THE NATURE CONSERVANCY

Indonesia Coastal & Marine Program

KOMODO NATIONAL PARK CETACEAN SURVEYS

MONITORING REPORT -
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APEX ENVIRONMENTAL

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1. Background

Indonesian waters have an exceptional cetacean diversity and close to 30 different cetacean species inhabit these waters. More than one third of all known whales and dolphins species worldwide can be found in the Indonesian Seas, including numerous rare and endangered species (IUCN 1996). Cetacean habitats include major rivers, mangroves as well as coastal and open ocean environments. These diverse habitats are often in close proximity to one another because of Indonesia's narrow continental shelf, abundant oceanic islands and extreme depth gradients. Yet no detailed scientific studies have been done in these waters on cetacean species diversity, abundance and distribution. A preliminary review of cetaceans sighted in Indonesian waters lists 29 species (Rudolph *et al.* 1997, Kahn *et al.* 2000). The occurrence of three species is still unconfirmed.

Data on cetacean species diversity, abundance and distribution is especially important when considering the complex regional oceanography. Indonesia is uniquely located as the only equatorial region worldwide where inter-oceanic exchange of marine flora and fauna occurs. Cetacean movements between the tropical Pacific and Indian Oceans can occur through the passages between the Lesser Sunda Islands which span over 900 km between the Sunda and Sahul shelves (Klinowska 1991). The critical migration routes of whales entering or leaving the Indian Ocean from or to the Pacific Ocean lies exclusively in the Indonesian Seas. The ecological significance of these passages remains poorly understood, yet their importance as migration corridors is highly probable. Indonesian cetaceans which include these passages in their local or long-range movements are vulnerable to numerous regional and local environmental impacts such as habitat destruction, subsurface noise disturbances, net entanglement, marine pollution and over fishing of marine resources (Hofman 1995; Fair and Becker, 2000).

Indonesia is an archipelagic nation where more than 17,000 islands make up a scant 24% of the nation's area and 76% is sea. Indonesia's 81,000 km shoreline is one of the world's longest and gives relatively easy access to coastal resources. Close to 140 million Indonesians live within 60 km of the coast and most of Indonesia's 6000 regional coastal communities are directly dependent on the oceans as the primary source of food and income (Dahuri and Dutton 2000). In addition, extractive as well as non-extractive marine industries such as oil and gas production, transportation, fisheries and tourism account for a quarter of Gross Domestic Product and employ more than 15% of Indonesia's workforce (Dahuri and Dutton 2000). Considering these factors it seems reasonable to suggest that most, if not all, of the impacts on cetaceans may occur in the waters of Indonesia. These impacts would affect residential whale and dolphin populations as well as several endangered migratory species such as the blue and fin whale (*Balaenoptera musculus and B. physalus*) which include these passages in their long-range movements. This is of special concern in the eastern Indonesian provinces of East Nusa Tenggara, North Sulawesi and Moluccu , where a strictly limited number of deep inter-island channels are suspected to function as migration corridors for cetaceans (PHPA 1984). These passages have considerable ecological significance and conservation value as an important migration corridor network for large cetaceans travelling from the Pacific Ocean and eastern Indonesian seas to the Indian Ocean, and vice versa. In addition, residential whale and dolphin populations are also likely to use these corridors as part of their home range.

Cetaceans are long-lived mammals, apex marine predators dependent on the long-term health of marine resources. Their ecology, longevity and mobility make cetaceans appropriate indicators for acute as well as chronic marine environmental impacts of relevance to regional Indonesian

communities. Thus, it is important to continue periodic visual and acoustic cetacean surveys as well as other cetacean conservation initiatives in Indonesia's waters.

2. The cetacean survey program in Komodo National Park and World Heritage Area.

Komodo National Park (KNP) is part of the Nusa Tenggara island chain and located between the islands of Sumbawa and Flores. KNP Park encompasses 603 km^2 of land and 1,214 km^2 of marine waters. It contains three large islands (Komodo, Rinca and Padar), as well as numerous smaller islands, coral cays and rocky outcrops. KNP also includes several inter-island straits and is of importance to the conservation of Indonesia's terrestrial as well as marine bio-diversity (Pet and Djohani 1996).

The Komodo area was established as a National Park in 1980 by the Government of Indonesia and declared a Man and Biosphere Reserve and a World Heritage Site in 1986. The Park is well known for the unique Komodo dragon (*Varanus komodoensis*), its vibrant coral reefs and world class dive sites. The waters of KNP and adjacent areas include numerous coastal and marine habitats, and are characterised by strong currents, localised upwellings and a complex oceanography.

KNP has an exceptional tropical marine bio-diversity and recent coral reef and fish surveys conducted by The Nature Conservancy (TNC) have identified at least 250 species of scleractinian corals, 70 species of sponges, over 900 species of fish and several species of marine turtles and mammals (TNC 1997). Its World Heritage Area status reiterates the importance to "ensure the identification, protection, conservation, presentation and transmission of world heritage values to future generations" (UNESCO 1972).

The rapid ecological assessments on cetacean diversity, distribution and abundance show that the Komodo National Park and World Heritage Area is an important habitat for whales and dolphins (Kahn *et al.* 2000), and its long-term protective management benefits from seasonal regular cetacean survey activities. The rapid ecological assessments assist with the on-going inventory program on KNP marine biological diversity, and aim to a) identify critical habitats for cetaceans, b) broaden the array of KNP conservation perspectives and park management measures, and c) provide an additional tool for environmental awareness and community related activities.

2.1 Survey Objectives

The key survey objectives of the KNP cetacean rapid ecological assessment program are:

1. To provide base-line data on cetacean diversity, distribution and abundance in all marine habitats of Komodo National Park (KNP) including:

    i. Coastal habitats of KNP to monitor the presence of vulnerable coastal cetaceans.
    ii. Inter-island straits and deep channels of KNP to examine their significance as migration corridors for wide-ranging migratory cetaceans occurring in eastern Indonesian waters.
    iii. Oceanic areas to the north and south of KNP to monitor the presence of oceanic cetaceans.

2. To monitor seasonal patterns in KNP cetacean diversity, distribution and abundance.

3. To identify sensitive marine areas for cetaceans, including preferred feeding grounds, mating locations and migration corridors.

4. To identify regional marine environmental impacts affecting KNP cetaceans.

5. To provide site and species-specific information on KNP cetaceans for:

    i. Marine resource and park management purposes.
    ii. Environmental awareness and educational programs.

