

## REPORT OF THE WORKING GROUP ON VITAL PARAMETERS AND DEMOGRAPHY

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### Age distribution of incidentally caught and stranded franciscanas

Age distribution of franciscanas incidentally caught in northern Rio de Janeiro State, southeastern Brazil, was reported for 62 males and 57 females (Di Benedetto and Ramos, 2000). Males ranged from 0 to 5 years but were mostly of age 2. Females ranged from 0 to 9 years and were mostly of ages 2 and 3. Overall, 74% of all captured animals were of three years or younger.

Age distribution of 260 franciscanas from incidental captures and strandings were obtained from three regions in southeastern Brazil: Espírito Santo State (ES) (n = 14), northern Rio de Janeiro State (NRJ) (n = 141) and São Paulo State (SP) (n = 105) (Ramos *et al.*, 2000). A comparison between the age distribution of incidental catches in NRJ and strandings in SP indicated a higher percentage of older animals in SP: 73% were between 0-3 years in NRJ (incidental captures); the same percentage was between 3-6 years in SP (strandings) (K-S Test, n=164,  $P \leq 0.05$ ). Since both samples are from different regions, it is unclear how to interpret the observed difference in age composition.

However, similarities have been detected in the age structure of incidentally caught franciscana when compared over the complete distribution. Age classes up to 3 years were the most representative in southern Brazil (Pinedo, 1994; Ott, 1998; Ott *et al.*, 2000), Uruguay (Kasuya and Brownell, 1979; Crespo *et al.*, 1986) and Argentina (Perez Macri and Crespo, 1989; Corcuera *et al.*, 1994). This suggests that captures are biased towards juveniles (see also IWC, 1994). Age distribution patterns for stranded franciscanas in other regions are unknown. A summary on information of age structure of the southern franciscana incidentally caught or stranded is given in Table 1.

### Age at sexual maturity

The mean age at sexual maturity (ASM) for females was calculated for Rio Grande do Sul State, southern Brazil (RS) (Danilewicz *et al.*, 2000), and compared to the corresponding values for other regions - (Punta del Diablo, Uruguay (UR) (Kasuya and Brownell, 1979) and Buenos Aires Province, Argentina (AR) (Corcuera, 1996) - and time windows (Danilewicz and Secchi, 2000). Depending on the estimation method, these values are within the following ranges: RS (3.2 - 3.7); UR (2.2 - 2.8) and AR (4.3 - 4.5). For the first time, an estimate of ASM of males collected in Rio Grande do Sul was presented (Danilewicz *et al.*, 2000). This estimate was based on 57 animals, and resulted in ASM estimates of between 3.0 and 3.6, depending on estimation method (logistic equation and DeMaster, respectively). Values on minimum age and size of sexual maturity for NRJ (Di Benedetto and Ramos, 2000) are 3 years and 130cm for female, and 2 years and 115cm for male. Age at sexual

maturity of animals incidentally caught along Paraná and southern São Paulo states was between 4 to 5 years. However, sample size was small (Rosas *et al.*, 2000).

### Exponential survival-fecundity rate of increase ( $r_s$ )

Caughley (1977) describes different concepts for the rate of population increase ( $r$ ) (Chapters 5 and 9). According to his classification, we will be referring to "the rate implied by the prevailing schedules of survival and fecundity",  $r_s$ . To simplify notation the subscript  $s$  will be dropped. In some instances the corresponding finite rate of increase  $\lambda$  ( $=e^r$ ) is given instead of  $r$ . In addition, the percentual annual growth rate  $R = 100 \cdot (\lambda - 1)$  is sometimes presented in the results.

The rate of increase ( $r$ ) of a specific franciscana stock (defined through a phylogeographic approach), which involves animals inhabiting southern Brazilian and Uruguayan waters (Secchi, 1999) was estimated from given schedules of survival and fecundity using Lotka's equation:

$$1 = \sum_{x=a}^w e^{-rx} l_x m_x$$

where:  $l_x$  ( $x = 0, 1, \dots, w$ ) is the probability of a female surviving the interval between birth to age  $x$  ( $l_0 = 1$ ),  $m_x$  ( $x = 0, 1, \dots, w$ ) is the expected number of female offsprings produced by a female aged  $x$  at the birth-pulse beginning the next year interval. The sex ratio at birth is approximately 1:1.  $a$  is the age of first reproduction (i.e.  $m_x = 0$  for  $x < a$ ) and  $w$  is the longevity defined as some maximal age after which  $l_x$  or  $m_x$  or both can be considered zero.

