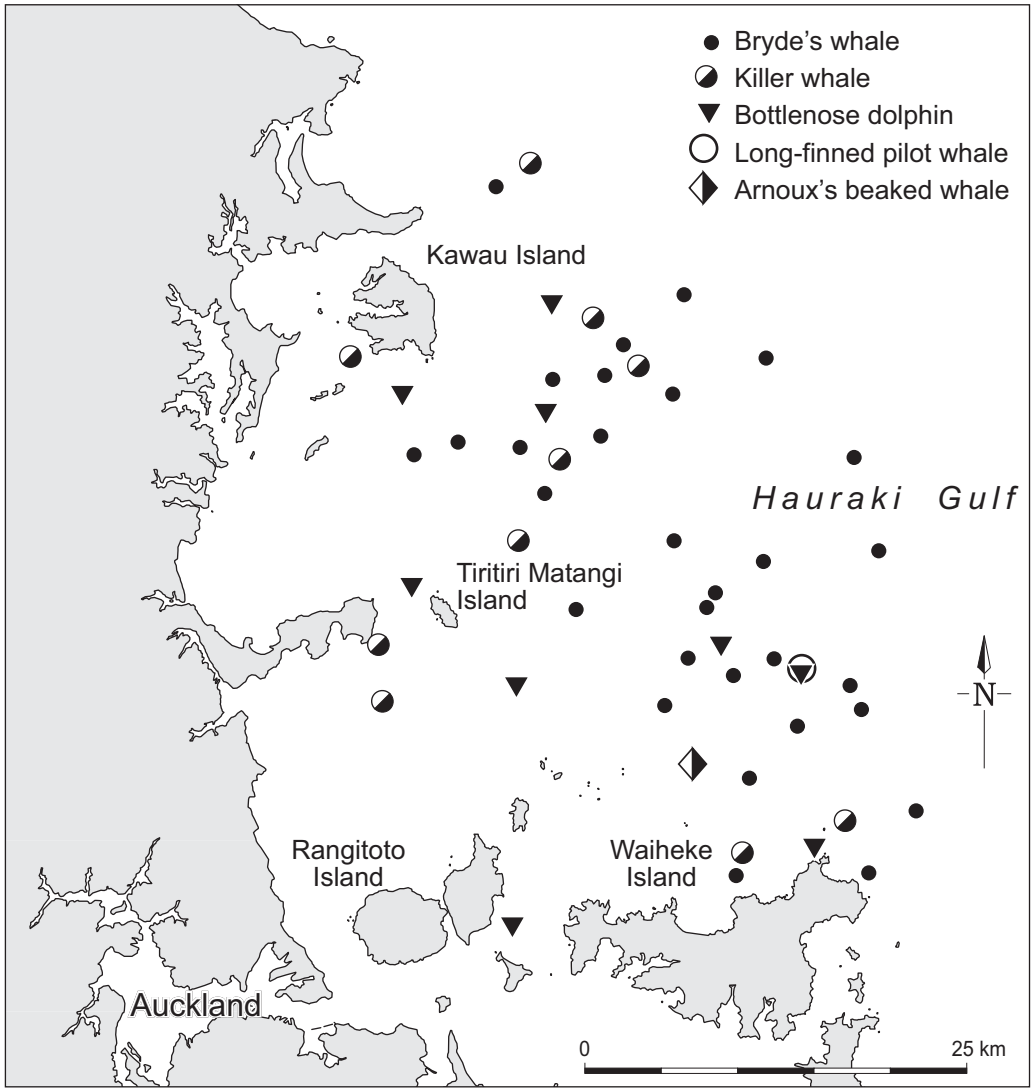

Figure 1. Sightings of five cetacean species in the study area during summer 2000/01, Hauraki Gulf, New Zealand.

