

Presence, behavior and re-sighting pattern of transient bottlenose dolphins (*Tursiops truncatus*) in the Humboldt Current System off north-central Chile

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Abstract

Biotic and abiotic factors determine the presence and habitat use pattern of individuals within a population. In this study, the presence, behavior and re-sighting patterns of transient bottlenose dolphins (*Tursiops truncatus*) were evaluated in relation to upwelling and downwelling events in a marine reserve in north-central Chile, between 2005 and 2009. The study period was divided into four phases according to wind direction and intensity: upwelling-favorable (UF), transition I (TI), convergence (Cv) or downwelling and transition II (TII). The results show that transient bottlenose dolphins are an open population with low re-sighting rates. The highest occurrence and a largest number of transient dolphins were identified during 2009 probably due to an increase in prey availability. The most frequent behavior observed was traveling, followed by feeding and socializing. Traveling was mainly recorded in individuals seen only once and in years with low productivity. In contrast, feeding was observed in individuals seen two or more times, was similar among phases and was more frequent in more productive years. Social behavior was associated with the highest re-sighting rates. This study documents how transient bottlenose dolphins use the area based on their re-sighting patterns, and suggests that periods of upwelling and downwelling modulate behavior displayed by these dolphins within the area.

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Introduction

The presence, abundance and habitat use of marine species are influenced by different biotic and abiotic factors, such as temperature and salinity (Parsons 1998), abundance and distribution of resources (Stevick et al. 2006), competition and predation (Papastamatiou et al. 2006), among others. The spatial and/or temporal variation of these factors, as well as the possible interactions among them, generally determines habitat use by animals, and in turn their presence, residency, behavior, and group size patterns (Wilson et al. 1997, Heithaus and Dill 2002). Because of habitat heterogeneity, variability in behavior and habitat use is to be expected in different areas.

For some cetacean species, habitat characteristics have been found to strongly influence differences in site fidelity (*e.g.*, Ballance 1992, Rossi-Santos et al. 2007). In the bottlenose dolphin, *Tursiops truncatus*, three residence patterns (*i.e.*, temporal variations in presence in a given area), have been described (Wilson et al. 1997, Connor et al. 2000, Zolman 2002). Year-round residents maintain a small home range and live within the same area for many years, or even their entire life. These individuals display daily feeding, reproductive activities and relatively short distance movements within the area (Connor et al. 2000, Gubbins 2002). This type of residency is generally observed when resources are predictable in both space and time (Gowans et al. 2007). Seasonal residents correspond to individuals that use a specific area for a couple of months or an entire season during consecutive years (Zolman 2002). This pattern is usually associated with spatio-temporal variation in prey availability (Mead and Potter 1990, Barco et al. 1999, Toth et al. 2011) and/or the presence of predators (Heithaus 2001, Heithaus and Dill 2002). Transient or nomadic residents correspond to animals that show minor or no site fidelity (Defran et al. 1999, Zolman 2002). These animals are generally observed in areas where resources are sparsely and unpredictably distributed (Gowans et al. 2007). The latter group has larger home ranges in comparison to those of year-round resident groups, and the schools are

likely to include a greater number of individuals and possess foraging and anti-predator strategies as consequence of their extensive home ranges (Ballance 1992, Defran and Weller 1999, Gowans et al. 2007). However, presence and behavior of transient groups can be expected to change within areas with high productivity.

In north-central Chile, the Marine Reserve of Chañaral and Choros-Damas Islands (MRC-CD), within the Humboldt Current System, is a dynamic and productive coastal environment due to the presence of an important wind-driven coastal upwelling center (Montecino et al. 2006a, Thiel et al. 2007). This upwelling center is characterized by high levels of primary production, and is driven by prevailing southwest winds particularly during late spring and summer (Montecino et al. 2006a). In contrast, there is downwelling, or upwelling relaxes during winter due to convergent winds coming from the North, and productivity is lower than in summer (Montecino et al. 2006a). Also, Montecino et al. (2006b) define two transitional phases, one in autumn and the other during early spring, based on the sea surface temperature.

The MRC-CD hosts a high diversity of marine animals, including marine birds and mammals (Luna-Jorquera et al. 2003, Pérez et al. 2006, Sepúlveda et al. 2009). Among these species, a year-round resident group of bottlenose dolphins has been reported since 1981 (González et al. 1989), with a total of 45 individuals sighted in sub-groups between 2 and 40 individuals (Gibbons 1992, Thomas 2005). Additionally, the occurrence of larger groups of more than 100 individuals has been recorded in this area. These larger groups have been classified as *pelagic* by Hanshing (2001), *non-resident* by Thomas (2005) and *transient* by Santos-Carvallo et al. (2015). To the best of our knowledge, no further studies have focused on habitat use and re-sighting patterns of transient groups in this productive but seasonally variable area.

The aim of this study was to evaluate the presence, re-sighting and behavior patterns of transient bottlenose dolphins in the MRC-CD. Since these parameters have been associated with

biotic and abiotic factors, the dynamic and productive coastal environment was expected to influence bottlenose dolphins in this area. Based on this, we hypothesized that: (1) higher occurrence, more frequent feeding behavior and a higher re-sighting rate in transient dolphins would be related to periods of upwelling-favorable winds (Aravena et al. 2014, Rahn et al. 2015); (2) more frequent travel behavior, lower occurrence and lower re-sighting rate in these groups would be related to convergent winds or downwelling conditions (Aravena et al. 2014, Montecinos et al. 2006a); and (3) a middle situation of occurrence, and re-sighting rate would be related to transitional periods between upwelling and downwelling conditions.

MATERIALS AND METHODS

Study area and data collection

The study was conducted between January 2005 and September 2009 in the MRC-CD: Chañaral Island (29.03°S, 71.57°W), Choros (29.26°S, 71.54°W) and Damas Island (29.23°S, 71.52°W) (Fig. 1). A total of 83 boat-based surveys were conducted, using a 7 m local fishing vessel equipped with a 40-hp outboard motor. Surveys were carried out during daylight hours from 8 am to 4 pm in Beaufort sea states of 3 or less.