6. To establish community-based cetacean monitoring programs through the active participation of management agencies and stakeholders including:

    i. TNC-Komodo Field Office staff
    ii. Balai Taman Nasional Komodo rangers
    iii. Komodo National Park dive operators.

3. Survey Methods and Research Activities.

The methodologies involved in this program have been specifically designed to cause minimal disturbance to cetaceans while allowing for discrete and close observations. These procedures have been practiced in Indonesian waters as well as in other parts of the world where benign cetacean research is conducted.

3.1 Survey method I: TNC speedboats.

The majority of the visual and acoustic cetacean surveys were carried out from a 25-foot TNC Yamaha speedboat cruising at 16-18 knots. This survey focused on the coastal areas, bays and inter-island passages of Komodo National Park. While underway, a minimum of two experienced observers conducted visual surveys of the surrounding waters. If cetaceans were sighted the vessel's course and speed were adjusted to allow for a discreet approach and close observation. Whenever possible a positive species identification (ID) was made. Unidentified cetacean encounters were recorded as such after a minimum of 10 minutes of visual survey efforts focused on obtaining a positive identification. Unidentified cetacean encounters were usually the result of unfavourable light conditions, sea state, lack of proximity, active avoidance behaviour or operational constraints.

Time, sea surface conditions, GPS location, species sighted, estimated abundance, group composition, the presence of newborn calves, minimum distance from vessel, direction of travel and selected behaviours and species associations were recorded on standardised, waterproof data sheets. Photo-identifications were made of individuals with distinctive colourations, marks or scars using a Nikon 601 SLR camera equipped with a Nikkor 70-300mm lens. In addition, a Sony PC-10 digital video camera was also frequently used to record the diversity of cetacean species and behaviours. After the ID and recordings were completed, the vessel departed from the sighting area at a reduced speed and resumed the predetermined survey route.

During offshore routes the visual surveys were complimented by periodical acoustic listening stations using a directional Vemco custom VHLF hydrophone (30Hz-20kHz) and audio amplifier. Acoustic surveys were only conducted if the vessel was located four or more nautical miles offshore to minimise any coastal interference. Listening stations were recorded every 30 minutes, or approximately 7-8 nautical miles apart depending on off-shore conditions. The survey commenced in the early morning departing from The Nature Conservancy - Komodo Field Office in Labuan Bajo, Flores, Nusa Tenggara Timor and returned before sunset each day.

3.2 Survey method II: Local live-aboard vessels.

Visual and acoustic cetacean surveys were also carried out from a local live-aboard vessel. Use of the live-aboard increased the coverage to remote areas and allowed the surveys to continue during less optimal weather conditions. The data collection procedures did not differ between survey methods and are described in Section 3.1. The vessel speed averaged 6-7 knots. Increased observer height and regular use of 40x8 marine binoculars increased the visual survey range. The majority of the acoustic surveys were conducted while on-board the live-aboard vessel. Listening stations were conducted on the hour for at least five minutes. Stations were only conducted when located more than 4 nautical miles (nm) off-shore to minimise disturbance and spaced approximately 7-8 nm apart. A detailed description of the methodologies has been published (Kahn *et al.* 2000).

4. Survey Results.

4.1 Visual survey effort.

Surveys were conducted from 18 September to 5 October 2000. In total, 12 cetacean species were identified. The survey effort comprised of 15 field days and totaled 109 active survey hours, with two experienced observers on watch. The surveys covered an estimated 1127 nautical mile (nm). The 12 species observed during 51 encounters were predominantly toothed whales and dolphins (Suborder Odontoceti), although two species of baleen whales *(Balaenoptera sp.*, Suborder Mysticeti) were also observed, including the rare and endangered blue whale (*B. musculus*). An estimated 1108 individual cetaceans were sighted during the visual survey effort (Table 1). An overview of the seasonal and annual comparison of visual survey effort is further detailed in Section 4.5.

4.2 Acoustic survey effort.

The acoustic survey included 39 hydrophone listening stations. The acoustic survey covered an estimated 2547 nm^2 in all. Acoustic contact with cetaceans was recorded in 30.8 % of the listening stations (Table 2). An overview of the seasonal and annual comparison of the acoustic survey results is described in Section 4.5.

4.3 Cetacean species diversity.

The cetacean surveys have established that Komodo National Park and its adjacent waters is a region of relatively high whale and dolphin diversity. During the October survey a record 12 species where observed including a high proportion of rare and endangered species. Cetaceans encountered during the survey include the long-nosed spinner dolphin (*S. longirostris*),

bottlenose dolphin (*T. truncatus*), pan-tropical spotted dolphin (*S. attenuata*), melon-headed whale (*P. electra*), Fraser's dolphin (*L. hosei*), pygmy killer whale *(F. attenuata*), rough-toothed dolphin (*S. bredanensis*), Risso's dolphins (*G. griseus*), orcas (*O. orca*), the Cuvier's beaked whale (*Z. cavirostris*), a solitary blue whale (*B. musculus*), and the unidentified rorqual whales described in previous reports and publications (Figure 1). During the October surveys these *Balaenoptera* whales were the focus of an ecological focus study and DNA sampling efforts (see Section 5).

The decrease in new species sighted during the 2000 surveys as compared to 1999 suggests that the KNP cetacean REA efforts have been successful in recording the majority of cetacean species which inhabit KNP waters (Figure 2). However, the two new species sighted near KNP waters included a fully mature blue whale as well as a pod of orcas. Both these species are data deficient (IUCN 1996) and probably rare in Indonesian waters. Species diversity continues to be a priority for all surveys as seasonal patterns in cetacean distribution are likely to occur in Indonesian and KNP waters.

4.3.1 Blue whales in KNP and adjacent waters

Blue whales (*Balaenoptera musculus*) have been previously reported in the KNP area, with a peak abundance in May (IUCN/UNEP 1988). The October 2000 blue whale sighting is the most recent confirmation that this highly endangered cetacean occurs within Indonesian waters. The blue whale's blow was sighted on the 1st of October 2000 from the TNC survey speedboat over 5 nm away.