Individual identification of Bryde's whales was based on photographs of natural markings (e.g. Katona et al. 1979; Bigg et al. 1986; Hammond 1986; Würsig & Jefferson 1990; Tershey 1992), predominantly on the dorsal fin. All other species encountered within the Gulf were photographed opportunistically. Photographs were taken on a Nikon F-70 EOS with a 300 mm zoom lens. A variety of film was used, including both colour and black/white print film, and colour slides.

3. Results

3.1 CETACEAN COMMUNITY COMPOSITION

We recorded 182 cetacean encounters on 144 of the 167 trips undertaken, comprising six different species (Table 1). The common dolphin (*Delphinus delphis*) was the most commonly sighted species. Bryde's whales were also relatively common, although in much fewer numbers. Occasional sightings were recorded of bottlenose dolphins (*Tursiops truncatus*), killer whales (*Orcinus orca*), long-finned pilot whales (*Globicephala melas*), and Arnoux's beaked whales (*Berardius arnouxii*) (Table 1, Fig. 1).

The frequency of trips where cetaceans were encountered ranged from 80% in January to 100% in February (Table 2). Each species showed different sighting

TABLE 1. RELATIVE ABUNDANCE OF THE CETACEAN COMMUNITY, HAURAKI GULF, 7 OCT 2000 – 16 FEB 2001.

SPECIES	SIGHTINGS	MEAN POD SIZE	PERCENTAGE OF SIGHTINGS
Common dolphin[1] *Delphinus delphis*	132	117.3	72.5
Bryde's whale[2] *Balaenoptera edeni*	29	1.0	15.9
Killer whale *Orcinus orca*	10	3.9	5.5
Bottlenose dolphin *Tursiops truncatus*	9	13.8	5.0
Long-finned pilot whale *Globicephala melas*	1	25	0.6
Arnoux's beaked whale *Berardius arnouxii*	1	4	0.6
Total	182		100

[1] Minimum common dolphin sightings, one sighting recorded per successful trip (i.e. number of common dolphin pods recorded per trip is not included in this analysis).

[2] Bryde's whales sightings, in this and subsequent tables, include all large baleen whale sightings whose behaviour, size, blow shape and fin shape suggested a Bryde's whale, even if the three rostrum ridges were not clearly visible.

TABLE 2. MONTHLY SIGHTINGS OF CETACEAN SPECIES AND PERCENTAGE OF TRIPS ON WHICH CETACEANS WERE SIGHTED, HAURAKI GULF, 7 OCT 2000 – 16 FEB 2001.

	SIGHTINGS (PERCENTAGE TRIPS ON WHICH CETACEANS SIGHTED)					TOTAL
	OCT	NOV	DEC	JAN	FEB	
Total no. of trips	28	33	33	49	24	167
Trips with sightings	26 (93%)	28 (85%)	27 (82%)	39 (80%)	24 (100%)	144 (86%)
Species sighted						
Common dolphin	23 (82.1%)	24 (72.7%)	25 (75.8%)	39 (79.6%)	21 (87.5%)	132
Bryde's whale	4 (14.3%)	5 (15.2%)	3 (9.1%)	8 (16.3%)	9(37.5%)	29
Killer whale	3 (10.7%)	4 (12.1%)	3 (9.1%)	–	–	10
Bottlenose dolphin	1 (3.6%)	5 (15.2%)	3 (9.1%)	–	–	9
Long-finned pilot whale	1	–	–	–	–	1
Arnoux's beaked whale	–	–	–	–	1	1
Total sightings	32	38	34	47	31	182

frequencies by month over the summer season. Common dolphins were seen all summer, as were Bryde's whales, although not as frequently. Killer whales (10 encounters) and bottlenose dolphins (9 encounters) were seen in October, November and December. Long-finned pilot whales were seen once, in October, and Arnoux's beaked whales were seen once, in February.

3.2 SEA-SURFACE TEMPERATURE AND WATER DEPTH

All sightings were recorded within a sea-surface temperature range of 17.0°–24.3°C, with a mean of 19.8°C (Table 3). Sightings were made within a depth range of 11 m to 53 m (mean 39.2 m) (Table 4). Most sightings of Bryde's whales and common dolphins were around the 40 m depth contour. Bottlenose dolphins and killer whales were generally seen closer inshore. Depth was estimated from a hydrographical chart based on global positioning satellite (GPS) location data.

