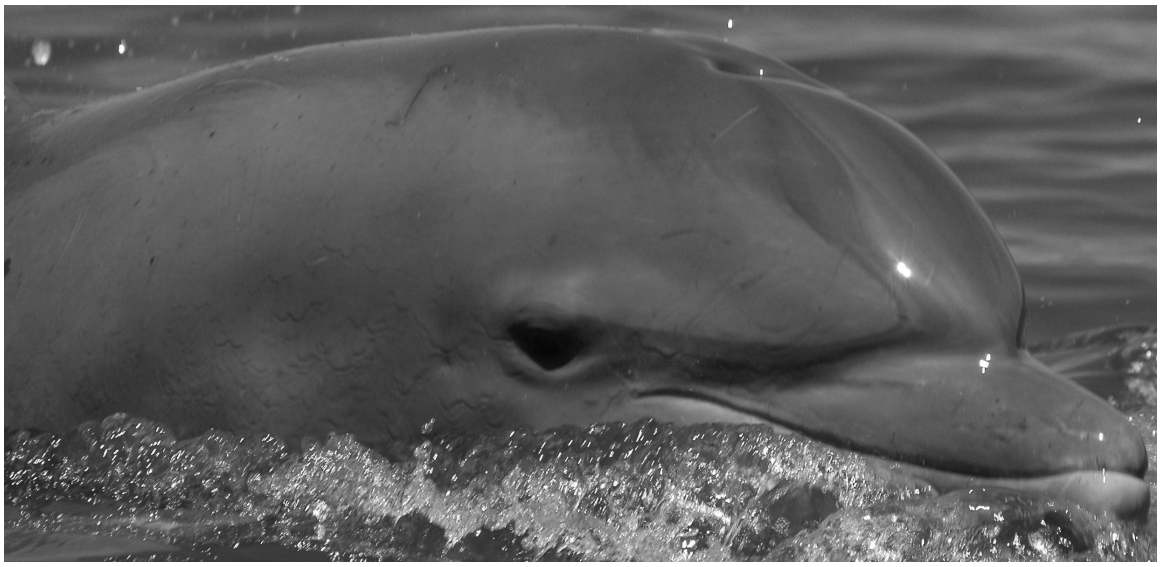
# FINAL REPORT

-Project-

**"Population Viability Analysis of a small resident population of bottlenose dolphins, *Tursiops truncatus*, in southern Brazil"**



**Dr. Eduardo Resende Secchi**

Rio Grande, Brazil, January 2007

## PROJECT TITLE

# "Population Viability Analysis of a small resident population of bottlenose dolphins, *Tursiops truncatus*, in southern Brazil"

## RESPONSABIITY AND EXECUTION

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**ABSTRACT**

Until recently incidental catches have been considered a minor source of mortality of bottlenose dolphins in Rio Grande do Sul, southern Brazil. Time series data of strandings have suggested a recent marked increase in mortality. Evidence suggests that the observed increase is due to incidental catches in fishing nets. Preliminary analysis carried out in 2004 indicated that the minimum observed number of dolphins killed in nets is above the maximum allowable fishing-related mortality (MALFIRM), suggesting that this small population is declining. This project was implemented to monitoring the dynamics (i.e., abundance, mortality, reproduction) and habitat use of the small population of bottlenose dolphins in southern Brazil and to assess the viability of this population. During this first year we followed the planned activities for the project. Only the age of stranded dolphins was not estimated according our plans. Between August 2005 and October 2006, 35 photo-identification surveys, corresponding to 256 hours and 25 minutes in the field were conducted. A total of 360 groups of bottlenose dolphins were observed (140 in 2005 and 220 in 2006). Approximately 2435 photographs were taken in 2005 and 4041 in 2006. Sixty-five dolphins were identified during the whole period. Mark-recapture analysis (using Chapman and Mth models), which take into account the proportion of marked individual in the population, estimated the total population size in 83 (95% CI = 74-92 for Mth) and 80 dolphins (95% CI = 71-89 for CH) in 2005 and 92 (95% CI = 84-100 for Mth) and 90 dolphins (95% CI = 83-97 for CH) in 2006. Thirty-seven beach surveys were conduct between November 2005 and October 2006, corresponding to a total effort of 5017.1 km of beach surveyed. Fourteen bottlenose dolphins were found dead on the beach. From 11 carcasses whose evidence of interactions with fisheries could be assessed, seven (63.6%) showed signs of entanglement in nets. Carcasses concentrated near estuary (74,4%) suggesting that they belong to the Patos Lagoon population. Mortality was high during late austral spring and summer The period of bottlenose dolphins mortality overlaps with the peak season of coastal artisanal gillnet fishery. Frequency distribution of length classes showed that most animals stranded were juveniles and sub-adults. Assuming the population size of 83 dolphins estimated for 2005, the fishing-related mortality rate represent of 0.084. A preliminary reproductive rate was calculated as the proportion of calves borned during the 2005/2006 reproduction period to the population size estimated in 2005 (n=83). Five mother and calves pairs were identified and the reproductive rate was estimated to be 6% (assuming the abundance estimate for 2005, 05/83 = 0.06) or 5% (assuming the abundance estimate for 2006, 05/92= 0.05). Therefore, the birth rate (6%) is lower than the fishing mortality rate (8%) and much lower than the total mortality rate (16% assuming all dead animals belong to the Patos Lagoon population). Eventhough this analysis is simple and preliminary, the evidence that this population might be declining is strong or at least that fishing related mortality is playing an important negative role on the fate of this population (see also evidence from the comparisons among photo-identification catalogues - annex I). A more detailed Population Viability Analysis is planned for 2007, depending on the continuity of this project.

## INTRODUCTION

In Rio Grande do Sul state, southern Brazil, franciscana and bottlenose dolphins (*Tursiops truncatus*) are the species most frequently found washed ashore (Pinedo, 1986, 1994). In the case of franciscana, most of the stranded animals probably came from bycatch (Pinedo, 1994; Secchi *et al*. 1997). Until recently, coastal fisheries were thought not to harm bottlenose dolphins. Pinedo (1986), after seven years of beach surveys along Rio Grande do Sul coast, suggested that incidental catch in fishing gear is not a major cause of mortality of bottlenose dolphins. Therefore, special attention has been given only to the franciscana bycatch issue (e.g. Secchi *et al*., 1997; Kinas and Secchi, 1998; Ott *et al*., 2002; Kinas, 2002; Secchi and Wang, 2002; Secchi *et al*. 2003a; Secchi *et al*., 2003b; Secchi and Fletcher 2004) and no detailed study to investigate incidental mortality of bottlenose dolphins in the area has been conducted so far.

In southern Brazil, bottlenose dolphins (*Tursiops truncatus*) are distributed very close to shore along the coast, forming very small populations commonly associated to estuaries and river mouths. A population of bottlenose dolphins inhabits the Patos Lagoon estuary and adjacent coastal areas (32º06'S / 052º02'W) (Figure 1) year around, where their vital activities take place (e.g. feeding, resting, reproduction) (Moller, 1993; Dalla Rosa 1999). Although dolphin distribution overlaps with extensive artisanal gillnetting, until recently bycatch was suspected to be a minor problem to this population.

However, since 2002, we have noticed a marked increase in the number of bottlenose dolphin found dead on the beach. Many carcasses showed net marks or mutilated body parts suggesting that the impact of fishing operations is likely to be much higher when compared against historical records. Therefore, we suspect that this population is declining.

In order to assess the impact of fishery activities in this population we started the project POPULATION VIABILITY ANALYSIS OF A SMALL RESIDENT POPULATION OF BOTTLENOSE DOLPHIN, *TURSIOPS TRUNCATUS*, IN SOUTHERN BRAZIL in 2005.

Figure 1. Study area.

The aims of this project was to investigate the dynamics, habitat use and distribution of this population in the Patos Lagoon estuary and adjacent coastal waters as well as to assess its viability. This sort of information can be very useful in identifying preferential habitat, areas of higher risk of entanglement and in evaluating the current status of this population. Therefore, in case the impact of fisheries is at unacceptable levels, the chances of survival of this local population can be increased by designing appropriate protected areas according to the results obtained through this project.

In this report we will describe the activities conducted during the implementation of the project and our results. The contents of this document are: information about photo-identification, abundance, mortality, preliminary reproduction rate and re-sighting rates.