The blue whale traveled towards the W at constant speed throughout most of the observation period from 10:30 - 13:59. During this time a total of 13 dive sequences were recorded and the blue whale's length was estimated at 24 m. This field estimate compares well with the average adult length of blue whales (25 m for males, 26.2 m for females - the maximum length scientifically obtained is 29.9 m), but is also the maximum length given so far for the pygmy blue whale (*B. musculus musculus*), a relatively new subspecies. Differentiating between these two is extremely difficult in the field and usually only apparent upon close examination off a carcass. Interestingly, a dead blue whale was reported to have washed up on a remote beach in the Northern Territory, Australia several weeks after the KNP observation. Further investigation of this stranding is in progress. Since the KNP cetacean program relies mostly on field observations, the identification of subspecies in this instance is not likely, and the species is recorded as the blue whale (*B. musculus*).

The blue whale was difficult to track for such a formidable animal as it routinely surfaced for only 1-2 minutes and 2 blows before commencing another dive. The average dive sequence duration (dive to dive) was 13.8 min, with a range of 5 -19 min. No acoustic contact was made during the 5 listening stations conducted during such dives. Fluke ups (the lifting of the tail prior to a dive) was observed during the majority of the dives. This feature, in addition to the whale's large size and position of the small dorsal fin also confirm the positive identification. The dive routine is similar to the migratory behaviour described of blue whales, and the month of observation suggests the whale could have been on its way back towards the known Antarctic feeding grounds during the southern summer (December - March). If so, it would have to migrate through the Nusa Tenggara passages. The whale's change of course from 270^{o} to 210^{o} at 13:37, heading towards Banta Isl. and the Sape Strait between Komodo and Sumbawa, may have been the approach towards the wider Indian Ocean migration route. The last sighting was a dive sequence at 13:59. The blue whale was heading straight for the Sape Strait passage.

Additional sighting efforts proved unsuccessful and a search pattern was initiated at 14:20. No further sightings of the whale's blow (estimated to reach 9 m high) nor its fluke were made. At 14:40 a listening station revealed the presence of orcas (*Orcinus orca*) in the area. At 14:45 a pod of 9 orcas was observed travelling from the San Geang area towards the northwest. The orcas showed interest in the speedboat and close observations of the orcas slow movements towards the north west were made until we departed the orcas for port at 16:00.

There is no direct evidence to suggest that an interaction between the blue whale and the orcas occurred. Nonetheless, it is likely that the blue whale may have changed its behaviour to avoid acoustic or visual detection by this known predator of large marine life, including blue whales. Evasive action by the blue whale would explain the absence of acoustic contact (although some low frequency blue whale vocalisations are out of the detection range of the hydrophone) and the sudden change in both dive pattern and travel direction.

Marking studies on blue whales have demonstrated that blue whales regularly move between high and low latitudes, covering thousands of nautical miles each year. An annual cycle of migration to polar feeding grounds in summer and a return to tropical waters in winter for breeding has been documented for the Southern Hemisphere population This population has been estimated at 10,000-12,000 animals, or 5% of the original population estimate. Of these approximately 6,000 individuals are pygmy blue whales (Martin 1990).

Our observation, together with occasional volunteer sightings in 1999 and 2000 of exceptionally large whales (tentatively identified as blue or fin whales) indicate these whales may be migrating through the region from April - October. The large Balaenopterids are perhaps more abundant in Indonesian waters than generally believed and the existence of an unknown tropical breeding ground of blue whales in Indonesian waters should be considered.

4.3.2 Notable absence of certain cetacean species

No sperm whales *(P. macrocephalus*) were sighted during both 2000 surveys, although during October 2000 acoustic contact was established once. Unfortunately it was impossible to track or obtain a visual identification on this pod because of a rapidly approaching storm. Another cetacean species which remains elusive, but which is expected to occur in the oceanic waters adjacent to KNP, is the short-finned pilot whale (*Globicephalus macrorhynchus*). The absence to date of *G. macrorhynchus* is all the more remarkable as this species is one of the most abundant members of the oceanic odontocete community in other parts of Indonesia (*Rudolph et al.* 1997, Kahn 1999) and is also relatively common in other tropical oceanic regions (e.g. Jefferson *et al*. 1993).

The continued absence thus far of several in-shore cetacean species is also noteworthy. Some of these vulnerable cetaceans, such as the Indo-Pacific humpbacked dolphin (*Sousa chinensis*), have known distribution ranges throughout coastal Indonesia and are expected to occur within KNP waters, but have so far not been sighted. Others, such as the Finless porpoise (*Neophocaena phocanoides*) and the Irrawaddy dolphin (*Orcaella brevirostris*), may have a discontinuous distribution and genetically distinct Asian and Australian populations.

4.4 Cetacean distribution in KNP

All cetacean sighting coordinates of the October 2000 survey were transcribed to a GIS format and assigned species-specific data points (Figure 1). The distribution of cetaceans shows the distribution of the cetacean species encountered. Cetacean species were colour-coded and allocated the following symbols:

Category	Symbol
Sub-order Mysticeti - baleen whales	●
Families Physeteridea and Kogiidae - sperm whales	■
Family Ziphiidae - beaked whales	★
Dolphins - Family Delphinidae	▲
Blackfish - a historical name for six Globicephalid dolphin species	✚
Unidentified small cetacean (≤ 6 metre)	△
Unidentified large cetacean (> 6 metre)	○

The distribution patterns of the previous surveys (Kahn *et al.* 2000) have been largely confirmed (Figure 1). The bottlenose dolphin, *T. truncatus*, continues to dominate the distribution of sightings within KNP borders, whereas the straits and offshore areas adjacent to KNP have a more diverse pattern. Especially the 2000m contour where KNP slopes steeply into the Flores Seas basin is an important region for both resident (melon-headed whales, *Kogia* spp) as well as migratory species such as the Risso's dolphin, orcas and blue whales. Within Park borders the most consistent sighting areas include the *Balaenoptera* baleen whales of Loh Dasami (Section 5) and the large pod of pan-tropical spotted dolphins (*S. attenuata*) off the south-east coast of Komodo.

4.5 Annual and seasonal patterns of KNP cetaceans

Examining patterns in cetacean distribution, diversity and abundance is notoriously difficult as these animals are elusive and often encountered under harsh sea conditions. In addition, fluctuations in survey dates, weather and operational factors mean that every survey is to some extend unique. The KNP survey program was established in April 1999 and the major results and corresponding survey efforts have revealed some interesting trends (Figure 3-ah). It should be noted that the initial April1999 survey was a feasibility study and familiarizations with the area as well as the reduced survey effort (10 day - Fig 3) means that the results of this survey should be interpreted with caution. To conduct a balanced design analysis of this ecological time series the standardised April 2001 survey must be included. This analysis will be available in mid-2001. The hours spend on visual survey are relatively similar, especially for the standard 15 day surveys. The area surveyed increases over time, indicating increased familiarity with the region

and more effective identifications (less identification time spend per encounter). This is also dependent on the total number of encounters.

