Dolphins distributions (Mammalia: delphinidae) in an upwellings zone (Chile)

Distribución de delfines Mammalia: delphinidae) en una zona de surgencias (Chile)

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Abstract
The results of a study on sighting frequency and relative abundance of delphinids along the coast of Northern Chile (18°30’S-25°23’S; from coast to 70°27’W), conducted between March and December 2000 in an area of 207.614,60 km² are reported. The following eight species were sighted: Short-beaked Common Dolphin (Delphinus delphis), Long-beaked Common Dolphin (Delphinus capensis), Short-finned Pilot Whale (Globicephala macrorhynchus), Risso’s Dolphin (Grampus griseus), Dusky Dolphin (Lagenorhynchus obscurus), Southern Right Whale Dolphin (Lissodelphis peronii), Striped Dolphin (Stenella coeruleoalba) and Bottlenose Dolphin (Tursiops truncatus). The distribution of dolphins north of Tocopilla showed relationship with the coastal upwelling front of that area, while off the Mejillones Peninsula the relative abundance and diversity of dolphins was associated with the extensive upwelling plume described for this area. T. truncatus was the most frequently sighted species (44.14% 111 herds) and represented 59.6% of the total observed specimens. L. peronii (15.10%) and L.obscurus (8.22%) follows numerically. Other species were represented by <4% of the total observed specimens.

The here found species are common to the Peruvian coast. Missing species are Phocoena spinipinnis, a more coastal species than the area covered by the present survey and Pseudorca crassidens, Feresa attenuata, Peponocephala electra and Stenella longirostris, which are from warmer waters and associated with the Paracas area. This study provides a first estimate of the distribution and relative abundance of small cetaceans of the upwelling ecosystem of Northern Chile.

Key words: Delphinus delphis, Delphinus capensis, Globicephala macrorhynchus, Grampus griseus, Lissodelphis peronii.

Resumen
Se comunican los resultados de un estudio de frecuencias de avistamiento y abundancias relativas de delfínidos a lo largo de la costa norte de Chile (18°30’S-25°23’S; desde la costa hasta 70°27’O), realizado entre marzo y diciembre de 2000 en un área de 207.614,60 km². Las siguientes especies fueron avistadas: delfín común de rostro corto (Delphinus delphis), delfín común de rostro largo (Delphinus capensis), ballena piloto de aleta corta (Globicephala macrorhynchus), delfín gris (Grampus griseus), delfín oscuro (Lagenorhynchus obscurus), delfín liso (Lissodelphis peronii), delfín listado (Stenella coeruleoalba) y trursión (Tursiops truncatus). La distribución de delfines al norte de Tocopilla mostró...
estar relacionada con el frente de surgencia de ese sector, mientras que frente a la Península de Mejillones las abundancias relativas y la diversidad de delfines estuvieron asociadas con la extensa pluma de surgencia descrita para dicha área. 

*T. truncatus* fue la especie más frecuentemente avistada (44,14% de 111 rebaños) y representada por 59,6% del total de individuos observados. *L. peronii* (15,10%) y *L. obscurus* (8,22%) siguen numéricamente, mientras que otras especies solo presentaron <4% del total de individuos estudiados. Las especies aquí encontradas son compartidas con las costas de Perú. Especies faltantes son *Phocoena spinipinnis*, una especie más costera que el área cubierta en el presente estudio, y *Pseudorca crassidens*, *Feresa attenuata*, *Peponocephala electra* y *Stenella longirostris*, que son de aguas más temperadas y asociadas al área en torno a Paracas. Este estudio representa la primera estimación de abundancias relativas de pequeños cetáceos para ecosistema de surgencias del norte de Chile.

**Palabras clave:**
*Delphinus delphis*, *Delphinus capensis*, *Globicephala macrorhynchus*, *Grampus griseus*, *Lissodelphis peronii*.

**INTRODUCTION**

El sistema de corriente de Humboldt (SCHS) es uno de los sistemas de corriente marina más productivos en la Tierra (Barnes & Hughes, 1988; Escribano & McLaren, 1999) y se extiende desde el sur de Chile (~42°S) hasta Ecuador e islas Galápagos (Thiel et al. 2007), caracterizado por un fuerte transporte equatorial con transporte Ekman aislado y upwelling de aguas frías con riqueza nutricional en el estrato de águas superficiales en el fotosíntico. La producción primaria puede llegar hasta 9.3 g C m⁻² d⁻¹ (Daneri et al. 2000).

El upwelling en el norte de Chile (norte de ~42°S) varía con la temporada y se presenta de forma constante durante los periodos climáticos (Shaffer et al. 1997; Torres et al. 1999).

La topografía costera (p. ej., puntos, capes) y la topografía del fondo también afectan la circulación de upwelling costero (Graham & Largier, 1997; Trowbridge et al. 1998), generando una pluma de upwelling mesoscale importante al norte de 18°22'S estudio área que puede identificarse como Península Mejillones, Punta Patache, Punta Chucumata, Punta Pisagua, Punta Camarones (Lagos et al. 2002; Marin & Moreno, 2002; Marin et al. 2003; Escribano et al. 2002, 2009).

Elupwelling plume de these centers can extend up to 50 km offshore (case of Mejillones Peninsula: Rodriguez et al. 1991; Marin et al. 2001; Sobarzo & Figueroa, 2001) and its interaction with the poleward Peruvian Counter-Current (PCC) may influence and exert a southward flow in Peruvian and northern Chilean waters up to 100–300 km from the coast (Silva, 1983; Strub et al. 1998), resulting in areas offshore and south of the upwelling focus that are relatively productive for oceanic feeders (Rendell et al. 2004) and creating a particularly productive habitat for fish spawning, eggs and larvae (Rojas et al. 2002) and in consequence feeding grounds for sea mammals.

This system is considered to be the most productive in terms of fish biomass, estimated to support a long-term production twenty times higher than the Benguela and Canary current systems (Marzolf & Tam, 2011) and supports the Chilean pelagic fishery, principally based on landings of anchovy, mackerel and pilchard, with total annual landings up to 6.9 million T between 18°25'S – 56°30'S (Thiel et al. 2007). But anchovy landings are most important in Northern Chile (Administrative Regions XV, I and II) with annual landings up to 2 million T in 1994-95 and around 0.5-1 annual T in last decades (SUBPESCA, 2016), with frequent interactions and incidental capture of top predators, mainly otariids, but also in lower rates sea birds, sea turtles and small cetaceans (Böhm et al. 2017).

