# Wild Fisheries

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## Effectiveness of an industry Code of Practice in mitigating the operational interactions of the South Australian Sardine Fishery with the short-beaked common dolphin (*Delphinus delphis*)

T.M. Ward, A. Ivey, D.J. Hamer and P. Burch

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SARDI Aquatic Sciences
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**Report to PIRSA Fisheries and Aquaculture**

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## ACKNOWLEDGEMENTS

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## EXECUTIVE SUMMARY


1. This is the fifth report by SARDI Aquatic Science to PIRSA Fisheries and Aquaculture on the operational interactions of the South Australian Sardine Fishery (SASF) with the common dolphin *Delphinus delphis*. The report presents observer and logbook data collected over the period November 2004 to 30 June 2011.
2. In 2010-11, observers monitored 91 of the 1010 net-sets in the SASF (9.0% coverage). Observers reported that a total of 39 common dolphins were encircled (42.9 per 100 net-sets) in 11 encirclement events and that two dolphins died (2.2 per 100 net-sets) in two mortality events.
3. Logbook data for the entire SASF during 2010-11 (1010 net-sets) recorded 126 dolphin encirclements over 40 events and seven mortalities occurred in seven mortality events.
4. The rate of encirclement and mortality recorded in logbooks when an observer was not present were 9.5 and 0.5 dolphins per 100 net-sets respectively. The rates of encirclement and mortality recorded by observers were 4.5 and 4.4 times higher, respectively, than those recorded in logbooks when an observer was not on board.
5. Extrapolation from observer rates suggest that 433 encirclements and 22 mortalities occurred across the fishery in 2010-11, whereas only 126 encirclements and seven mortalities were recorded logbooks.
6. Rates of encirclement and mortality remain substantially lower than prior to the introduction of the code of practice (CoP).

## 1.0 INTRODUCTION

Oceans cover approximately 70% of the Earth's surface and marine capture fisheries are an important source of protein for humans (FAO 2008). The additional land clearing required to replace fish protein with terrestrial livestock production would have significant negative impacts on global biodiversity and greenhouse gas production. It is essential that wild living resources harvested from the oceans are available to sustain the world's future human population. The challenge for the fishing industry, resource managers, fisheries scientists and conservationists is to ensure that the world's marine fisheries are managed sustainably (Worm et al. 2006, 2009).

For the last two decades, it has been widely recognised that fisheries must be ecologically sustainable, which means that not only must the target stock be maintained at productive levels but that negative impacts on other components of the ecosystem must also be minimised (e.g. Garcia 1997, 2000). Mitigating the operational interactions of fisheries with Threatened, Endangered and Protected Species (TEPS) is an important element of the ecosystem-based approach to fisheries management. In many countries, including the USA and Australia, the need for fisheries to assess and mitigate interactions with TEPS is prescribed in Federal and State fisheries and conservation legislation.

Purse-seining is used to target schooling pelagic fishes that support some of the world's largest fisheries, including those for tunas (e.g. *Thunnus* spp), sardine (*Sardinops sagax*) and anchovy (*Engraulis* spp.). Like several other fishing methods (Alverson et al 1994), purse-seining has been shown to have operational interactions with marine mammals, especially dolphins (Delphinidae) and porpoises (Phocoenidae). The best known example of this interaction is in the tuna fishery in the eastern tropical Pacific in which several hundred thousand spotted (*Stenella attenuata*), spinner (*S. longirostris*) and common (*Delphinus* spp.) dolphins were killed each year until gear modifications and changes to fishing practices were implemented and succeeded in reducing mortality rates by more than 95% (Francis and Orbach, 1992; Joseph, 1995; Wade, 1995; Gosliner, 1999; Archer et al. 2001, 2004).

A study by Hamer et al. (2008) documented the successful mitigation of the operational interactions of the South Australian Sardine Fishery (SASF) with the short-beaked common dolphin (*Delphinus delphis*) following the implementation of a

TEPS Code of Practice (CoP) and the establishment, in 2005, of a TEPS Working Group involving licence holders, skippers, fisheries managers and scientists. The rates of encirclement and mortality calculated from observer data in 2005-06 were reduced by 87% (down from 178 to 22 dolphins per hundred net-sets) and 97% (down from 39 to one dolphin per hundred net-sets), respectively, compared to rates calculated in 2004-05, before the introduction of the CoP. It was estimated that eight mortalities occurred across the entire fleet during the seven-month study period after the CoP was introduced, whereas approximately 377 dolphins were estimated to have died during the initial seven-month observer program in 2004-05. The reduction in interaction rates was attributed to avoidance methods used to prevent encirclement and release procedures used to reduce the mortality rates of encircled dolphins. Discrepancies between encirclement and mortality rates calculated from observers and logbook data were reduced to less than factors of two (down from factors of 27 and 54, respectively). Hamer et al. (2009a) emphasized the important role that establishing and maintaining an effective working relationship between industry and scientists had played in achieving this important conservation outcome.
A study published shortly after Hamer et al. (2008) suggested that the existence of a high level of genetic differentiation between populations of short-beaked common dolphin in South Australia and south-eastern Tasmania and emphasized the need for effective mitigation of the operational interactions of the SASF with this species (Bilgmann et al. 2008). Although Hamer et al. (2008) demonstrated that the CoP was effective in mitigating the operational interactions of the SASF with the short-beaked common dolphin, the performance of the CoP was only assessed over the relatively short period of seven months (Hamer et al. 2008; Bilgman et al. 2009). Successful bycatch mitigation programs typically involve longer ongoing observer coverage, expert review and continuous improvement of mitigation practices (Waugh et al. 2008; Wiley et al. 2008). Bilgman et al. (2009) identified the need for continued independent monitoring of the SASF to estimate the magnitude of ongoing interactions and assess the long-term efficacy of the CoP.

In the period since the study by Hamer et al. (2008), the level of observer coverage in the SASF increased to >20% between 2007-08 and 2009-10, the CoP has been refined and additional measures have been taken to address interactions with the short-beaked common dolphin. The refined CoP for the SASF explicitly aims for world's best practice and a process for continuous improvement in mitigating interactions with TEPS. Each crew is re-inducted to the CoP prior to the start of each fishing season. Flowcharts documenting the role of each crew member in mitigating

interactions with TEPS have been developed and placed in the wheelhouse of each vessel. Before beginning work, every new crew member is formally inducted to the CoP and advised of their specific roles and responsibilities in mitigating interactions with TEPS. Skippers meetings are held every two months to discuss the effectiveness of avoidance and release procedures and identify options for improvement of the CoP. The TEPS Working Group, which has been expanded to include a representative of the Department of Environment and Natural Resources, meets quarterly to consider data summaries for the preceding three months and, if warranted, identify refinements to the CoP or other aspects of the mitigation process. Formal reports on the interaction rates of the SASF with the short-beaked common dolphin are published annually (e.g. Hamer et al. 2007, Hamer and Ward 2007, Hamer et al. 2009b).

