

## REPORT OF THE WORKING GROUP ON FISHERY INTERACTIONS

Paulo H. Ott, Eduardo R. Secchi, Ignacio B. Moreno, Daniel Danilewicz, Enrique A. Crespo, Pablo Bordino, Renata Ramos, Ana Paula Di Benedetto, Carolina Bertozzi, Ricardo Bastida, Regina Zanelatto, Jorge Perez and Paul G. Kinas

Mortality of franciscana in fishing operations has been observed for almost sixty years. Reports on by-catch in shark gillnet fisheries off Uruguay date back to the early forties (Van Erp, 1969). Although gillnetting in Argentina and southern Brazil also emerged in the forties as a consequence of Second World War demands for cheap protein and vitamins (De Buen, 1950, 1952; Popovici and Angelescu, 1954; Crespo *et al.*, 1994; Haimovici *et al.*, 1997), no record of by-catch exists for those areas. Gillnet fisheries for bottom-dwelling fish became the major conservation concern for franciscana in both countries only in the eighties. Nowadays, by-catch has been reported from all main fishing villages along most of the species geographical distribution (e.g. Corcuera, 1994; Crespo *et al.*, 1994; Pinedo, 1994a; Siciliano, 1994; Praderi, 1997; Secchi *et al.*, 1997; Zanelatto, 1997; Di Benedetto *et al.*, 1998; Ott, 1998). Gillnet fishing characteristics are summarized in Table 1. By-catch estimates for each of the proposed Franciscana Management Areas (FMAs) (Secchi *et al.*, in press) are shown in Figure 1.

**Uruguay:** Franciscana by-catch exists since the beginning of the gillnet fishery for sharks off Punta del Diabo (Van Erp, 1969). As early as the late sixties, annual by-catch may have reached 1,500 to 2,000 animals (Brownell and Ness, 1970; Pilleri, 1971). Results of the first systematic survey indicated a by-catch of at least 536 dolphins between 1971 and 1973 (Brownell and Praderi, 1974; Brownell, 1975). A mean annual by-catch of 279 franciscanas was reported for the following four years (Praderi 1985). Praderi (1984) and Crespo *et al.* (1986) also estimated the annual by-catch of franciscanas and presented levels of Catch Per Unit of Effort (CPUE) based on an extensive monitoring program of the fisheries between 1974 and 1983. A review paper on incidental mortality of the species in Uruguayan waters showed that at least 3,683 dolphins were killed in the region between 1974 and 1994 (Praderi, 1997). Annual estimates ranged between 66 and 418 dolphins caught in 1994 and 1974, respectively. In general, nets were set in water depths ranging from 6 to 30m, but most of the by-catch occurred in water from 10 to 20m deep (Praderi, 1997).

Franciscana by-catch occurs in gillnets with stretched mesh sizes varying from 10 to 34cm. However, nets with the largest mesh size, targeting sharks (e.g. *Carcharhinus* spp, *Carcharias platensis* and *Galeorhinus galeus*), were responsible for about 70 to 90% of the captures (e.g. Praderi, 1997). During the last decades the stocks of targeted sharks have declined to an extent that the fisheries became unprofitable. Consequently, the fishing effort with the larger mesh sizes (i.e. 32-34cm) dropped from almost 100% in the sixties and seventies to only 20% in the mid nineties. Most of the fishers who traditionally used large boats with large mesh-sized nets to catch sharks are currently using smaller boats with small mesh-sized nets and now target bonny fishes (e.g. Sciaenidae fishes). Some are trawling for shellfish (*Adelomelon brasiliana*) (Praderi, 1997). These changes in the Uruguayan coastal fishery may allow franciscana to recover from the by-catch experienced in the past (Praderi, 1997). However, an uncontrolled increase of fishing effort using

small mesh-sized nets for coastal bonny fishes and an intense by-catch of franciscana in adjacent areas of southern Brazil (see below) could compromise this recovery process.