The oldest reported franciscana is a 21 years old female (Pinedo, 1991). The maximum age reported for males is 16 years (Kasuya and Brownell, 1979). Therefore, the life span seems to be around 20 years. However, only a small percentage of the animals live more than 10 years (Kasuya and Brownell, 1979; Pinedo, 1994; Ott *et al.*, 2000; Pinedo and Hohn, 2000; Ramos *et al.*, 2000).

Uncertainties in age-specific fecundity and survival schedules were incorporated in the estimates of  $r$  in the form of Monte Carlo simulations. For each simulation, fecundity rates were sampled from a Beta probability distribution with age-specific parameters estimated from information on pregnancy rates (see section on age-specific fecundity and data in Table 2). Due to a lack of data on age-specific survival rates for franciscanas, rates were sampled from a random combination of survival curves from other mammals. This alternative to modelling age specific survival rates of cetacean populations has been used previously (Barlow and Boweng, 1991; Caswell *et al.*, 1998).

The effects on the estimated rate of increase  $r$  in response to:

- age at first reproduction ( $a$ );
- longevity ( $w$ ) and
- two different criteria for pregnancy rate (i.e.. presence of *corpus luteum* or of foetuses),

**Table 1.** Summary of available information on age structure of southern franciscana incidentally caught in Argentina, Uruguay and southern Brazil.

Area	Period	n	mode (%)	% <4 GLGs	Max. (F)	Max. (M)	Source
Uruguay <sup>a</sup>	1970-1973	218	1 (46,8)	77.5	13	16	Kasuya and
Uruguay	1980-1981	114	1 (45,6)	93.9	5	5	Crespo <i>et al.</i> 1986
Uruguay	1969-1982	246	1 (37,0)	70.0	-	-	Pinedo 1994
Buenos Aires Province	1983-1986	22	1 (36,4) and	86.4	4	4	Perez-Macri and
Buenos Aires Province	1988-1990	42	0 (21,4) and	64.3	7	8	Corcuera <i>et al.</i> 1994
Rio Grande do Sul	1976-1986	184	1 (19,0)	50.0	-	-	Pinedo, 1994
Rio Grande do Sul	1992-1997	147	1 (34,7)	77.6	11	8	Ott <i>et al.</i> 2000

References: (n) number of analysed animals; (GLGs) Growth Layers Groups, which correspond to age in years; (Max. F) maximum recorded age for females; (Max. M) maximum recorded age for males (compiled by Ott *et al.*, 2000).

a- Sampling biased for adult females collected for reproductive studies

b- Dolphins washed ashore collected in beach surveys

**Table 2.** Reproductive status of female franciscanas incidentally caught in coastal gillnet fisheries in Rio Grande do Sul.

Age	Nx	Pregnant (Px)		Immatures	$m_x$ (Foetus)	$m_x$ (CL)
		Foetus	CL			
0	7	0	0	7	0	0
1	23	0	0	23	0	0
2	11	0	0	11	0	0
3	12	5	8	4	0.315	0.333
4	3	2	2	1	0.335	0.335
5	3	2	3	0	0.335	0.5
6	4	4	4	0	0.5	0.5
7+	9	3	9	0	0.5	0.5
	72	16	26	46	0.165	

References: (Nx) number of females of age x in sample; (Px) number of pregnant females of age x; ( $m_x$  foetus) age-specific fecundity estimated using the presence of foetuses as pregnancy criterion; ( $m_x$  CL) age-specific fecundity estimated using the presence of Corpus Luteum (CL) in the ovaries as pregnancy criterion (adapted from Danilewicz and Secchi, 2000).

were examined by comparing different scenarios (Secchi, 1999). In each, a total of 1000 random runs were performed. According to the most optimistic scenario (i.e. using lowest possible value for  $a$ , the *corpus luteum* as criterion of pregnancy, and highest reported value of longevity) the estimated mean value for  $\lambda$  ( $=e^r$ ) was 1.02 (SE = 0.4). Thus, the estimated mean percentual annual growth rate was 2%. The scenario considered by Secchi to be most realistic (i.e. using parameter values that agree with available data) provided an annual growth rate of only 0.16%. Although there was much uncertainty in the estimates, the simulations suggested that the potential rate of annual increase of franciscana populations (based on the data from southern Brazil and Uruguay) is unlikely to exceed 2%. This value agrees with the low potential rate of population increase observed in other small cetaceans (e.g. Reilly and Barlow, 1986; Sooten and Lad, 1991; Caswell *et al.*, 1998).

