Marine Ecosystems

Assessment of dolphin interactions, effectiveness of Code of Practice and fishing behaviour in the South Australian Sardine Fishery in 2025

Roger Kirkwood and Simon Goldsworthy

SARDI Publication No. F2010/000726-17
SARDI Research Report Series No. 1295

SARDI Aquatic and Livestock Sciences
PO Box 120 Henley Beach SA 5022

July 2026

Report to PIRSA Fisheries and Aquaculture

Government of South Australia
Department of Primary Industries and Regions

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Assessment of dolphin interactions, effectiveness of Code of Practice and fishing behaviour in the South Australian Sardine Fishery in 2025

Report to PIRSA Fisheries and Aquaculture

Roger Kirkwood and Simon Goldsworthy

SARDI Publication No. F2010/000726-17
SARDI Research Report Series No. 1295

July 2026

The Department of Primary Industries and Regions cares for the Country and communities of South Australia.

We ensure the land, sea, water and sky are healthy for future generations and strive to better understand their spiritual and cultural significance for Aboriginal people across the state.

In the spirit of reconciliation, our commitment is to build progressive and trusting relationships, to share knowledge and learn from each other.

We recognise and own a difficult past, and together we will walk forward.

We acknowledge the many Aboriginal people of this Country as the oldest continuous living culture in the world.

This publication may be cited as:
Kirkwood, R. and Goldsworthy, S.D. (2026). Assessment of dolphin interactions, effectiveness of Code of Practice and fishing behaviour in the South Australian Sardine Fishery in 2025. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic and Livestock Sciences), Adelaide. SARDI Publication No. F2010/000726-17. SARDI Research Report Series No. 1295. 49pp.

Author(s):	Roger Kirkwood and Simon Goldsworthy
Reviewer(s):	Greg Ferguson, Marissa Hutchings (SARDI) and Annabel Jones (PIRSA)
Approved by:	Dr Stephen Mayfield Program Leader – Fisheries
Signed:	
Date:	3 July 2026
Distribution:	PIRSA Fisheries and Aquaculture, SARDI Aquatic and Livestock Sciences, Parliamentary Library, State Library and National Library
Circulation:	OFFICIAL

ALL ENQUIRIES
South Australian Research and Development Institute - Aquatic and Livestock Sciences
2 Hamra Avenue West Beach SA 5024
PO Box 120 Henley Beach SA 5022
P: (08) 8207 5400
E: pirsa.sardiaquatics@sa.gov.au
W: http://www.pir.sa.gov.au/sardi

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

Production of this report was funded by PIRSA Fisheries and Aquaculture through licence fees levied off commercial vessels in the South Australian Sardine Fishery (SASF). We thank licence holders and their representatives, skippers and crews of the SASF for providing observers with access to vessels and for providing logbook data and Wildlife Interaction Forms. Adam Kemp and observers from Seatec Marine Pty Ltd collected much of the data on which this report is based and did excellent work. A good relationship between skippers and observers is important for a fisheries monitoring program and has been evident in this fishery.

We thank Angelo Tsolos and his team in PIRSA Fisheries and Aquaculture for diligently extracting data from logbooks, observer returns, and Wildlife Interaction Forms, and Annie Sterns for administrative support.

Dr Greg Ferguson and Dr Marissa Hutchings, SARDI, and Dr Annabel Jones, PIRSA, reviewed drafts of the report. The report was approved for release by Dr Stephen Mayfield (Program Leader, Fisheries, SARDI Aquatic & Livestock Sciences) and cleared for release by Dr Gretchen Grammer (Research Director, Fisheries, SARDI Aquatic & Livestock Sciences).