**Argentina:** Perez-Macri and Crespo (1989) presented the first mortality estimates and CPUE for franciscana in Argentine waters. This study surveyed several fishing communities between 1984 and 1986 and estimated an annual mortality of at least 340-350 animals. Corcuera (1994), Corcuera *et al.* (1994) and Crespo *et al.* (1994) provided further information concerning franciscana and gillnet interactions along the Argentine coast, especially for the fishing communities placed along the Buenos Aires Province coast. The most complete information available comes from Necochea and Claromec , where fisheries have been monitored since 1984 and 1988, respectively. The CPUE of franciscana has decreased considerably during the last years in Necochea, which holds one of the largest gillnet fishing fleet in Argentina. Such a decrease is mainly due to movements of the fleet to fishing grounds further offshore (Corcuera *et al.*, 1994). Nowadays, most of the franciscana by-catch in Argentine waters occurs in fisheries carried out from small fishing camps in the Buenos Aires Province. Thus, the coastal habitat of franciscana makes it vulnerable to by-catch in small scale inshore gillnets (Corcuera, 1994; Cappozzo *et al.*, 2000). Data over seven years, from mid 80's and early 90's, suggested an average annual by-catch of 237 (95% CI: 208 to 269) franciscanas in southern Buenos Aires Province (Corcuera, 1994; Corcuera *et al.*, 1994). Fishing villages of the northern Buenos Aires Province were monitored in 1997 and 1998 and annual by-catch in this area was estimated to be 228 (95% CI: 200 to 260) animals (Corcuera *et al.*, 2000). Estimates of by-catch for the same region from 1999 suggested a mean annual by-catch of 209 (95% CI: 145 to 298) franciscanas (Cappozzo *et al.*, 2000). The overall mortality of the species in the entire Buenos Aires Province seems to be around 450 to 500 dolphins/year (Cappozzo *et al.*, 2000; Corcuera *et al.*, 2000). It is important to note that research carried out onboard artisanal fishing boats off Cabo San Antonio resulted in much higher annual by-catch (17 dolphins per boat) than estimates obtained from interviews (10 dolphins per boat) (Bordino *et al.*, 2000). Therefore, since most of the available data on by-catch in Argentine waters (e.g. Corcuera, 1994; Corcuera *et al.*, 1994; Cappozzo *et al.*, 2000) were obtained from interviews, it is likely that the total annual by-catch for this area is considerably underestimated.

A variety of fisheries operate along the Buenos Aires Province coast, depending on season and target species. However, most of the captures of franciscana occur in water shallower than 20m deep in gillnets set for croaker (Sciaenidae species) and sharks (*Galeorhinus galeus*, *Mustelus* spp, *Eugomphodus taurus*, *Squatina argentina*) (Corcuera *et al.*, 1994; Crespo *et al.*, 1994). In Necochea, gillnets catching most of the franciscana are set at the bottom and have stretched mesh sizes from 18 to 28cm. Off Claromec , franciscana by-catch also occurs in gillnets with stretched mesh sizes from 7 to 36cm (Corcuera, 1994; Corcuera *et al.*, 1994).

**Table 1.** Summary of incidental mortality of franciscana and the involved fisheries in the western South Atlantic.

| Locality   | Geographic Sector* | Annual Mortality   | General Characteristic of the Fisheries   | Data Source  | Reference  |
|--|--------------------|--|---|--|--|
| Regência and Povoação, ES/Brasil<br>Latitude:<br>19°38'S       | 2                  | Min.: 5<br>Ave.: -<br>Max.: 10   | Fleet: 12 small boats<br>Power engines: -<br>Gear: gillnets<br>Main target species: -<br>Mesh size: -<br>Net width: -<br>Net length: -<br>Depth:-<br>Distance from the coast: 1 nautical mile offshore<br>Fishing season: -<br>CPUE: -<br>Dolphin use: blubber as bait for lobster trap and muscle for human consumption.   | Occasional interview (1987 and 1989).  | Siciliano <i>et al.</i> , 1994;<br>Ramos <i>et al.</i> , 1994.         |
| Atafona, RJ/Brasil<br>Latitude:<br>21°37'S                     | 3                  | Min.: 8<br>Ave.: 15<br>Max.: 22  | Fleet: 140 boats (7-12m long) (~45% use gillnets).<br>Power engines: 15-60Hp<br>Gear: surface and bottom gillnets<br>Main target species: sciaenids and sharks<br>Mesh size: 14cm<br>Net height: 5.6m<br>Net length: up to 2,400m<br>Depth: 6-70m<br>Distance from the coast: up to 60 nautical miles offshore<br>Fishing season: year-round<br>CPUE: -<br>Dolphin use: blubber as shark bait in longline fishery   | 12 years (1987-1999) fleet monitoring program (45% of the fleet).  | Di Benedetto <i>et al.</i> , 1998;<br>Di Benedetto and Ramos, 2000.    |
| Bertioga to Peruíbe, SP/Brasil<br>Latitude:<br>23°59'S-24°20'S | 4 and 5            | Est. a:<br>Min.: 22<br>Ave.: -<br>Max.: -<br><br>Est. b:<br>Min.: 14<br>Ave.: -<br>Max.: - | Fleet: 6 small boats (6-8m long)<br>Power engines: 18-40Hp<br>Gear: surface and bottom gillnets<br>Main target species: sciaenids, sharks<br>Mesh size: 7-16cm<br>Net height: 1.6-3.3m (bottom gillnets); 7.4-10m (surface gillnets)<br>Net length: 120-1,800m<br>Depth: up to 25 m<br>Distance from the coast: -<br>Fishing season: year-round<br>CPUE: 0.0020 franciscana x(1,000 m <sup>2</sup> of net x day) <sup>-1</sup><br>Dolphin use: no records | a) 2 years (1998-2000) survey of stranded cetaceans.<br><br>b) 2 years (1998-2000) fleet monitoring program (100% of the fleet).<br>Interview and onboard surveys. | a) Vicente <i>et al.</i> , 2000.<br><br>b) Bertozzi and Zerbini, 2000. |

continued...