The knowledge of small odontocetes in the HCS, particularly delphinids, is inadequate (Clarke, 1962; Cárdenas et al. 1986; Aguayo-Lobo, 1999), although there are numerous studies that provide valuable local background on small cetaceans (Aguayo, 1975; Gallardo & Pastene, 1983; Guerra et al. 1987 b; Van Waerebeek & Guerra, 1987, 1988; González et al. 1989; Cárdenas et al. 1991; Canto et al. 1992; Sanino et al. 2003a,b; Sielfeld et al. 2003).

In the Chilean sector of the HCS (south of 18°S), Delphinidae is represented by nineteen
species (Aguayo, 1975; Sielfeld, 1983; Cárdenas et al. 1986; Guerra et al. 1987a, b; Canto et al. 1992; Aguayo-Lobo et al. 1998a; Hucke-Gaete, 2000), eight of which inhabit the neritic littoral zone. Abundance indexes off Chile have only been calculated for few of these species (Aguayo-Lobo et al., op. cit.), but the population size of most part of these species in the southeast Pacific is unknown.

Estimates of cetacean abundance and population density are key to assessing potential effects of anthropogenic perturbations on cetacean populations (Carretta et al. 2006) and in understanding the ecological role of cetaceans in marine ecosystems (Trites et al. 1997). However, there is little published information on current abundance to evaluate direct anthropogenic impacts on cetacean species and to estimate their food requirements (Barlow & Forney, 2007), aspects currently fundamental to regulate the by catch, the incidental death and other direct damages associated with the anchovy purse seine fishing of Northern Chile, the food needs of top depredators to ensure the implementation of the “ecosystem management concept” adopted by the “Nueva Ley de Pesca y Acuicultura de Chile” (Ley 18.892 y modificaciones de la Ley 21.134 del 16/02/2019) (Chilean Fishing Law), and to support the Protection programs for the various vulnerable and/or endangered species (sea turtles, birds, sea mammals).

Consequently the present paper focuses on the presence and relative abundances of delphinid species off Northern Chile, to contribute to understand the distribution and abundance of small cetacean in the northern part of the Humboldt Current ecosystem, comprising the following objectives: 1) identify the species, 2) evaluate their distribution, 3) analyze the species relative abundances and 4) the relationship with the upwellings.

MATERIALS AND METHODS

Study area

The cruise was off Northern Chile (18°30'S-25°23'S; from coast to 70°27°W) (Fig. 1). This areas is influenced by the Mejillones Peninsula that impacts the spatial distribution of winds and currents, reinforces the coastal upwelling and modifies the latitudinal distribution of the Ekman transport (Letelier et al. 2012) and defined as a local biogeographic unit of the transitional zone between Northern and Central Chile, whose southern limit is 30°S (Camus, 2001). It also represents the southern distribution limit for various coastal fishes (Sielfeld et al. 2010) and fishing stocks as the case of the anchovy (CCTPP, 2014). The coastline north of the Mejillones Peninsula (23°S) is relatively straight, and aligned primarily in a north-south direction and a large part of the biological productivity develops in a narrow strip along the coast (Fig. 2), particularly in areas of active upwelling between 18° - 35°S (Fonseca & Farías, 1987; Fonseca, 1989; Vergara, 1991, 1992; Strub et al. 1998).

Equipments

The data were collected from the 13 m sailing vessel “Balaena” from March to December 2000 (Appendix 1). The surveys used acoustic searching with an omni-directional hydrophone (Benthos AQ4 with Ithaco pre-amplifiers). During daylight (7:00 -18:30 =11.5h) only, visual searching by a staff of three independent observers ordered in three shifts of 4 hr. Date, hour and geographic position were recorded automatically every 5 min using a Trimble Transpak and Garmin 65 GPS navigator.

Cruises

The present study corresponds with an annex result of the Project of Sound Recording on Sperm whale (Rendell et al. 2004). Details of the general navigation track were given by Whitehead (2003) and Rendell et al. (op. cit.) and totaled 158 days at sea during 9 cruises (Table 1) at monthly intervals during year 2000.

Due to operational reasons related to supply and base port the survey area was divided in the following sectors: following 18°30'-19°59'S (Sector 1: Arica-Pisagua), 20°-22°29'S (Sector 2: Iquique-Tocopilla), 22°30'-23°59'S (Sector 3: Mejillones-Antofagasta) and 24°-25°,30°S (Sector 4: El Cobre-Taltal) (Figs. 1, 3; Appenedix 1).

During navigation straight segments between georeferenced start and end points were considered as “transects”, with length expressed in km. Hundred and two of these units were surveyed, totaling 9.703,2
km (= 5,239.3 nautical miles). Fig. 3 shows navigation track and transects. The distance (Km) between points was estimated using the Vincenty equation (1975) to calculate distances on spheroidal surfaces in geodesy. For distribution data analyses the transects were ordered north south by geographical degree.

T.obs. = total observation hours; M.day = mean of daily observation time; T.obs.b. = total observation hours during good conditions; b = daily mean with good sea and weather conditions.

Species

Taxonomic identification of individuals was corroborated following the Review of Small Cetaceans of Culik (2004) and The Sierra Club Handbook of Whales and Dolphins of Leatherwood et al. (1983). Special attention was given to the short-beaked Delphinus delphis and the long-beaked D. capensis that were distinguished by the less crisp and colorful colour pattern of the first one (Perrin, 2002). The nomenclature used followed Aguayo-Lobo et al. (1998a).

Sightings

Species identification and group size were recorded independently by each of the three observers of the corresponding shift. The raw data expressed in Appendix 1 represent a numerical average between the records of the three observers. The sightings were assisted with 10X50 binoculars and a Canon EOS
**DELFÍNIDOS FRENTE AL NORTE DE CHILE**

**Fig. 2.** Chlorophyll concentration during March 2000 off the north coast of Chile. Composition of monthly data. Source: NASA Goddard Space Flight Center, Ocean Ecology Laboratory, Ocean Biology Processing Group; (2014): Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Ocean Color Data, NASA OB.DAAC. https://doi.org/10.5067/ORBVIEW-2/SEAWIFS_OC.2014.0. Accessed on 2019/04/17.