Acoustic contacts are more frequent during the October surveys as are the number of species positively identified. The total number of individual cetacean sighted is highly variable with October 1999 as the most abundant survey period to date. These results must be treated with caution however, as new information on residency of certain pods becomes available. The likely residency of two large pods of melon-headed whales and pan-tropical spotted dolphins could distort the abundance numbers if encountered frequently on separate survey days. This aspect of data doubling can be better compensated for once additional information becomes available of the resident cetacean populations of KNP through the on-going species - specific identification efforts of marked individuals.

4.5.1 Visual surveys - species-specific sighting patterns

The relative proportions of species sighting frequencies and abundance for each survey period are also of interest (Figs 4-5). As both the sighting and abundance patterns are similar, only the sighting pattern (Table 3, Figure 4) will be discussed here. Figure 4 shows twenty cetacean species or other recognition categories (i.e. large or small unidentified cetacean, blackfish). It presents the sighting pattern data of all surveys to date and allows for the following species categories:

I. Species consistently sighted during all surveys

   i. Bottlenose dolphin
   ii. Spinner dolphin
   iii. Melon-headed whale

These species are likely to be present in KNP and adjacent waters year round and are relatively abundant.

II. Species consistently sighted during three survey periods

   i. Pan-tropical spotted dolphin
   ii. *Balaenoptera* whale
   iii. Fraser's dolphin
   iv. Rough-toothed dolphin
   v. False killer whale

These species are likely to be present in KNP and adjacent waters year round but are relatively uncommon.

III. Species consistently seen during a particular season (i.e. an inter-moonsoon survey period)

   - October period

      i. Pygmy killer whale
      ii. Risso's dolphin
      iii. Cuvier's beaked whale

- April

    i. Pygmy and/or dwarf sperm whale (*Kogia* spp.)

These species are likely to be present in KNP and adjacent waters during the identified periods but are relatively rare at other times. If this trend continues it would indicate a migratory pattern in these species and potentially identify KNP as an ecologically important area to these transient species for this period.

The other species identified are currently data deficient. Only one of the species encountered in KNP waters, the sperm whale, was sighted during the 1999 surveys only. Keeping in mind that the current two year data set is barely the minimum for seasonal and annual comparisons, it is likely that with additional survey efforts a clearer distinction between KNP resident and transient cetacean species will be possible. In addition, the continued survey efforts and the proposed focus research programs will concentrate on species-specific habitat use, its ecological functions and KNP management implications.

4.5.2 Acoustic contacts - annual and seasonal patterns

The annual acoustic survey summaries do not indicate any difference between 1999 and 2000 program years (Fig 6a). However, the seasonal acoustic surveys to date indicate the October period has a substantial increase in cetacean acoustic contacts with identical listening effort. This indicates an increase in cetacean abundance during this period, as in accordance with the visual abundance survey results (however, the visual abundance may be skewed towards to October period), and species positively identified (averaging eight species for the April periods, twelve for October).

4.6 Cetacean survey field training and educational activities

The field training of TNC-KFO staff during the October 2000 surveys was similar, but less extensive, to the previous survey. The main reasons for the reduced training and educational efforts were the lack of staff availability due to their assistance to other TNC programs active at that time and a reorganisation of the Komodo Field Office. The KNP cetacean survey training goals as well as the educational and environmental awareness activities are described in previous monitoring reports (Kahn 2000).

5. Focus of Komodo National Park's rorqual whales (Balaenoptera sp.)

The Komodo baleen whales have been sighted during the last three survey periods in coastal waters off Gili Mota (October 1999) and Loh Dasami, Nusa Kode Strait (April and Oct 2000), as well as along the southeast coast of Rinca and in the vicinity of Loh Liang, Komodo (Oct 2000). The majority of these sightings occurred within Park boundaries. The whales have been most frequently sighted in Loh Dasami, Nusa Kode Strait. Feeding behaviours and social interactions have been observed here, indicating a habitat preference for this area.

After extensive review of cetacean field guides and literature, it became clear the whales encountered did not conform to any rorqual species' morphology published thus far. The high quality slide images and digital footage obtained during the surveys have been reviewed by

several cetacean experts world wide, yet the species identification remained unconfirmed. The *Balaenoptera* characteristics observed are unusual and include:

- Relatively pointed rostrum
- Prominent single ridge on rostrum
- Inconspicuous blow
- Relatively small (approx. 8-10m)
- Prominent light grey/whitish pectoral fins
- Extremely falcate dorsal fin
- Complex colour pattern including light grey chevron, nape streak and thorax patch.

The difficulties in identifying this large marine mammal are not so surprising, as *Balaenoptera* whale morphologies in the Indo-Pacific, and especially South East Asia, are not well known. Several cetacean species from this region are described solely from skulls and occasional strandings and not in living detail. Other cetacean species in Australasia are being reviewed taxonomically and re-classified with additional (sub) species (e.g. Perrin *et al*. 1996; IWC 2000). Thus, the current observational and photographic field methods were unlikely to result in a positive identification of this species and limited further investigation. Instead, a DNA biopsy sample was obtained during the October 2000 survey in collaboration with PKA (Indonesian National Parks) and approved by LIPI (Indonesian Institute for Sciences).

This material has been sampled with a relatively non-invasive method for DNA complex analysis. The biopsy was successfully taken during the first attempt and no reaction of the whale to the sampling was evident. Surface feeding behaviours were observed shortly afterwards and the whale remained in the focus research area for the remainder of the day. This biopsy sample should allow for a positive *Balaenoptera* species identification in the near future and possibly a stock identification (which is the major knowledge gap for the management of living cetaceans) using comparative DNA analysis (Dizon *et al.* 2000). The DNA analysis will also add important information on the regional genetic and morphological variation of South East Asia's Balaenopterid cetacean species. This knowledge is crucial for future cetacean surveys and ecological cetacean research in the region.