#### Age-specific survival rate ( $l_x$ )

This is an attempt to develop a franciscana mortality schedule based on available information on reproductive and longevity parameters, considering expert opinion on the range of plausible values for these parameters. In order to find a range of possible age specific survival rates for franciscana the following 'best case scenario' was used in 1000 Monte Carlo simulations: age of first reproduction ( $a$ ) = 3,  $w = 21$ ;  $m_x$  and using the presence of foetus as criterion for pregnancy. From these simulations age specific survival curves were selected which resulted in an annual growth rate between 0.5% and 6.0%. This arbitrary range includes biologically plausible values for cetaceans (e.g. Reilly and Barlow, 1986; Best, 1993). For the selected survival rates the mean and standard deviation of age-specific survival rates were calculated (Secchi *et al.*, 2000). Estimated mean adult (individuals older than 1

year of age) survival rate was 88.6% (SE 5%), with only 67% (6.4%) of franciscanas reaching 1 year of age. These values are recommended as inputs for simulation exercises in the absence of data-based parameter estimates.

### Trends in stranding rates

Long-term trends in fishing effort of the coastal bottom gillnet fishery were compared to long-term stranding rates of franciscana in southern Brazil (Pinedo and Polacheck, 1999). Stranding rates prior to 1990 were over three times higher than those after 1990. This decrease was significant ( $p = 0.001$ ). Pinedo and Polacheck (1999) also suggested that stranding rates declined markedly from the late seventies to early eighties, while in the 1990s they have remained low and relatively stable. Stranding rates may reflect general trends in total bycatch of franciscana. If this is the case, a decline in franciscana abundance is the most likely explanation for the declining or stable stranding rates observed during a period of increasing coastal gillnet fishing effort (Pinedo and Polacheck, 1999).

### Simulation Studies

Simulation studies to examine the effects of incidental captures on population dynamics were reported for RS. Using Lotka's equation (Secchi and Kinas, 2000, Secchi 1999) and information on age-specific fecundity, longevity, ASM (all taken from field data) and a very general age-specific survival curve, the resulting annual growth rate of the population, indicated a declining population. The integration of this model with time-series of stranding data (Pinedo and Polacheck 1999) improved the growth rate estimates (Kinas, 2000). However, the conclusion that the stock is currently declining, was not changed.

Population viability analysis (PVA) was performed using different approaches (Kinas, 2000, Secchi *et al.*, 2000). Under current harvest rates (somewhere between 0.029 and 0.070 (Kinas, 2000)), the probability of population decrease within 20 years is estimated to be between 61% and 79% (Secchi *et al.*, 2000). Similarly, the time until the population reaches 10% of its current size was estimated to be between 16 and 41 years (median = 23 years). Further analysis (Kinas, 2000) suggests that by halving current harvest rates this time increases to between 20 to 66 years (median = 31 years). However, due to lack of information on current population size, it is unclear if a population  $1/10$  the size of the existing one is sustainable or too small for survival.

A limitation of both models above (Kinas, 2002 and Secchi *et al.*, 2000) is the fact that density-dependence or other compensatory mechanisms (i.e. modelling at the level of metapopulation) were not included in the model.