| Campaigns | Dates       | Days (n) | T.obs. | M.day | T.obs.b. | M.day b. |
|-----------|-------------|----------|--------|-------|----------|----------|
| 1         | 28/03 - 17/04 | 21       | 241.5  | 11.5  | 188.5    | 8.98     |
| 2         | 25/04 - 16/05 | 21       | 241.5  | 11.5  | 184.5    | 8.79     |
| 3         | 24/05 - 14/06 | 22       | 195.5  | 11.5  | 171.5    | 10.26    |
| 4         | 26/06 - 09/07 | 14       | 184.0  | 11.5  | 110.0    | 6.88     |
| 5         | 14/07 - 03/08 | 21       | 241.5  | 11.5  | 215.5    | 10.26    |
| 6         | 18/08 - 05/09 | 19       | 195.5  | 11.5  | 137.5    | 8.09     |
| 7         | 26/09 - 17/10 | 12       | 230.0  | 11.5  | 177.5    | 8.88     |
| 8         | 26/10 - 13/11 | 9        | 195.5  | 11.5  | 127.5    | 7.50     |
| 9         | 22/11 - 10/12 | 19       | 218.5  | 11.5  | 184.0    | 9.68     |
| **TOTALS** | **28/03 - 10/12** | **158** | **1,943.5** | **11.5** | **1,496.5** | **8.70** |

Table 1. Sighting effort by sighting trip between March and December 2000 off Northern Chile.
3000 camera with a 75-300 zoom, and digitalized with Surfer Software (WIN 32), version 6.04. Total sightings during the complete cruise are summarized in Table 1 and sightings for each transect in Table 2. Each sighting consisted in: 1) species identification, 2) herd size and 3) estimated distance to first observation point. The sightings were expressed as Sighting Rate (individuals a/o herds/day).

Statistical analyses

Using average effort (hours of observation with good observation conditions/days at sea = ≤ Beaufort 4 and calm to moderate breeze) (Table 1) an “sighting (or encounter) rate” was calculated for each species following Aguayo-Lobo et al. (1998b) and Hucke-Gaete (1998), expressed in sightings/day (times a species was sighted each day) and animals/day (individuals of each species sighted during a day). The estimation of these values was considered important by allowing comparisons with the results presented by the previous authors.

Interpretation of species distribution patterns was supported by Kernel distribution maps (Gaussian Function; 95% concentration ellipses level) from PAST 2.17 Statistical Programme (Hammer, 2018).
RESULTS

Species observed

Small cetacean herd sightings were made, corresponding to 5,841 individuals of 8 dolphin species: Short-beaked Common Dolphin (*Delphinus delphis*) (Dd), Long-beaked Common Dolphin (*Delphinus capensis*) (Dc), Short-finned Pilot Whale (*Globicephala macrorhynchus*) (Gm), Risso’s Dolphin (*Grampus griseus*) (Gg), Dusky Dolphin (*Lagenorhynchus obscurus*) (Lo), Southern Right Whale Dolphin (*Lissodelphis peronii*) (Lp), Striped Dolphin (*Stenella coeruleoalba*) (Sc) and Bottlenose Dolphin (*Tursiops truncatus*) (Tt) (Appendix 1).

Association between species

The 21.62% of the recorded specimens (1,263 of 5,841 ind.) integrated herds of more than one species. Nineteen herd sightings (17.12%) and 269 specimens (4.61%) were observed in association with sperm whales (*Physeter catodon*) and 2 groups (44 individuals) were found with *Otaria byronia* (Appendix 1).

Seven groups (565 individuals) were associated with sea birds, of which 505 were Lp from the sector in front of Mejillones (23°24'-38'S) (Appendix 1, Table 1).

Association between delphinid species were mainly represented by associations with Tt: 1 case with Gg off Arica (18°49'S), 1 case with Sc off Mejillones (23°45'S), 1 case with Lo off Mejillones (23°03'S) and 5 cases with Gm between 21°55'-24°27'S (Appendix 1).

Sightings

Tt was the most frequently sighted species (44.14%; 49 of the 111 herds) and represented 59.6% of the total observed specimens (3,481 out of a total of 5,841). Lp (n = 882; 15.10%) and Lo (n = 480; 8.22%) follows numerically. Other species were represented by <4% of the total observed specimens (Table 2).

Latitudinal distribution of species

The principal dolphin sightings were around 21°00'-21°59'S (12.7%) in sector 2 and 23°00'-23°59'S (68.6%) in sector 3 (Table 2; Fig. 4a). Other sectors were represented by ≤ 5%.

Regarding herd sightings 39.6% around 23°00'-23°59'S (Table 2).

The sighting of specimens per species in the latitudinal perspective (18°-25°S) (Table 2) shows that Dd was concentrated mainly around 18°00'-18°59'S (48.8%) and 21°00'-21°59'S (34.2%). Dc concentrated around 21°00'-21°59'S (92.6%), Gm and Gg respectively concentrated 85.6% and 92.3% of their observations between 21°00'-23°59'S (Fig. 4c), Lo 88.5% at 23°S, Lp 100% at 23°00'-24°59'S. Tt was the only species represented along the entire latitudinal gradient, however with 61.3% of individuals sighted at around 23°00'-23°59'S (Fig. 4b). The only sighting of Sc was also made in that sector.

This trend is also repeated if herds are considered (Table 2), where the highest percentages of herd sighting of Gg, Gm, Lp, Lo, Sc and Tt is coincident with the sectors indicated for specimen numbers. Exceptions are Dd and Dc where the respective higher abundances were in the 18° and 21° sector, resulting from the existence of greater herds in that sectors.

Latitudinal species assemblage composition changes

The species structure (%) expressed by geographical degree (Table 3) shows Tt (59.6%) and Lp (15.1%) as the most sighted species. Along the latitudinal gradient (18°-25°S) the predominant species was Tt, except around 18°00'-18°59'S in which Dd stood out (> 75%) and around 24°00'S-24°59'S where it is surpassed by Lp (58.3%).

The 18°00'-18°59'S sector with a predominant presence of Dd (75.2%), 19°-23° Tt (44.7-84.7%) and 23°00'-24°59'S, presence of Lp (18.4-58.9%) and in general by greater number of species. The sightings expressed in number of herds is not consistent with the above, except Tt that stands out with 30.0-62.5% over the sighting of herds of the other species.

Sighting Rates (specimens and/or herds/day)

For the total sighting records Tt showed the highest sighting rate (22.0 ind./day; 0.31 herds/day). The remaining species had values ≤ 0.05 herds/day and ≤ 5 ind./day (Table 4).
Campaign 8 (October/November = spring) stood out with the highest sighting rate (313.7 ind./day) and campaign 4 (June/July = winter) with the lowest value (7.1 ind./day) (Table 4) mainly due to the dominant presence of $T. t$. (2.341 individuals; 82.9% of all individuals in the campaign).