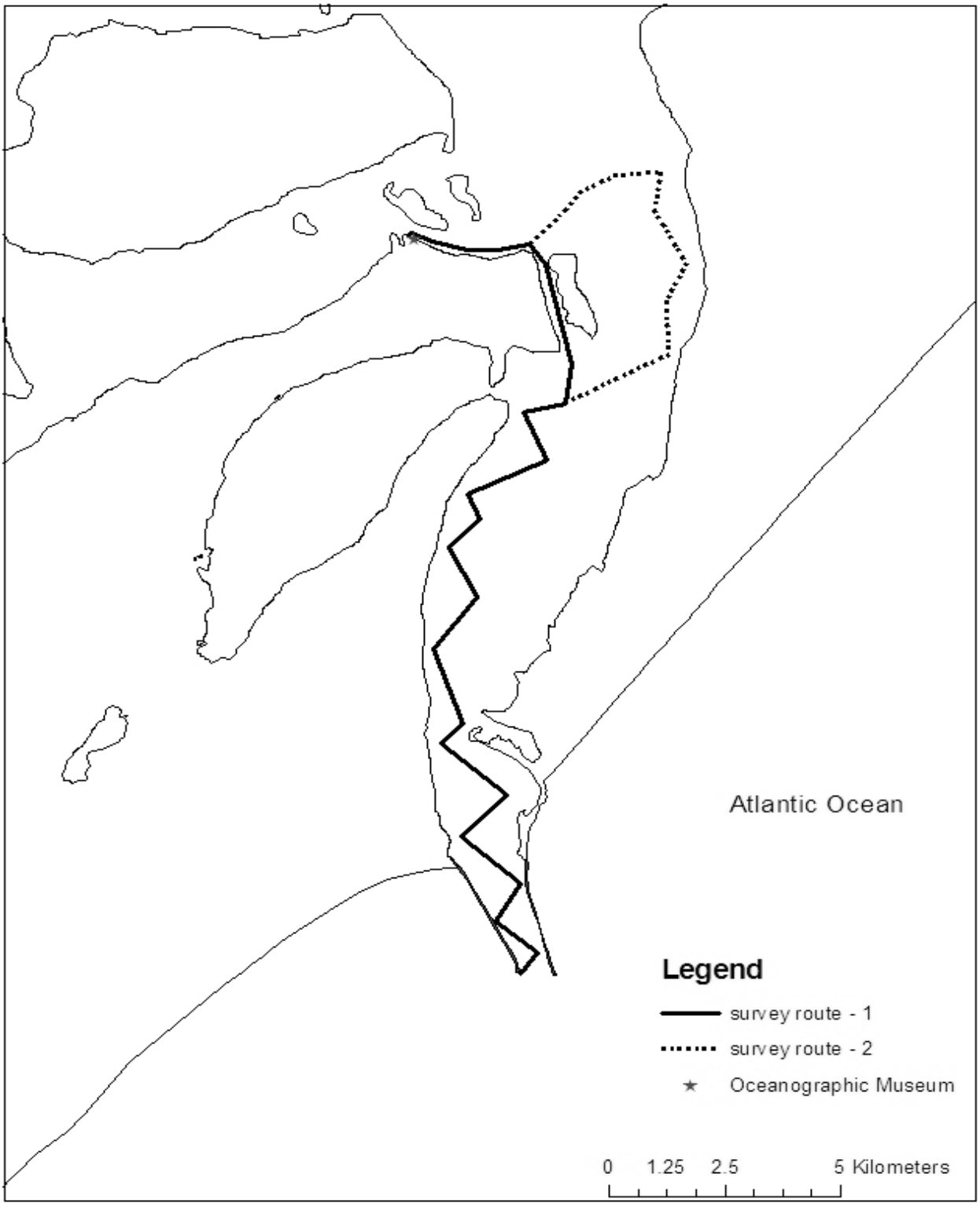
## 1. PHOTOIDENTIFICATION

*Study area and data collection*

Between August 2005 and October 2006, 35 photo-identification surveys, corresponding to 256 hours and 25 minutes in the field were conducted. Surveys were alternated between two pre-defined routes covering an area of approximately 40 $km^2$ (figure 2). Searching for dolphin groups were conducted onboard a 5.3 m aluminum boat equipped with a 60 hp outboard engine. Two observers scanned 180 degree without binnoculars and the searching speed ranged from 8-10 kts. When a group of dolphins was encountered, information about time and duration of encounter, geographic position (registered in a GPS), group size (minimum, maximun and best counting), behaviuor, and group composition (number of calves, juveniles and/or adults) were recorded. Groups were carefully approached for the photo-id work. Photos were taken using a Nikon D70's with a 300mm lens (f 2.1). Dorsal fin photographs were taken randomly. We took as many photographs as possible to increase the probability of obtaining at least one good quality photograph all dolphins in the group and that were photographed. After this, we returned to the line transect to resume the searching.

*Data analysis*

Each picture was analyzed according to quality, which took into account the degree of exposure of the dorsal fin, angle, distance, focus and contrast. To avoid false positive/negative, only pictures grade 1 (i.e. all dorsal fin exposed, close, on focus, perpendicular and with good contrast) were considered. Individual recognition was based on long-lasting marks, such as cuts and nicks or deformities (see an example in figure 3). Individual dolphins were identified from photographs based primarily on the size, location and pattern of notches on the trailing edge of the dorsal fin and on the back right behind the dorsal fin (Wells and Scott 1990).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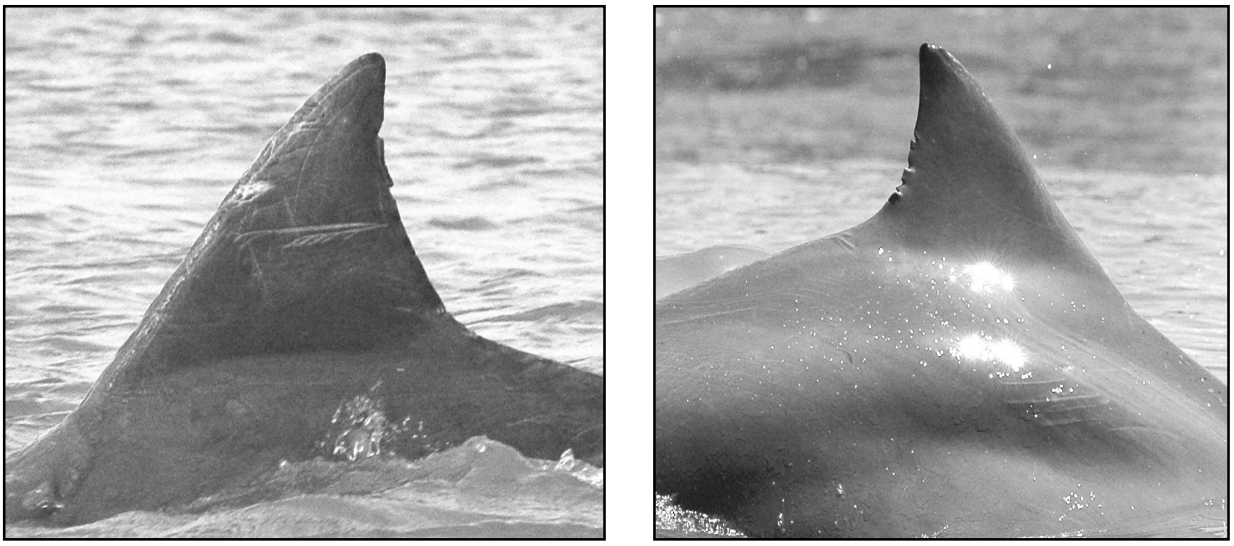

Figure 3. Exemples of long-lasting marks used to individual recognition in this study.

**PHOTO-IDENTIFICATION**

Thirteen surveys were conduct between August and December 2005 and 22 between January and October 2006 to photo-identify bottlenose dolphins in the Patos Lagoon estuary. A total of 99 hs and 25 min and 157 hs was spent in the field, respectively.

Bottlenose dolphins were encountered in all surveys and a total of 360 groups were observed (140 in 2005 and 220 in 2006). Dolphin sightings were concentrated near the estuary mouth (Figure 4).


Atlantic Ocean
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dolphin_groups
0
1,200
2,400
4,800 Meters

Group size ranged from 1 to 23 individuals (mode = 2; mean = 4; SD = 3). Approximately 2435 photographs were taken in 2005 and 4041 in 2006. Sixty-five dolphins were identified during the whole period, 55 in 2005 and 61 in 2006. The resighting rate between 2005 and 2006 (i.e. the number of dolphins photo-identified in 2005 and re-photographed in 2006) was high (n=51) (92.7%). Four dolphins previously catalogued in 2005 were not re-sighted in 2006. During 2006, 10 dolphins not seen in 2005 were added to the catalogue. Figure 5 shows the re-sighting frequencies during the study period.