### References

- Barlow, J. and Boveng, P. (1991) Modeling age-specific mortality for marine mammal populations. *Marine Mammal Science* 7: 50-65.
- Best, P.B. (1993). Increase rates in several depleted stocks of baleen whales. *ICES Journal of Marine Science* 50: 169-186.
- Caswell, H., Brault, S., Read, A.J. and Smith, T.D. (1998) Harbor porpoise and fisheries: an uncertainty analysis of incidental mortality. *Ecological Applications* 8: 1226-1238.
- Caughley, G. (1977) *Analysis of vertebrate population*. John Wiley & Sons, New York.
- Corcuera, J. (1996) *Edad de madurez sexual del delfin franciscana en el sur de la Provincia de Buenos Aires, Argentina*. Page 39 in Abstracts, VII Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur. 22-25 October, Viña del Mar.
- Corcuera, J., Monzón, F., Crespo, E.A., Aguilar, A. and Raga, J.A. (1994) Interactions between marine mammals and the coastal fisheries of Necochea and Claromecó (Buenos Aires, Argentina). Pages 283-290 in Perrin, W.F., Donovan, G.P. and Barlow, J. (Eds) *Gillnets and cetaceans*. International Whaling Commission (special issue 15), Cambridge.
- Crespo, E.A., Perez-Macri, G. and Praderi, R. (1986) Estado actual de la población de franciscana (*Pontoporia blainvillei*) en las costas uruguayas. Pages 92-105 in Castello, H.P. (Ed.) *Actas I Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur*, Buenos Aires.
- Danilewicz, D.S., Secchi, E.R., Ott, P.H., and Moreno, I.M. (2000) Analysis of the age at sexual maturity and reproductive rates of franciscana (*Pontoporia blainvillei*) from Rio Grande do Sul, southern Brazil. *Comunicações do Museu de Ciências e Tecnologia*. PUCRS 13: 89-98.
- Danilewicz, D.S. and Secchi, E.R. (2000) Reprodução em fêmeas de toninha, *Pontoporia blainvillei*, no Rio Grande do Sul. Technical Paper WP23 presented to the IV Workshop para a Coordenação da Pesquisa e Conservação da Franciscana, *Pontoporia blainvillei*, no Atlântico Sul Ocidental. 05-09 November 2000. Porto Alegre.
- Danilewicz, D.S., Claver, J.A., Pérez-Carrera, A.L. and Secchi, E.R. (2000) Maturidade sexual e sazonalidade reprodutiva em machos de toninha, *Pontoporia blainvillei*, no Rio Grande do Sul. Technical Paper WP10 presented to the IV Workshop para a Coordenação da Pesquisa e Conservação da Franciscana, *Pontoporia blainvillei*, no Atlântico Sul Ocidental. 05-09 November 2000. Porto Alegre.
- Di Benedetto, A.P.M. and Ramos, R.M.A. (2000) *Pontoporia blainvillei* (Gervais & D'Orbigny, 1844) in the northern Rio de Janeiro (21°18'S-22°25'S), Brazil. Technical Paper WP11 presented to the IV Workshop para a Coordenação da Pesquisa e Conservação da Franciscana, *Pontoporia blainvillei*, no Atlântico Sul Ocidental. 05-09 November 2000. Porto Alegre.
- International Whaling Commission. (1994) Report of the Workshop on Mortality of Cetaceans in Passive Fishing Nets and Traps. Pages 1-72 in Perrin, W.F., Donovan, G.P. and Barlow, J. (Eds) *Gillnets and cetaceans*. International Whaling Commission (special issue 15), Cambridge.
- Kasuya, T. and Brownell, R.L. (1979) Age determination, reproduction and growth of franciscana dolphin, *Pontoporia blainvillei*. *Scientific Reports of the Whales Research Institute* 31: 45-67.
- Kinas, P.G. (2002) The impact of incidental kills by gillnets on the franciscana dolphin (*Pontoporia blainvillei*) in southern Brazil. *Bull. Mar. Sci.* 70(2): 409-421.
- Ott, P.H. (1998) *Análise das capturas acidentais de Pontoporia blainvillei* (Gervais & D'Orbigny, 1844) (Cetacea, Pontoporiidae) nas comunidades pesqueiras do litoral Norte do Rio Grande do Sul, Sul do Brasil. Master Thesis. Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre. 121pp.
- Ott, P.H., Secchi, E.R., Crespo, E.A. and Dans, S. (2000) Estrutura etária da população de *Pontoporia blainvillei* acidentalmente capturada pela atividade pesqueira na costa do Rio Grande do Sul - Brasil. Pages 62-64 in UNEP/CMS (Eds) *Report of the Third Workshop for Coordinated Research and Conservation of the Franciscana Dolphin* (*Pontoporia blainvillei*) in the Southwestern Atlantic. UNEP/CMS, Bonn.
- Perez-Macri, G. and Crespo, E.A. (1989) Survey of the franciscana, *Pontoporia blainvillei*, along the Argentine coast, with a preliminary