This study reports on the interactions of the SASF with the short-beaked common dolphin (*Delphinus delphis*) during the period from 2004-05 to 2010-11. Data for 2004-05 and 2005-06, which were also presented in Hamer et al. (2008), are included here to provide a context for results from the more recent years. The objectives of the study are to: i) describe and compare patterns of dolphin encirclement and mortality recorded in fishery logbooks and by observers; (ii) estimate the number of dolphin encirclements and mortalities that occur in the SASF each financial year; and (iii) assess the efficacy of the refined CoP in mitigating the interactions of the SASF with the short-beaked common dolphin.

## 2.0 METHODS

### 2.1 South Australian Sardine Fishery

The South Australian Sardine Fishery (SASF) is Australia's largest single-species fishery (by weight) with total annual catches over the last five years of ~ 30,000 tonnes. An additional 4,000 tonnes has been permitted to be caught outside of traditional fishing areas since the 2010 season. The SASF operates primarily in southern Spencer Gulf (Figure 1) and was established in 1991 to provide fodder for the grow-out of wild-caught southern bluefin tuna (*Thunnus maccoyi*). However, an increasing proportion of the catch is now taken for human consumption and recreational fishing bait.

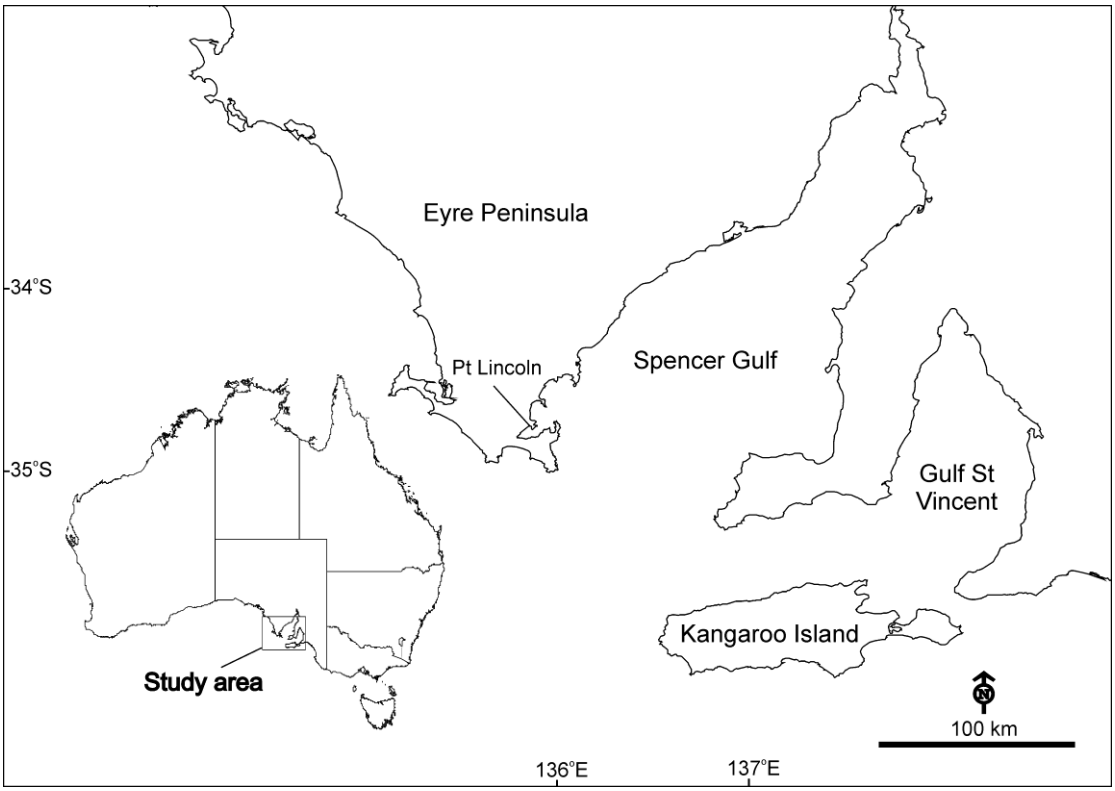


**Figure 1.** Location of the study, fishing areas and sites mentioned in the text.

The SASF is a limited-entry fishery with 14 licence holders. It is managed using a Total Allowable Commercial Catch (TACC) and Individual Transferable Quotas (ITQs), but there are also restrictions on the length and depth of the purse-seine net (1,000 and 200 m, respectively) and mesh size (14 to 22 mm). The full costs of the policy, research and compliance programs used to manage the fishery are recovered from fishers through license fees.

Licence-holders are actively involved in management of the SASF and conduct frequent meetings with PIRSA Fisheries and Aquaculture and SARDI Aquatic Sciences. There is a formal Management Plan and defined Harvest Strategy (Shanks 2005). The revised Harvest Strategy for the SASF indicates that the baseline TAC (30,000 tonnes) will be maintained while the latest estimate of spawning biomass remains between the limit reference points of 150,000 and 300,000 t and there is no other evidence of serious stock decline.

Fishery-independent stock assessments using the Daily Egg Production Method were done annually from 1995 to 2007 and now biennially (e.g. Ward et al. 2009). Fishery Assessment Reports that integrate fishery-independent and dependent data using an age structured model and that review fisheries management arrangements are completed biennially (in alternate years to the Spawning Biomass Reports). Catch and Disposal Records are monitored and there is an extensive compliance program to ensure catches do not exceed the TACC. A TEPS-specific compliance program was introduced in 2010/11. The program involved overt and covert at-sea monitoring by the fisheries patrol vessel and raising awareness of TEPS interaction reporting responsibilities directly with skippers during port meetings, at the wharf and during boarding at sea. A total of 15.5 days were completed by PIRSA Fisheries and Aquaculture; no TEPS interactions were observed.

## 2.2. Logbook program

Fishers are required to complete Monthly Logbooks that document the date, location and timing of each net-set, the weight of each catch and the details of interactions with TEPS (e.g. number of encirclements, number of mortalities). The Monthly Logbook for each vessel must be submitted to SARDI Aquatic Sciences before the fifteenth day of the following month. Since 2007, fishers have also been required to complete Wildlife Interaction Forms when interactions with TEPS occur, these data are validated, stored and collated by SARDI Aquatic Sciences.

## 2.3 Observer program

An Observer Program was conducted by SARDI Aquatic Sciences from November 2004 to January 2006 and by Protec Marine Pty. Ltd. from February 2006 to June 2011. Each observer monitored fishing activities from a high, unobstructed vantage point such as the wheelhouse, wheelhouse-roof or bow, depending on the vessel and prevailing weather conditions. The observer searched for dolphins in the illuminated

area surrounding the vessel immediately prior to setting the net and within the circumference of the net during the fishing operation. Observer effort was spread across the fleet and throughout the year.