<<Fig. 1 near here>>

During each survey, a visual examination of the area was undertaken by at least three experienced observers with the naked eye and binoculars. In the presence of dolphins, the boat approached them at a constant speed with caution, remaining parallel to the group without disturbing them, following the protocol of Würsig and Jefferson (1990). A “group” was defined as two or more dolphins in association, within 100 m of each other, moving in the same direction and engaging in the same behavior (Shane 1990, Hastie et al. 2003). A “sighting” corresponded to each time an individual or group was observed (Karczmarski et al. 2000).

For each sighting, time, position, group size, and group behavior were recorded. Group size and composition was determined by counting the minimum, maximum and mean number of adults and calves (Karczmarski et al. 2000).

Identification of productivity phases

The presence of different phases of productivity in the MRC-CD was evaluated using wind direction and intensity. Local wind information for the entire study period was obtained from a coastal meteorological station located in Coquimbo Bay (30.0°S, 71.4°W) at 122m above sea level. These data are a good proxy to characterize the Coquimbo Bay upwelling system, where the study area is located (Bravo et al. 2016). Wind data were decomposed into North-South (along-shore) and East-West (across-shore) wind components. Only the along-shore wind component was considered in this study, because it directly triggers upwelling events (Figueroa and Moffat 2000). Positive values correspond to North winds (downwelling), and negative values correspond to South winds (upwelling). Four phases were defined for the study area: (1) upwelling-favorable (UF) from October to February, with a predominance of southerly winds (negative values) of 0.9 ms^{-1} and 0.6 ms^{-1} and corresponding to higher primary productivity than the rest of the phase; (2) transition I (TI), from March to April with southerly winds (negative values) of intensities of 0.2 ms^{-1} , corresponding to a transition from higher to lower primary productivity; (3) convergence (Cv) or downwelling, from May to July with northerly winds (positive values) of 0.5 ms^{-1} and 0.1 ms^{-1} , corresponding to lower primary productivity than upwelling phase, and (4) transition II (TII), from August to September with southerly winds (negative values) of 0.4 ms^{-1} and 0.5 ms^{-1} , corresponding to a transition from lower to higher primary productivity (Fig. 2) (modified from Montecino et al. 2006b).

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Occurrence patterns

In order to evaluate the occurrence of transient dolphins in the study area, two time scale analyses (annual and per phase) were conducted. The annual occurrence index (AOI) is the total number of transient dolphin sightings per year in relation to the annual effort (2005-2009). Similarly, the phase occurrence index (POI) considers the total number of transient dolphin sightings per phase (UF, TI, CV and TII) in relation to phase effort.

Re-sighting patterns

The identification of individuals was done using photo-identification. This technique relies on matching the distinctive dorsal fin features using natural markings such as nicks and notches on both the trailing and leading edges of the dolphin fin (Würsig and Jefferson 1990). Each dolphin group was photographed by at least two researchers with experience in photo-identification using Canon digital cameras EOS 5D and 40D and autofocus 70-200 mm and 100-400 mm zoom lenses. The photographs were taken randomly and perpendicular to the body axis, as was suggested by Würsig and Jefferson (1990).

In the laboratory, photographs were first assessed for quality (focus, clarity, contrast, angle, visible portion of fin and percentage of picture filled by the fin) using Adobe Photoshop CS2 imaging software, and the best quality photographs were selected for analysis. Second, only individuals that had distinguishable features on the dorsal fin were considered. Third, photographs of each encounter previously selected were visually compared over all encounters to perform the matching process. The visual process was carried out by two experienced researchers, using Windows Photo Gallery and Adobe Photoshop Lightroom (version 2.7) imaging software. The matching process determines whether dolphins from an encounter are already considered in the existing catalog or are new additions (Würsig and Jefferson 1990). In this way the photo-identification catalog of transient bottlenose dolphins in the MRC-CD was

constructed. The number of identified individuals was standardized according to the annual and phases effort.

A discovery curve was constructed based on the identification and re-sightings of individuals. The transient bottlenose dolphin population within MRC-CD was considered closed if the same individuals were always found in the area, or open if new individuals were found entering and leaving the area (Bearzi et al. 1997, Toth et al. 2011).

Re-sighting patterns were quantified by a residence index (RI) (ranging from 1 to 100), using the following equation (modified from Lusseau 2005):

$$RI = \frac{S}{M} \times 100$$

where RI = residence index, S = total number of months in which a particular individual was observed, and M = total number of monthly surveys. Multiple sightings of a dolphin within the same month were considered as a single sighting.

Additionally, a re-sighting rate (RR) was calculated to show the proportion of identified individuals re-sighted in the MRC-CD on an annual basis (Annual Re-sighting Rate, ARR) and on a phase basis (Phase Re-sighting Rate, PRR). ARR or PRR were quantified using the following equation (modified from Wedekin et al. 2010):

$$RR = \frac{rd}{di}$$

where RR = re-sighting rate (annual, ARR; phase, PRR), rd = number of re-sighted dolphins during a particular year (annual, rda) or phase (rdp), di = number of dolphins identified in that year (annual, dia) or phase (dip). The number of re-sighting individuals was standardized according to the annual and phase effort (ARR (or PRR) / annual (or phase) effort).

Behavioral sampling and analysis

Behavioral observations of transient bottlenose dolphins were conducted using the group scan sampling methodology (Mann 1999), in order to include the greatest proportion of individuals within the group (Altmann 1974) and to avoid bias due to conspicuous individuals and/or behaviors (Mann 1999). This method assumes that all individuals within that group showed the same behavior (Mann 1999). The behavior of dolphins was classified into four categories based on specific observed behavioral events (Shane et al. 1986): feeding, resting, socializing and traveling (Table 1). The behaviors were ordered according to their observed frequency during the sighting. In this way, the most frequent behavior was recorded first and the least frequent at the end.