5.1 Sampling technique

The technique used to obtain the genetic material is relatively non-invasive, and compatible with the benign living cetaceans research methods used in this program thus far. The technique was chosen after extensive advice from several cetacean researchers in the USA and Australia. In essence, we have used a small biopsy cylinder of 20 mm long with a diameter of 5mm attached to a long pole. This approach does not involve any specialised equipment and can be quickly employed once the whales are sighted. We discretely approached within 3 m of the surfacing whale with a TNC speedboat and used the telescopic pole to jab the whale's anterior flank, just under the dorsal fin. A single skin and blubber sample was obtained for DNA analysis during the first attempt. The utmost care was taken not to harm the whale accidentally during the approach and sampling, and no change of behaviour was observed. The sample was then duplicated upon request of LIPI and stored locally. They will be transported to a DNA laboratory for analysis once cleared for export according to CITES specifications and Indonesian law.

5.2 Sample storage:

Samples are stored in 20% DMSO preservative in saturated salt at 0° C temperature (or below). This is a standard field procedure for storing cetacean genetic material.

5.3 Sample transport:

Samples will be shipped via airbag in an institutional CITES exchange. The material and preservative are considered non-hazardous material and this procedure is standard for small quantities. We are scheduling to ship the samples to the CITES registered Southwest Fisheries Science Center, La Jolla, USA where several DNA complex analysis on South-East Asia's cetaceans are conducted.

An ecological focus study is warranted to further investigate the potentially resident KNP *Balaenoptera* whales. Important data for management consideration includes numerous population biology parameters, movement patterns and habitat use, as well as the evaluation of environmental impacts and additional protective management measures.

6. Species-specific habitat use of KNP and adjacent waters

One of the main long-term objectives of the rapid ecological assessment surveys is to investigate cetacean movements and habitat use within Komodo National Park and its adjacent waters. This is necessary in order to develop ecologically-based conservation measures for management plans relevant to cetaceans and other large migratory marine life.

6.1 Indications of critical habitats for KNP cetaceans.

For the purposes of this REA survey program critical habitats to cetaceans are defined as preferred feeding areas, breeding and calving grounds as well as migration routes and corridors. The October 2000 KNP cetacean rapid ecological assessment confirmed *all* the previous identifications of several species-specific habitat preferences (see also Kahn 2000):

i. Pan-tropical spotted dolphins (*S. attenuata*) - The majority of sightings were recorded in the KNP waters just south of Nusa Kode, Selat Linta, South Komodo and Selat Sape.

ii. Melon-headed whales (*P. electra*) - Exclusively encountered in the oceanic survey to the north of KNP along the 2000m depth contour. *P. electra* was encountered in this area during all survey periods to date, indicating this species may have a resident population in KNP waters.

iii. Rorqual whales (*Balaenoptera sp.*) - Repeated sightings at the Flores - Gilli Mota and Rinca - Nusa Kode channels indicate a habitat preference for continental island passages with high relief, deep and sheltered waters and strong tidal currents. Loh Dasami has been identified as an important feeding area.

iv. Bottlenose dolphin (*T. truncatus*) - Most common in-shore species and commonly found in the passages of KNP. No obvious small-scale coastal preferences are evident.

v. Long-nosed spinner dolphins (*S. longirostris*) - Most common off-shore species, no obvious small-scale oceanic preferences are evident.

7. Threats to KNP cetaceans

The majority of threats to KNP's cetaceans are fisheries related and include both acoustic impacts (especially through reef blasting) as well as by-catch and net entanglement. Several non-fishery disturbances are also impacting on the KNP cetaceans (see Kahn 2000 for overview). Regionally, South-East Asia's in-shore and river cetacean species are most at risk of extirpation or even extinction as the majority of human activities and habitat alterations occur in these habitats (Jefferson and Reeves 1998). However, even oceanic cetacean species are considered increasingly vulnerable, especially when their seasonal movements and calving grounds include inshore and coastal areas (Kemp 1996).

7.1 Observed threats to KNP cetaceans

No direct bombing activities were observed during the October 2000 survey. Nonetheless, on one occassion bombers where given chase by the survey vessel after three suspicious boats and bombing related activities were observed near South Padar and several reports of bombing activities within Park boundaries confirm this is still very much a threat to all KNP's marine resources, including whales and dolphins.

7.2 Other threats.

Of special concern is the Loh Dasami, Nusa Kode area where both *Balaenoptera* whales and large groups of fishermen from Sape were frequently sighted during the October 2000 survey. In addition to the fishery-related threats and net -entanglement for these potentially resident whales, the area is also popular with the dive industry and guests often approach or attempt to swim with the whales once sighted. Whale watch guidelines have been produced and informally given to several operators, but a concentrated focus by Park management authorities in the form of increased patrols and additional regulation for this area would be warranted.

No major accumulations of floating plastic debris were encountered, as expected during this period of reduced rainfall and run-off, but a significant amount of plastic bags was seen on numerous days in the Loh Dasami area. As this area is a known feeding habitat for large marine planktivores including mantas, whales sharks and baleen whales, such floating debris is potentially lethal.

8. Conclusion

Indonesia's cetaceans, as highly effective and specialised predators, are an important component of this diversity and inhabit river, coastal and oceanic habitats. However, there is a considerable lack of scientific knowledge of relevance to marine resource management on the ecology of Indonesia's living cetaceans and this situation can only be improved by regional cetacean surveys. The current rapid ecological assessment in Komodo National Park has confirmed the relative high cetacean diversity and abundance findings of previous 1999-2000 surveys, and indicates that Komodo National Park and adjacent waters of the Flores and Sumba Seas support a diverse community of whales and dolphins throughout the year. Indications of critical habitats

for cetaceans are increasingly apparent as more data on resident and migratory species becomes available.

The two main recommendations which stem from the October 2000 surveys specifically are 1) the need for additional protective measures for the Komodo *Balaenoptera* whales. The *Balaenoptera* whales are likely to be resident in the KNP area and their coastal habitat usage within the Park brings this endangered species into direct conflict with fishery and tourism interests, and 2) the need to realise the planned expansion of KNP boundaries to include both Banta Island and Sape Strait to ensure unobstructed migratory corridors for large marine life, including the endangered and inspiring blue whale (*B. musculus*), which frequent the Indonesian Seas on its regional migration. The protection of the Indian-Pacific Ocean migration corridors for cetaceans and other large migratory marine life has been recognised as a high priority marine conservation measure over 15 years ago (i.e. Salm 1984, PHPA 1984). The inclusion of a major Nusa Tengarra passage in a National Park and World Heritage site in 2001 would be an important step towards achieving a protective management regime of significance to the Indonesian Seas and neighbouring ocean basins.