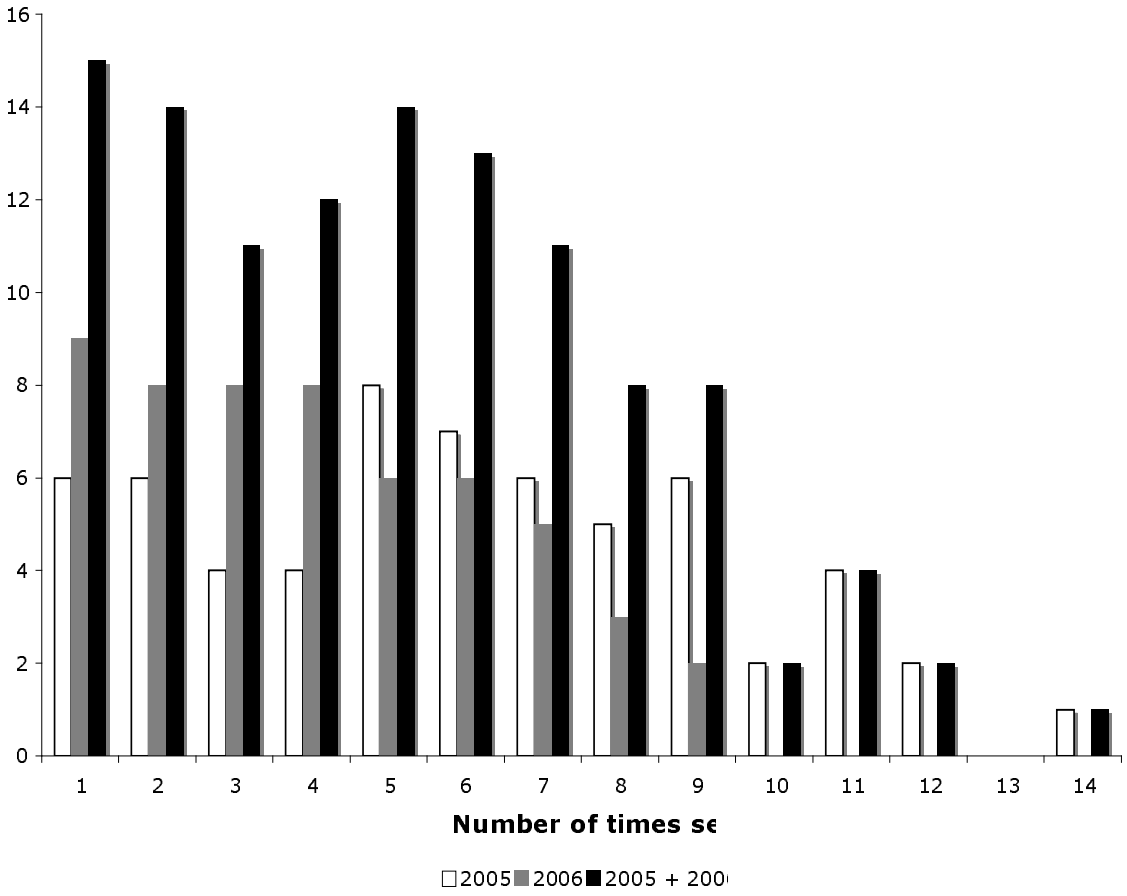



Figure 5. Frequency of re-sightings of bottlenose dolphins photo-identified during 35 surveys (n=35) carried out between August 2005 and October 2006 (black bars). Frequecy of re-sightings for each year separately is represented by withe bars (2005, n=13) and gray bars (2006, n= 22).

The number of dolphins identified during each survey was very similar between years, varing from 6 to 32 (mean = 17.2; SD = 7) in 2005 and from 4 to 30 (mean = 16.7; SD = 6.5 (table 1, 2).

Table 1. The number of dolphins photographed with long-lasting marks and the number of new captures per survey during 2005.

| # Survey | N dolphins captured | New Captures |
|---|---|---|
| 1 | 11 | 11 |
| 2 | 22 | 19 |
| 3 | 16 | 7 |
| 4 | 32 | 9 |
| 5 | 16 | 0 |
| 6 | 13 | 0 |
| 7 | 6 | 1 |
| 8 | 17 | 1 |
| 9 | 27 | 2 |
| 10 | 13 | 2 |
| 11 | 14 | 3 |
| 12 | 23 | 0 |
| 13 | 14 | 0 |
| *Average* | *17.2* | |
| *Sd* | *7.03* | |

Table 2. The number of dolphins photographed with long-lasting marks and the number of new captures per survey during 2006.

| # Survey | N dolphins captured | New Captures |
|---|---|---|
| 14 | 14 | 14 |
| 15 | 18 | 11 |
| 16 | 12 | 5 |
| 17 | 4 | 0 |
| 18 | 23 | 6 |
| 19 | 20 | 5 |
| 20 | 6 | 1 |
| 21 | 22 | 2 |
| 22 | 21 | 5 |
| 23 | 12 | 2 |
| 24 | 8 | 0 |
| 25 | 11 | 0 |
| 26 | 17 | 1 |
| 27 | 22 | 1 |
| 28 | 14 | 1 |
| 29 | 17 | 1 |
| 30 | 15 | 1 |
| 31 | 12 | 0 |
| 32 | 30 | 1 |
| 33 | 24 | 1 |
| 34 | 21 | 0 |
| 35 | 24 | 0 |
| *Average* | *16.7* | |
| *Sd* | *6.5* | |

## 2. ABUNDANCE ESTIMATE OF PATOS LAGOON POPULATION: 2005/2006

*Data Set selection*

A photo-identification data set from 13 surveys (Aug-Oct 2005) was analised. The Capture Software (Otis et al., 1978; Rextad and Burnham, 1991), used to estimate the number of marked dolphins in the population, support no more than eighteen sampling occasions. Therefore, to estimate the abundance in 2006 4 (the least efficient) out of 22surveys (e.g. partial surveys) were excluded.

*Model Selection*

Abundance estimates were based on two mark-recapture models for closed populations: $M_{th}$, which assumes heterogenity and time variation in the capture probabilities and Petersen with Chapman's modification (CH) estimator, which considers only two sampling periods and assumes the same capture probabilities among individuals. In the first ($M_{th}$), a matrix conteining historic data from marked animals was incorporated in the program *Capture*, from which estimated the number of dolphins with long-lasting marks. In the second case (CH) the first six surveys were considered as a marking period and the last 7 were used as re-capture period for 2005 and the first nine suveys were considered as marking period and the last nine as re-capture for 2006.

*Estimating Individuals presenting long-lasting marks in the population*

For each survey, photos were analized according to the quality criteria mentioned above. Only pictures grade 1 were used to estimate abundance. Indivuduals that presented some kind of long-lasting marks were assigned as "marked" dolphins. Individuals without long-lasting marks were defined as "unmarked" dolphins. Whenever a marked individual was detected, we compared the dorsal fin with a previous photo-id catalogue. If the marked dolphin was never been photographed before it was included in the catalogue as a new marked animal. If the dolphin had been catalogued before, it was considered re-captured. An "X" (presence-absence) Matrix containing the historical capture records for each marked individual was constructed.

*Estimating the total population size*

The proportion of individuals with long-lasting marks for each group was summed and divided by total number of groups analyzed to estimate the proportion of dolphins with long-lasting marks in the population (θ). Thus, theta (θ) was used to correct the total population size ($N_T$), which is given by the ratio $N/\theta$. Calves were treated considered unmarked dolphins and were incorporated in the estimation of theta (Wilson *et al*., 1999). Independent estimations of theta were obtained for each year.

**RESULTS**

The discovery curve for individuals with long-lasting marks identified in 2005, 2006 and during both years combined showed similar patterns (figures 5, 6 and 7). The patterns (or the tendence to stability) of the discovery curves suggest population closure, which were modelled accordingly.

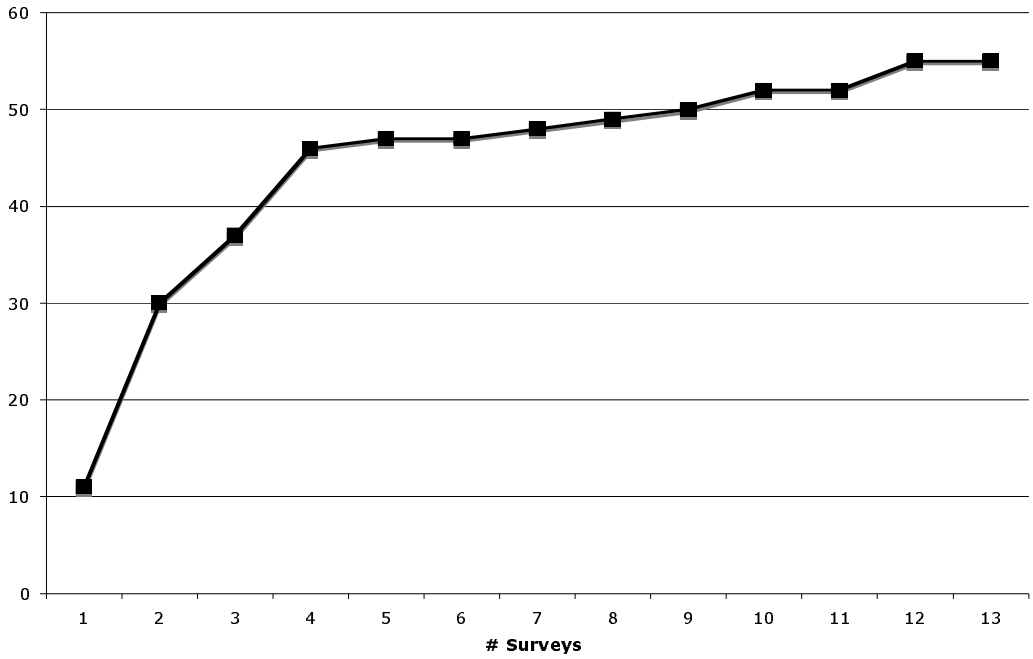



Figure 6. Discovery curve of bottlenose dolphins photo-identified in 2005.