**Table 1.** Summary of incidental mortality of franciscana and the involved fisheries in the western South Atlantic.

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| Locality  | Geographic Sector* | Annual Mortality  | General Characteristic of the Fisheries  | Data Source   | Reference  |
|---|--------------------|---|--|---|--|
| Cananéia, SP/Brasil<br>Latitude:<br>25°00'S                           | 5                  | Est. a:<br>Min.: 9<br>Ave.: -<br>Max.: -<br><br>Est. b:<br>Min.: 11<br>Ave.: -<br>Max.: 330 | Fleet: 30 boats (18m long)<br>Power engine: -<br>Gear: surface and bottom gillnets<br>Main target species: sciaenids and sharks<br>Mesh size: 7-13cm<br>Net height: 5-10m<br>Net length: up to 6,000m (bottom gillnets); up to 2,000m (surface gillnets)<br>Depth: -<br>Distance from the coast: 10-40 nautical miles offshore<br>Fishing season: year around (bottom gillnets), May-July (surface gillnets)<br>CPUE: -<br>Dolphin use: no records | a) 2 years (1986-1988) survey of stranded cetaceans.<br><br>b) 2 years (1998-2000) fleet monitoring program (3% of the fleet, n = 30). Interview. | a) Schmiegelow, 1990<br><br>b) Rosas <i>et al.</i> , 2000a.                                |
| Pontal do Sul and Matinhos, PR/Brasil<br>Latitude:<br>25°18'S-25°58'S | 6                  | Est. a:<br>Min.: 5<br>Ave.: -<br>Max.: -<br><br>Est. b:<br>Min.: 10<br>Ave.: -<br>Max.: 25  | Fleet: small boats (7-10m long)<br>Power engine: 11-36Hp<br>Gear: surface and bottom gillnets<br>Main target species: sciaenids, sharks, mullets, flounders<br>Mesh size: 6-22cm<br>Net height: 2-5m (bottom gillnets); 8-12m (surface gillnets)<br>Net length: 500-1,200m<br>Depth: up to 30m<br>Distance from the coast: up to 5 nautical miles offshore<br>Fishing season: year around<br>CPUE: -<br>Dolphin use: eventually human consume      | a) 7 years (1991-1997) survey of stranded cetaceans.<br><br>b) 2 years (1998-2000) fleet monitoring program. Interview.                           | a) Zanellato, 1997;<br>Rosas <i>et al.</i> , 2000b.<br><br>b) Rosas <i>et al.</i> , 2000a. |
| Farol de Santa Marta, SC/BR<br>Latitude:<br>28°29'S                   | 7 and 8            | Est. a:<br>20-30<br><br>Est. b:<br>120  | Fleet: 60-70 small boats<br>Power engine: -<br>Gear: gillnet<br>Main target species: sciaenids, gadids and sharks<br>Mesh size: 10-40cm<br>Net height: 3m<br>Net length: 1,500-2,225m<br>Depth: -<br>Distance from the coast: ~8-10 nautical miles offshore<br>Fishing season: year-round<br>CPUE: -<br>Dolphin use: -   | a) Occasional Interview.<br><br>b) 1 year (1994-1995) fleet monitoring program (25% of the fleet). Interview and onboard data.                    | a) Pinedo, 1994b<br><br>b) Cremer <i>et al.</i> , 1995                                     |

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**Table 1.** Summary of incidental mortality of franciscana and the involved fisheries in the western South Atlantic.