EXECUTIVE SUMMARY

This report documents interactions between Common Dolphins (*Delphinus delphis*) and the South Australian Sardine Fishery (SASF) during 2025. A total of 1063 net-sets were deployed, with 51% occurring in the two months of April and May. As in previous years, the majority of net-sets were in the Spencer Gulf Zone (69%), followed by the Outside Zone (28% comprising 25% on the west coast of Eyre Peninsula and 3% south-east of Kangaroo Island), and the Gulf St Vincent Zone (3%). Observer coverage was 20.7%, exceeding the target level of 20%, and was well distributed across fishing effort by month, vessel, and fishing zone.

During 2025, 55 dolphin encirclement events were recorded, involving a total of 184 dolphins. Although above the level in 2024 (52 events and 142 dolphins), this continued a >50% reduction from levels recorded between 2020 and 2023 (annual mean ± SE; 121 ± 3 events and 419 ± 6 dolphins encircled). Continuation of the low levels of encirclement may have been influenced by implementation of dolphin deterrent devices in the fishery in 2025. Three dolphin mortality events involving single dolphins were recorded, two when no observer was present and one with an observer present. The 5-year running mean for annual dolphin mortalities based on observer data dropped from 11 per year for years 2020–2024 to 10 per year for years 2021–2025.

In 2025, the indices of fishing behaviour across the fleet, including the mean sardine catch retained per net-set, the proportion of net-sets with zero catch, and the number of net-sets per trip, did not show significant differences between the observed and unobserved net-sets. These data indicated no apparent observer-effect, as was also evident in 2024.

Tabulated key results from monitoring of SASF dolphin interactions in 2021 to 2025.

Year	% net-sets observed	% net-sets with dolphins encircled		% net-sets with dolphin mortality		Mean sardine catch per net-set	
		With observer	Without observer	With observer	Without observer	With observer	Without observer
2021	11.6	18	14	3.0	0.3	29	44
2022	11.3	10	11	2.0	0.2	27	46
2023	13.2	14	13	0.0	0.2	33	43
2024	21.6	4	6	0.0	0.3	47	48
2025	20.7	6	5	0.5	0.2	39	42

Keywords: Purse-seine fishery, Observer, Logbook, *Sardinops sagax*, *Delphinus delphis.*

1. INTRODUCTION

1.1. Background

South Australian Sardine Fishery

The South Australian Sardine Fishery (SASF) is Australia's largest fishery in terms of landed tonnage. It operates from Port Lincoln, South Australia. The SASF is a purse-seine fishery that targets Australian Sardines (*Sardinops sagax*), which in 2025 had an estimated biomass in South Australia of 557,000 t (Ivey et al. 2025). SASF annual sardine landings increased from 7 t in 1991, to 3,809 t in 1999, and 39,809 t in 2005 (PIRSA 2014). Catch declined to 23,507 t in 2006. Since then, annual catches have gradually increased, reaching 48,500 t in 2025 (Bailleul et al. 2025). The fishery operates mostly in Spencer Gulf, the West Coast of Eyre Peninsula and in Gulf St Vincent. Some product is used for human consumption and fishing bait, but most is used as a feed source for the 'ranching' of Southern Blue-fin Tuna (*Thunnus maccoyii*).

Since 2005, fishing effort in the SASF has averaged 960 net-sets by 10–15 vessels per year, with 11 vessels operating each year since 2022. Recent vessel lengths have ranged between 17–45 m and had maximum capacities of ~30–200 t of sardines. A key feature of the fishery is that virtually all net-sets are at night, when sardines school near the surface. The majority of fishing trips are overnight and involve 1–3 net-sets. Multi-day trips are required to access more distant fishing areas or if fishing success is reduced, for example by strong winds or failure to locate appropriate fish schools.

Common Dolphins in South Australia

Common Dolphins (*Delphinus delphis*) are widely distributed in the tropical and temperate waters of the Atlantic, Pacific, and Indian Oceans (Perrin 2017). Density estimates in South Australian waters have ranged between 0.5 and 0.7 individuals per km^2 (Filby et al. 2010, Bilgmann et al. 2017, Parra et al. 2021, Goldsworthy et al. 2025). There have been abundance estimates in two years in the core range of the SASF (Spencer Gulf, Investigator Strait, and shelf waters to 100 m depth), providing estimates of approximately 25,000 in 2011 to 27,000 in 2021 (Parra et al. 2021, Goldsworthy et al. 2025). Based on these estimates, between 50,000 and 100,000 Common Dolphins could be present in South Australian waters.