TABLE 3. MEAN SEA-SURFACE TEMPERATURE (SST) FOR THE HAURAKI GULF WHEN CETACEANS SIGHTED, 7 OCT 2000–16 FEB 2001.

SPECIES	*n*	Mean SST (°C)	SD
Common dolphin	42	19.7	± 1.5
Bryde's whale	17	19.7	± 1.3
Killer whale	10	19.3	± 1.1
Bottlenose dolphin	8	19.5	± 1.7
Long-finned pilot whale	1	23.5	–
Arnoux's beaked whale	1	18.2	–
Mean for all species		19.8	

TABLE. 4. MEAN WATER DEPTH IN THE HAURAKI GULF WHERE CETACEANS SIGHTED, 7 OCT 2000–16 FEB 2001.

SPECIES	*n*	MEAN DEPTH (m)	SD
Common dolphin	102	39.2	± 7.5
Bryde's whale	30	43.2	± 5.6
Killer whale	9	35.3	± 11.8
Bottlenose dolphin	9	36.4	± 11.2
Long-finned pilot whale	1	43.0	–
Arnoux's beaked whale	1	38.0	–
Mean for all species		39.2	

3.3 SPECIES ACCOUNTS AND INTERACTIONS

3.3.1 Bryde's whales

A total of 29 Bryde's whales were encountered over the sampling period. In eight of these sightings (27.6%) the rostral ridges were not visible, and there is potential for mis-identification, particularly with the larger sei whale (*Balaenoptera borealis*). However, as the blow shape, fin shape, colour, size and behaviour were consistent with confirmed Bryde's whale sightings, these eight are included in the analysis.

Eighteen different animals were identified by individual markings, predominantly from the dorsal fin. Animal HG01/10 was sighted twice during the summer over a 2-day period. One mother–calf pair was recorded (female HG01/13) on 24 January 2001. The calf was large, and presumably not a newborn. Photographs of the dorsal fin were collected where possible (n = 26). Of the 18 photographs used in the catalogue, 13 (72%) exhibited good, or very good, identification features. The additional eight photographs did not provide enough detailed information to include in the accession catalogue (identification proportion of 69.2%).

Bryde's whales were sighted in all months over the sampling period (n = 29 encounters) (Table 2). They were seen most frequently during early February, at the end of the summer sampling season. Other than the female–calf pair, they were predominantly seen alone, or in loose aggregations, where whales were always at least one nautical mile apart. No clear associations were made between any adult whales.

Whales were predominantly feeding during encounters (90.9%), often in association with common dolphins and Australasian gannets (*Morus serrator*).

The distribution of Bryde's whales was predominantly centred around the middle of the inner Gulf (Fig. 1, Appendix 1). Anecdotal reports suggest that Bryde's are often seen further north of Little Barrier Island (the most northern point of our sampling area), and on the west coast of Great Barrier Island (A. Baker, pers. comm.). Both of these areas were too distant for the research vessel to sample, given the commercial operating time restrictions.

Bryde's whales were often seen in association with common dolphins, and on one occasion (11 Nov 00) with killer whales.

3.3.2 Common dolphins

Common dolphins were seen in all months over the sampling period (n > 132). They were the most abundant and widespread of the cetaceans recorded in the Hauraki Gulf over the summer sampling period, and were seen predominantly in the middle of the inner Gulf (for distribution and abundance of common dolphin, see Leitenberger 2002).