<<Table 1 near here>>

The frequency of the behavior observed during the entire study period was compared using a standardized measure of the frequency of each predominant behavior with the following proportion:

$$SFB = \frac{\sum fc}{\sum ER} \times 100$$

where *SFB* is the standardized frequency of a behavior, $\sum fc$ is the sum of frequencies of a particular behavior in a defined period, and $\sum ER$ is the sum of total behaviors displayed during the same period. *SFB_a* and *SFB_p* refer to the frequency of displayed behaviors among years and phases, respectively. A similar analysis was performed grouping individuals with the same RI. Thus, for each RI a *SFB_{RI}* was calculated. These last analyses were performed for the three most frequently recorded behaviors.

Statistical analyses

Group sizes were presented as medians (25% and 75%, interquartile range) because the data were highly variable and sample sizes were relatively small. Kruskal-Wallis non-parametric tests were used to compare survey effort across phases and years, and to compare occurrence patterns

across years (AOI) and phases (POI), because the data departed from normality (Zar 1999). The Mann-Whitney *U*-test was performed to compare differences between years and phases when variances were not homogeneous. Contingency tables (2x2) were created to test whether the main behavioral categories varied among years, phases and/or RI, and to test differences in the number of identified individuals per hour among years and phases. All the analyses were performed in Statistica 7.0 (StatSoft, Inc. 2004) at the significance level $\alpha = 0.05$.

RESULTS

Survey effort lasted from 2 to 7 h survey⁻¹ (mean = 4.2 h) and was similar across years ($H_{(4,83)} = 1.68$; $P = 0.79$), and phases ($H_{(3,83)} = 6.82$; $P = 0.08$). The total survey effort was 353 h; 28 h were spent with transient bottlenose dolphins.

Occurrence patterns

Transient bottlenose dolphins were recorded in 28 of the 83 surveys (33.7%). The AOI showed significant differences among years ($H_{(4,83)} = 13.34$; $P = 0.01$), with higher occurrence of transient bottlenose dolphins during 2009 (Table 2). Otherwise, no differences were found in the POI per phase ($H_{(3,83)} = 0.14$; $P = 0.99$) (Table 3).

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Re-sighting patterns

In 22 of the 28 surveys transient bottlenose dolphins were photo-identified. After the matching process, 581 distinct individuals were identified. Of these, 465 (80%) were sighted only once (RI = 2.5); 91 (15.7%) were sighted twice (RI = 5.0); and 25 (4.3%) were sighted three or four times (RI = 7.5-10). The discovery curve increased continuously and did not reach an asymptote (Fig. 3). Most distinct individuals per hour occurred during 2009, while the fewest

were recorded in 2005 (Fig. 4a). In terms of phase, most distinct individuals were recorded during UF and TI phases, and the least during the Cv phase (Fig. 4b).

The annual re-sighting rate (ARR) varied among years, reaching a maximum value during 2007 (Fig. 4a), when more than 50% of the individuals identified in that year were re-sighted. The lowest ARR values were recorded during 2008 (Fig. 4a). The re-sighting rate also varied among phases (PRR) reaching the highest values during TII and the lowest values during UF and Cv (Fig. 4b).

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Group size and behavioral patterns

Group sizes were estimated during 29 of the 33 sightings. Group sizes were highly variable, ranging from five to about 1000 individuals with a median (md) of 70 (25% = 12; 75% = 120). Highest median values were obtained during TI (md = 110) and UF (md = 70) phases, while lowest values were recorded during Cv (md = 30.5) and TII (md = 20) phases.

Dolphin group behavior varied significantly during the study period, with traveling being significantly higher than other behaviors (Table 4). No significant differences were found between the frequencies of feeding, resting and socializing. Considering an interannual comparison of the three most frequent behaviors, the highest frequency of travelling was recorded during 2005 (Fig. 5a), while feeding behavior was most frequently recorded in 2008 and 2009, and was not observed in 2005 (Fig. 5b). Finally, social behavior was observed during all years, but significantly higher in 2007 (Fig. 5c). On the other hand, when comparing behaviors among phases, traveling had higher frequency during the Cv and TII phases (Fig. 6a); whereas feeding was similar during all four phases (Fig. 6b). Social behavior was only recorded during UF and TI phases (Fig. 6c). Finally, the analysis of individual behavior with respect to RI

(SFB_{RI}) showed that the largest proportion of traveling behavior was displayed by the animals seen only once ($RI = 2.5$), while the largest proportion of feeding behavior was found in animals sighted two or more times (Table 5). No variation in RI was found in social behavior (Table 5).

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DISCUSSION

The number of identified transient bottlenose dolphins observed in the study area increased continuously during the entire study period, suggesting an open population, due to a regular influx of new animals to the study area (Parra et al. 2006, Reisinger et al. 2010). The large number of identified individuals, the continuous increase of new identified animals and large proportion of them seen only once suggest that the animals seen in MRC-CD form part of a much larger population, as reported by Reisinger et al. (2010) for Indo-Pacific bottlenose dolphins in South African coast.

Eighty-percent of transient bottlenose dolphins were observed only once, and the most frequent behavior recorded for these individuals was traveling, suggesting that the study area is mainly used as a transit zone. These results were similar to those found by Barco (1995) off the coast of Virginia and Toth et al. (2011) off the New Jersey coast, in the United States. Both studies reported a similar increasing pattern in the rate of discovery of new individuals, and suggest that dolphins were possibly using the area as a corridor. By contrast, individuals that were seen two or more times using the study area not only as an area for traveling, but mainly for feeding and social activities. This association between behaviors and re-sighting rates suggest

that the residence index of transient bottlenose dolphins in the MRC-CD is in accordance with different habitat uses.

The group sizes of transient dolphins were highly variable (5 to 1000 individuals), with a greater median than previous reports (*e.g.*, Defran and Weller 1999, Bearzi 2005, Silva et al. 2008). It has been proposed that large groups of dolphins are made up of sub-groups which form temporary alliances in response to predators (Shane et al. 1986, Speakman et al. 2006, Gowans et al. 2007), or to spatial-temporal variations in resource availability (Saayman and Tayler 1973, Shirakihara et al. 2002, Gowans et al. 2007). These social strategies could be used by transient groups in the MRC-CD, and could explain the high variability in group size.