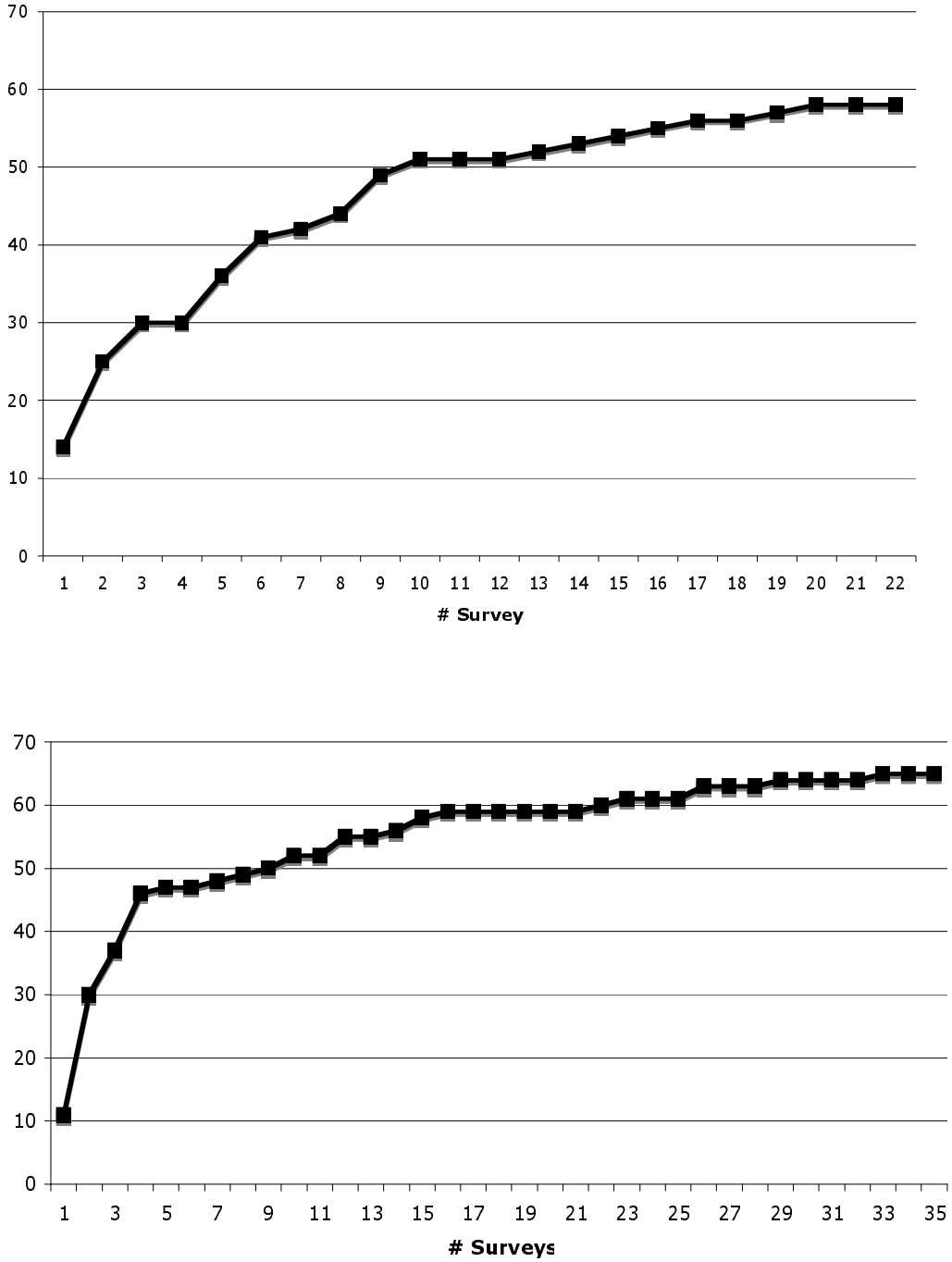



Figure 8. Discovery curve of bottlenose dolphins photo-identified during the whole period (between August 2005 and October 2006).

The Mth and CH models estimated 59 (95% CI = 57-64) and 57 (95% CI = 54-64) dolphins with long-lasting marks for 2005, respectively (Table 3). In 2006, Mth model estimated 61 marked dolphins (95% CI = 59-67) while for Chapman's model the estimate was 60 dolphins (95% CI = 58-62) (Table 5). The corrected total population sizes, which take into account the proportion of marked individual, were 83 (95% CI = 74-92 for Mth)

and 80 dolphins (95% CI = 71-89 for CH) in 2005 (Table 4) and 92 (95% CI = 84-100 for Mth) and 90 dolphins (95% CI = 83-97 for CH) in 2006 (see Table 5). Comparasions between abundance estimation are shown in Figure 9.

Table 3. General results of abudance estimation for Mth and Chapman models from 13 surveys (t=13) carried out in 2005 period. N capt = number of dolphins photo-identified ; N^= estimated number of dolphins with long-lasting marks in the population ; Nt = total population size estimated.

| | Year 2005 (t=13) | | | | | |
|---|---|---|---|---|---|---|
| | **N capt** | **N ^** | **IC (95%)** | **θ** | **N t** | **IC (95%)** |
| Chapman | 55 | 57 | 54 - 60 | 0.713 | 80 | 71-89 |
| Model Mth | 55 | 59 | 57 - 64 | 0.713 | 83 | 74-92 |

Table 4. Abundance estimates for Mth and Chapman models from 18 surveys (t=18) carried out in 2006 period. N capt = number of dolphins photo-identified; N^= estimated number of dolphins with long-lasting marks in the population; Nt = estimated total population size.

| | Year 2006 (t=18) | | | | | |
|---|---|---|---|---|---|---|
| | **N capt** | **N ^** | **IC (95%)** | **θ** | **N t** | **IC (95%)** |
| \ Chapman | 58 | 60 | 58-62 | 0.664 | 90 | 83-97 |
| Model Mth | 58 | 61 | 59-67 | 0.664 | 92 | 84-100 |

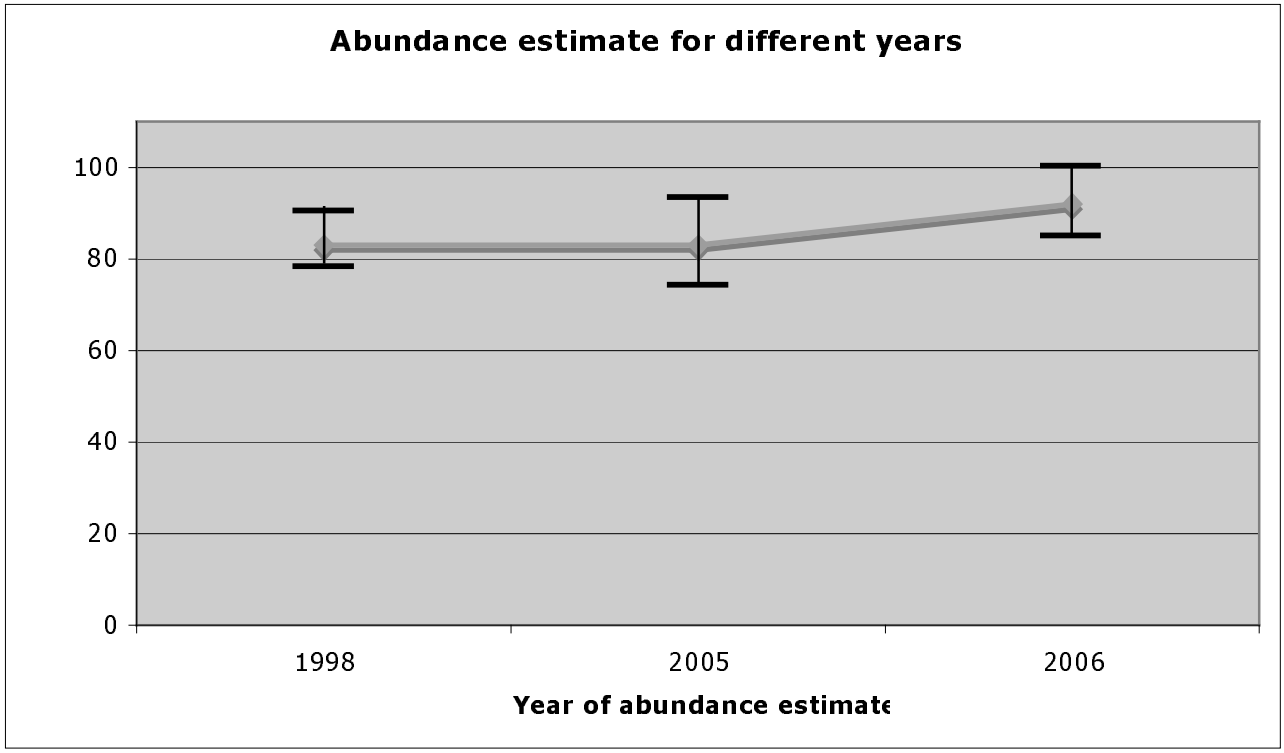



Figure 9. Graphic representation comparing the abundance estimates from Mth model for 1998 (from Dalla Rosa, 1999), 2005 and 2006.