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Tables

Table 1: KNP cetacean visual survey summary for the October 2000 period.

KNP cetacean visual survey effort 18 September - 5 October	Survey method 1	Survey method 2	Survey October
Total no. of days surveyed	10	5	15
Survey effort (hrs)	68	41	109
Estimated area surveyed (nm)	882	245	1127
Cetacean identification encounters	33	18	51
Estimated number of cetaceans surveyed	696	412	1108
Cetacean species identified	10	6	12

Table 2: KNP cetacean acoustic survey summary for the October 2000 period.

KNP cetacean acoustic survey effort 18 September - 5 October	
Listening stations	39
Cetacean contact	12
Acoustic encounter rate (%)	30.8
Area covered (nm^2)	2457

Table 3: Cetacean species positively identified in Komodo National Park and adjacent waters for the 1999 - 2000 survey periods.

Cetacean species		May 1999	Oct 1999	April 2000*	Oct 2000*
1. Long-nosed spinner dolphin	*S. longirostris*	◆	◆	◆	◆
2. Bottlenose dolphin	*T. truncatus*	■	■	■	■
3. Pan-tropical spotted dolphin	*S. attenuata*		■	■	■
4. Melon-headed whale	*P. electra*	●	●	●	●
5. Rorqual whale	*Balaenoptera sp.*		●	●	●
6. Sperm whale	*P. macrocephalus*	●	●		
7. Fraser's dolphin	*L. hosei*		●	●	●
8. Risso's dolphin	*G. griseus*		●		●
9. Pygmy killer whale	*F. attenuata*		○		○
10. Pygmy/dwarf sperm whale	*Kogia sp.*	○	○	○	
11. False killer whale	*P. crassidens*	○	○	○	
12. Common dolphin	*Delphinus sp.*	○			
13. Rough-toothed dolphin	*S. bredanensis*		○	○	○
14. Cuvier's beaked whale	*Z. cavirostris*		○		○
15. Blue whale	*B. musculus*				○
16. Orca	*O. Orca*				○

◆ = Abundant; ■ = Common; ● = Uncommon; ○ = Rare

(* - Categories based on Kahn *et al.* 2000).

Figures

Figure 1: Cetacean species diversity and distribution in Komodo National Park and adjacent waters - October 2000 survey.

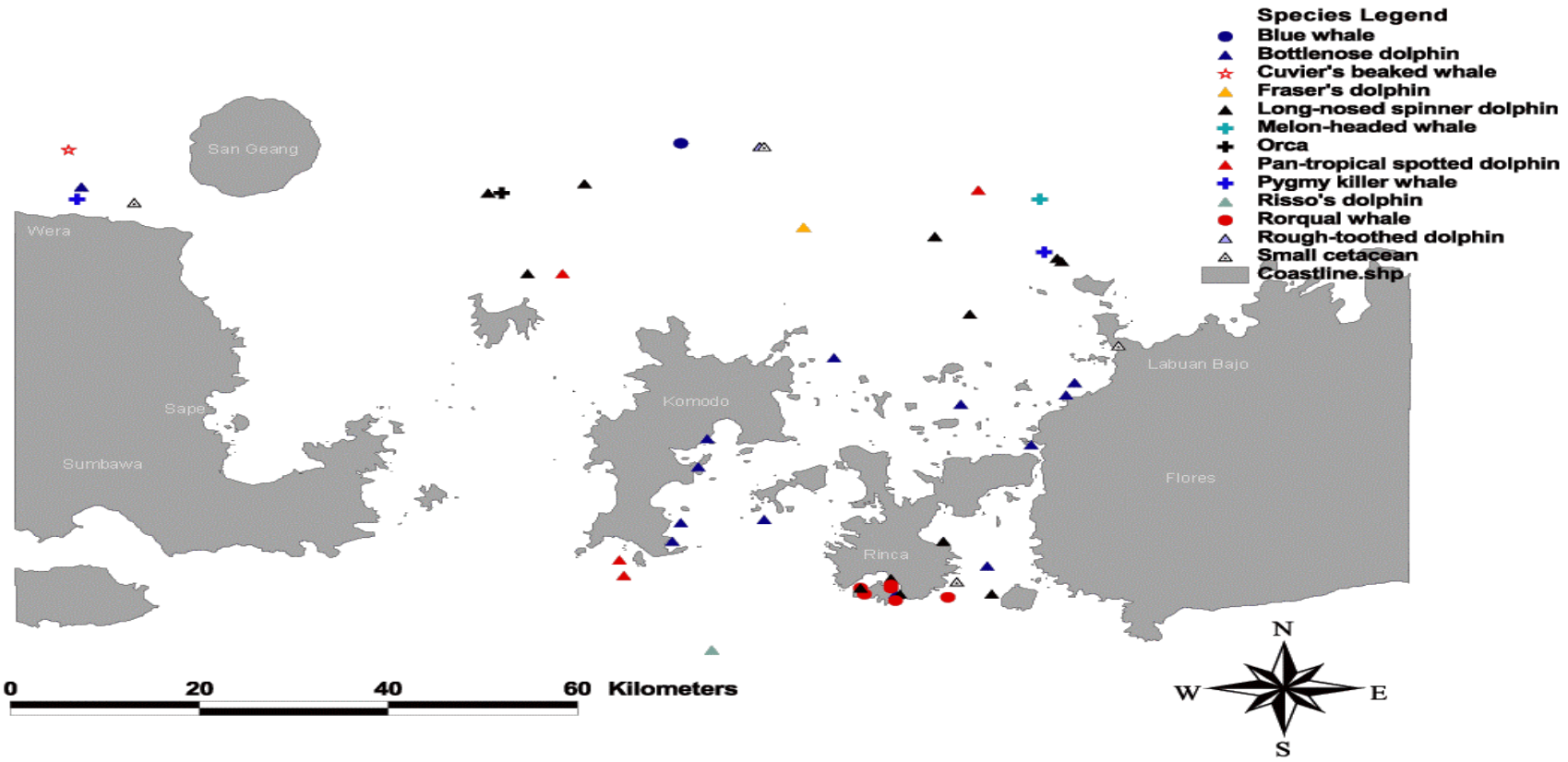

Figure 2: The number of new cetacean species positively identified during the KNP surveys periods.