Data recorded on Observer Datasheets included the vessel name, meteorological conditions, date, location and timing of each net-set, details regarding the interactions with TEPS (e.g. number of encirclements, number of mortalities), the nature and success of avoidance and release procedures used and the timing of implementation. The avoidance procedures used were 1) searching for dolphins prior to setting the net (deemed successful if no dolphins were detected and no encirclement occurred) and 2) delaying the setting of the net (deemed successful if setting was delayed due to the presence of dolphins and no dolphins were encircled when the net was set). The release methods considered in the report are: no action (where no effort was made to release encircled dolphins); corkline weights (where weights were used to sink the corkline to provide an opening for dolphin egress); TEPS gate (panel of net was unclipped from corkline to provide an opening for dolphin egress); physical removal (where dolphins were removed from the net by crew members in a skiff); and opening the front of net. Data recorded on Observer Datasheets were validated, stored and collated by SARDI Aquatic Sciences.

## 2.4 Data analysis

Total encirclements and mortalities for each financial year were estimated from the rate per net-set where observers were present, multiplied by the total number of net sets in the season (confidence intervals around the mean rate of encirclements and mortalities were calculated using a Normal approximation to the Poisson distribution (Seber 1982)). Uncertainties around all estimates are presented as 95% CIs.

## 3.0 RESULTS

### 3.1 Fishing patterns

Data from Fishery Logbooks show that the level of fishing effort within a financial year ranged from 884 net-sets in 2007-08 to 1069 net-sets in 2009-10 (Table 1). In most years, most fishing effort was recorded between January and June (Figure 2; 3). In some fishing seasons, significant effort occurred in December (e.g. 2005-06) and July (2009-10). Most fishing was conducted in lower Spencer Gulf (Figure 5; 6). Recent changes in spatial management of the SASF have directed some effort outside of traditional fishing areas, most of this is being conducted in St Vincent Gulf and western Eyre Peninsula.

Direct comparisons of Observer Datasheets and Fishery Logbooks suggested that some fishers did not always record data for each net-set separately (i.e. catches from several net sets were sometimes recorded as coming from a single set). For this reason, it is likely that the number of net sets made annually in the SASF is higher than indicated in Table 1.

### 3.2 Patterns of dolphin encirclement and mortality

*Logbook program*

The number of dolphin encirclements recorded in Fishery Logbooks increased from 63 (in 28 separate encirclement events) in 2004-05 to 179 (60 events) in 2009-10 (Table 1). In 2010-11 126 encirclements (in 40 separate events) were recorded in logbooks. In contrast, the number of mortalities recorded in Fishery Logbooks was relatively stable, with seven (six events) recorded over a seven month period in 2004-05 and seven (seven events) recorded in 2010-11.

*Observer program*

During 2004-05 and 2005-06, the Observer Program was conducted between November and June only (Figure 2), after which observations were made over the entire financial year (with the exception of October-December 2009 and October-November 2010). The number and percentage of net-sets observed each year increased from 49 (5.0%) in 2004-05 to 233 (26.2%) in 2008-09, with the largest increase occurring between 2006-07 and 2007-08 (Table 1). In 2010-11 observed net-sets decreased to 91 (9.0%). The highest levels of fishing and observer effort occurred consistently during the second half of the financial year (Figure 2; 3).

The number of dolphins encircled while an observer was onboard fell from 87 (18 events) in 2004-05 to 20 (nine events) in 2005-06, even though 89 net-sets were monitored compared to 49 net-sets the previous year (Table 1). In 2006-07, 60 dolphins were encircled (14 events) during the 82 net-sets monitored by observers. In the three years from 2007-08 to 2009-10, the number of dolphins encircled remained relatively stable (i.e. 53-89 dolphins in 21-28 events), despite the increase in the number of net-sets observed (189 net-sets in 2007-08 to 266 net-sets in 2009-10). In 2010-11 the number of encircled dolphins fell to 39 (11 events) although only 91 net-sets were observed (Table 1; Figure 4)

The number of observed dolphin mortalities fell from 19 (11 events) in 2004-05 to one in 2005-06, but increased to seven (four events) in 2006-07 (Table 1). In 2007-08, 11 mortalities (eight events) were recorded by observers and that number fell to five (three events) and two (two events) in 2008-09 and 2009-10, respectively. In 2010-11 two mortalities (two events) were observed.

The number of encirclements observed remained relatively stable and the decline in the number of mortalities observed mainly reflected the increase in the percentage of encircled dolphins that survived, which rose from 78% in 2004-05 to 95% in 2005-06 (Figure 7). Although there was a decrease in post encirclement survival to 88% in 2006-07, it increased to reach 98% in 2009-10. In 2010-11 95% of encircled dolphins were successfully released when an observer was present.

### 3.3 Rates of dolphin encirclement and mortality

*Observed rates*

The rates of dolphin encirclement recorded by observers fell from 178 (95% CI = 140-215) per hundred net-sets in 2004-05 to 22 (12-34) per hundred net-sets in 2005-06, but increased to 73 (55-92) per hundred net-sets in 2006-07 (Figure 8). The observed rates of encirclement in 2007-08, 2008-09, 2009-10 and 2010-11 were 47 (37-57), 23 (17-29), 33 (25-41) and 43 (29-56) dolphins per hundred net-sets, respectively (Figure 8).

The observed dolphin mortality rates fell from 39 (95% CI = 21-56) per hundred net-sets in 2004-05 to one (0-3) per hundred net-sets in 2005-06 (Figure 8), but increased to nine (2-15) per hundred net-sets in 2006-07, before declining to six (2-9), two (0-4), one (0-2) and two (0-5) per hundred net-sets in 2007-08, 2008-09, 2009-10 and 2010-11, respectively.

*Logbook rates excluding observed events*

The rate of encirclement and mortality recorded in logbooks (excluding observed interactions) was unable to be calculated in 2004-05 as more interactions were observed than were recorded in logbooks (Figure 8). In 2005-06 the rate of encirclement reported in Logbooks when an observer was not onboard was 12 dolphins per 100 net-sets (95% CI = 9-14) then fell to 5 (3-6) in 2006-7. A rise to 16 (13-19) in 2008-09, saw this rate approach the rate when an observer was present (23(17-29); Figure 8). The rate of encirclement in the absence of an observer fell to 10 (7-11) in 2010-11, lower than the rate recorded by observers over the same period (43 (29-56); Figure 8).

The rate of mortality calculated from logbook records excluding observed events was consistently lower than the rate calculated from observed events (Figure 8).

## 3.4 Estimates of dolphin encirclement and mortality

Extrapolation from observer data collected during the seven month study period in 2004-05 suggest that a total of 1728 (95% CI = 1365-2091) and 377 (208-547) dolphins were encircled and died, respectively (Figure 9), whereas logbook data indicated that only 63 dolphins were encircled and seven died (some encirclements and mortalities recorded by observers were not recorded in logbooks). Estimates of total dolphin encirclements and mortalities calculated from observer data for the corresponding seven month sampling period in 2005-06, i.e. 169 (95-243) and eight (0-25), respectively, were lower and more similar to the numbers recorded in logbooks (98 and five, respectively).