Even though a high mortality was detected in the last four years, no differences were in the abundance estimate beteween 1998 and 2005. The abundance for 2006 was higher than for 2005 the confidence interval overllaps suggesting no significant difference in the estimates between years, though a more rigorous statistical analysis is needed. Given the high observed mortality between 2002 and 2005 (Fruet et al., 2005), a decline in population size from 1998 (the year of the first abundance estimate – see Dalla Rosa, 1999) to 2005 had been suspected. The fact that no decline was detected might simply indicate that two sampling periods are not enough to detect any trend in abundance. A larger time series is needed. On the other hand, the possibility that this population is not declining cannot be discarded. However, given the observed mortality, only a very high annual population growth rate would compensate the mortality. A Bottlenose dolphin population in Florida grows at an annual rate of about 4-5%. This rate is much lower than the rate of removal of the Patos Lagoon population. The most reasonable explanation, however, could be a low bycatch prior 2002 (see Fruet et al., 2005) allowing the population increased from 83 dolphins in 1998 (Dalla Rosa, 1999) to about 94 in 2002

(considering an annual rate of population increase of about 4-5%), then, after this period, the population experimented a high mortality and decreased again to about 83 in 2005 (this report). A higher abundance estimated for 2006 could indicate a population increase which is an unexpected result given the number of dolphins found dead washed ashore with marks suggesting bycatch (see below). This result therefore might be suggesting the need of a more rigorous analisys of the data. For example, estimates for 2005 were based on only surveys 13 surveys carried out in a short "condensed" period. The data set used to estimate abundance in 2006 came from 18 more-spaced-in-time surveys. Surveys carried out in consecutive days (as in 2005) have a higher probability of sampling replication, as the same group of dolphins can remain in the survey area for consecutive days. If that is the case, abundance estimate for 2005 could be underestimated. In order to investigate for this possibility, abundance for 2006 was estimated from two selected data sets: a) 13 surveys carried out in a short period (between April-July) and b) 12 surveys spread out along the year with at least 20 days separating subsequent surveys, to minimise data replication.

The results showed differences between the two estimtes. When data from short-period surveys were used, the abundance tended to be smaller (Table 5). Abundance estimated from data spread out through the year tended to be higher (Table 6).

Table 5. General results of abundance estimation for Mth and Chapman models from 13 surveys (t=13) data set carried out in a short time period during 2006. N capt = number of photo-identified dolphins; N^= estimated number of dolphins with long-lasting marks in the population; Nt = estimated total population size..

**Year 2006 (13 surveys)**

| | N capt | N ^ | IC (95%) | θ | N t | IC (95%) |
|---|---|---|---|---|---|---|
| **Chapman** | 55 | 56 | 53-59 | 0.667 | 84 | 77-91 |
| **Model Mth** | 55 | 58 | 56-66 | 0.667 | 87 | 78-96 |

Table 6. General results of abundance estimation for Mth and Chapman models from 12 surveys (t=12) data set selected to avoid replications during 2006. N capt = number of photo-identified dolphins; N^= estimated number of dolphins with long-lasting marks in the population; Nt = estimated total population size.

**Year 2006 (12 surveys/possible no replications)**

| | N capt | N ^ | IC (95%) | θ | N t | IC (95%) |
|---|---|---|---|---|---|---|
| **Chapman** | 56 | 58 | 55-61 | 0.649 | 89 | 81-97 |
| **Model Mth** | 56 | 62 | 59-74 | 0.649 | 95 | 82-108 |

**3. MORTALITY**

*Study area and data collection*

Beach surveys using a four-wheel drive truck were conducted to record and/or collect carcasses of cetaceans along the 355 km long sandy coast of the southern part of Rio Grande do Sul state, southern Brazil, from November 2005 to October 2006.

Surveys were carried out as systematically as possible. Depending on logistics and weather conditions, alternated surveys covering a stretch of 137 km to the north (Peixe Lagoon - 31°21´S) and 218 km to the south (Chui – 33°44'S) of the Patos Lagoon estuary took place once a week. All carcasses found were collected or measured and analysed to search for evidence of interactions with fishing operations. When possible, reproductive organs of relatively fresh individuals were collected to complement studies on reproduction (e.g. mean age at attainment of sexual maturity can be estimated from carcasses).

*Trends in stranding frequency and interactions with fisheries*

It was assumed that all dolphins found along the coast adjacent to the estuary belong to the Patos Lagoon population. Stranding rates were calculated for each year as the number of carcasses per survey effort (km of coast surveyed). Fishing-related mortality was determined based on the presence of net marks or mutilations. Net marks were detected only on fresh carcasses.

**RESULTS**

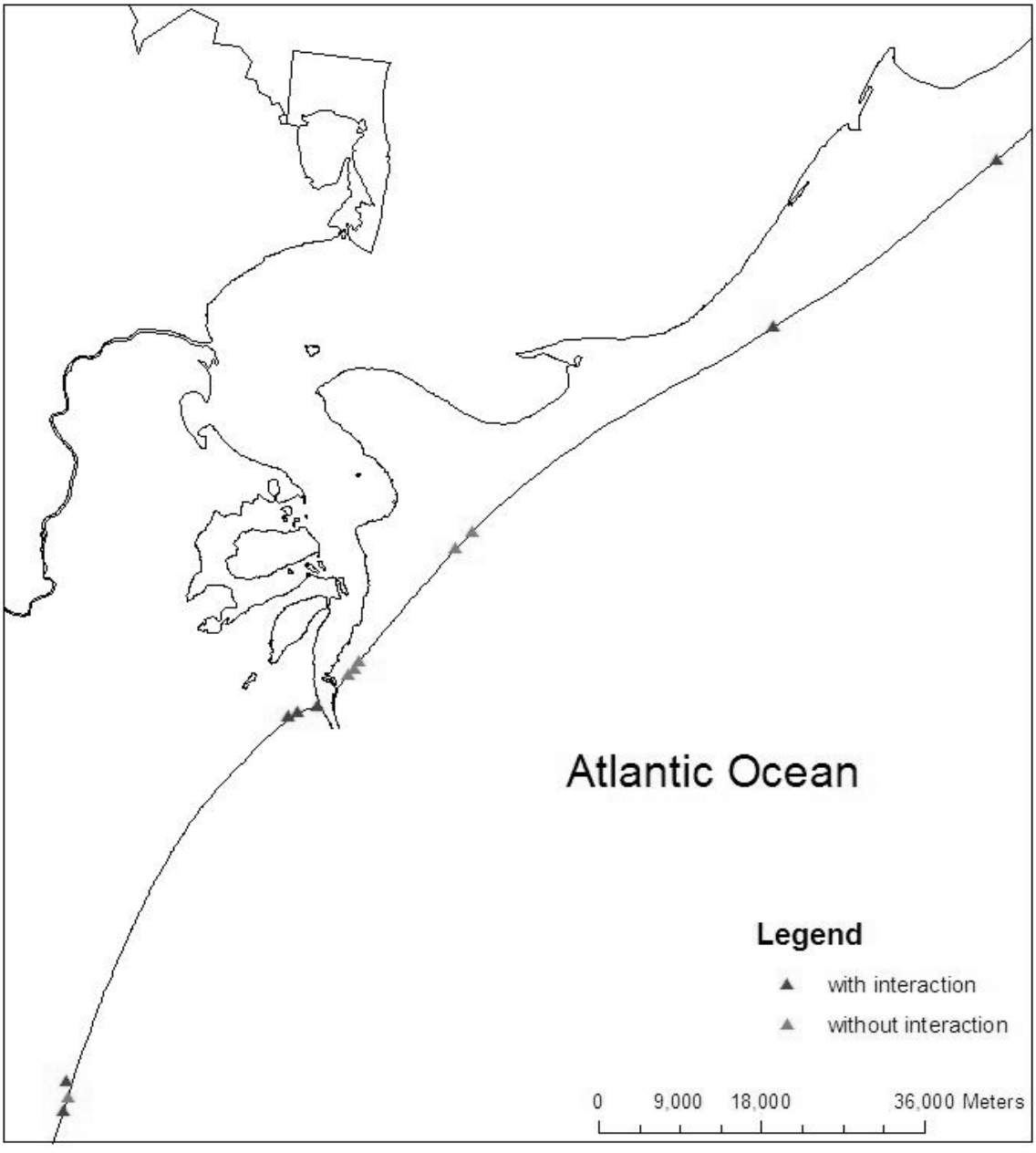
*Mortality*

Thirty-seven beach surveys were conduct between November 2005 and October 2006, corresponding to a total effort of 5017.1 km of beach surveyed. Out of those, 20 surveys (3082.9 km) covered the southern and 17 (1934.2 km) the northern area. Fourteen bottlenose dolphins were found dead on the beach, 7 of which (46.15%) showed signs of interactions with fisheries and three specimens were too decomposed to allow an evaluation (Table 7).