Herd size

Aggregations were generally quite variable, ranging from 1 individuals ($T. t.$) to 250 individuals ($L. p.$) (Table 5). The species with the largest herds was $L. p.$ (average=122,5 individuals), though herd size for this species varied considerably (ranging from 1 to 250; SD=112,06). Large aggregations were also noted for $T. t.$ (2-160 ind.; average 36,1 ind.) and $D. d.$ (8-150 ind.; average 52,6 ind.). The numerically most important herds ($T. t.$ 2.470, $L. p.$ 734, $L. o.$ 425) (Appendix 1) were observed around 24°00'-24°59'S.

DISCUSSION

The recorded species are the same found by Van Waerebeek et al. (1988) for the littoral zone of Peru, with the exceptions of $P. s.$ (typical of coastal habitats, and incompletely covered by the present survey), $P. c.$, $F. a.$, $P. e.$ and $S. l.$, which are from warmer waters and associated with the Paracas area and/or the northern region of Peru.

All these species have been previously cited for the study area by Aguayo (1975)
Fig. 4. Kernel density maps (Gaussian function, concentration ellipses level 95%):
a. all species; b. *Tursiops truncatus*; c. *Globicephala macrorhynchus* and *Grampus griseus*.

and Aguayo-Lobo *et al.* (2002). Aguayo-Lobo *et al.* (1998 a,b) cited *Delphinus capensis*, *D. delphis*, *Feresa attenuata*, *Globicephala macrorhynchus*, *Globicephala melas*, *Grampus griseus*, *Lagenorhynchus obscurus*, *Lissodelphis peronii*, *Orcinus orca*, *Pseudorca crassidens*, *Stenella coeruleoalba*, *Steno bredanensis* and *Tursiops truncatus* for the northern area of Chile. The lack of observations of *Feresa attenuata* in the present study is probably explained by its preference for subtropical and tropical waters, as noted by Hoyt (1999).

All the present *Globicephala* sightings were positively identified as *G. macrorhynchus*. *Globicephala melas*, the most abundant dolphin in the Humboldt Current System (Clarke *et al.* 1978), was not sighted in the present study, probably due to its preference for colder waters (Aguayo-Lobo *et al.* op. cit.).

The only record of *Steno bredanensis* for Chile comes from an individual sighted in the area of Botija (24°30’S), off Antofagasta Region (Van Waerebeek & Guerra, 1988) most probably corresponding to the Peruvian population, that extends to the south, particularly during “El Niño” events (Aguayo-Lobo *et al.* 1998a), penetrating Chilean waters in search of food. The present study took place during a cold, “Inter-El Niño” period, explaining the species absence.

The distribution of the small cetaceans indicates a close relationship with the oceanographic conditions of the upwelling system described by Hormazábal *et al.* (2001) for the study area.

Accordingly, the distributional scheme north of Tocopilla corresponds precisely with the upwelling zone characterized by Fuenzalida (1992) and Blanco *et al.* (2001), while off the Mejillones peninsula the abundance and diversity of the dolphins is associated with the intense upwelling plume of this area (Castilla *et al.* 2002). The effect of the Mejillones upwelling on the distribution and feeding of the sperm whale (*Physeter macrocephalus*) was analyzed previously by Rendell *et al.* (2004) and Flores (2005).

The ocean environment west of the upwelling fronts (west of 71°W) displayed lower densities of groups and species of dolphins, here interpreted as response to the lower productivity of these more oceanic areas (Wyrtki, 1964; Fonseca & Farías,
The here found species and their abundances coincide in their specific structures as much as in relative abundances with the species assemblage cited by Van Waerebeek et al. (1988) for the Peruvian coast, including the subsequent additions of Lissodelphis peronii made by Lazarte & Valdivia (1998) and Van Waerebeek et al. (1991). Peponocephala electra, a strongly oceanic species scarce off the Peruvian coast (Van Waerebeek et al. op cit.) was not found off the Chilean coast. Stenella attenuata and S. longirostris, tropical species that do not reach south of 21.5°S (Perrin, 1975) were also not found in the study area.

Therefore, the here found species assemblage is part of the same species group common to the Peruvian coast, characterized fundamentally by the abundance of Tursiops truncatus (over 40% of the sightings and over 60% of the individuals sighted) (Van Waerebeek et al. (1991) for Peruvian data and present Table 3 for Chilean data).

The conservation status of most of the here involved species is “insufficiently known” (Delphinus delphis, D. capensis, Globicephala macrorhynchus, Grampus griseus and Lagenorhynchus obscurus), the coastal ecotype of Tursiops truncatus is “in danger” and the resting population of the same species “insufficiently known” (Ministerio de Medio Ambiente, 2020).

The present sighting rates (sightings/day) of L. obscurus, L. peronii and T. truncatus showed higher sighting rates (1.02, 1.02 and 5.58 sightings/day respectively), as compared

### Table 3. Latitudinal species composition (%) changes.

#### Individuals

| Species          | 18°00'–18°59' | 19°00'–19°59' | 20°00'–20°59' | 21°00'–21°59' | 22°00'–22°59' | 23°00'–23°59' | 24°00'–24°59' | Total  |
|------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------|
| D. delphis       | 75.19         | 2.65          | 9.47          | 11.81         | 3.51          |               |               | 14.81  |
| D. capensis      | 2.12          | 20.30         |               |               |               |               |               | 3.51   |
| G. macrorhynchus | 5.26          | 2.30          | 10.07         | 3.36          | 2.02          |               |               | 11.61  |
| G. griseus       | 7.52          | 6.77          | 3.02          | 1.51          |               |               |               | 2.21   |
| L. obscurus      |               | 16.39         | 5.03          | 10.67         |               |               |               | 3.22   |
| L. peronii       |               |               |               |               |               |               |               | 15.10  |
| S. coeruleoalba  |               |               |               |               |               |               |               | 0.26   |
| T. truncates     | 12.03         | 84.66         | 65.57         | 44.52         | 76.51         | 62.00         | 21.66         | 59.60  |
| Indet.           | 10.58         | 18.03         | 9.12          | 5.37          | 5.67          | 1.18          |               | 6.32   |