The most frequent behaviors recorded in transient bottlenose dolphin groups in the MRC-CD were traveling, followed by feeding and socializing, in accordance to other studies of the same species with low fidelity to one particular area (*e.g.*, Hanson and Defran 1993, Bearzi 2005, Bearzi et al. 2009). The traveling behavior was higher in 2005, suggesting that dolphins could have invested more time traveling in search of food during this year. In fact, 2005 was characterized by minimum commercial fish landings in the port of Coquimbo, located 70 km south of the study area (Sernapesca 2005, 2006, 2007, 2008, 2009). Thus, in areas where food availability is poor or scarce, a search mode can be expected, where straight-line travel minimizes the time spent between patches and reduces search redundancy (Zollner and Lima 1999). The feeding behavior was higher in 2008 and 2009. Potential prey items for the bottlenose dolphin are anchovy (*Engraulis ringens*), chub mackerel (*Scomber japonicus*), Chilean jack mackerel (*Trachurus murphyi*), Pacific menhaden (*Ethmidium maculatum*) and South Pacific hake (*Merluccius gayi gayi*) (Van Waerebeek et al. 1990, Hanson and Defran 1993), and these showed highest landings in the port of Coquimbo during 2009, in comparison to the previous years (2005-2008) (Sernapesca 2005, 2006, 2007, 2008, 2009). A relationship between level of primary productivity and fisheries catches has been suggested (Beddington 1995, Pauly and

Christensen 1995). Thus, maximum feeding behavior registered during 2009 could be related to an increase in food availability in the study site and in adjacent areas during that year (Wilson *et al.* 1997, Heithaus and Dill 2002). In the same way, during 2009 a large number of transient dolphins were identified and the highest annual occurrence index (AOI) value was recorded. A similar relationship was found across phases, where most transient individuals were identified in the UF and TI phases. This situation also suggests an increment in food availability in both phases that influences, at least in part, the presence of individuals in the study area (Wilson *et al.* 1997). Similar results were found by Wilson *et al.* (1997), who found that the number of identified dolphins increased in summer, suggesting the arrival of new individuals during this season, due to an increase in food availability.

In terms of phases, a relationship between phases of higher productivity (UF phase) and feeding behaviors was expected. On the contrary, during periods of food scarcity (CV phase), a transitory use of the habitat with more traveling behavior was expected. These predictions were partially supported. Although traveling was the most frequent behavior recorded during the CV and TII, feeding activities were similar all year-round during all phases. Because a resident population of bottlenose dolphins is found in the study area year-round (Thomas 2005, Santos-Carvalho *et al.* 2015), we suppose that food availability is sufficient for dolphins and thus feeding behavior does not change across the year. Interestingly, even though dolphins were seen feeding during all phases, large groups of dolphins were registered during UF and TI, and only small groups of animals were seen during Cv and TII phases, suggesting that seasonal variations in food sources may influence feeding behavior and group size in transient bottlenose dolphins. Even though TI and TII are both transitional phases, these results suggest that TI would be more similar in environmental conditions to UF and thus more productive than TI, which is closer to Cv. In this way, seasonal variations in food sources may influence feeding behavior and group size in transient bottlenose dolphins.

A different scenario occurred in 2007. During this year, the most frequent behavior displayed by transient dolphins was socializing, also with the highest value of annual re-sighting rate (ARR). Dolphins may prefer some habitats not only because of prey availability, but also because these habitats may allow them to carry out social interactions or avoid predators, and they feed only when the opportunity presents itself (Allen et al. 2001). In the same manner, a predominance of social behavior in the transient population was recorded during the productive phases UF and TI. It has been reported that social behaviors are generally related to reproduction (Constantine et al. 2004), which can occur year-round in this species, although births do increase during spring and summer (Urian et al. 1996, Mann et al. 2000, Currey et al. 2007). This suggests that UF and TI phases in the MRC-CD may present favorable environmental conditions, such as higher temperatures (Montecino et al. 2006a) and/or greater food availability that would promote the development of social activities linked to reproduction, care of offspring and the reinforcement of social bonds among individuals. A similar situation was described by Hanson and Defran (1993) off San Diego, California, where the social activity of dolphins was mainly carried out during the summer months, and was attributed to seasonal changes in water temperature and prey abundance, demonstrating a seasonal adaptation of reproduction to decrease the energetic cost of thermoregulation.

In conclusion, the findings of this study reveal that re-sighting patterns of transient bottlenose dolphins reflect habitat use, suggesting that environmental conditions in the MRC-CD, such as food availability and upwelling-favorable winds, influence the behavior displayed by these dolphins within this area. As predicted, low occurrence of transient dolphins and traveling behaviors were more frequent during periods of food scarcity (CV and TII phases). However, the feeding behavior was not related to period of upwelling-favorable winds, and was recorded at all phases. Results from this study provide baseline data about the presence and use of the MRC-CD by bottlenose dolphins, which is relevant information considering the different activities

performed in the area (resource extraction, fishery, scientific research, wildlife tourism). Additionally, it is important to maintain long-term environmental and biological data collection, and long-term monitoring of the demographic parameters of these dolphins to accurately assess any future changes in prey abundance, direct anthropogenic disturbance, and/or population decline (Koper et al. 2016).

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TABLES

Table 1. Behavior classification of bottlenose dolphin groups in the MRC-CD according to Shane *et al.* (1986).