Table 7. Bottlenose dolphins stranded between October 2005 and October 2006. Question mark indicates animals in advanced decomposition for which evidence of fishery interactions could not be assessed.

| | Date | Total length | sex | Fishery interaction |
|---|---|---|---|---|
| 1 | Oct -16-2005 | 273 cm | F | Yes |
| 2 | Nov-03-2005 | 125 cm | M | ? |
| 3 | Dec-01-2005 | 315 cm | M | ? |
| 4 | Dec-15-2005 | 339 cm | M | No |
| 5 | Dec-15-2005 | 281 cm | F | No |
| 6 | Dec-26-2005 | 169 cm | | No |
| 7 | Dec-30-2005 | 342 cm | M | Yes |
| 8 | Jan-27-2006 | 325 cm | | ? |
| 9 | Fev-09-2006 | 330 cm | M | Yes |
| 10 | Fev-16-2006 | 228 cm | M | Yes |
| 11 | Mar-16-2006 | 308 cm | | Yes |
| 12 | Apr-19-2006 | 247 cm | | No |
| 13 | May-04-2006 | 227 cm | | Yes |
| 14 | May-05-2006 | 148 cm | M | Yes |

Ten dolphin carcasses (74,4%) were found no more than 50 km to the north or to the south of the estuary (Figure 10), suggesting that they belong to the Patos Lagoon population. Only one carcass was found distant of estuary mouth (200 km south). Six carcasses (42.9%) were found to the south and eight (57.1%) to the north of Patos Lagoon estuary.



The number of carcasses washed ashore decreased as distance from estuary mouth increased either to the south or to north (Figure 11).

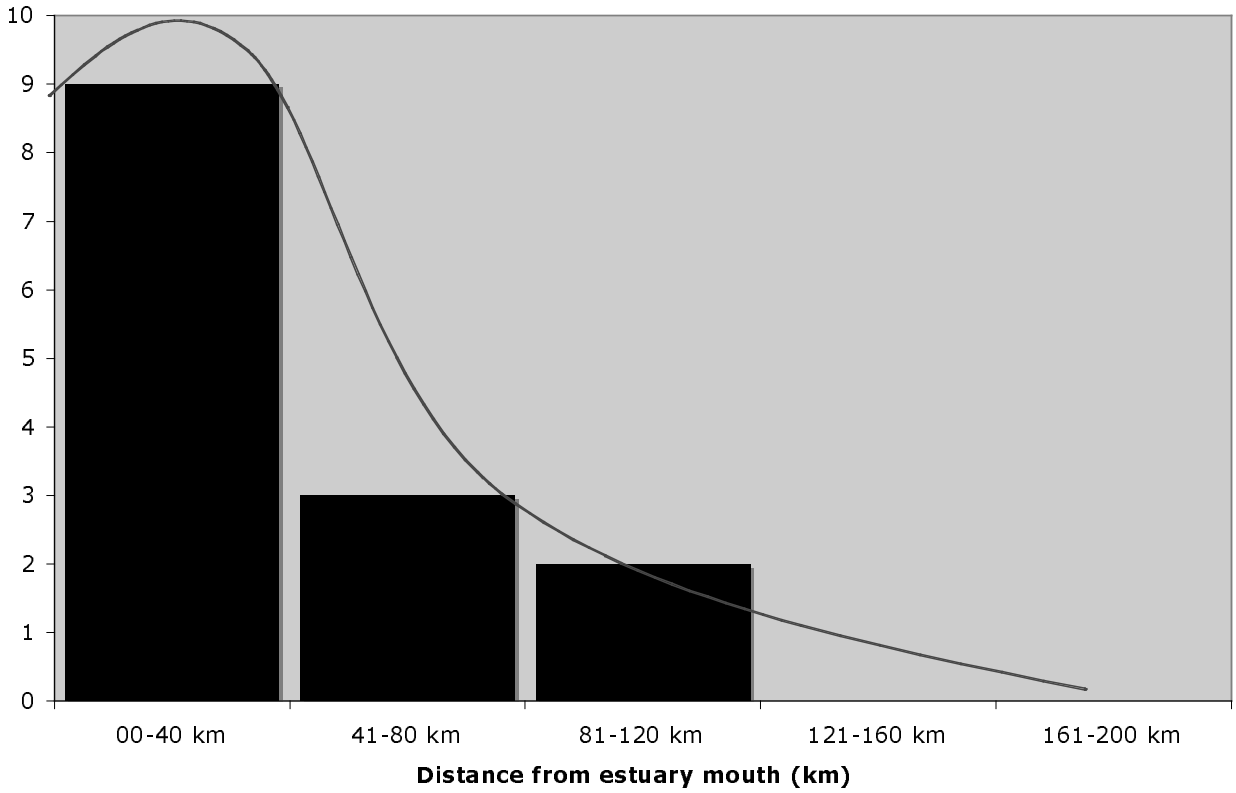



Figure 11. Number of carcasses of bottlenose dolphins washed ashore between October 2005 – October 2006 related to the distance from Patos Lagoon estuary mouth.

The mortality of dolphins during this period was clearly seasonal. Mortality was high during late austral spring (September – December) and summer (January-March) (Figure 12). The period of bottlenose dolphins mortality overlaps with the peak season of coastal artisanal gillnet fishery. Moreover, the high number of dolphins presenting evidences of being caught in nets confirmed the impact of fisheries in this small population. Stranding rates were low in winter and autumn probably due to low fishing effort during this period.

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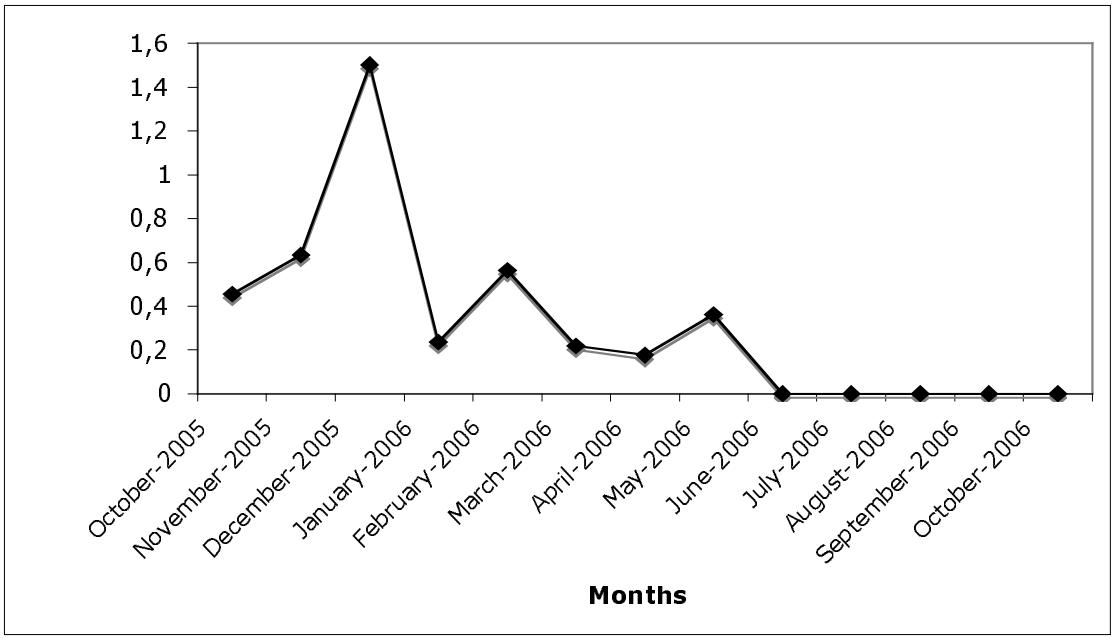


Figure 12 Seasonal trends in mortality of bottlenose dolphins. Strandig rates are number of dolphins per 100 km of beach surveyed.

The mean total length of bottlenose dolphins collected during 2005/2006 period was 261.2 cm (SD=73 cm). Frequency distribution of length classes showed that most animals stranded were juveniles (between 241 and 280 cm of length) and sub-adults (between 281-320 cm of length) (Figure 13).

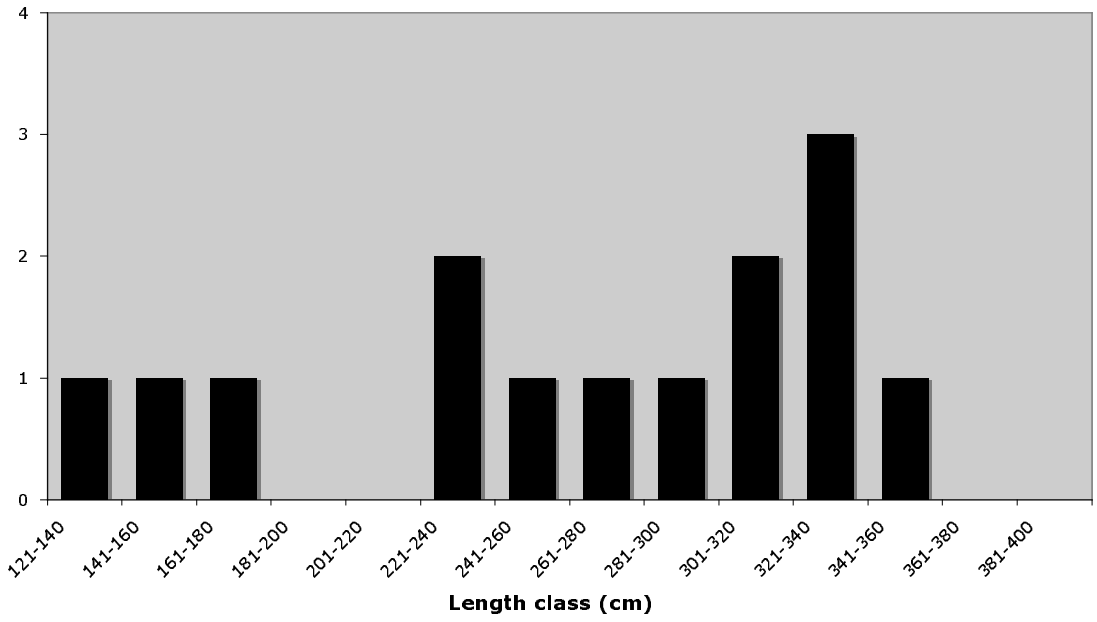


Figure 13. Length-class distribution of bottlenose dolphins washed ashore in southern Rio Grande do Sul coast between 2005-2006.