#### Herds

| Species          | 18°00'–18°59' | 19°00'–19°59' | 20°00'–20°59' | 21°00'–21°59' | 22°00'–22°59' | 23°00'–23°59' | 24°00'–24°59' | Total  |
|------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------|
| D. delphis       | 20.00         | 20.00         | 5.88          | 10.00         |               |               |               | 3.60   |
| D. capensis      | 20.00         | 5.88          | 10.00         |               |               |               |               | 2.70   |
| G. macrorhynchus | 20.00         | 5.88          | 10.00         |               |               |               |               | 8.11   |
| G. griseus       | 20.00         | 11.76         | 7.14          | 4.55          |               |               |               | 5.41   |
| L. obscurus      |               | 6.25          | 7.14          | 15.91         |               |               |               | 8.11   |
| L. peronii       |               |               |               | 15.91         | 20.00         |               |               | 8.11   |
| S. coeruleoalba  |               |               |               | 2.27          |               |               |               | 0.90   |
| T. truncatus     | 40.00         | 40.00         | 62.50         | 52.94         | 57.14         | 34.09         | 30.00         | 44.14  |
| Indet.           | 20.00         | 31.25         | 17.65         | 14.29         | 18.18         | 20.00         |               | 18.92  |

1987; Morales et al. 1996; Hormazábal et al. 2001; Hormazábal & Shaffer, 2002; Schneider et al. 2003; Fuenzalida et al. 2007).
### Table 4. Sighting rates of herds (herds/day) and specimens (specimens/day) off Northern Chile.

#### Specimens/day

| Campaign | Dates       | Days | Dd  | Dc  | Gm  | Gg  | Lo  | Lp  | Sc  | Tt  | indet. | Totals |
|----------|-------------|------|-----|-----|-----|-----|-----|-----|-----|-----|--------|--------|
| 1        | 28/03 - 17/04 | 21   | 1.43| 0.38| 1.43| 0.92|     |     |     | 0.95| 5.62   | 10.76  |
| 2        | 25/04 - 16/05 | 21   | 0.24| 0.33| 1.43|     |     |     |     | 17.14| 1.62   | 20.76  |
| 3        | 24/05 - 14/06 | 22   | 4.55|     |     | 1.82|     |     |     | 3.68| 0.05   | 10.09  |
| 4        | 26/06 - 09/07 | 14   |     |     |     |     | 1.29| 5.21| 1.07| 9.29| 7.14   | 7.14   |
| 5        | 14/07 - 03/08 | 21   |     |     |     |     | 0.71| 1.43| 12.05| 0.05| 0.05   | 14.29  |
| 6        | 18/08 - 05/09 | 19   |     |     |     |     | 3.42| 0.47|     |     |        | 17.42  |
| 7        | 26/09 - 17/10 | 12   |     |     |     |     | 12.83| 5.00| 0.17| 37.92| 1.58   | 58.33  |
| 8        | 26/10 - 13/11 | 9    |     |     |     |     | 3.44| 38.89| 11.22| 260.11|        | 313.67 |
| 9        | 22/11 - 10/12 | 19   |     |     |     |     | 3.68|     | 1.05 |     | 14.32  | 24.58  |
| **Totals** | **28/03 - 10/12** | **158** | **1.30** | **1.03** | **0.75** | **0.80** | **3.04** | **5.58** | **0.095** | **22.03** | **2.34** | **36.97** |

#### Herds/day

| Campaign | Dates       | Days | Dd  | Dc  | Gm  | Gg  | Lo  | Lp  | Sc  | Tt  | indet. | Totals |
|----------|-------------|------|-----|-----|-----|-----|-----|-----|-----|-----|--------|--------|
| 1        | 28/03 - 17/04 | 21   | 0.05| 0.05| 0.10| 0.05|     |     |     | 0.05| 0.28   | 0.57   |
| 2        | 25/04 - 16/05 | 21   | 0.05|     |     | 0.05| 0.14|     |     | 0.62| 0.19   | 1.05   |
| 3        | 24/05 - 14/06 | 22   | 0.05|     |     |     | 0.05|     |     | 0.36| 0.05   | 0.50   |
| 4        | 26/06 - 09/07 | 14   |     |     |     |     | 0.07| 0.14| 0.07| 0.36| 0.36   | 1.00   |
| 5        | 14/07 - 03/08 | 21   |     |     |     |     | 0.05| 0.05| 0.10| 0.05| 0.05   | 0.29   |
| 6        | 18/08 - 05/09 | 19   |     |     |     |     | 0.21| 0.05|     |     | 0.21   | 0.47   |
| 7        | 26/09 - 17/10 | 12   |     |     |     |     | 0.17| 0.17| 0.08| 0.25| 0.25   | 1.00   |
| 8        | 26/10 - 13/11 | 9    |     |     |     |     | 0.33| 0.11| 0.22| 0.01|        | 1.56   |
| 9        | 22/11 - 10/12 | 19   |     |     |     |     | 0.05|     | 0.05|     | 0.32   | 0.58   |
| **Totals** | **28/03 - 10/12** | **158** | **0.03** | **0.02** | **0.06** | **0.04** | **0.06** | **0.06** | **0.01** | **0.31** | **0.13** | **0.70** |
to values of 0.13, 0.13 and 0.76 sightings/day respectively for the same species, indicated by Aguayo-Lobo et al. (op. cit.). Making a difference *D. delphis* with 1.01 sightings/day for the Valparaíso-Easter Island sector (Aguayo-Lobo et al. 1998b) is less abundant in the present study area (0.34 sightings/day).

*T. truncatus*, the most abundant species off the northern part of Chile (20°11'–S–32°13'S), reached up to 306,940 animals/day comparable to 309.20 animals/day found by Hucke-Gaete (1998) for the coast of central Chile and by Aguayo-Lobo et al. (1998a) between Valparaíso and Easter Island.

The sighting rate of *L. obscurus* in the present study area (38.96 animals/day, Cruise 8) than values reported for the littoral zone of central Chile (Aguayo-Lobo et al. 1998a; Findlay et al. 1998). The maximum sighting rate here found for *L. peronii* (37.9 animals/day, Cruise 7) compared with previous research data: 180 animals/day (January 1998, south of 40° latitude) (Findlay et al. op. cit.) and 122.6 animals/day (Aguayo 1966) is consequent with the appreciation of Aguayo (op. cit.) suggesting that the species would be most abundant in the area south of the country.

These comparisons are not strictly comparable due to different years between this work and previous research. Also the present campaigns were carried out in autumn, winter and spring, while Hucke-Gaete (1998) did it in summer and Aguayo-Lobo et al. (1998b) in winter for the Valparaíso to Easter Island section. Therefore, it must be considered that new studies and future surveys in upwelling areas will corroborate or modify the present conclusions.