Behavior	Definition
Traveling	Dolphins involved in persistent directional movement usually faster than the idle speed of the observing boat. Group spacing varies and individuals swim with short, relatively constant dive intervals.
Feeding	Dolphins involved in efforts to capture and consume prey as shown by chasing fish on the surface, coordinated deep diving with loud exhalations (but not chuffing) and rapid circle swimming in one location (but not chasing another dolphin). There was usually no contact among individuals (as often observed when socializing). Prey were sometimes observed in dolphin's mouths and frequently observed during the foraging bout.
Resting	Dolphins engaged in a low level of activity, with slow movements as a tight group (<i>i.e.</i> , less than one body length among individuals) and were occasionally stationary. Resting lacked the active components of the other behaviors described.
Socializing	It is composed of several high-energy activities. Dolphins observed leaping, chasing, and engaged in body contact with each other. Involved aspects of play and mating with other dolphins.

Table 2. Annual occurrence index (AOI) of transient bottlenose dolphins *Tursiops truncatus* in the MRC-CD from 2005 to 2009. Results of Mann-Whitney tests are also shown; significant differences are presented in bold.

Year	AOI	2005		2006		2007		2008	
		<i>U</i>	<i>p</i>	<i>U</i>	<i>p</i>	<i>U</i>	<i>p</i>	<i>U</i>	<i>p</i>
2005	0.06	-	-						
2006	0.06	214.0	0.86	-	-				
2007	0.10	121.5	0.35	100.0	0.25	-	-		
2008	0.11	164.0	0.25	136.0	0.18	115.5	0.96	-	-
2009	0.22	52.5	<0.01	41.5	<0.01	39.0	<0.05	55.0	<0.05

Table 3. Phase occurrence index (POI) of transient bottlenose dolphins *Tursiops truncatus* in the MRC-CD from 2005 to 2009. Upwelling-favorable (UF), transition I (TI), convergence (Cv), and transition II (TII). Results of Mann-Whitney tests are also shown.

Phase	POI	UF		TI		CV	
		<i>U</i>	<i>p</i>	<i>U</i>	<i>p</i>	<i>U</i>	<i>p</i>
UF	0.11	-	-				
TI	0.08	375.0	0.73	-	-		
Cv	0.12	227.0	0.94	116.5	0.78	-	-
TII	0.09	228.0	0.95	90.0	0.87	75.5	0.81

Table 4. Behavior analysis of transient bottlenose dolphins *Tursiops truncatus* recorded in the MRC-CD from 2005 to 2009. SFB is the standard frequency behavior. Results of Chi-square tests are also shown; significant differences are presented in bold.

Behavior	SFB (%)	Traveling		Feeding		Resting	
		X^2	p	X^2	p	X^2	p
Traveling	43.9	-	-	-	-	-	-
Feeding	22.8	5.7	0.02	-	-	-	-
Resting	12.3	14.1	<0.001	2.2	0.1	-	-
Socializing	21.0	12.6	0.009	0.05	0.8	1.6	0.2

Table 5. Behavior and RI of transient bottlenose dolphins *Tursiops truncatus* in the MRC-CD.

Results of Chi-square tests are also shown; significant differences are presented in bold.

Behavior	RI	% ind.	2.5		5.0	
			χ^2	<i>P</i>	χ^2	<i>P</i>
Traveling	2.5	68	-	-	-	-
	5.0	41	14.7	<0.001	-	-
	≥ 7.5	35	21.8	<0.001	0.8	0.38
Feeding	2.5	16	-	-	-	-
	5.0	33	7.8	0.005	-	-
	≥ 7.5	45	19.8	<0.001	3.0	0.08
Socializing	2.5	16	-	-	-	-
	5.0	26	3.0	0.08	-	-
	≥ 7.5	10	0.5	0.46	1.0	0.31