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| Locality   | Geographic Sector* | Annual Mortality   | General Characteristic of the Fisheries   | Data Source  | Reference   |
|--|--------------------|--|---|--|---|
| Torres and Tramandai/Imbe, RS/BR<br>Latitude:<br>29°15'S-29°58'S | 8 and 9            | Est. a:<br>Min.: 300<br>Ave.: 425<br>Max.: 550<br><br>Est. b:<br>46                    | Fleet: 30 boats (10-18m long)<br>Power engine: 90-160Hp<br>Gear: bottom and surface gillnets<br>Main target species: sciaenids, gadids and sharks<br>Mesh size: 9-38cm<br>Net height: 3m (bottom gillnets); 8-15m (surface gillnets)<br>Net length: up to 4,500m (bottom gillnets); 300-1,500m (surface gillnets)<br>Depth: 10-40m<br>Distance from the coast: up to 20 nautical miles offshore<br>Fishing season: year-round<br>CPUE: 0.0540 to 0.0880 franciscanas x (1,000 m of net x day) <sup>-1</sup><br>Dolphin use: no records at the present (occasionally in the past)  | a) 5 years (1992-1997) fleet monitoring program (40 % of the fleet).<br>Interview and onboard surveys.<br><br>b) 10 years (1991-2000) survey of stranded cetaceans.  | a) Ott, 1998; Ott <i>et al.</i> , 2000a.<br><br>b) Moreno <i>et al.</i> , 2001.   |
| Rio Grande, RS/Brasil<br>Latitude:<br>32°05'S                    | 10                 | Est. a: 84<br><br>Est. b:<br>Min.: 196<br>Ave.: 461<br>Max.: 518<br><br>Est. c:<br>810 | Fleet: 140 – 150 boats (12 – 16m long)<br>Power engine: 90 – 120Hp<br>Gear: gillnets (passive and active)<br>Main target species: sciaenid and pomatomids<br>Mesh size: 9-16cm<br>Net height: 2-4 (passive nets) and 6-14m (active)<br>Net length: 3,000-11,000m (passive); 800-4,000m (active)<br>Depth: up to 35m<br>Distance from the coast: up to 30 miles offshore<br>Fishing season: year round<br>CPUE: 0.0066 franciscanas x (1,000m of net x day) <sup>-1</sup> (passive);<br>0.0038 franciscanas x (operation x day) <sup>-1</sup><br>Dolphin use: few fishers use the oil to waterproof boats and the meat is sometimes used for feeding dogs and even rarely for human consumption. | a) 11 years (1976-1987) survey of stranded cetaceans.<br><br>b) 1 year (1994) fleet monitoring program (25% of the fleet).<br>Interview.<br><br>c) 1 year (2000) fleet monitoring program (7% of the fleet).<br>Interview. | a) Pinedo, 1994a.<br><br>b) Secchi <i>et al.</i> , 1997; Kinas and Secchi, 1998, 1999.<br><br>c) Secchi <i>et al.</i> , unpubl. data. |
| Uruguay<br>Latitude:<br>33°45'S-34°55'S                          | 11 and 12          | Min.: 66<br>Ave.: 184<br>Max.: 418   | Fleet: 20 boats in the 70's, 3 boats in the mid 1990's, fishing only off Punta del Diablo. (6-8m long)<br>Power engine: up to 80Hp<br>Gear: gillnets<br>Main target species: historically sharks, currently sciaenids<br>Mesh size: 10-12, 20-22 and 32-34cm<br>Net height: 3-5m<br>Net length: up to 1,680m<br>Depth: 6-30m<br>Distance from the coast: 2-30 nautical miles offshore<br>Fishing season: mostly in summer<br>CPUE: 0.0064 franciscanas x (1,000 m of net x day) <sup>-1</sup><br>Dolphin use: recent commercial use of franciscana oil  | 20 years (1974-1994) fleet monitoring program (most of the fleet).<br>Interviews.  | Praderi <i>et al.</i> , 1989;<br>Praderi, 1997  |

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**Table 1.** Summary of incidental mortality of franciscana and the involved fisheries in the western South Atlantic.

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| Locality   | Geographic Sector* | Annual Mortality  | General Characteristic of the Fisheries   | Data Source   | Reference  |
|--|--------------------|---|---|---|--|
| North Buenos Aires Province/Argentina<br>Latitude:<br>35°00'-38°08'S   | 12, 13 and 14      | Est. a:<br>Min.: 200<br>Ave.: 228<br>Max.: 260<br><br>Est. b<br>Min.: 145<br>Ave.: 209<br>Max.: 298 | Fleet: 45 boats (5-12m long)<br>Power engine: -<br>Gear: gillnets<br>Main target species: sciaenids and sharks to a less extent<br>Mesh size: 10-30cm<br>Net height: 3-5m<br>Net length: 200 to 4,000m<br>Depth: up to 25-30m<br>Distance from the coast: up to 25-30 nautical miles<br>Fishing season: mostly in summer<br>CPUE: 0.2161 to 0.4289 franciscanas x (1,000 m of net x day) <sup>-1</sup><br>Dolphin use: human consume ("mushame") in some areas  | a) 1 year (1997-1998) fleet monitoring program.<br>Interviews.<br><br>b) 1 year (1999-2000) fleet monitoring program.<br>Interview and onboard surveys.                     | a) Corcuera <i>et al.</i> , 2000<br><br>b) Capozzo <i>et al.</i> , 2000                      |
| South Buenos Aires Province/Argentina<br>Latitude:<br>38°08'S -40°30'S | 14, 15 and 16      | Est. a:<br>Min.: 208<br>Ave.: 237<br>Max.: 269<br><br>Est. b:<br>Min.: 96<br>Ave.: 135<br>Max.: 189 | Fleet: 22 boats using gillnets (5-12m long), 58 using shrimpers<br>Power engine: -<br>Gear: gillnets and shrimp trawling nets<br>Main target species: sciaenids and sharks to a less extent (gillnets), <i>Pleoticus</i> sp. and <i>Artemesia</i> sp. (shrimpers)<br>Mesh size: 10-30cm for gillnets, 2-6cm for shrimpers<br>Net height: 3-5m for gillnets<br>Net length: 200 to 4,000m for gillnets<br>Depth: up to 25-30m<br>Distance from the coast: up to 25-30 nautical miles offshore<br>Fishing season: mostly in summer<br>CPUE (gillnets): 0.0734 franciscanas x (1,000 m of net x day) <sup>-1</sup><br>High mortality also reported for shrimp trawling nets<br>Dolphin use: - | a) 7 years (1988-1994) fleet monitoring program.<br>Interview and onboard surveys.<br><br>b) 1 year (1999-2000) fleet monitoring program.<br>Interview and onboard surveys. | a) Corcuera, 1994;<br>Corcuera <i>et al.</i> , 1994.<br><br>b) Capozzo <i>et al.</i> , 2000. |