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**Table 5. Herd size by species.**

| Species | Herds (n) | Range (specimens) | Mean (X) | Standard deviation (std) |
|---------|-----------|-------------------|----------|------------------------|
| Gm      | 9         | 5 – 25            | 12.0     | 9.06                   |
| Gg      | 6         | 9 – 30            | 14.7     | 8.62                   |
| Tt      | 49        | 1 – 1500          | 36.1     | 45.76                  |
| Dd      | 4         | 5 – 105           | 51.3     | 21.75                  |
| Dd      | 3         | 4 – 150           | 54.0     | 67.90                  |
| Lo      | 9         | 2 – 350           | 22.6     | 9.94                   |
| Sc      | 1         | 15                | -        | -                      |
| Lp      | 9         | 1 – 250           | 122.5    | 112.06                 |
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### APPENDIX 1. Sightings of delphinids during the navigation campaigns.

| Campaigns | n°   | Date      | Time   | Species                   | Specimens (n) | Latitude | Longitude | Observations                                      |
|-----------|------|-----------|--------|---------------------------|---------------|----------|-----------|--------------------------------------------------|
| 1         | 1    | 29-03-2000| 1715 h | Delphinids indet.         | 20            | 19°44'S  | 71°02'W  | with *Physeter catodon*                           |
| 2         | 04-04-2000| 1255 h   | *Grampus griseus*         | 20            | 21°35'S  | 70°30'W  |                                                  |
| 3         | 07-04-2000| 1503 h   | Delphinids indet.         | 1             | 24°15'S  | 71°08'W  |                                                  |
| 4         | 07-04-2000| 1420 h   | *Delphinus delphis*       | 30            | 24°14'S  | 71°10'W  |                                                  |
| 5         | 07-04-2000| 1600 h   | *Delphinus capensis*      | 8             | 24°20'S  | 71°10'W  |                                                  |
| 6         | 12-04-2000| 1948 h   | Delphinids indet.         | 2             | 24°55'S  | 71°15'W  |                                                  |
| 7         | 13-04-2000| 1705 h   | *Lagenorhynchus obscurus* | 20            | 23°15'S  | 70°55'W  |                                                  |
| 8         | 13-04-2000| 2320 h   | Delphinids indet.         | 30            | 22°53'S  | 70°56'W  | detected with hydrophone                          |
| 9         | 14-04-2000| 0659 h   | *Grampus griseus*         | 10            | 22°59'S  | 71°05'W  |                                                  |
| 10        | 14-04-2000| 0825 h   | Delphinids indet.         | 25            | 22°55'S  | 71°02'W  |                                                  |
| 11        | 14-04-2000| 1250 h   | *Tursiops truncatus*      | 20            | 22°34'S  | 70°40'W  |                                                  |
| 12        | 15-04-2000| 1136 h   | Delphinids indet.         | 40            | 21°05'S  | 71°00'W  |                                                  |
| 2         | 26-04-2000| 0945 h   | *Globicephala macrorhynchus* | 7  | 18°52'S  | 70°46'W  |                                                  |
| 2         | 27-04-2000| 1420 h   | *Tursiops truncatus*      | 150           | 19°43'S  | 70°41'W  |                                                  |
| 3         | 28-04-2000| 1940 h   | Delphinids indet.         | 10            | 20°27'S  | 70°41'W  |                                                  |
| 4         | 29-04-2000| 0200 h   | Delphinids indet.         | 3             | 20°41'S  | 70°53'W  | detected with hydrophone                          |
| 5         | 29-04-2000| 0400 h   | Delphinids indet.         | 6             | 20°46'S  | 70°58'W  | detected with hydrophone                          |
| 6         | 30-04-2000| 2020 h   | Delphinids indet.         | 15            | 20°31'S  | 70°35'W  | detected with hydrophone                          |
| 7         | 03-05-2000| 0715 h   | *Lagenorhynchus obscurus* | 15            | 22°03'S  | 70°35'W  |                                                  |
| 8         | 03-05-2000| 0915 h   | *Tursiops truncatus*      | 40            | 22°03'S  | 70°25'W  | Associated with sea birds and southern sea lion   |
| 9         | 06-05-2000| 0930 h   | *Lagenorhynchus obscurus* | 5             | 22°57'S  | 72°01'W  |                                                  |
| 10        | 06-05-2000| 0950 h   | *Lagenorhynchus obscurus* | 10            | 22°57'S  | 72°03'W  |                                                  |
| 11        | 11-05-2000| 0922 h   | *Tursiops truncatus*      | 15            | 20°40'S  | 70°39'W  |                                                  |
| 12        | 11-05-2000| 1000 h   | *Tursiops truncatus*      | 15            | 20°38'S  | 70°39'W  |                                                  |
| Campaigns | n° | Date       | Time  | Species              | Specimens (n) | Latitude   | Longitude   | Observations |
|-----------|----|------------|-------|----------------------|---------------|------------|-------------|--------------|
| 13        | 13 | 11-05-2000 | 1141 h| *Tursiops truncatus* | 10            | 20°32'S    | 70°37'W     |              |
| 14        | 14 | 12-05-2000 | 1325 h| *Tursiops truncatus* | 25            | 20°37'S    | 70°55'W     |              |
| 15        | 15 | 12-05-2000 | 1555 h| *Tursiops truncatus* | 20            | 20°38'S    | 70°44'W     |              |
| 16        | 16 | 12-05-2000 | 1700 h| *Tursiops truncatus* | 30            | 20°38'S    | 70°39'W     |              |
| 17        | 17 | 12-05-2000 | 1730 h| *Tursiops truncatus* | 10            | 20°37'S    | 70°38'W     |              |
| 18        | 18 | 12-05-2000 | 1755 h| *Tursiops truncatus* | 10            | 20°36'S    | 70°39'W     | 1 calf       |
| 19        | 19 | 12-05-2000 | 1845 h| *Tursiops truncatus* | 10            | 20°35'S    | 70°43'W     |              |
| 20        | 20 | 12-05-2000 | 1915 h| *Tursiops truncatus* | 15            | 20°30'S    | 70°41'W     |              |
| 21        | 21 | 13-05-2000 | 1726 h| *Tursiops truncatus* | 10            | 19°52'S    | 70°48'W     |              |
| 22        | 22 | 15-05-2000 | 1130 h| *Delphinus delphis*  | 5             | 19°49'S    | 72°10'W     |              |