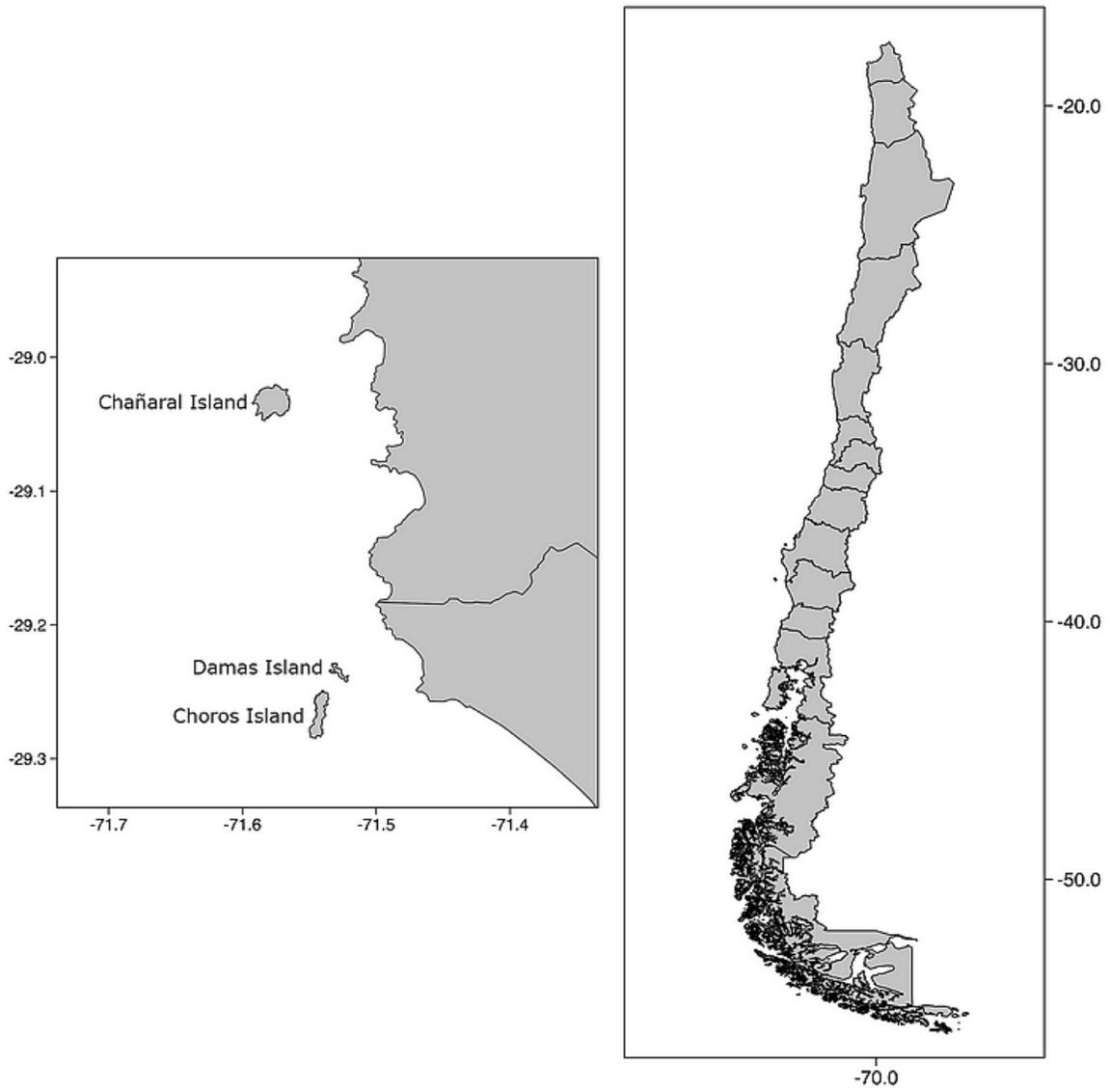


Figure 1. Location map of the study area.

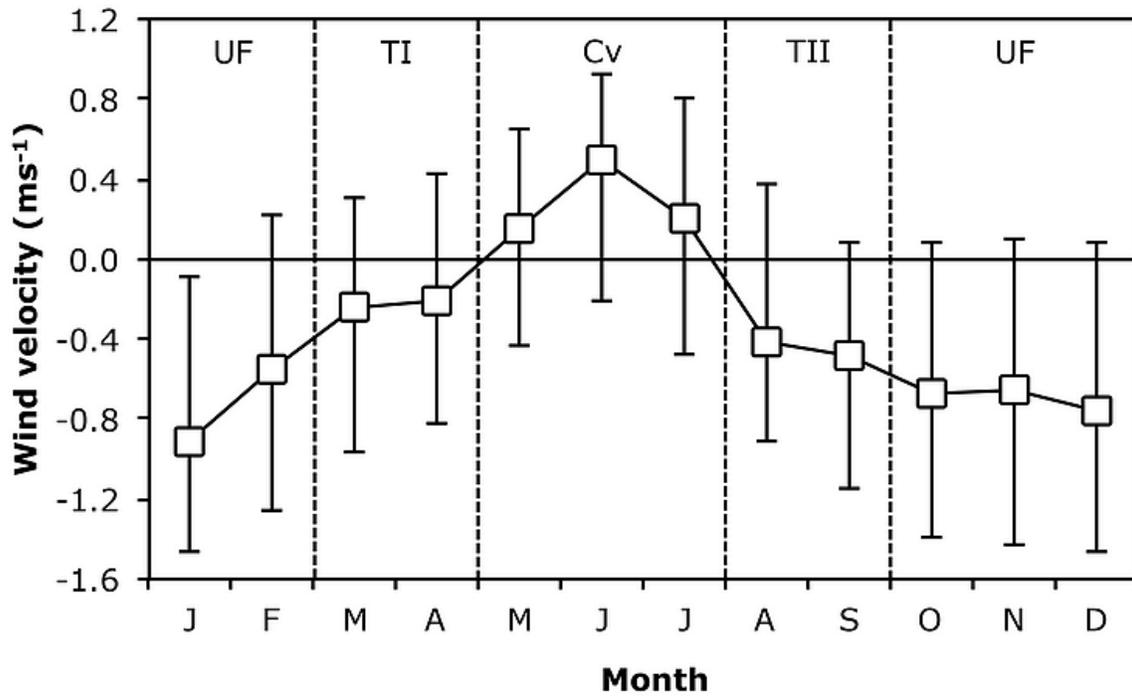


Figure 2. Monthly distribution of wind velocity (ms^{-1}) by phase in Coquimbo Bay from 2005 through 2009. Upwelling-favorable (UF), transition I (TI), convergence (Cv), and transition II (TII). Boxes indicate median values and whiskers indicate 25th and 75th percentiles.