## References:

(Est.) estimation, (Min.) minimum, (Ave.) average, (Max) maximum.

\* Geographic Sectors are shown in the Report of the Fourth Workshop (Secchi *et al.*, in this volume)

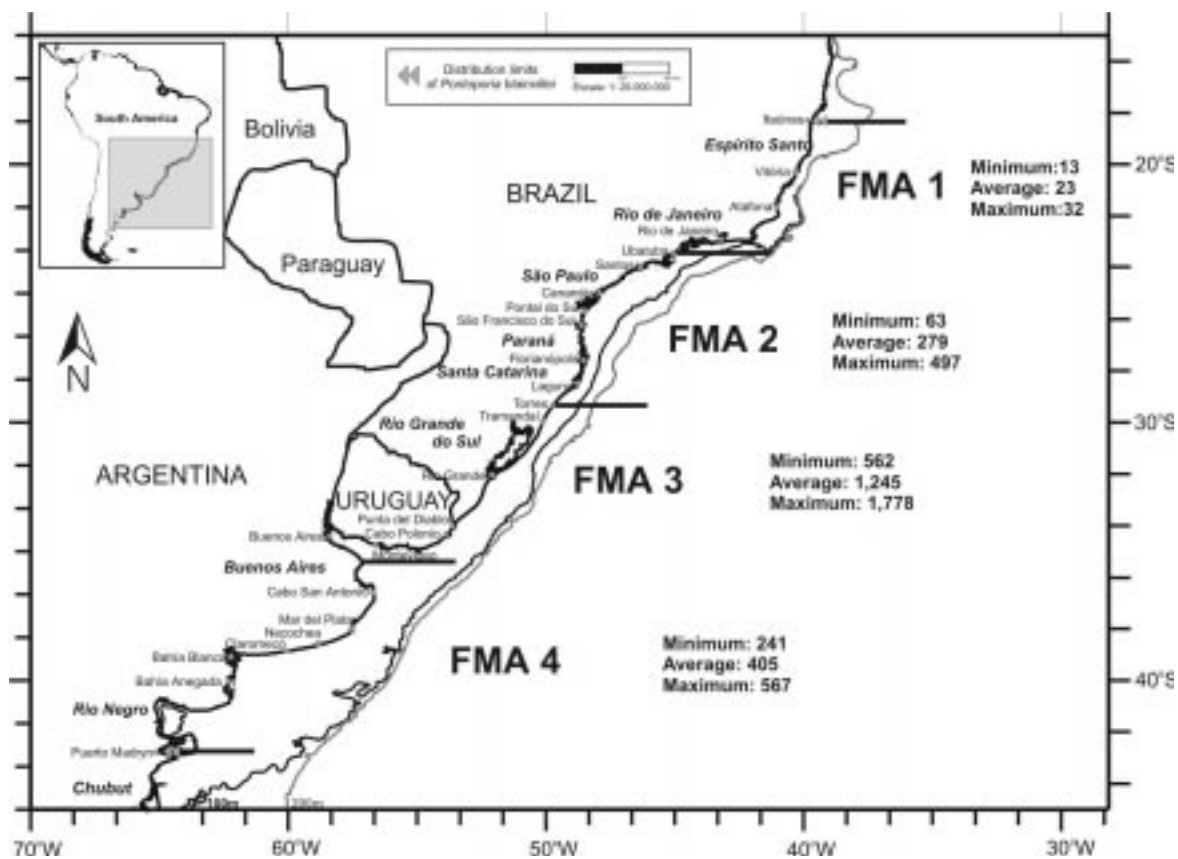


Figure 1. By-catch estimates for each of the proposed Franciscana Management Areas (FMAs).