*Fishing-related mortality*

From 11 carcasses whose evidence of interactions with fisheries could be assessed, seven (63.6%) showed signs of entanglement in nets. Evidence of interactions included mutilations (n=3), nets entangled on the carcass (n=2) and net marks (n=2) (Figure 14).

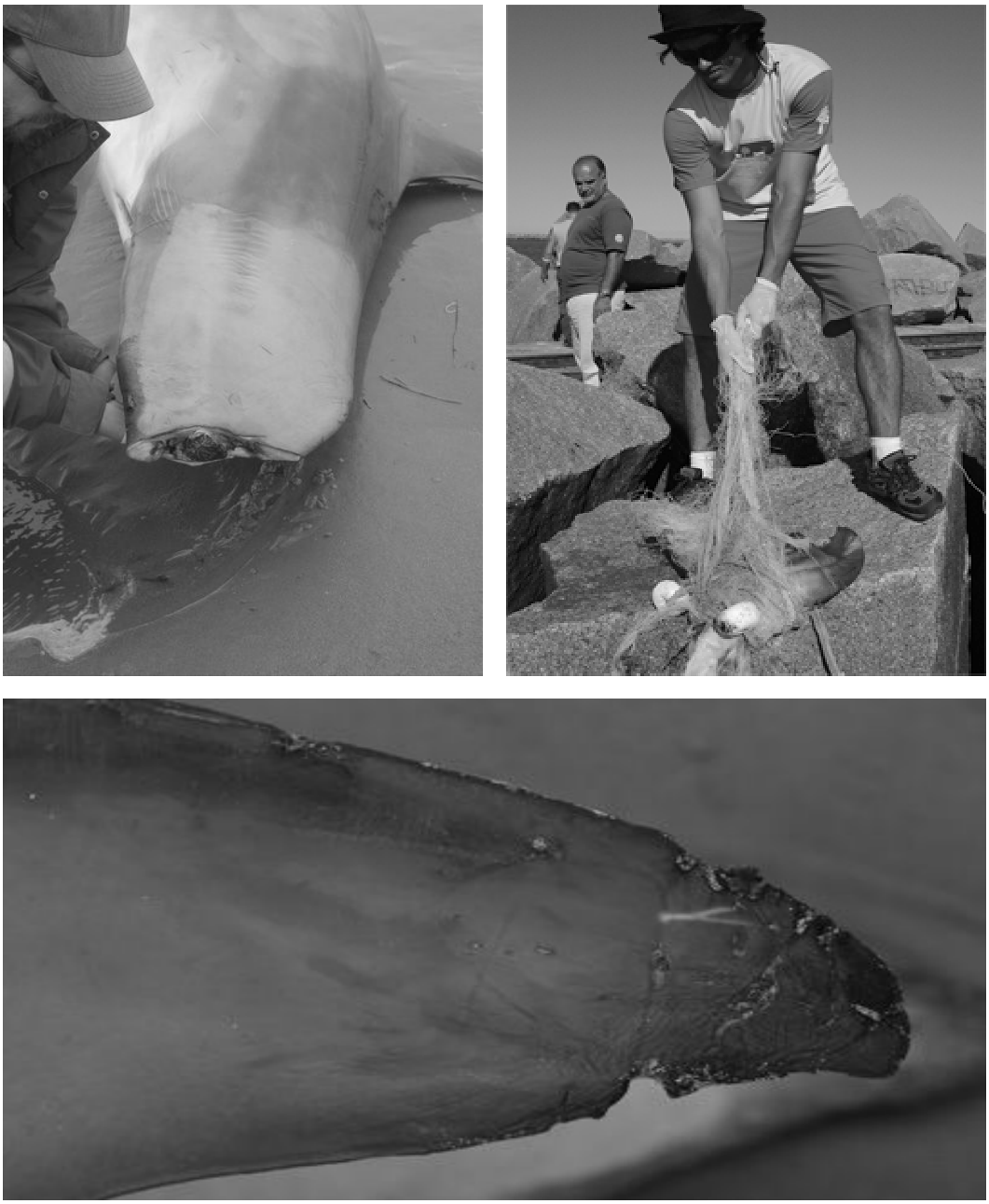

Figure 14. Exemples of evidences of interactions between dolphins and fishery operations. (a) A female bottlenose dolphin washed ashore with mutilated caudal peduncle. (b) Male bottlenose dolphin entangled in net. (c) Net marks on the right pectoral fin.

The seven bottlenose dolphins presenting evidences of bycatch were found less than 60 km from to the north (29.6%) or to the south (71.4%).

Bycatch was high on spring and summer (71.43%) (n=5). From those animals whose sex could be determined 4 were males and 1 was a female. The mean total length of dolphins incidentally caught on nets was 265 cm (SD= 69). Immature animals represented majority of the bycatch. Dolphins with total length between 140-330 cm represented 85.7% (n=6). Assuming the population size of 83 dolphins estimated for 2005, the fishing-related mortality rate represent of 0.084. It is worthwhile to notice that the estimated fishing related mortality rates is probably underestimated as lack of evidence of entanglement in some carcasses does not necessarily mean that the animals were not incidentally killed in nets, especially those decomposed carcasses.

**4. Reproductive rate**

A preliminary reproductive rate was calculated as the proportion of calves borned during the 2005/2006 reproduction period to the population size estimated in 2005 (n=83). Five mother and calves pairs were identified (see example in Figure 14) and the reproductive rate was estimated to be 6% (assuming the abundance estimate for 2005, 05/83 = 0.06) or 5% (assuming the abundance estimate for 2006, 05/92= 0.05). Therefore, the birth rate (6%) is lower than the fishing mortality rate (8%) and much lower than the total mortality rate (16% assuming all dead animals belong to the Patos Lagoon population). Eventhough this analysis is simple and preliminary, the evidence that this population might be declining is strong or at least that fishing related mortality is playing an important negative role on the fate of this population (see also evidence from the comparisons among photo-identification catalogues - annex I). A more detailed Population Viability Analysis is planned for 2007, depending on the continuity of this project.

**5. Age-estimation of stranded dolphins**

We could not estimate the age of stranded dolphins. The equipment necessary to prepare tooth sections is under responsibility of the Demersal Fishery Resources Laboratory at the Federal University of Rio Grande (FURG), and was not available during this period due to other priorities of that Laboratory. However, teeth of all carcasses were collected and stored for future analysis, which is also planned for 2007.

**Future planned activities:**

According to our planned activities elaborated for a 2-year project, next year we will continue to estimate the population parameters (e.g., abundance, mortality, reproductive rates) to perform a population viability analysis. Furthermore, we will estimate the age-structure of stranded dolphins and will start to collect home-range data. The table below shows more detailed planned activities for 2007:

| *YEAR 2* | ***J*** | ***F*** | ***M*** | ***A*** | ***M*** | ***J*** | ***J*** | ***A*** | ***S*** | ***O*** | ***N*** | ***D*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Photo-ID survey*** | *3* | *3* | *3* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *3* | *3* |
| ***Home Range survey*** | *1* | *1* | *1* | *1* | *1* | *1* | *1* | *1* | *1* | *1* | *1* | *1* |
| ***Beach survey*** | *6* | *6* | *6* | *6* | *6* | *6* | *6* | *6* | *6* | *6* | *6* | *6* |
| ***Photo-analysis*** | | | | | | | *X* | | | | | *X* |
| ***Mortality analysis*** | | | | | | | *X* | | | | | *X* |
| ***Reproductive analysis*** | | | | | | | | | *X* | *X* | *X* | *X* |
| ***Age analysis*** | | | | | | | *X* | *X* | *X* | *X* | *X* | *X* |
| ***Abundance estimate*** | | | | | | | | | | | | *X* |
| ***Assessement modeling*** | | | | | | | | | | | | *X* |
| ***Partial Reports*** | | | | | | | *X* | | | | | |
| ***Final Report*** | | | | | | | | | | | | *X* |

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# ANNEX I

## TEMPORAL COMPARISONS OF CATALOGUES OF PHOTO-IDENTIFIED BOTTLENOSE DOLPHINS (*Tursiops truncatus*) IN THE PATOS LAGOON ESTUARY AS A TOOL TO ASSESS IMPACT OF FISHING RELATED MORTALITY

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In order to assess the resighting rates and to verify if the resighting rates observed between years are sigficantly different from the expected we compared photo-identification catalogues from 1994, 1998 and 2005.