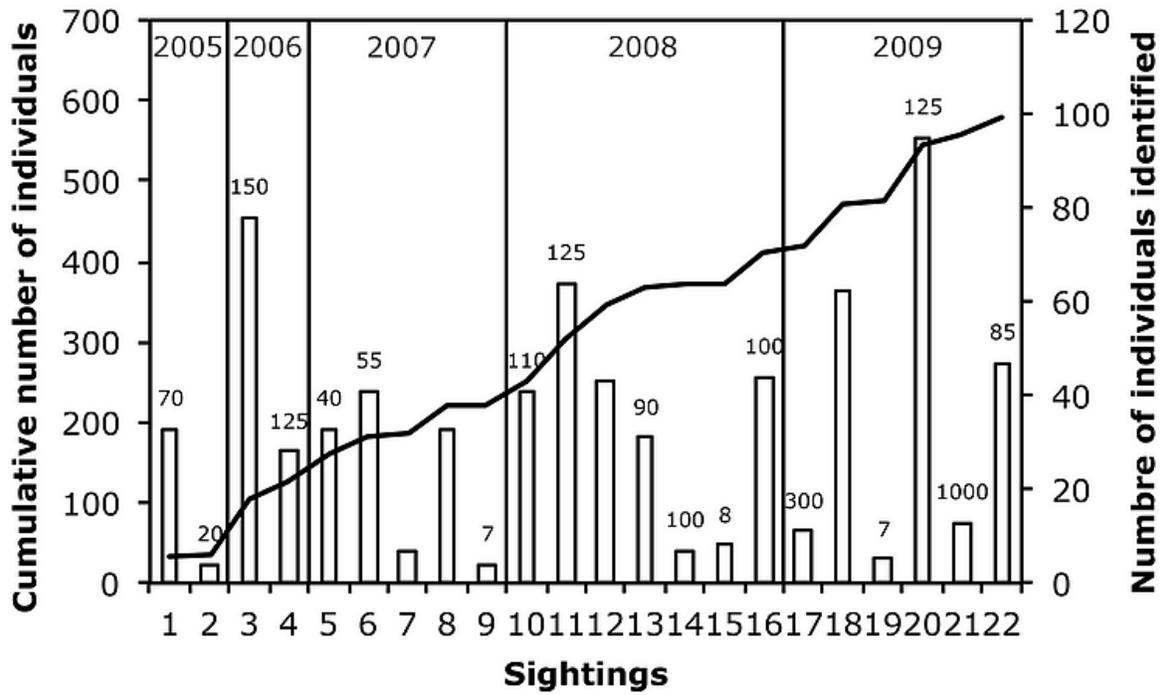


Figure 3. Cumulative discovery curve (line), and number of identified individuals per sighting (white bars) of transient bottlenose dolphins *Tursiops truncatus* in the MRC-CD from 2005 to 2009. Numbers on the top of the bars indicate the estimated group size for each sighting.

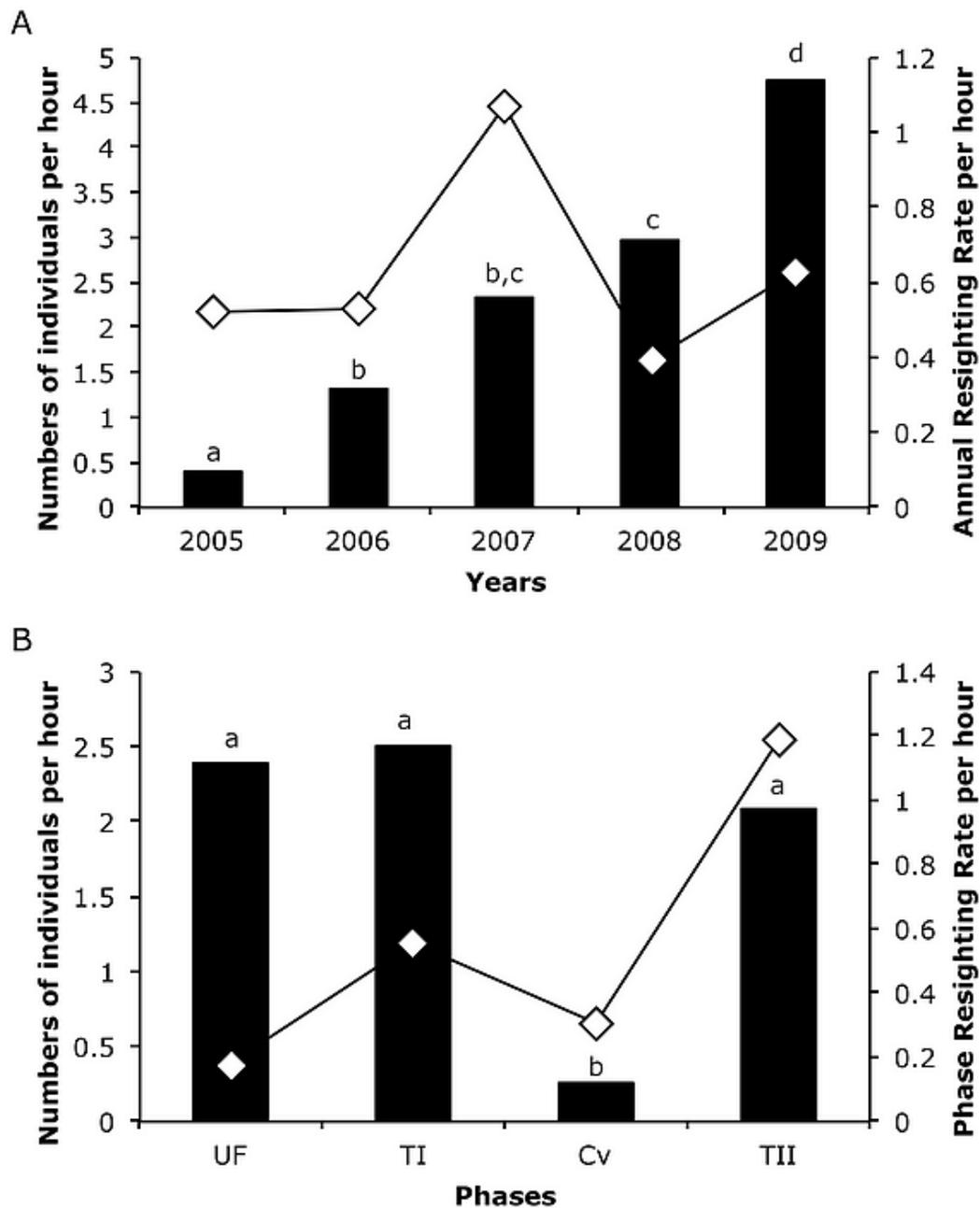


Figure 4. Total number individuals per hour (black bars), and re-sighting rate per hour (line with diamonds) for (a) years and (b) phases, observed in transient bottlenose dolphins *Tursiops truncatus* in the MRC-CD. For the total number of individuals per hour, different letters indicate statistically significant differences using chi-square (X^2) analysis ($\alpha = 0.05$).