Gillnet fishing effort has decreased in some important fishing ports (e.g. Necochea and Claromecó) due to the decline of some shark stocks (see Chiaramonte, 1998). Reduction in fishing effort has also occurred off Cabo San Antonio because of interactions with southern sea lions (*Otaria flavescens*), which damage the nets and the catches (Cappozzo *et al.*, 2000). Although this decline of gillnetting activities might reduce franciscana by-catch, shrimp trawling nets have recently been responsible for a high by-catch off Ingeniero White and Puerto Rosales, southern Buenos Aires Province (Cappozzo *et al.*, 2000).

Coastal gillnetting activities are highly seasonal, occurring only during spring in some areas and extending from spring to summer in others (Corcuera, 1994; Cappozzo *et al.*, 2000). However, the annual level of franciscana by-catch seems to be high and should be evaluated according to the population size. Therefore, abundance estimates for franciscana off Argentina are a priority for the near future.

To date, no surveys to estimate by-catch in Rio Negro Province have been done. In the Province of Chubut no gillnet is used. Bottom trawling fisheries directed to hake, *Merluccius hubbsi*, predominate. However, the hake fishery occur further offshore beyond the franciscanas' habitat. Also dredge trawls are used to catch shellfish (e.g. *Mytilus edulis* and *Chlamys tehuelchus*). Although they occur in coastal waters, no franciscana catches have been reported in these fisheries (Crespo *et al.*, 1994).

**Brazil:** The coastal gillnet fishery emerged in the forties

and increased especially during the eighties. Vessels expanded in size and engines became more powerful, which allowed longer trips and the use of larger nets (Haimovici *et al.*, 1997). A wide variety of vessels and fishing gears are employed according to the season and target species. However, active and passive gillnets targeting sciaenids (e.g. *Micropogonias furnieri*, *Cynoscion* spp, *Menticirrhus* spp), pomatomids (*Pomatomus saltatrix*) and sharks (e.g. *Mustelus* sp., *Sphyrna* spp, *Rhizoprionodon* sp.) predominate in coastal waters (see Table 1). The boats used in this fishery range in length from 6 to 18m and normally operate from coastal to offshore (60 nautical miles) waters. Gillnets vary in length from 120 to 11,000m (e.g. Rio Grande), with stretched mesh sizes varying from 7 to 40cm. Most of the gillnets are set in waters 30m deep, which corresponds to the preferred habitat of the franciscana (Praderi *et al.*, 1989; Secchi and Ott, 2000). The fishery as well as captures of franciscanas occur throughout the year.

Although the gillnet fishery exist since the 40s, the first information regarding franciscana by-catch was published in the eighties (e.g. Pinedo, 1982, 1986; Praderi *et al.*, 1989). However, this information was based exclusively on the number of animals with gillnet marks found dead on beaches in southern Brazil. According to Pinedo (1994a), 1,085 specimens were found along the Rio Grande do Sul coast between 1976 and 1987. Further information on franciscana strandings was also published for other areas

along the Brazilian coast (e.g. Schmiegelow, 1990; Pinedo, 1994a; Vicente *et al.*, 2000; Moreno *et al.*, 2001). However, the first study of incidental mortality of franciscana dolphins based on monitoring of fishing operations was started in the late 80's for a small village (Atafona) in Rio de Janeiro State, southeastern Brazil (Lodi and Capistrano, 1990). Since then, this fishing village has been systematically surveyed. From 1986 to 1999, a total of 181 franciscanas were incidentally caught in gillnets in this area, representing a mean annual mortality of  $15 \pm 7$  dolphins (Di Benedetto *et al.*, 1998; Di Benedetto and Ramos, 2000). Franciscana by-catch in fishing communities of the Rio Grande do Sul State, southern Brazil, has also been systematically studied since the 90's. The estimated annual mortality of franciscana for this area ranges from 496 to 1,360 dolphins (Moreno *et al.*, 1997; Secchi *et al.*, 1997; Ott, 1998; Kinas and Secchi, 1998, 1999; Secchi, 1999; Ott *et al.*, 2000a). These are the highest levels of incidental kills of franciscana (Table 1). Removal rates relative to population size are high and possibly unsustainable on a long-term basis (Secchi, 1999; Kinas, 2000; Secchi and Kinas, 2000; Secchi *et al.*, 2000; Secchi *et al.*, 2001).

It is worthwhile to notice that these by-catch values, estimated from monitoring the gillnet fishing fleet in southern Brazil, are appreciably higher than data for the same region based on beached animals (e.g. Pinedo, 1994a; Moreno *et al.*, 2001). This strongly suggests that data gathered from beach surveys should be viewed with caution when evaluating the impact of fisheries.