In 2006-07, extrapolations from observer data suggested that 681 (95% CI = 509-854) dolphins were encircled and 79 (95% CI = 21-138) dolphins died, whereas only 101 encirclements and 10 mortalities were recorded in logbooks. The rates of encirclement and mortality calculated from observer data were 15 and 24 times higher, respectively, than rates calculated from logbook data when observers were not present.

Extrapolations from observer data for 2007-08 suggested that 416 (95% CI = 330–503) dolphins were encircled and 51 (95% CI = 21–82) died whereas logbook data indicated that 158 encirclements and 14 mortalities occurred. Rates of encirclement

and mortality calculated from observer data were five and 13 times, respectively, the rates calculated from logbook data when observers were not present.

In 2008-09, the observer-based estimate and logbook-count of encirclement, i.e. 202 (95% CI = 148-257) and 159 dolphins, respectively, were more similar than the estimate and count of mortality, i.e. 19 (2-36) and five dolphins, respectively. The encirclement rate calculated from observer data was 1.4 times the rate calculated from logbook data when no observer was present. No mortalities were recorded in logbooks when an observer was not present.

The estimates of encirclement and mortality extrapolated from observer data for 2009-10, i.e. 350 (95% CI = 276-423) and 8 (0-19) dolphins, respectively, were almost twice that recorded in logbooks (179 encirclements and five mortalities). The encirclement and mortality rates calculated from observer data were 2.9 and 2.0 times, respectively, the rates calculated from logbook data when no observer was present.

Extrapolations from observer data for 2010-11 suggested that 433 (95% CI = 297–569) dolphins were encircled and 22 (95% CI = 0–53) died whereas logbook data indicated that 126 encirclements and 7 mortalities occurred. Encirclement and mortality rates calculated from observer data were 4.5 and 4.4 times, respectively, the rates calculated from logbook data when observers were not present.

### 3.5 Code of Practice assessment

In 2004-05, before the introduction of the CoP, fishers did not actively search for dolphins prior to fishing or delay setting the net when dolphins were present (Table 2). However, after the introduction of the CoP, fishers consistently searched for dolphins before setting the net and consistently delayed setting when dolphins were observed near the vessel. The success of these avoidance procedures is reflected in the reductions in dolphin encirclement rates in recent years (Table 2, Figure 7).

In 2004-05, before the introduction of the CoP, a wide range of procedures were used to release dolphins. For example, specifically-designed weights were used to submerge the corkline and allow dolphins to swim out of the net. Similarly, purpose-built panels of net (TEPS gates) were sometimes opened to allow dolphins to escape. On other occasions, crew members (and at times observers) in small

vessels physically removed dolphins from the net. At other times, the front of the net was opened to allow dolphins to swim away.

Currently corkline weights and the TEPS Gate are no longer used because they are difficult to deploy and dolphins do not always exit through the relatively small openings provided by these methods. Physical removal is also avoided, in part because of potential risks to crew safety. The release procedure now recommended in the CoP, (opening the front of the net) appears to be successful in allowing dolphins to escape (Table 2).

**Table 1.** Number of net-sets, % observer coverage, dolphin encirclements and mortalities (numbers and events) recorded in Fishery Logbooks and Observer Datasheets in 2004-05, before the introduction of the industry Code of Practice, and 2005-06 to 2010-11, after its introduction. Note that for 2004-05 and 2005-06 data are only included for the seven month period of the observer program in those years (November–June).

| Year | Total Net-sets (Logbooks) | Observed Net-sets (Datasheets) | % Observer Coverage | Encirclements No. (events) | | Mortalities No. (events) | |
|---|---|---|---|---|---|---|---|
| | | | | Logbook | Observer | Logbook | Observer |
| 2004-05 | 973 | 49 | 5.0 | 63 (28) | 87 (18) | 7 (6) | 19 (11) |
| 2005-06 | 753 | 89 | 11.8 | 98 (47) | 20 (9) | 5 (5) | 1 (1) |
| 2006-07 | 931 | 82 | 8.8 | 101 (43) | 60 (14) | 10 (5) | 7 (4) |
| 2007-08 | 884 | 189 | 21.4 | 158 (59) | 89 (28) | 14 (10) | 11 (8) |
| 2008-09 | 890 | 233 | 26.2 | 159 (61) | 53 (21) | 5 (3) | 5 (3) |
| 2009-10 | 1069 | 266 | 24.9 | 179 (60) | 87 (26) | 5 (5) | 2 (2) |
| 2010-11 | 1010 | 91 | 9.0 | 126 (40) | 39 (11) | 7 (7) | 2 (2) |

**Table 2.** Number of applications and percentage success of the avoidance and release procedures identified the industry Code of Practice in preventing encirclement and mortality of dolphins in the SASF during 2004-05 to 2010-11. The Code of Practice was introduced in 2005-06.

| Year | Avoidance Procedures No. (% success) | | Release Procedures No. (% success) | | | | |
|---|---|---|---|---|---|---|---|
| | Search | Delay | No action | Corkline Weights | TEPS Gate | Physical removal | Open front of net |
| 2004-05 | 0 | 0 | 32 (15.6) | 8 (53.3) | 2 (50.0) | 18 (88.9) | 20 (80.0) |
| 2005-06 | 6 (100.0) | 15 (100.0) | 0 | 4 (50.0) | 7 (42.9) | 3 (100.0) | 13 (92.3) |
| 2006-07 | 96 (85.4) | 19 (89.5) | 0 | 0 | 4 (100.0) | 2 (100.0) | 6 (83.3) |
| 2007-08 | 216 (87.0) | 50 (78.0) | 0 | 0 | 2 (100.0) | 6 (66.7) | 11 (72.7) |
| 2008-09 | 243 (91.4) | 24 (95.8) | 0 | 0 | 1 (0.0) | 5 (80.0) | 2 (100.0) |
| 2009-10 | 280 (90.7) | 101 (93.1) | 0 | 0 | 0 | 0 | 10 (90.0) |
| 2010-11 | 95 (88.4) | 17 (94.1) | 1 (100.0) | 0 | | 4 (50.0) | 7 (100.0) |