Common dolphins were often recorded in association with Bryde's whales, usually in feeding aggregations. These species have been noted to associate elsewhere in large feeding aggregations (Breese & Tershy 1993). These feeding 'work-ups' were often easily located by the presence of Australasian gannets. Other seabirds observed in association with cetaceans in the Gulf include

Buller's shearwater (*Puffinus bulleri*), flesh-footed shearwater (*Puffinus carneipes*), fluttering shearwater (*Puffinus gavia*), white-faced storm petrel (*Pelagodroma marina*), and white-fronted tern (*Sterna striata*).

3.3.3 Killer whales

Killer whales were sighted during the first three months of the summer season (October–December) (n = 10) (Table 2). Identification photographs were collected opportunistically. Killer whales were seen interacting with common dolphins at least twice (30 Oct 00 and 14 Nov 00), and in the vicinity of Bryde's whales at least once (11 Nov 00). Aggressive behaviour towards common dolphins was noted in these interactions, with killer whales predating upon the dolphins. Killer whales in New Zealand are known to feed on fish and rays (Visser 1999) as well as marine mammals (Constantine et al. 1998).

Such interactions between killer whales and common dolphins were observed on at least two occasions in the Gulf (*Dolphin Explorer* crew, pers. comm.). No aggressive or predatory behaviour was observed between the killer whales and the Bryde's whale.

3.3.4 Bottlenose dolphins

Bottlenose dolphins were also seen during the first three months of the sampling period (n = 9) (Table 2). Identification photographs were collected opportunistically. On one occasion (14 Oct 00) a pod of bottlenose dolphins was recorded in association with a pod of long-finned pilot whales.

3.3.5 Long-finned pilot whales

Approximately 25 long-finned pilot whales were seen on 14 October, in mid-Gulf (Fig. 1). This pod was in association with a group of bottlenose dolphins. Elsewhere, pilot whales have been described in non-aggressive association with bottlenose dolphins (Weller et al. 1996; Balance & Pitman 1998; Baraff & Asmutis-Silva 1998) and a humpback whale (*Megaptera novaeangliae*) (Ciano & Jørgensen 2000).

3.3.6 Arnoux's beaked whales

Arnoux's beaked whales were seen once on 4 February 2001, north of Waiheke I. (Fig. 1). This pod displayed aerial behaviour, but no individual identification photographs were collected.

4. Discussion

4.1 CETACEAN COMMUNITY

The cetacean community of the Hauraki Gulf is dominated by schools of common dolphins. These feed on small fish and squid (e.g. Ohizumi et al. 1998), and often in the Gulf these schools are associated with other feeding predators such as Bryde's whales, gannets, shearwaters, and terns.

The common dolphin schools of the Hauraki Gulf were often found along the 40 m depth isobath, following the tidal convergence line (K. Algie, pers. comm.). Generally, the common dolphin is regarded as a deep-water species, found in depth ranges of up to 3500 m, in upwelling-modified waters (Reilly 1990; Fielder & Reilly 1994; Smith & Whitehead 1999). These researchers suggest that *Delphinus* sp. exhibit preference for such areas of highly variable oceanographic features, where upwelling occurs seasonally. However, the central Hauraki Gulf where our sightings were recorded has a fairly level seabed of mud and broken shell, with an average depth of approximately 39–47 m (see Table 4).

Findlay et al. (1992) suggest that the offshore distribution of small cetaceans appears to be determined by water depth, possibly through the distribution of principal prey, and the inshore distribution determined by water temperature. Furthermore, Kenney & Winn (1986) suggest that cetacean distributions are determined by the distributions of the most important prey species.

Because both Bryde's whales and common dolphins are often seen during feeding behaviour, it is likely that the distribution of prey may be the important factor in their distribution in the Hauraki Gulf. As water depth does not vary greatly, it is likely that water temperature is a more important factor than depth within the Gulf.

It is not yet known whether this group of common dolphins is resident in the Gulf year-round. The mean sea-surface temperature (SST) range for common dolphin sightings in the Gulf over the summer was between 17.0°C and 23.1°C (Table 3). The minimum SST for the Gulf in the cool-water months can be as low as 14.0°C (NIWA pers. comm.). In other parts of their range, common dolphins were not found at this temperature (e.g. Dohl et al. 1985).