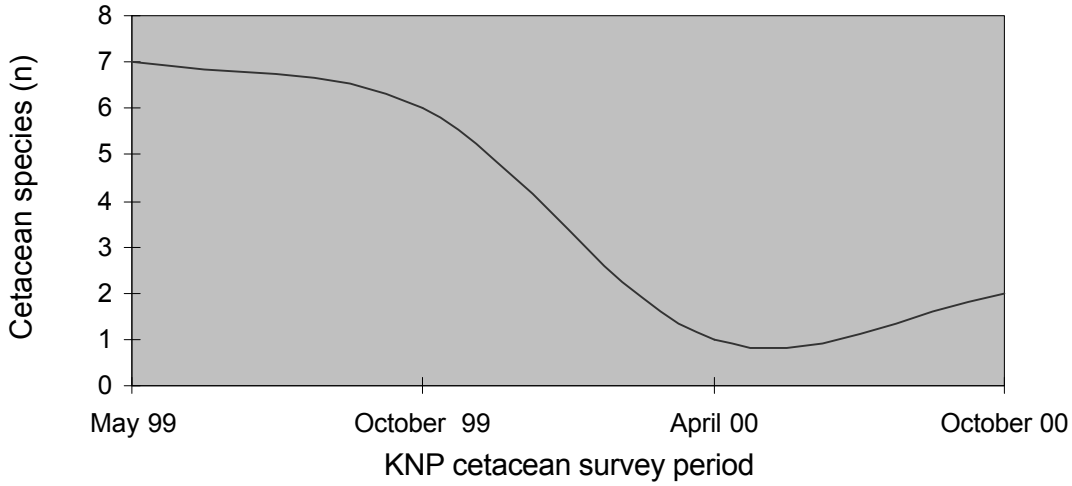

Figure 3a: Active survey days for each survey period.

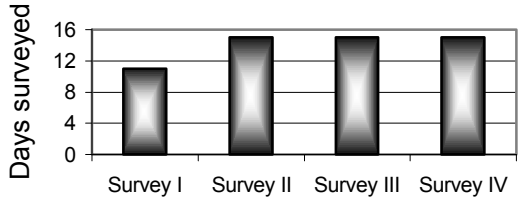

Figure 3b: Active survey hours for each survey period.

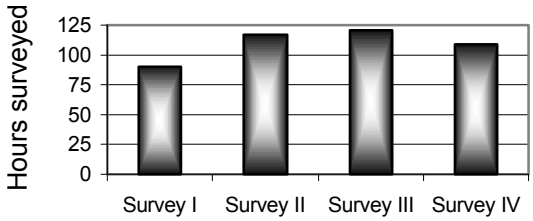

Figure 3c: Estimated area surveyed for each survey period.

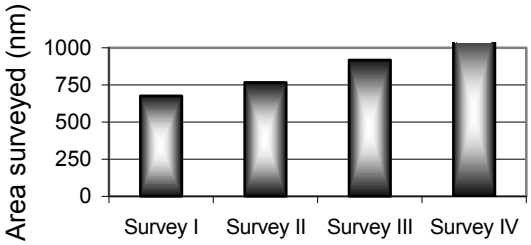

Figure 3d: Number of listening stations for each survey period

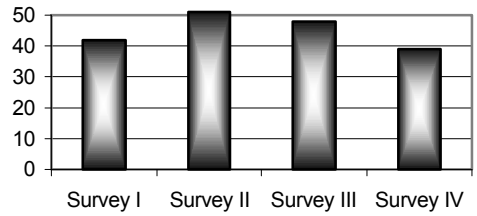

Figure 3e: Percentage of listening stations with cetacean acoustic contact for each survey period.

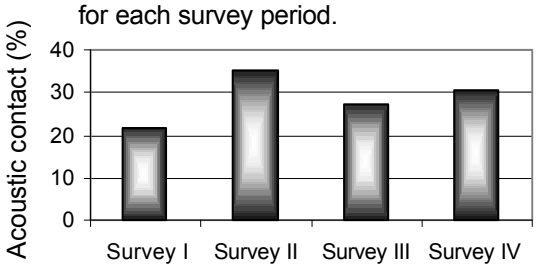

Figure 3f: Number of species positively identified for each survey period.

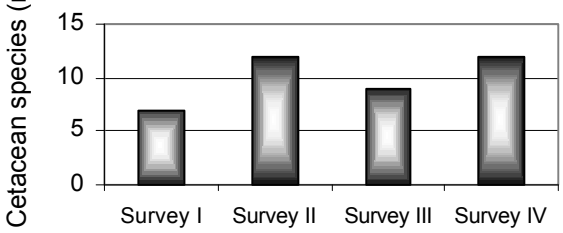

Figure 3g: Total number of cetacean sighting frequencies for each survey period.

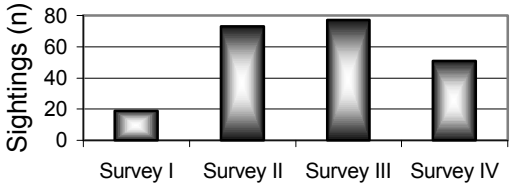

Figure 3h: Estimated number of individual cetaceans sighted for each survey period.

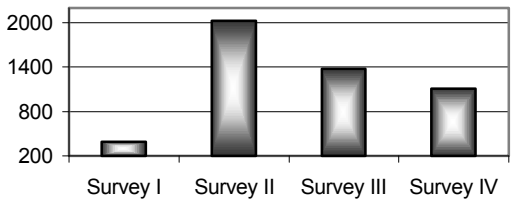

Figure 4: Percentage of species-specific cetacean sightings for each survey period.