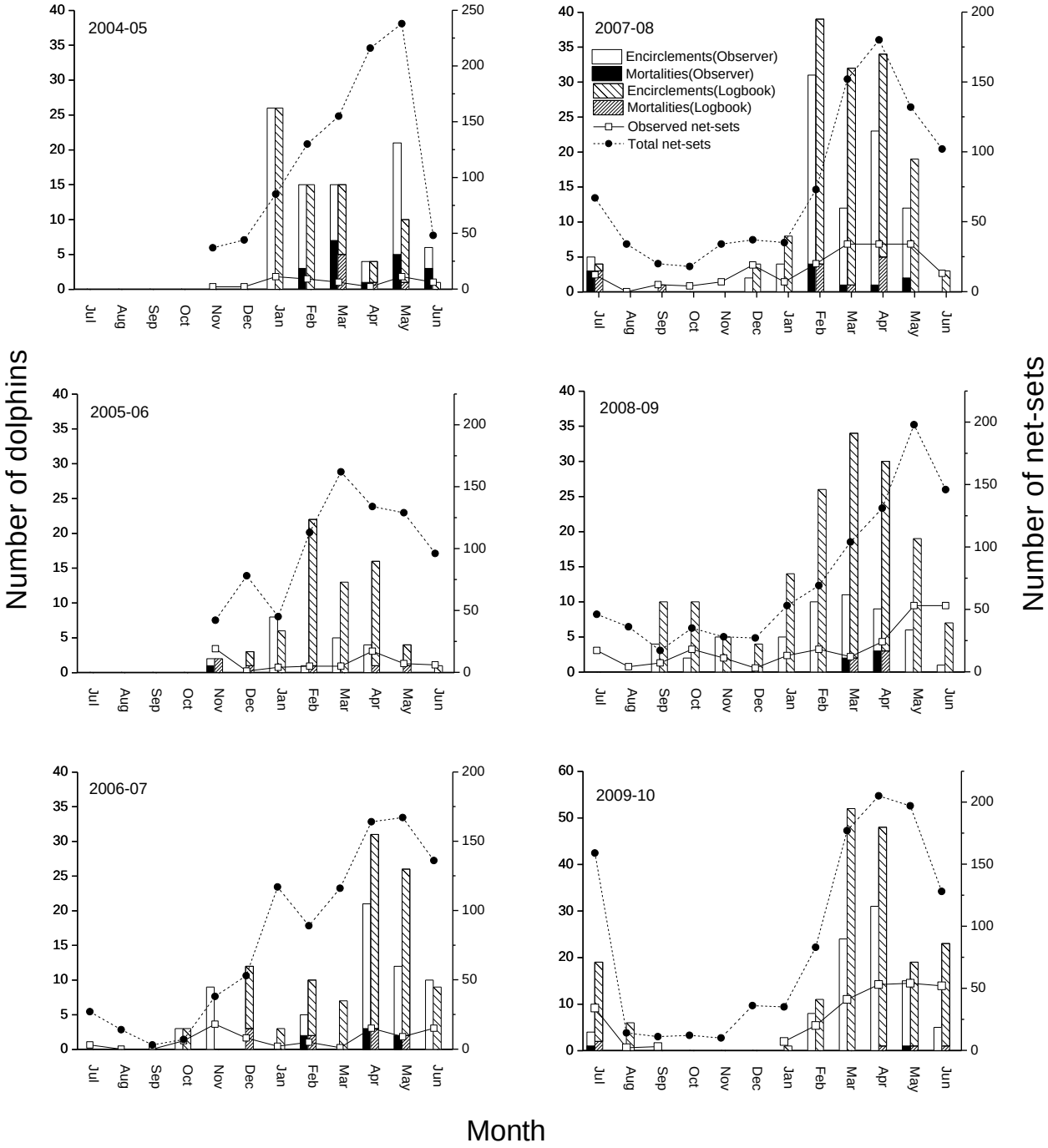


**Figure 2.** Monthly fishing effort (logbook net-sets), observer effort (observed net-sets), and number of dolphin encirclements and mortalities before (2004-05) and after (2005-06 to 2009-10) the introduction of the industry Code of Practice in the South Australian Sardine Fishery. Note change of scale for 2009-10.

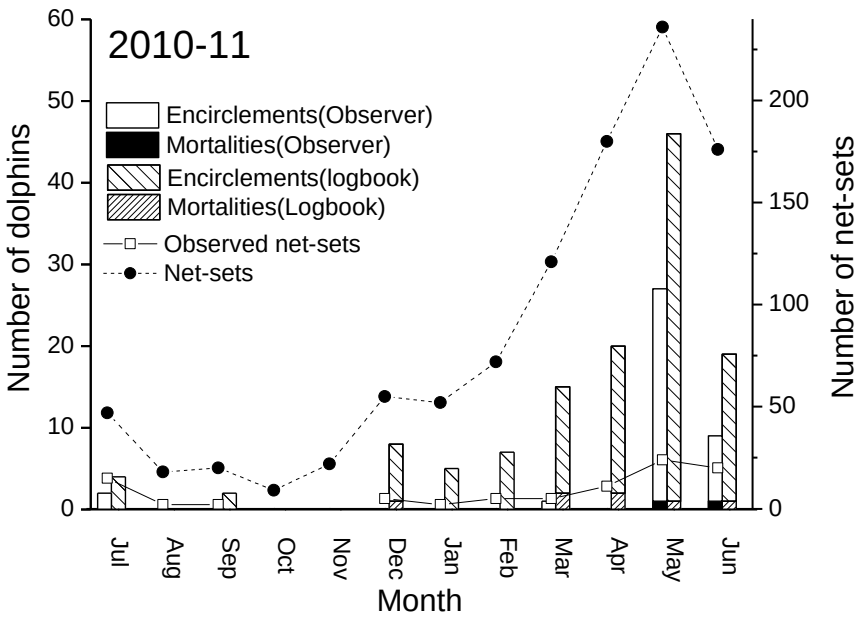


**Figure 3.** Monthly fishing effort (logbook net-sets), observer effort (observed net-sets), and number of dolphin encirclements and mortalities for the 2010-11 fishing season

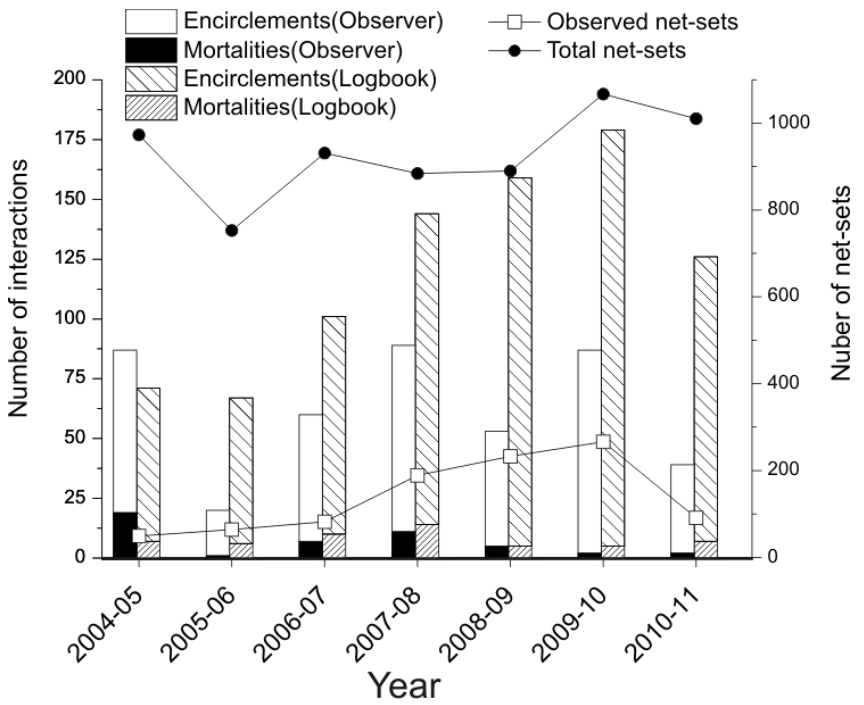


**Figure 4.** Fishing effort (logbook net-sets), observer effort (observed net-sets), and number of dolphin encirclements and mortalities for financial years from before (2004-05) and after (2005-06 to 2010-11) the introduction of the industry Code of Practice in the South Australian Sardine Fishery.