There is evidence of genetic population structure of Common Dolphins in south-eastern Australia, with those in South Australian waters potentially belonging to a genetically linked population that extends from the Great Australian Bight to western Bass Strait (Bilgmann et al. 2008, 2014). However, recent genetic studies of inferred migration levels suggest that there could be a semi-isolated sub-population within Gulf St Vincent (Barceló et al. 2021, 2022). If that is the case, Common Dolphins in Gulf St Vincent may need to be considered as a separate group from those elsewhere in South Australia.

In Australia, all cetaceans (including Common Dolphins) are listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act, Chapter 5, Division 3: Whales and other cetaceans). Under this Act, it is an offence for a person to cause the death or injury of a cetacean (Section 229), unless that action has received Ministerial accreditation (Section 231). Where fisheries interact with cetaceans, the Minister can accredit relevant management plans, regimes or policies if satisfied that "*the plan, regime or policy requires persons engaged in fishing under the plan, regime or policy to take all reasonable steps to ensure that cetaceans are not killed or injured as a result of fishing*" (Section 245).

Separately from the EPBC Act, within South Australian waters, legislation regarding interactions with cetaceans includes the *National Parks and Wildlife Regulation 2010 (Protected Animals – Marine Mammals)*, *National Parks and Wildlife Act 1972*, *Animal Welfare Act 1985* and *Fisheries Management Act 2007*. Regulations within these acts pertain to minimum approach distances, disturbance avoidance, vessel speed in the vicinity of cetaceans, avoidance of injury to individuals, compulsory reporting of interactions, and penalties for non-compliance.

<u>Interactions</u>

Interactions between Common Dolphins and the SASF occur when nets are set around schools of sardines. Dolphins may be feeding on the sardines, but not seen by the fisher, or dolphin approach after the nets are set (Hamer et al. 2008, Jaiteh et al. 2013, Kemper et al. 2023). Dolphins are present outside of nets feeding on sardines following more than 60% of observed net-sets, indicating they are attracted to the operations (e.g., see Kirkwood and Goldsworthy 2022). Since 2013, Common Dolphins have been encircled in 10% of SASF net-sets and dolphin mortalities have been recorded in 1% of net-sets (Kirkwood and Goldsworthy 2024a). Mortalities may result due to injury from interactions with the net, drowning, or stress due to 'entrapment' or separation, of calves from mothers or individuals from social groups (Forney et al. 2002, Edwards 2006, St Aubin et al. 2013, Kemper et al. 2023).

In 2004–05, a researcher-based observer program recorded high Common Dolphin interaction rates in the SASF and under-reporting of interactions (Hamer et al. 2007, 2008, Ward et al. 2015a). To help reduce the dolphin interactions, in 2006 the South Australian Sardine Industry Association (SASIA) developed a Code of Practice (CoP - which has been regularly updated; see Appendix 1) and the State Government initiated an independent observer program. Over time, dolphin encirclement rates in observed and unobserved net-sets converged, and have been similar since 2012, occurring in approximately 10% of net-sets (Kirkwood and Goldsworthy 2024a, 2024b). The rate of Common Dolphin mortality events also declined. In the periods 2006–2012 and 2013–2023, mortalities were recorded in 2.2% and 1.1% of observed net-sets, respectively, and 0.3% to 0.2% of unobserved net-sets, respectively (Kirkwood and Goldsworthy 2024b).