In recent years, many other studies concerning the franciscana and gillnet interactions have been carried out along the Brazilian coast. Although data from monitoring of fishing fleets are not available for many areas between Rio Grande do Sul and Rio de Janeiro States, some villages along the Santa Catarina, Paraná and São Paulo States coasts have been monitored recently. Preliminary by-catch estimates are available for some of them (e.g. Cremer *et al.*, 1995; Bertozzi and Zerbini, 2000; Rosas *et al.*, 2000a). Some of these data (e.g. Bertozzi and Zerbini, 2000) suggest that small fishing villages can impose a great impact on franciscana population, similar to the situation off the Argentine coast. On the coast of Paraná State, there are a few records of franciscana deaths in longlines (Zanellato, 1997), though this seems to be rare.

To summarize the information from fleet monitoring schemes, annual mortality of franciscana due to by-catch off the Brazilian coast ranges from 564 to 1,889 (Table 1). These results certainly represent an underestimation of the by-catch in Brazilian waters because many coastal fishing villages are either poorly or not surveyed at all. In addition, fishers in general tend to under-report by-catches. Therefore, increasing the monitoring effort of the gillnet fishery, including the small fishing camps, is urgently needed. Moreover, levels of franciscana mortality in longlining and trawling operations need to be investigated in order to obtain a more complete understanding of the threats fisheries pose to franciscana in Brazilian waters.

**General characteristics of the bycatch of franciscana dolphins:** The mortality of franciscana is incidental and there

is no indication of direct exploitation of the species. The dolphins are typically found dead in gillnets when fishers retrieve their catch. Even though there are a few records of dolphins released alive from nets (e.g. Crespo *et al.* 1994; Bertozzi and Zerbini, 2000), in general there is little opportunity for live release of the dolphins. This is likely due to the long time that gillnets remain in the water. Soak time ranges typically from 8 to 24 hours.

Fishers normally discard by-caught dolphins offshore, although in some regions captured animals may be consumed or used otherwise. Blubber has been used as shark bait in longline fisheries in a fishing village in southeastern Brazil (Atafona), although this fishery is currently uncommon in that area (Di Benedetto and Ramos, 2000). Along the Paraná coast, there are records of franciscana meat being used for human consumption (Zanellato, 1997). In southern Brazil, fishers sometimes use oil obtained from franciscana carcasses to waterproof boats. In addition, meat may be used to feed dogs and rarely for human consumption (Secchi *et al.*, 1997). Nevertheless, this is not a tradition in these communities and dolphins killed in gillnets are typically discarded at sea. In Uruguay, franciscana oil is recently being used commercially to treat horsehair (UNEP/CMS, 2000). In Argentine waters there is little utilisation of by-catch, although in a few areas (e.g. San Clement del Tuyú) sun dried and salted meat, locally known as "mushame", is consumed by Turkish, Jewish and Arabian members of the communities (Praderi *et al.*, 1989). In several coastal communities in the Buenos Aires Province there are also popular references to the use of franciscana oil in the early 20th century, chiefly for domestic medical treatments and improvement of horse saddle leather (R. Bastida, pers. commn).

Fishers do not consider franciscana as a competitor for fish resources. Although the carcasses of an entangled dolphin can cause damage to nets during hauling, these damages are typically small, especially when compared to those caused by southern sea lions (*Otaria flavescens*) (e.g. Corcuera *et al.*, 1994; Ott, 1998).

Most franciscanas are caught in gillnets in spring and summer in Uruguayan and Argentine waters and year around off Brazil (Table 1).

Although most of the captures involve one or two animals (e.g. Corcuera *et al.*, 1994; Ott, 1998; Rosas *et al.*, 2000a), up to nine dolphins were caught in a same net (2,000m long) off southern Brazil (Moreno *et al.*, 1997). Both males and females are vulnerable to fishing operations, although the sex ratio of incidentally caught animals varies between regions (e.g. 1.61 males/female [n=47] in Buenos Aires Province, Argentina; 1.1 males/female [n=107] in Rio Grande, Brazil) (Corcuera, 1994; Secchi *et al.*, 1997, respectively).