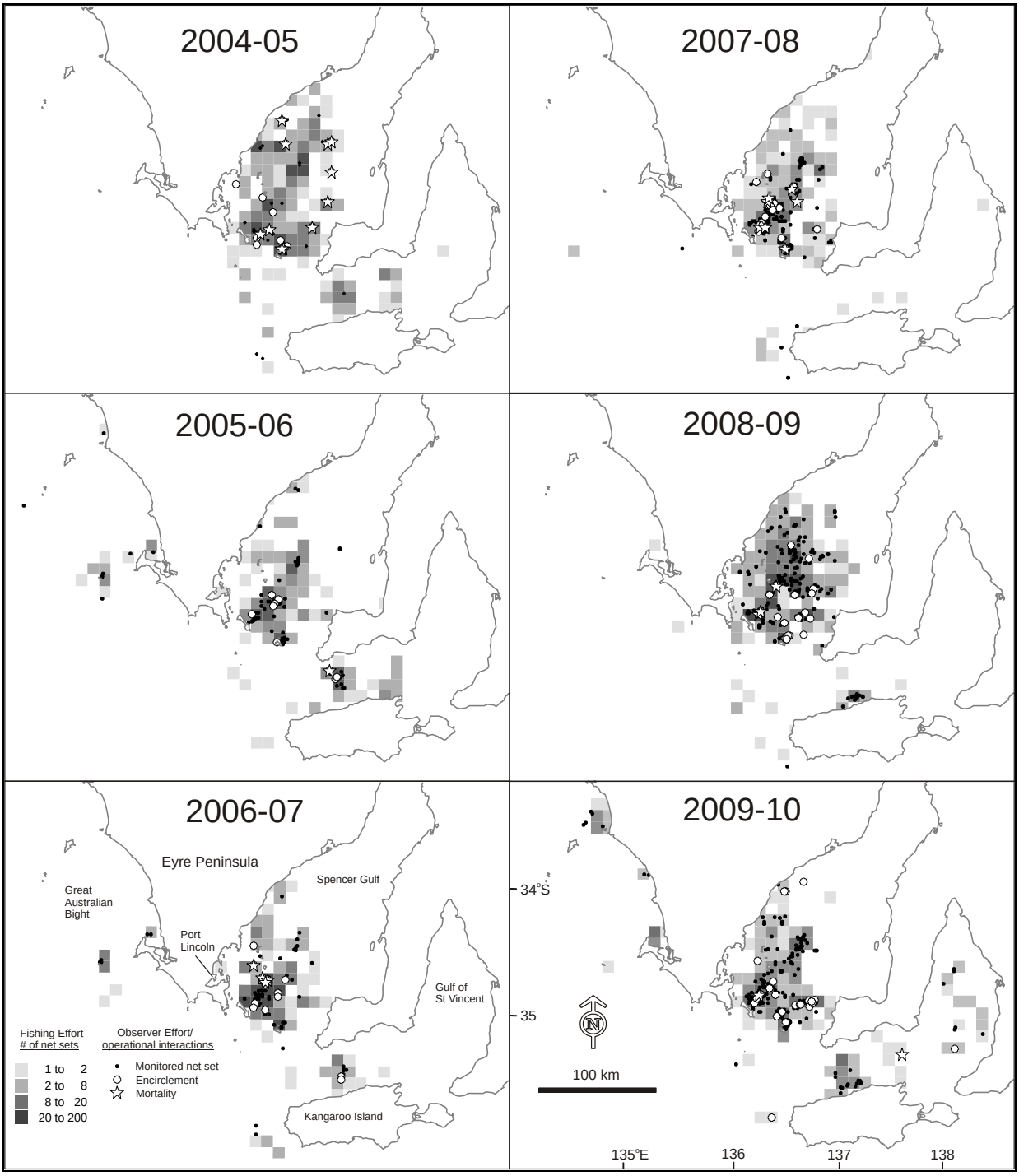


**Figure 5.** Spatial distribution of fishing effort, location of observed net sets, encirclement and mortality events in the SASF during 2004-05 to 2009-10.

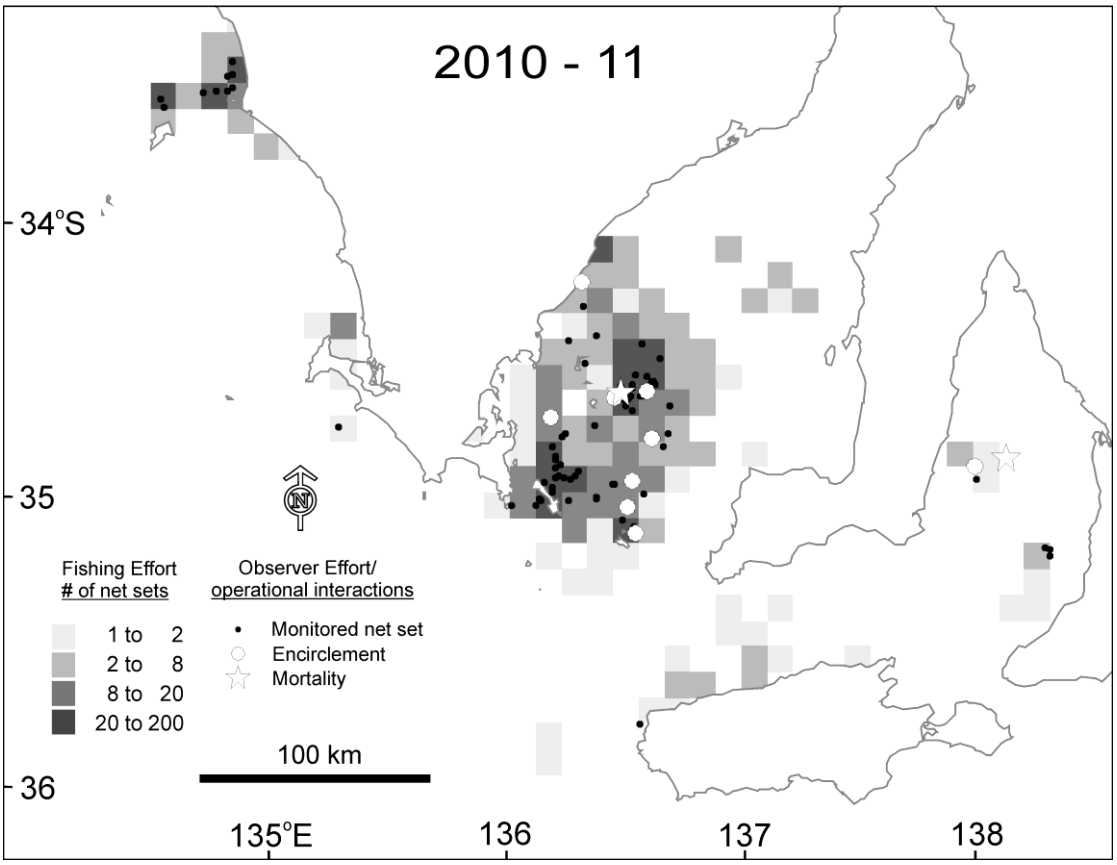


**Figure 6.** Spatial distribution of fishing effort, location of observed net sets, encirclement and mortality events in SASF during 2010-11.