Since 2007, SARDI has provided annual assessments of the independent observer program, dolphin interactions and efficacy of the CoP (Hamer and Ward 2007, Hamer et al. 2009, Ward et al. 2010, 2011, 2012, 2013, 2015a, 2015b, Mackay and Goldsworthy 2016, 2017, Goldsworthy 2018, Goldsworthy et al. 2019, Kirkwood et al. 2020, Kirkwood and Goldsworthy 2021, 2022, 2024a, 2024b). In most years, the observer program has aimed at and achieved coverage of at least 10% of net-sets. Occasionally, in response to a strong observer effect and discrepancy in reporting of dolphin mortalities when observers were present or absent, the state government has increased observer coverage to 20 or 30% of net-sets.

Under-reporting of bycatch mortalities in the absence of observers has been documented in many fisheries and attributed to a range of factors. These include the desire to avoid potential negative consequences associated with reporting and the decreased likelihood of detecting cryptic mortalities when an observer is not present (Archer et al. 2001, Gilman et al. 2013, Heinemann 2017, Emery et al. 2019, Moore et al. 2021, Kennelly 2020). As a result, observer data rather than fishery-wide data are considered more reliable to estimate minimum bycatch mortality levels.

Observer data can under-estimate actual interaction rates when there are costs associated with compliance: this is termed an ‘observer effect’ (Johnson et al. 1999, Burns and Kerr 2008, Zollett et al. 2015, Luck et al. 2020). It is therefore precautionary to consider dolphin mortality rates recorded by observers as minimum rates (see Benoît and Allard 2009, Kennelly 2020, Wakefield et al. 2018). Evidence for a strong observer effect means that interaction rates recorded by observers may grossly under-represent actual interaction rates.

Quantifying observer effects in fisheries can be challenging without a method for recording fisher behaviour when observers are not present, such as through an electronic monitoring system

(Bartholomew et al. 2018, Ward et al. 2023,). In the absence of such a system, assessments must rely on indirect indices that could suggest changes in fishing behaviour when an observer comes onboard. In the SASF, key indices used to compare fishing behaviour with and without observers present have been *sardine catch per net-set*, *net-sets per trip*, *percentage net-sets with zero catch*, and *dolphin mortality rates*. Differences in these indices with and without an observer present have persisted in the SASF. In 2024, however, for the first time in the observer program the indices did not differ significantly, suggesting there was no apparent observer-effect.

In March 2022, the federal government Department of Climate Change, Energy, the Environment and Water (DCCEEW) placed a condition on accreditation of the SASF's under the EPBC Act, requiring that suitable systems be implemented to ensure that under-reporting was not occurring. Trials of on-board camera systems were proposed to audit dolphin interaction reporting in the absence of observers. While camera trials were being developed, to better monitor the fishery and help reduce the discrepancy between observed and unobserved interaction rates, observer coverage was increased to 20% and this took effect in July 2023. Low levels of dolphin interactions in 2024 may have been influenced by the changing management initiatives and fishing practices. They were also likely to have been influenced by an extensive and persistent cold-water upwelling event in 2024 (Kirkwood et al. 2025). In 2025, acoustic dolphin deterrent devices (DDDs; model DDD–03H, STM Industrial Electronics, Italy) were introduced into the fishery by the SASF. Trials of on-board camera systems were postponed while trialling of the DDDs was in progress.

1.2. Objectives

The aim of this report was to assess the SASF observer program, Common Dolphin interaction rates, and the level of compliance with the CoP in 2025.

Key objectives of this assessment were to:

1) Examine patterns of observer coverage in 2025,
2) Assess dolphin interaction rates with the SASF in 2025,
3) Assess the effectiveness of the CoP in mitigating interactions in 2025,
4) Assess dolphin interactions and fishing patterns with and without observers present, and
5) Collate and present 2025 data against data from previous years.

2. METHODS

2.1. Data sources

Three data sources for the 2025 calendar year were collated, cross-checked for accuracy, and incorporated into long-term data bases for the SASF. Sources were logbook data, observer datasheets and wildlife interactions forms.