Over the summer sampling period, no apparent variation in seasonal distributional was noted for common dolphin or Bryde's whales. However, killer whales, bottlenose dolphins, and pilot whales were found only in spring and early summer, and Arnoux beaked whales were only found in late summer. Elsewhere, findings vary on the variability of common dolphin seasonal abundance and distribution, with some studies reporting variation (Forney & Barlow 1998) and others reporting none (Reilly 1990). It may be that this seasonal variability is due to the availability of prey.

Further study into the schooling fish population and its seasonality within the Gulf may give results that are reflected in the seasonality of the cetacean community, particularly for common dolphins and Bryde's whales.

4.2 BRYDE'S WHALES

Bryde's whales are thought to occur between 40°N and 40°S, with a preference for water temperatures between approximately 15° and 20°C (Cummings 1985; Carwardine 1995; Yoshida & Kato 1999). The species is easily distinguished at close range from other rorqual whales by three longitudinal ridges on the top of the head. Bryde's whales are reported from a number of areas in South Pacific and Australian waters (Chittleborough 1959; Omura 1962; Paterson & Van Dyck 1988; Shimada & Pastene 1995; Priddel & Wheeler 1997), including both the Tasman (Privalikhin & Berzin 1978) and Pacific coasts of New Zealand (Gaskin 1968, 1972; Baker 1983).

There are thought to be two forms of Bryde's whales, a larger offshore form and a smaller inshore form (e.g. Leatherwood & Reeves 1983; Cummings 1985; Carwardine 1995; Yoshida & Kato 1999). The Bryde's whales found in New Zealand waters are thought to be the larger form as described by Rice (1998).

Bryde's whales are not known to follow long-distance migrations (Omura 1962; Cummings 1985), but in temperate waters are thought to be semi-migratory, making local and seasonal movements (Gaskin 1968, 1972; Leatherwood & Reeves 1983) following schools of fish (Omura 1962). Their predominant diet is thought to consist of schooling fish, such as anchovies, herring, saury, pilchards and mackerel (Omura 1962; Cummings 1985).

It is unknown whether the Hauraki Gulf population is resident, although Gaskin (1968) suggests that they can be found in the Hauraki Gulf – Bay of Plenty area year-round.

Most encounters between the whales and the tour vessel did not provide easy opportunities to photograph the dorsal fin. The animals generally avoided the vessel, usually surfacing heading away it, especially when the vessel made a direct attempt to approach them. Occasionally, however, an individual would approach the vessel of its own accord, usually when the vessel was stationary. Bryde's whales have been known to approach boats more readily when the engine is cut (e.g. Hoffmann 1998). The tour vessel, operating under commercial restraints, did not have the option of staying for indefinite periods with any one whale to ensure successful collection of photographic identification data.

The population has a relatively high proportion of identifiable individuals; therefore, a dedicated Bryde's whale survey is more likely to obtain good identification results.

The Hauraki Gulf Bryde's whales were most often seen either individually or in loose aggregations spread over a nautical mile or more. No individual associations could be assessed, with the exception of one mother–calf pair. Of the eighteen identified individuals, only one was re-sighted within the season, suggesting, at best, only a semi-resident pod. Longer-term mark and recapture or satellite tracking studies would give a more accurate assessment of residential status for the Hauraki Gulf Bryde's whale population.

5. Conclusions

The Hauraki Gulf cetacean community can be studied aboard the commercial marine mammal tour vessel *Dolphin Explorer*. The common dolphin is often encountered, and research could be based on this species. The vessel covers a large area of the Gulf, and encounters with a range of species could provide information on the importance of the Gulf to cetaceans. Further environmental data, such as SST, water depth and location, would provide important information for management, particularly where cetaceans move across shipping lanes.