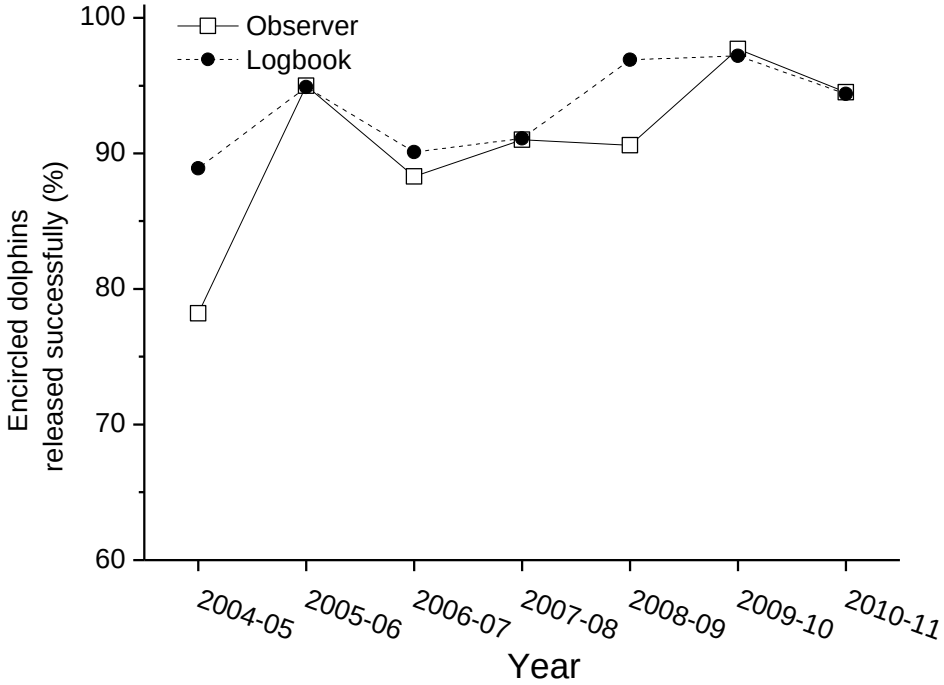


**Figure 7.** Percentage of encircled dolphins that were successfully released in the South Australian Sardine Fishery from 2004-05 to 2010-11 based on data from Observer Datasheets and Fishery Logbooks.

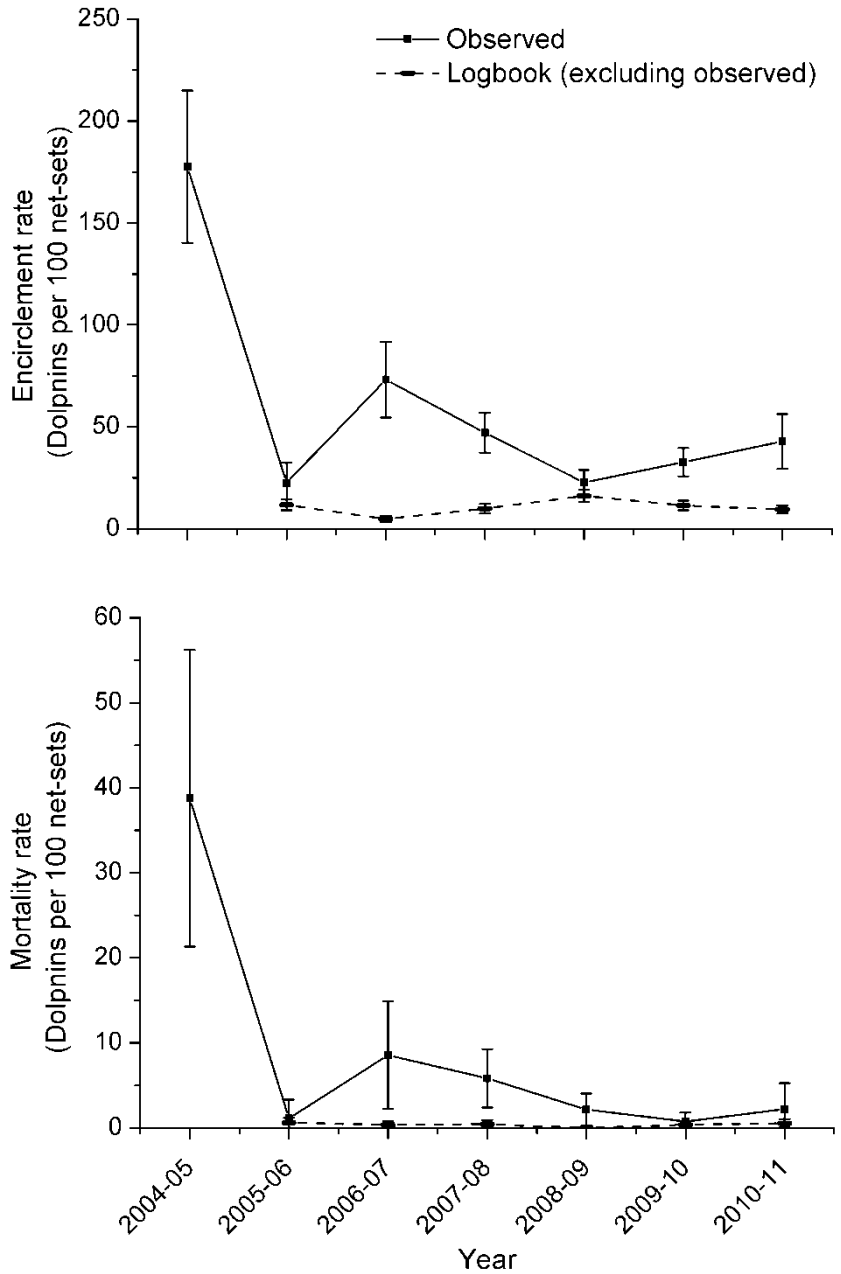


**Figure 8.** Rates of encirclement and mortality of short-beaked common dolphins in the South Australian Sardine Fishery between 2004-05 and 2010-11 calculated from observer and logbook data. Error bars are 95% confidence intervals. Note logbook data is calculated excluding observed interactions, in 2004-05 observed interactions exceeded logbook interactions.