| Campaigns | n° | Date       | Time  | Species              | Specimens (n) | Latitude   | Longitude   | Observations |
|-----------|----|------------|-------|----------------------|---------------|------------|-------------|--------------|
| 3         | 1  | 30-05-2000 | 1125 h| *Delphinus delphis*  | 100           | 18°34'S    | 70°27'W     |              |
|           | 2  | 01-06-2000 | 1120 h| *Lagenorhynchus obscurus* | 40           | 20°48'S    | 71°02'W     |              |
| 3         | 3  | 01-06-2000 | 1454 h| *Tursiops truncatus*  | 50            | 21°07'S    | 71°01'W     |              |
|           | 4  | 02-06-2000 | 1600 h| Delphinids indet.     | 1             | 22°20'S    | 71°15'W     |              |
| 5         | 5  | 04-06-2000 | 0820 h| *Tursiops truncatus*  | 3             | 22°04'S    | 71°19'W     | with *Physeter catodon* |
|           | 6  | 04-06-2000 | 0848 h| *Tursiops truncatus*  | 6             | 22°03'S    | 71°19'W     | with *Physeter catodon* |
| 7         | 7  | 04-06-2000 | 0950 h| *Tursiops truncatus*  | 7             | 22°01'S    | 71°17'W     | with *Physeter catodon* |
|           | 8  | 04-06-2000 | 1050 h| *Tursiops truncatus*  | 5             | 22°00'S    | 71°17'W     | with *Physeter catodon* |
| 9         | 9  | 04-06-2000 | 1145 h| *Tursiops truncatus*  | 2             | 21°58'S    | 71°17'W     | with *Physeter catodon* |
| 10        | 10 | 04-06-2000 | 1224 h| *Tursiops truncatus*  | 3             | 21°57'S    | 71°17'W     | with *Physeter catodon* |
| 11        | 11 | 04-06-2000 | 1700 h| *Tursiops truncatus*  | 5             | 21°49'S    | 71°19'W     | with *Physeter catodon* |