Similar to other small cetaceans, a large proportion of by-caught franciscanas are immature (e.g. Kasuya and Brownell, 1979; Crespo *et al.*, 1986; Perez-Macri and Crespo, 1989; Corcuera *et al.*, 1994; Ott *et al.*, 2000b; Ramos *et al.*, 2000). For example, in fishing communities of Argentina, Uruguay and Brazil, more than half of the caught specimens were less than 3 years old (Table 2). This bias towards higher catches of

**Table 2.** Age structure of franciscana dolphins incidentally caught in gillnet fisheries.

| Locality                 | Geographic Sector* | Period  | n   | Mode Age (% in brackets) | % of < 3 years | Maximum Age | Reference                     |
|--------------------------|--------------------|---------|-----|--------------------------|----------------|-------------|-------------------------------|
| Brazil (RJ)              | 3                  | 1989-98 | 91  | 2 (28.5)                 | 75.0           | 9           | Di Benedetto and Ramos, 2000  |
| Brazil (RS) <sup>a</sup> | 8-10               | 1976-80 | 97  | 1 (23.7)                 | 42.3           | 16          | Pinedo, 1994b                 |
| Brazil (RS) <sup>a</sup> | 8-10               | 1982-86 | 81  | 3 (16.0)                 | 37.0           | 13          | Pinedo, 1994b                 |
| Brazil (RS)              | 8-10               | 1992-97 | 147 | 1 (34.7)                 | 64.0           | 11          | Ott <i>et al.</i> , 2000b     |
| Uruguay <sup>b</sup>     | 11-12              | 1970-73 | 218 | 1 (46.8)                 | 73.9           | 16          | Kasuya and Brownell, 1979     |
| Uruguay                  | 11-12              | 1969-72 | 102 | 1 (29.4)                 | 52.0           | 21          | Pinedo, 1994b                 |
| Uruguay                  | 11-12              | 1973-75 | 108 | 1 (38.0)                 | 63.9           | 14          | Pinedo, 1994b                 |
| Uruguay                  | 11-12              | 1980-82 | 34  | 1 (55.9)                 | 70.6           | 19          | Pinedo, 1994b                 |
| Uruguay                  | 11-12              | 1980-81 | 114 | 1 (45.6)                 | 80.7           | 5           | Crespo <i>et al.</i> , 1986   |
| Argentina (BA)           | 13-14              | 1983-86 | 22  | 1 (36.4) -<br>3 (36.4)   | 50.0           | 4           | Perez-Macri and Crespo, 1989  |
| Argentina (BA)           | 14                 | 1988-90 | 42  | 0 (21.4) -<br>1 (21.4)   | 57.1           | 8           | Corcuera <i>et al.</i> , 1994 |

References: (a) sample from stranded animals; (b) sample bias toward adult females for reproductive studies.

\* Geographic Sectors are shown in the Final Report of the Fourth Workshop (in this volume); (n) sample size; (RJ) Rio de Janeiro; (RS) Rio Grande do Sul; (BA) Buenos Aires Province. Age estimated based on growth layer groups (modified from Ott *et al.*, 2000b).

juveniles compared to adult individuals could reflect either the age structure of local populations or different behaviour of young animals, making them more vulnerable to incidental catches. Since we have no information on local age structures and age-related behavioural differences, it is not possible to determine the reason for this age bias in incidental catches. Nevertheless, potential effects of these captures on future recruitment rates of the population are a cause for concern, especially considering the low reproductive potential and short life span of the franciscana (Secchi, 1999; Danilewicz *et al.*, 2000).

**Conservation measures:** Although gillnet fishing is recognized as the major threat to franciscana populations, few attempts have been made to reduce or eliminate the incidental capture of this species in gillnets. Until recently, only two management actions were proposed for some fishery communities: replacing gillnets with longlines (Corcuera *et al.*, 1994) and seasonal area closures in southern Brazil (Secchi, 1999). Even though these measures may be effective, both may reduce fishers' income and would be difficult to implement. Therefore, new approaches are urgently needed.

Bordino *et al.* (2000) carried out an experiment using acoustic pingers to reduce by-catches of franciscana off Cabo San Antonio, Argentina. Although the pingers reduced the by-catches, they also increased the rate of attacks of southern sea lions on fish caught in the nets. Therefore, acoustic devices seem unsuitable as a long-term management option in this region. However, further pinger studies should be carried out in other areas. New approaches to gillnet modifications to minimise franciscana mortality should be encouraged. Nevertheless, evaluation of potential solutions must consider possible effects on the wider marine ecosystem in which they are to be employed. In addition, impacts

on the social and cultural aspects of the local communities involved must also be taken into account.

### Recommendations

The rate of by-catch of franciscana across its distribution urgently requires management measures to prevent the collapse of local populations or stocks. These measures need to be based on reliable and up-to-date information. Therefore, we recommend (see also the recommendation of the workshop):

- To estimate by-catch as accurately as possible using direct monitoring by independent on-board observers, wherever it is practical;
- To estimate CPUE using standardised and complete description of fishing effort, including its seasonal variability and fishing characteristics (e.g. type of nets, fishing area, size and power of boats);
- To identify areas and/or season of highest by-catch; and
- To model the effects of fishing by-catch on the potential rate of population increase by varying fishing effort and population parameters.

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