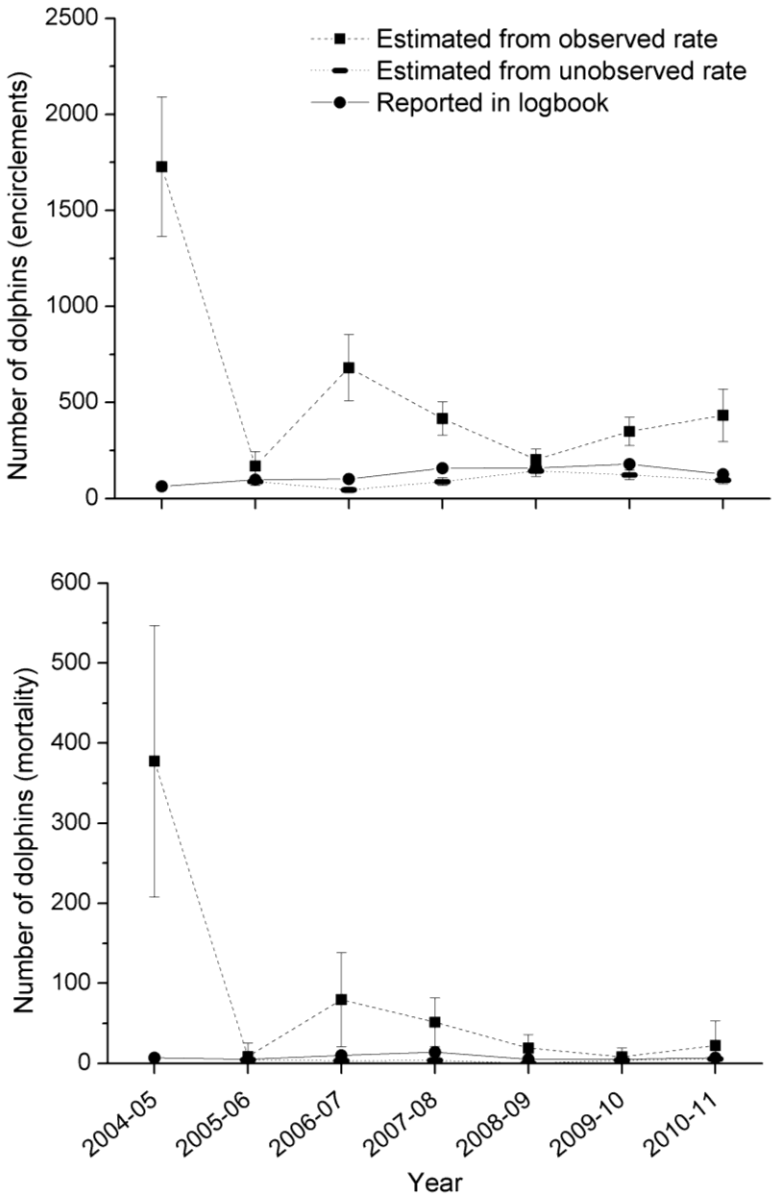


**Figure 9.** Numbers of dolphin encirclements and mortalities in the South Australian Sardine Fishery each financial year based on numbers recorded in fishery logbooks and extrapolation from rates calculated from observer and logbook (without observers) data. Error bars are 95% confidence intervals.

## 4.0 DISCUSSION

The industry Code of Practice continues to be effective in reducing the interaction rates of the SASF with the common dolphin. In 2004-05, before introduction of the CoP, the observed rate of encirclement in the SASF was 178 (95% CI = 140-215) dolphins per hundred net-sets but after the CoP was introduced this rate did not exceed 73 dolphins per hundred net sets in any year. More importantly, the observed mortality rate in 2004-05 was 39 (21-56) dolphins per hundred net sets but did not exceed nine dolphins per hundred net sets after the CoP was introduced.

The reduction in the encirclement rate reflects the success of the avoidance and release procedures specified in the CoP in preventing interactions from occurring. In 2004-05, before the code was introduced, fishers seldom searched for dolphins prior to setting the net or delayed setting the net when dolphins were observed near the vessel. However, over the last five years these practices have been increasingly adopted in the fishery and are now standard operating procedures, being documented in the vessel-specific flowcharts that outline the role of each crew member in mitigating interactions with TEPS and which are located in the wheelhouse of each vessel.

The large reduction in the mortality rates since the introduction of the CoP reflects the co-occurrence of several changes in fisher behaviour. Most importantly, the reduction in encirclement rates has reduced the potential for mortality events to occur. However, the increase in the survival rate of encircled dolphins has also played an important role and is the result of both reductions in the time taken to respond to encirclements (thus reducing stress) and improvements in the procedures used to release dolphins. The reduction in response time since 2004-05 reflects: i) the requirement for all crew members to scan the area inside the net to determine if dolphins are present as soon as the net is set (pursed); ii) the obligation to immediately report observed encirclements to the skipper; and iii) the skipper's responsibility to enact release procedures as soon as practical and make releasing the dolphin(s) the priority for the fishing operation.

The success of the CoP is best shown in the large reductions in the estimates of total encirclements and mortalities in the SASF since the code was introduced. Extrapolation from observer data suggests that in the seven month study period before the introduction of the CoP in 2004-05, 1728 (1365-2091) and 377 (208-547)

dolphins were encircled and died, respectively, whereas it was estimated that 169 (95-243) dolphins were encircled and eight (0-25) died in the corresponding period after its introduction. Total observer data over the last four years (2007-2011) suggest that fewer animals have been encircled (1401) and died (100) than during the initial seven month study period. In 2010-11, an estimated 433 (297-569) dolphins were encircled and 22 (0-53) died. The rate of mortality recorded by observers in 2010-11 was approximately one twentieth of rate recorded in 2004-05.

The remaining issue of concern regarding the interaction of the SASF with the short-beaked common dolphin is the discrepancy between the rates of interactions reported by observers and recorded in logbooks. In 2010-11, the estimates of encirclement and mortality extrapolated from observer data were higher than the numbers recorded in logbooks. The reason for this difference is that the encirclement and mortality rates calculated from observer data were 4.5 and 4.4 times, respectively, the rates calculated from logbook data when no observer was present. These findings imply that the interaction rates of the SASF with the short-beaked common dolphin continue to be under-reported in Fishery Logbooks.

The low rates of encirclement and mortality of the short-beaked common dolphin recorded by observers provides evidence of the efficacy of the industry CoP established by the SASF (Bilgman et al. 2008, 2009; Hamer et al. 2008, 2009a). Ironically, these low interaction rates will also make it difficult to measure future changes in the performance of the CoP with statistical precision and to formally compare observed and reported mortality rates. Nevertheless, accurate reporting of operational interactions with TEPS is a requirement of the CoP. The TEPS Working Group has identified that reducing the discrepancy between the interaction rates reported by observers and recorded in logbooks is a high priority for the fishery. A strategy to explicitly address this issue needs to be developed.

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