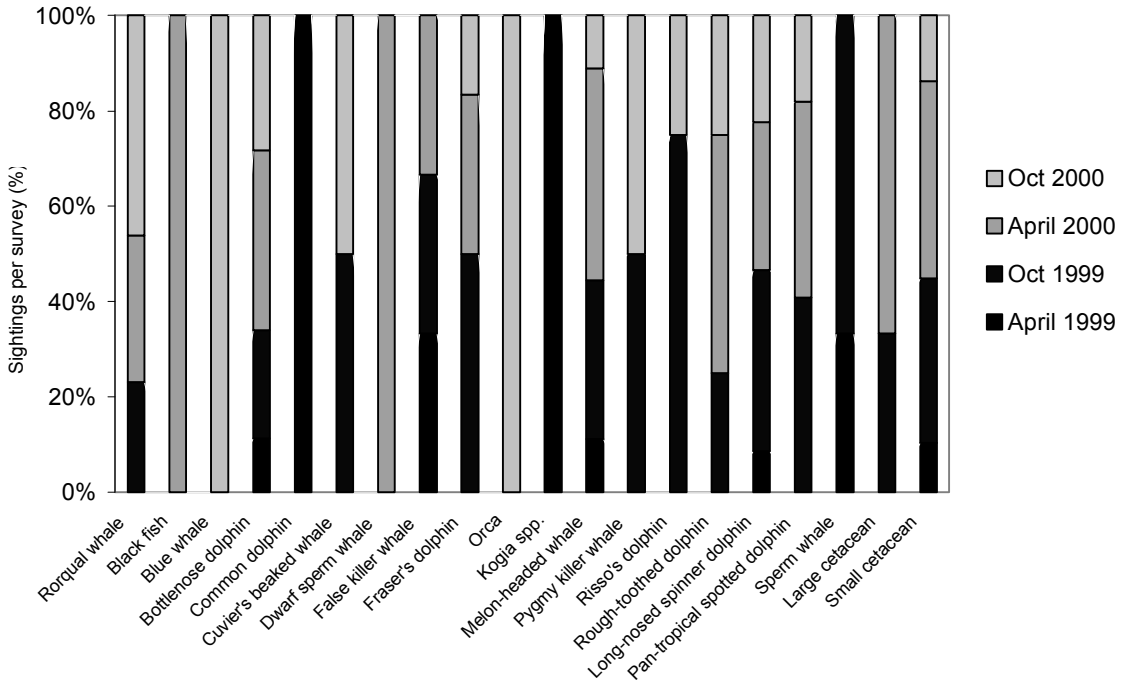

Figure 5: Percentage of species-specific cetacean abundance for each survey period.

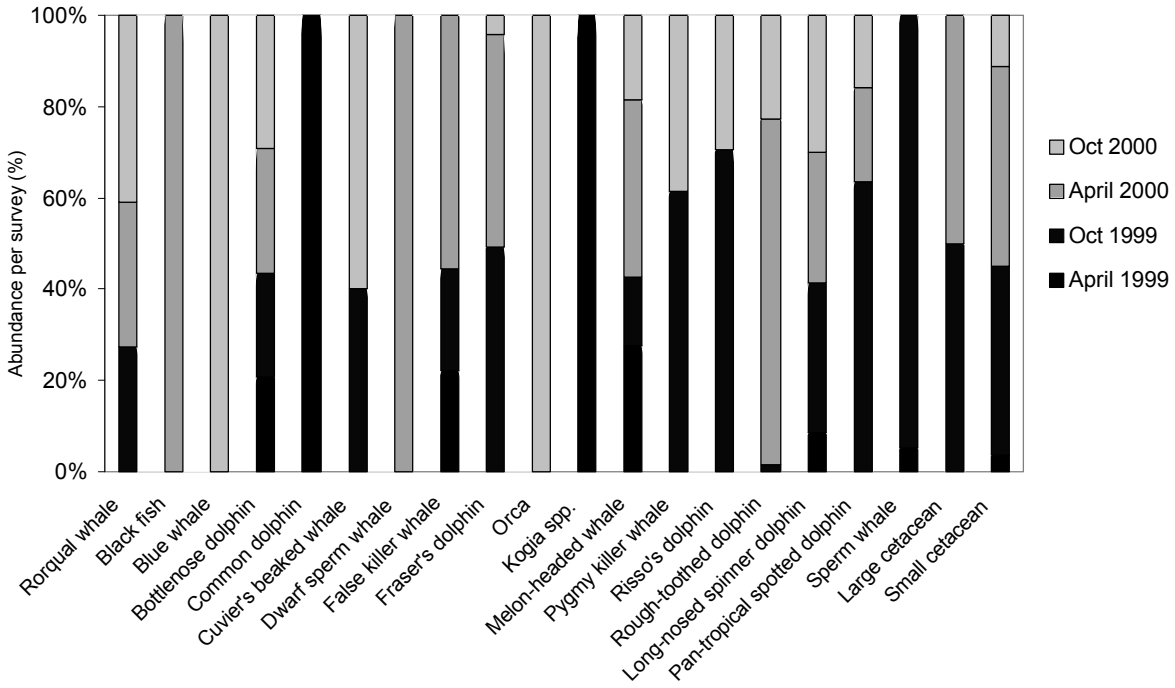

Figure 6a: Acoustic survey summary - annual results (1999 and 2000).

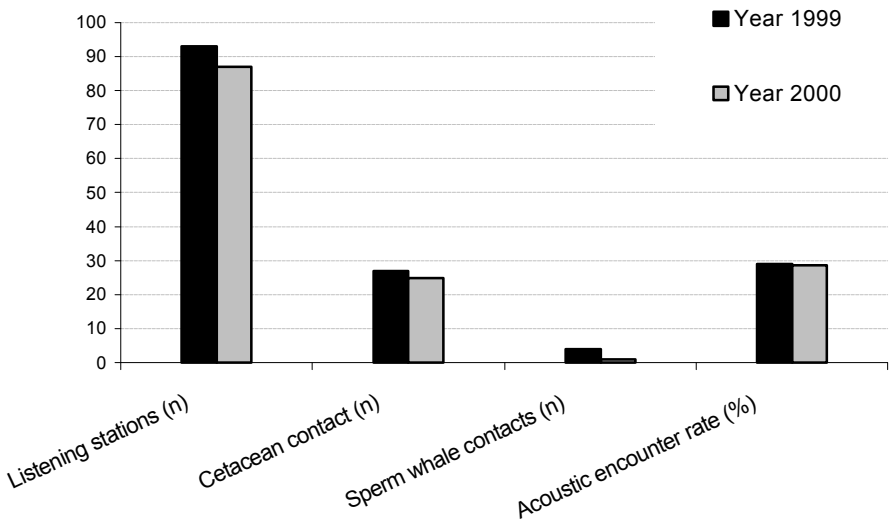

Figure 6b: Acoustic survey summary - seasonal results (April and October, both years combined).