Only dolphins with evident long-lasting marks were used for comparison, so the difference of the photographs quality between years does not affect the results. Few assumptions were considered before the analysis:

- The survey effort was large enough to identify most of the marked individuals in the three periods. According to Dalla Rosa (1998) the discovery curve stablishes after the 13$^{th}$ survey. All studies had more than 13 surveys and took place in the same area;
- The survival rate (S) for non-calves was 0.96. This is the only known survival rate for non-calves of this species and was estimated for a population in Florida (Wells & Scott, 1990);
- Individuals with long-lasting marks are older than individuals with small or no marks (DuFresne, 2004; Wilson *et al.*, 1999)
- Individuals that were not resighted were considered dead.

The expected resighting number was calculated by projecting an initial population of identified dolphins assuming a survival rate of 0.96. Projections to obtain the expected resighting number using a survival rate of 0.95 and 0.94 were also performed for comparison to the optimistical scenario of a 0.96 survival rate, which is the higher rate known for small cetaceans. The difference between the expected and the observed resightings was tested through the Chi-square.

From 28 dolphins catalogued in 1994, 20 (71.43%) were recorded in the 1998 catalogue, composed of 42 animals, and 12 (42.85%) were also present in the 2005 catalogue, composed of 50 individuals (Figure 1). The number of resightings in 1998 did not differ significantly from any of the expected numbers. On the other hand the number of resightings in 2005 was significantly different when the survival rate was 0.96 (Table 1). If the survival rate of this population is 0.96, the results indicate an increase in the mortality of dolphins after 1998.

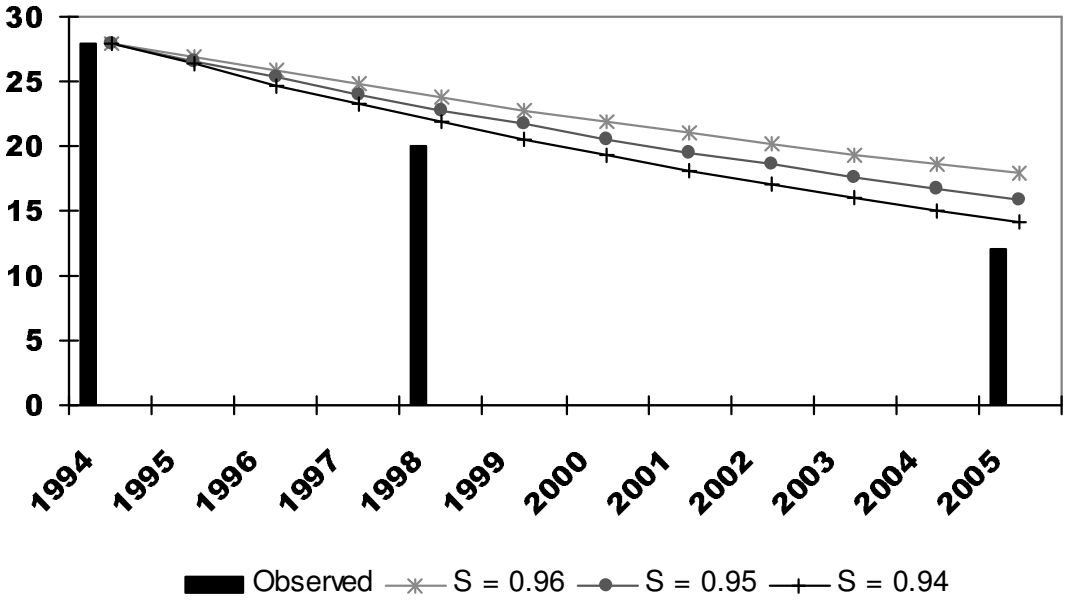


Table 1. Number of dolphins catalogued in 1994, and resighted in 1998 and 2005.

| | Number Observed | S | Number Expected | Chi-square | P |
|---|---|---|---|---|---|
| **1994** | 28 | | | | |
| **1998** | | 0.96 | 24 | 3.573 | 0.059 |
| | 20 | 0.95 | 23 | 1.522 | 0.217 |
| | | 0.94 | 22 | 0.477 | 0.489 |
| **2005** | | 0.96 | 18 | 4.706 | ***0.030*** |
| | 12 | 0.95 | 16 | 1.786 | 0.184 |
| | | 0.94 | 14 | 0.321 | 0.571 |

From the 20 dolphins resighted in 1998, 11 were also catalogued in 2005 (Figure 2). This observed number does not differ significantly from the expected numbers for any of the survival rates considered (Table 2). By considering the 22 animals that acquired long-lasting marks after 1994 (*i.e.* animals catalogued in 1998 but not in 1994), only 9 were resighted in 2005 when the expected number of resightings was 14, 16 and 17 for the three survival rates considered (Figure 3). The observed number of dolphins is significantly from the expected for all survival rates (Table 2). Assuming that animals with recently acquired marks are younger, this higher mortality of dolphins catalogued only in 1998 might indicate a higher vulnerability of younger animals to entanglement in nets, which coincides with the observed age structure of beached carcasses showing evidence of interaction with fisheries (see section about Mortality in this report).

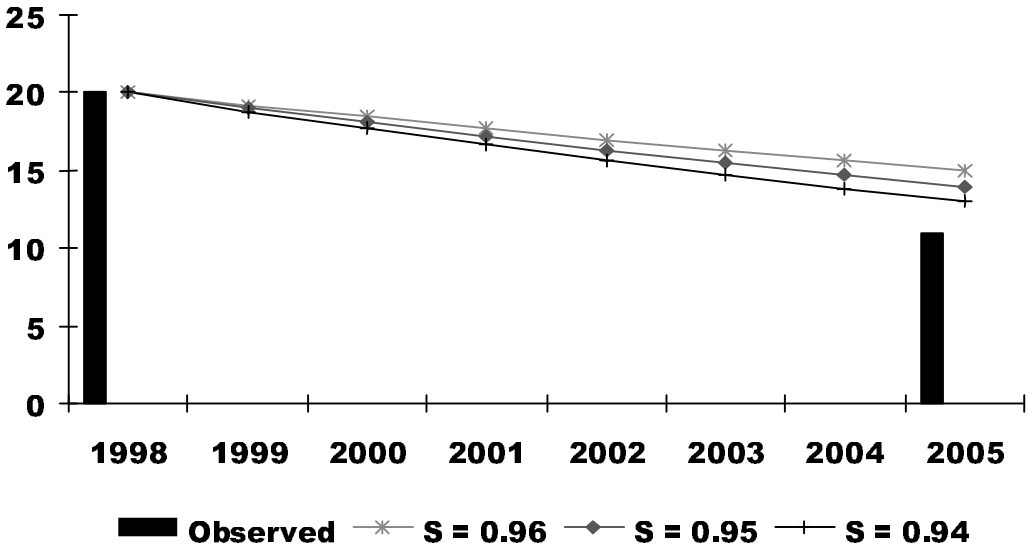


Figure 2. Number of dolphins resighted since 1998 and the projections of the expected number according to different survival rates (S).

Table 2. Number of dolphins catalogued in 1994 (older) and 1998 (younger) and resighted in 2005.

| | 1998 | S | Number Expected | Chi-square | p |
|---|---|---|---|---|---|
| **Dolphins catalogued since 1994** | | 0.96 | 15 | 3.267 | 0.07 |
| | 20 | 0.95 | 14 | 1.488 | 0.22 |
| | | 0.94 | 13 | 0.482 | 0.48 |
| **Dolphins catalogued in 1998** | | 0.96 | 17 | 14.56 | ***0.000*** |
| | 22 | 0.95 | 15 | 6.338 | ***0.012*** |
| | | 0.94 | 14 | 3.978 | ***0.046*** |

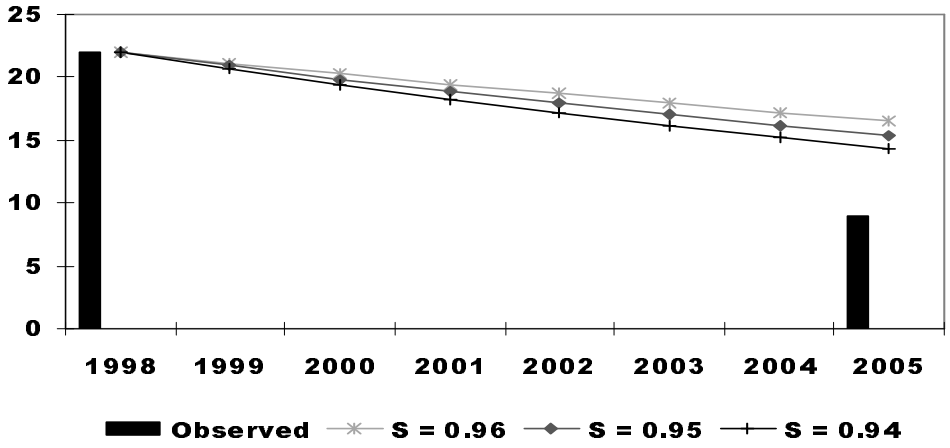


Figure 3. Number of dolphins catalogued for the first time in 1998 and the projections of the expected number according to different survival rates (S).

The results of this study corroborates with other studies, which detected an increase in the fishing related mortality of dolphins after the year 2000 in this area. Therefore comparison between catalogues can be a simple and efficient tool to assess impacts on a population.