| Campaigns | n° | Date       | Time  | Species              | Specimens (n) | Latitude   | Longitude   | Observations |
|-----------|----|------------|-------|----------------------|---------------|------------|-------------|--------------|
| 4         | 1  | 20-06-2000 | 1531 h| *Tursiops truncatus*  | 12            | 18°31'S    | 70°29'W     | with *Physeter catodon* |
|           | 2  | 22-06-2000 | 1320 h| *Tursiops truncatus*  | 20            | 21°43'S    | 71°03'W     | with *Physeter catodon* |
|           | 3  | 22-06-2000 | 1349 h| Delphinids indet.     | 10            | 21°46'S    | 71°02'W     |              |
| 4         | 4  | 22-06-2000 | 1505 h| Delphinids indet.     | 10            | 21°52'S    | 71°01'W     |              |
| Campaigns | n°  | Date       | Time   | Species                      | Specimens (n) | Latitude | Longitude | Observations                          |
|-----------|-----|------------|--------|------------------------------|---------------|----------|-----------|----------------------------------------|
| 5         | 28-06-2000 | 1132 h    | Tursiops truncatus         | 25             | 24°03'S | 71°50'W  |                                        |
| 6         | 30-06-2000 | 1332 h    | Delphinids indet.         | 30             | 23°38'S | 70°50'W  |                                        |
| 7         | 01-07-2000 | 0800 h    | Delphinids indet.         | 45             | 23°59'S | 71°05'W  |                                        |
| 8         | 02-07-2000 | 1800 h    | Lagenorhynchus obscurus    | 18             | 23°21'S | 71°11'W  |                                        |
| 9         | 04-07-2000 | 0724 h    | Delphinids indet.         | 5              | 23°48'S | 71°49'W  |                                        |
| 10        | 04-07-2000 | 0915 h    | Tursiops truncatus         | 35             | 23°45'S | 71°45'W  | with P. catodon and S. coeruleolab     |
| 11        | 04-07-2000 | 0915 h    | Stenella coeruleolab      | 15             | 23°45'S | 71°47'W  | with P. catodon and T. truncatus       |
| 12        | 04-07-2000 | 1145 h    | Tursiops truncatus         | 38             | 23°45'S | 71°40'W  |                                        |
| 13        | 04-07-2000 | 1733 h    | Lissodelphis peronii      | 25             | 23°52'S | 71°35'W  | with Physeter catodon                  |
| 14        | 05-07-2000 | 0900 h    | Lissodelphis peronii      | 48             | 24°06'S | 71°16'W  | with Physeter catodon                  |
| 5         | 21-07-2000 | 1620 h    | Grampus griseus           | 30             | 21°06'S | 71°42'W  |                                        |
| 2         | 27-07-2000 | 1033 h    | Lissodelphis peronii      | 250            | 23°24'S | 71°12'W  | with sea birds                          |
| 3         | 31-07-2000 | 0414 h    | Delphinids indet.         | 1              | 23°18'S | 71°09'W  | detected with hydrophone              |
| 4         | 31-07-2000 | 1403 h    | Globicephala macrorhynchus| 15             | 23°16'S | 71°14'W  | 1 calf; with P. catodon               |
| 5         | 01-08-2000 | 1828 h    | Tursiops truncatus         | 1              | 23°46'S | 71°06'W  |                                        |
| 6         | 02-08-2000 | 2035 h    | Lissodelphis peronii      | 3              | 23°26'S | 70°56'W  |                                        |
| 6         | 19-08-2000 | 0750 h    | Tursiops truncatus         | 35             | 23°42'S | 71°38'W  | with G. macrorhynchus                  |
| 2         | 19-08-2000 | 0755 h    | Globicephala macrorhynchus| 18             | 23°42'S | 71°38'W  | 2 calves; with T. truncatus            |
| 3         | 20-08-2000 | 1125 h    | Grampus griseus           | 9              | 22°39’S | 71°45’W  | with P. catodon                        |
| 4         | 21-08-2000 | 0750 h    | Tursiops truncatus         | 145            | 22°24’S | 71°44’W  | 1 calf                                |
| 5         | 21-08-2000 | 0936 h    | Globicephala macrorhynchus| 25             | 22°15’S | 71°48’W  | with T. truncatus                      |
| 6         | 21-08-2000 | 0941 h    | Tursiops truncatus         | 2              | 22°18’S | 71°47’W  | with G. macrorhynchus                  |
| 7         | 21-08-2000 | 1054 h    | Globicephala macrorhynchus| 5              | 22°15’S | 71°48’W  |                                        |
| 8         | 01-09-2000 | 1040 h    | Tursiops truncatus         | 75             | 21°55’S | 71°02’W  | with G. macrorhynchus                  |
| Campaigns | n° | Date       | Time   | Species                        | Specimens (n) | Latitude      | Longitude     | Observations                                      |
|-----------|----|------------|--------|--------------------------------|---------------|---------------|--------------|---------------------------------------------------|
| 7         | 1  | 26-09-2000 | 1627 h | *Lissodelphis peronii*         | 250           | 23°38'S      | 70°55'W      | with sea birds                                    |
| 2         | 2  | 29-09-2000 | 1114 h | *Tursiops truncatus*           | 12            | 21°35'S      | 71°30'W      |                                                   |
| 3         | 3  | 30-09-2000 | 0600 h | Delphinids indet.              | 10            | 20°59'S      | 71°09'W      | detected with hydrophone                           |
| 4         | 4  | 01-10-2000 | 1827 h | *Delphinus capensis*           | 4             | 19°36'S      | 70°49'W      | with *P. catodon* and otarids                     |
| 5         | 5  | 02-10-2000 | 0830 h | *Grampus griseus*              | 10            | 18°49'S      | 71°15'W      | with *T. truncatus*                               |
| 6         | 6  | 02-10-2000 | 0830 h | *Tursiops truncatus*           | 4             | 18°49'S      | 71°16'W      | with *G. griseus*                                 |
| 7         | 7  | 05-10-2000 | 1240 h | *Delphinus capensis*           | 150           | 21°48'S      | 70°57'W      |                                                   |
| 8         | 8  | 06-10-2000 | 0826 h | *Grampus griseus*              | 50            | 23°26'S      | 70°43'W      | 1 calf; with *L. peronii*                         |
| 9         | 9  | 06-10-2000 | 0826 h | *Lissodelphis peronii*         | 5             | 23°26'S      | 70°42'W      | with *G. griseus* and sea birds                   |
| 10        | 10| 10-10-2000 | 0826 h | *Lissodelphis peronii*         | 200           | 23°01'S      | 70°50'W      |                                                   |
| 11        | 11| 11-10-2000 | 1809 h | *Tursiops truncatus*           | 3             | 23°03'S      | 70°32'W      | with *L. obscurus* and sea birds                  |
| 12        | 12| 11-10-2000 | 1809 h | *Lagenorhynchus obscurus*      | 2             | 23°02'S      | 70°35'W      | with *T. truncatus* and sea birds                 |
| 8         | 8  | 26-10-2000 | 1607 h | *Lagenorhynchus obscurus*      | 350           | 23°46'S      | 70°40'W      | with *L. peronii*                                 |
| 2         | 2  | 26-10-2000 | 1607 h | *Lissodelphis peronii*         | 1             | 23°46'S      | 70°40'W      | with *L. obscurus*                                |
| 3         | 3  | 27-10-2000 | 1756 h | *Globicephala macrorhynchus*   | 10            | 24°27'S      | 71°44'W      | with *T. truncatus*                               |
| 4         | 4  | 27-10-2000 | 1756 h | *Tursiops truncatus*           | 15            | 24°27'S      | 71°44'W      | with *G. macrorhynchus*                           |
| 5         | 5  | 29-10-2000 | 1330 h | *Lissodelphis peronii*         | 100           | 24°39'S      | 71°06'W      |                                                   |
| 6         | 6  | 31-10-2000 | 1617 h | *Globicephala macrorhynchus*   | 15            | 23°24'S      | 72°02'W      | with *P. catodon*                                 |
| 7         | 7  | 04-11-2000 | 1349 h | *Tursiops truncatus*           | 6             | 22°58'S      | 72°12'W      |                                                   |
| 8         | 8  | 04-11-2000 | 1740 h | *Tursiops truncatus*           | 60            | 23°04'S      | 72°05'W      |                                                   |
| 9         | 9  | 05-11-2000 | 0640 h | *Tursiops truncatus*           | 100           | 23°18'S      | 71°48'W      |                                                   |
| 10        | 10| 05-11-2000 | 0858 h | *Tursiops truncatus*           | 150           | 23°22'S      | 71°45'W      |                                                   |
| 11        | 11| 08-11-2000 | 1702 h | *Globicephala macrorhynchus*   | 6             | 23°24'S      | 71°23'W      |                                                   |
| 12        | 12| 09-11-2000 | 1516 h | *Tursiops truncatus*           | 10            | 23°38'S      | 70°50'W      |                                                   |
| Campaigns | n° | Date       | Time   | Species              | Specimens (n) | Latitude    | Longitude    | Observations                  |
|-----------|----|------------|--------|----------------------|---------------|-------------|--------------|-----------------------------|
| 13        | 13 | 10-11-2000 | 1223 h | *Tursiops truncatus* | 500           | 23°05'S     | 71°09'W      |                             |
| 14        | 14 | 12-11-2000 | 1945 h | *Tursiops truncatus* | 1500          | 23°04'S     | 71°44'W      |                             |
| 9         | 1  | 25-11-2000 | 2025 h | *Tursiops truncatus* | 2             | 23°00'S     | 71°47'W      |                             |
| 2         | 2  | 25-11-2000 | 2300 h | Delphinids indet.    | 50            | 22°53'S     | 71°50'W      | detected with hydrophone    |
| 3         | 3  | 26-11-2000 | 1755 h | *Tursiops truncatus* | 20            | 22°35'S     | 71°19'W      | with *P. catodon*          |
| 4         | 4  | 27-11-2000 | 0300 h | Delphinids indet.    | 15            | 22°18'S     | 71°16'W      | detected with hydrophone    |
| 5         | 5  | 27-11-2000 | 1350 h | *Tursiops truncatus* | 25            | 21°55'S     | 71°23'W      |                             |
| 6         | 6  | 27-11-2000 | 1745 h | *Delphinus delphis*  | 70            | 21°51'S     | 71°18'W      |                             |
| 7         | 7  | 27-11-2000 | 2200 h | *Tursiops truncatus* | 200           | 21°41'S     | 71°18'W      |                             |
| 8         | 8  | 29-11-2000 | 1745 h | *Tursiops truncatus* | 10            | 23°22'S     | 71°38'W      |                             |
| 9         | 9  | 01-12-2000 | 0912 h | *Lagenorhynchus obscurus* | 20      | 23°28'S     | 71°34'W      |                             |
| 10        | 10 | 03-12-2000 | 1349 h | *Tursiops truncatus* | 15            | 25°19'S     | 71°30'W      | with sea birds              |
| 11        | 11 | 08-12-2000 | 1030 h | Delphinids indet.    | 40            | 23°06'S     | 72°01'W      |                             |
|           |    |            |        | **TOTAL**            | **5841**      |             |              |                             |