- evaluation of mortality in coastal fisheries. Pages 57-63 in Perrin, W.F., Brownell, R.L., Kaiya, Z. and Jiankang, L. (Eds) *Biology and Conservation of the River Dolphins*. Occas. pap. IUCNSSC3. Gland.
- Pinedo, M.C. (1991) *Development and variation of the franciscana Pontoporia blainvillei*. Doctoral Thesis, University of California, Santa Cruz. 406pp.
- Pinedo, M.C. (1994) Impact of incidental fishery mortality on the age structure of *Pontoporia blainvillei* in southern Brazil and Uruguay. Pages 261-264 in Perrin, W.F., Donovan, G.P. and Barlow, J. (Eds) *Gillnets and Cetaceans*. International Whaling Commission (special issue 15), Cambridge.
- Pinedo, M.C. and Polacheck, T. (1999) Trends in franciscana (*Pontoporia blainvillei*) stranding rates in Rio Grande do Sul, Southern Brazil (1979-1998). *Journal of Cetacean Research and Management* 1: 179-189.
- Pinedo, M.C. and Hohn, A. (2000) Growth layer patterns in teeth from the franciscana, *Pontoporia blainvillei*: developing a model for precision in age estimation. *Marine Mammal Science* 16: 1-27.
- Ramos, R., Di Benedetto, A.P.M. and Lima, N.R.W. (2000) Growth parameters of *Pontoporia blainvillei* in northern Rio de Janeiro, Brazil. *Aquatic Mammals* 26.1: 65-75.
- Ramos, R.M.A, Di Benedetto, A.P., Siciliano, S., Santos, M.C., Zerbini, A.N., Bertozzi, C., Vicente, A., Zampirolli, E., Siqueira, F., De Vivo, M. and Lima, N.R.W. (2000) Informações sobre idade e crescimento de *Pontoporia blainvillei* no litoral sudeste do Brasil Technical Paper WP12 presented to the IV Workshop para a Coordenação da Pesquisa e Conservação da Franciscana, *Pontoporia blainvillei*, no Atlântico Sul Ocidental. 05-09 November 2000. Porto Alegre.
- Reilly, S.B. and Barlow, J. (1986) Rates of increase in dolphin population size. *Fishery Bulletin* 84: 527-533.
- Rosas, F.W, Monteiro Filho, E.L.A., and Oliveira, M.R. (2000) Incidental catches of franciscana dolphins (*Pontoporia blainvillei*) on the southern coast of São Paulo State and the coast of Paraná State, Brazil. Technical Paper WP2 presented to the IV Workshop para a Coordenação da Pesquisa e Conservação da Franciscana, *Pontoporia blainvillei*, no Atlântico Sul Ocidental. 05-09 November 2000. Porto Alegre.
- Secchi, E.R. (1999) *Taxa de crescimento potencial intrínseco de um estoque de franciscanas, Pontoporia blainvillei (Gervais & D'Orbigny, 1844) (Cetacea, Pontoporiidae) sob o impacto da pesca costeira de emalhe*. Master Thesis. Fundação Universidade Federal do Rio Grande, Rio Grande. 152pp.
- Secchi, E. and Kinan, P.G. (2000) Evidências para o declínio de um estoque de franciscanas, *Pontoporia blainvillei*, devido às capturas acidentais em redes de emalhe Technical Paper WP13 presented to the IV Workshop para a Coordenação da Pesquisa e Conservação da Franciscana, *Pontoporia blainvillei*, no Atlântico Sul Ocidental. 05-09 November 2000. Porto Alegre.
- Secchi, E.R., Slooten, E. and Fletcher, D. (2000) Population Viability Analysis (PVA) for a franciscana stock: when is time for action? Technical Paper WP6 presented to the IV Workshop para a Coordenação da Pesquisa e Conservação da Franciscana, *Pontoporia blainvillei*, no Atlântico Sul Ocidental. 05-09 November 2000. Porto Alegre.
- Slooten, E. and Lad, F. (1991) Population biology and conservation of Hector's dolphin. *Canadian Journal of Zoology* 69: 1701-1707.

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