Bryde's whales appear to be relatively common in the Gulf, and basic data should continue to be collected from the commercial vessel opportunistically. However, due to the behaviour of the whales, the time constraints of the vessel, and the sampling data required, a dedicated platform is necessary for detailed research. This would allow the collection of better identification photographs, allowing a more accurate analysis of population density and distribution, in addition to further data collection methods such as biopsy sampling. This population has a relatively high proportion of identifiable individuals, and good photographic opportunities would provide much information on its demographics.

The Bryde's whale population appears to be fluid, with animals not resident in the inner Gulf for long periods. If this proves to be the case, careful approaches from tour vessels should not pose a long-term threat of harassment to each individual. However, longer-term research on the stability of this population in the Gulf, and the behaviour of the whales to approaching vessels, is recommended.

The data presented here give only a brief overview of the cetacean community of the Hauraki Gulf, in one season. However, the Gulf appears to be an important habitat used by a population of Bryde's whales and common dolphins, both of which may prove to be semi-resident, and an area intermittently used by other cetaceans, including rare species.

Further research on each species, particularly Bryde's whales, and the community in general is warranted. Baseline data of the Hauraki Gulf cetaceans are required for good management practice. Useful information could be obtained by further study aboard *Dolphin Explorer.* Bryde's whale identification photographs could continue to be collected opportunistically, and behaviour to vessel approaches could be monitored. A second Bryde's whale survey in the late winter/early spring season would provide a second sampling season to allow a population estimate, and may indicate longer-term residency patterns. Baseline data, such as GPS location, SST and water depth ranges for each species, could be collected during all encounters. Further investigation into the importance of the 40 m tidal convergence zone would also be valuable.

Use of a dedicated research platform would allow more intensive Bryde's whale research, better photographic identification analysis, and further sample collection such as biopsy sampling. Long-term sampling would provide data on cetacean seasonal variation in abundance and distribution. Correlation with

oceanographic conditions could be investigated. Satellite tracking of Bryde's whales would provide data on diurnal and inter- and intra-seasonal movements.

Finally, genetic material could be collected from all New Zealand stranded Bryde's whales for analysis, and correlated with samples from other areas (e.g. Priddel & Wheeler 1998).

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Appendix 1

DISTRIBUTION OF BRYDE'S WHALES, HAURAKI GULF, SUMMER 2000/01

DATE	POSITION SOUTH*	POSITION EAST*
25 Oct 00	36° 21.100	174° 54.770
26 Oct 00	36° 30.24	174° 53.8
28 Oct 00	36° 28.5	174° 57.9
31 Oct 00	36° 30.670	174° 52.400
11 Nov 00	36° 44.4	175° 06.6
13 Nov 00	36° 39.989	175° 09.028
14 Nov 00	36° 31.9	174° 57.5
18 Nov 00	36° 30.756	174° 57.0
28 Nov 00	36° 35.8	175° 04.8
04 Dec 00	36° 24.8	175° 03.6
10 Dec 00	36° 27.7	175° 00.7
27 Dec 00	36° 27.015	175° 07.122
04 Jan 01	36° 39.299	175° 11.737
05 Jan 01	36° 38.169	175° 06.089
06 Jan 01	36° 34.214	175° 07.168
13 Jan 01	36° 35.366	175° 05.183
22 Jan 01	36° 38.408	175° 11.195
24 Jan 01	36° 30.413	175° 11.142
25 Jan 01	36° 29.889	175° 00.018
29 Jan 01	36° 44.978	175° 12.155
05 Feb 01	36° 42.80	175° 14.19
08 Feb 01	36° 39.290	175° 03.003
08 Feb 01	36° 37.780	175° 04.225
09 Feb 01	36° 33.501	175° 03.271
09 Feb 01	36° 37.634	175° 07.913
10 Feb 01	36° 33.627	175° 12.300
13 Feb 01	36° 36.123	174° 59.149
14 Feb 01	36° 28.357	175° 03.184
14 Feb 01	36° 41.850	175° 06.928
16 Feb 01	36° 27.133	175° 01.213

*Recorded from global positioning satellite.