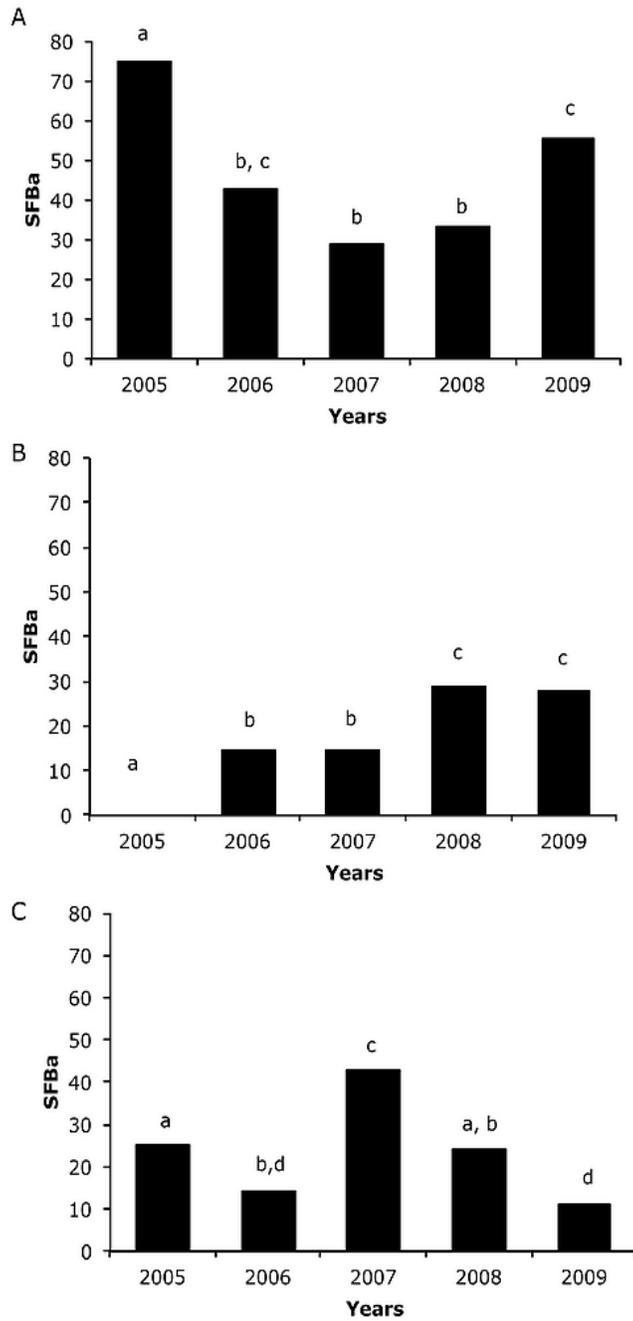


Figure 5. Standardized annual frequency of behavior (SFBa) for (a) traveling, (b) feeding and (c) socializing observed in transient bottlenose dolphins *Tursiops truncatus* from 2005 to 2009 in MRC-CD. Different letters indicate statistically significant differences among years using chi-square (χ^2) analysis ($\alpha = 0.05$).

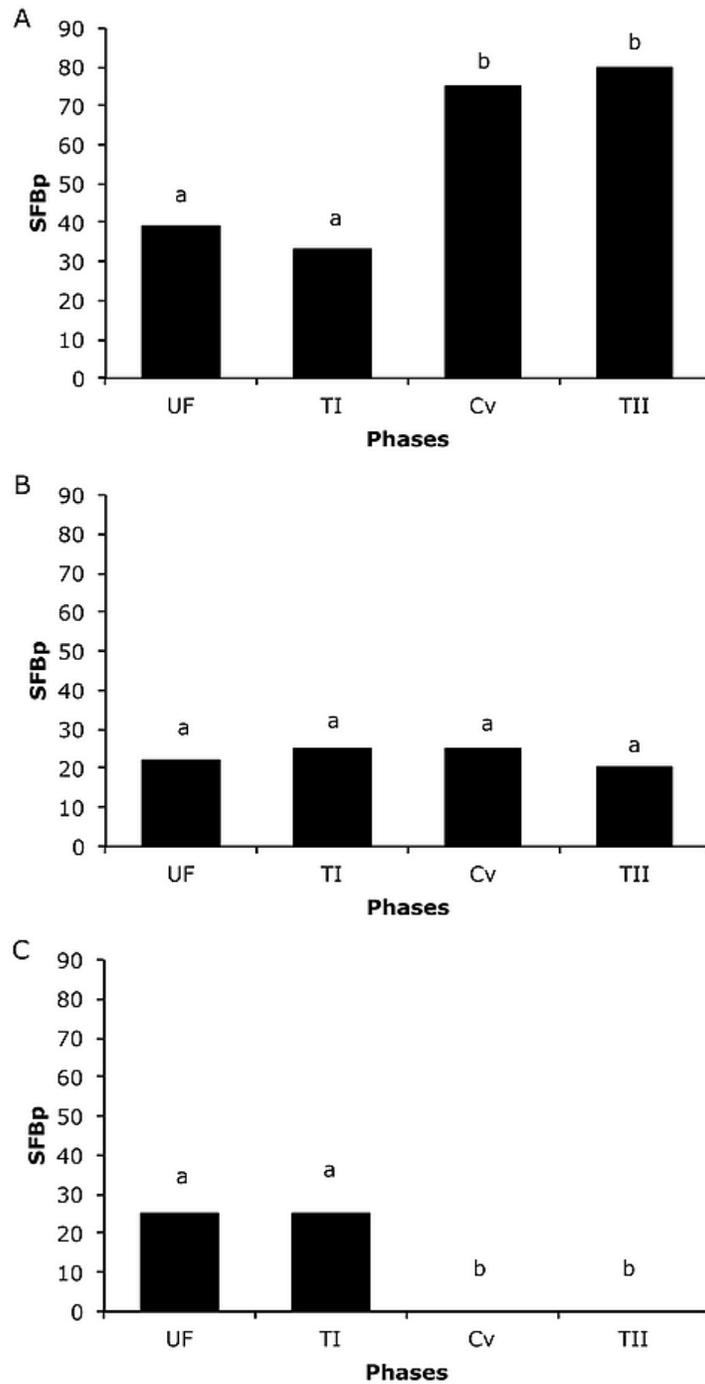


Figure 6. Phase standardized frequency of behavior (SFBp) for (a) traveling, (b) feeding and (c) socializing behavior states observed in transient bottlenose dolphins *Tursiops truncatus* among phases in MRC-CD. Different letters indicate statistically significant differences between phases using chi-square (χ^2) analysis ($\alpha = 0.05$).