South Australian Sardine Fishery Logbook Data

Logbook data, recorded by commercial fishers for each net-set since 1999, include vessel, date, location, time of net-set, and estimated catch.

In 2025, the fishery operated in three zones, the Spencer Gulf (SGZ), the Gulf St Vincent (GSVZ), and the Outside (Figure 1). The Outside Zone comprises two geographically separate regions: west of the Eyre Peninsula, termed West Coast (WCOZ), and south-east of Kangaroo Island, termed South-East (SEOZ).

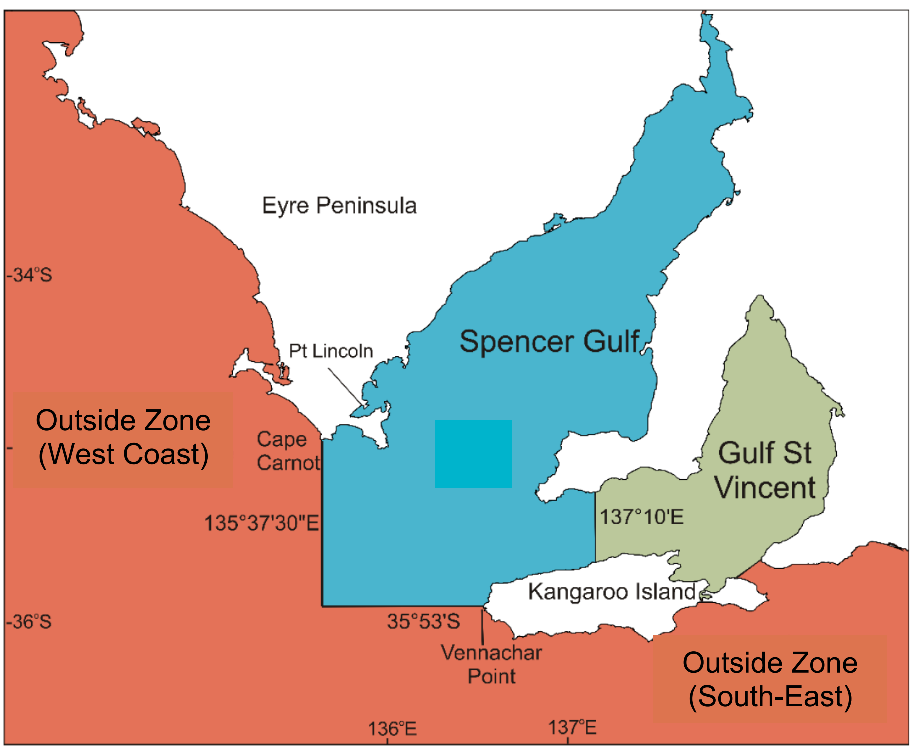


Figure 1. Spatial management zones for the SASF. For this report, the Outside Zone is split into the West Coast and South-East regions (adapted from PIRSA 2000).

SASF Observer Datasheets

Observer data recorded since 2005 for individual net-sets document the log-sheet number, date, net-sets, locations, weather conditions, fishing procedures, CoP procedures, Common Dolphin interaction details, and interactions with other wildlife (see Appendix 2). Before 2012, observer coverage was designated as a percentage of ‘nights of fishing’ and thereafter, as a percentage of ‘net-sets’.

Observers board a vessel for trips of one (most common) to four-nights. Observer effort aims to achieve the target percent coverage within each month, for each vessel and in each fishing area.

The allocation of observers to vessels was structured rather than randomised. For example, when coverage was set at 10%, when a vessel approached 10 net-sets since its last observed net-set, an observer boarded the vessel as soon as practicable. Allocation also considered that monthly and zonal coverage should be at the annual rate. Therefore, at times, an observer could be assigned to the next available vessel or vessel going to that zone, exceeding its coverage for that month, which would be accounted for with fewer net-sets for that vessel in a later month.

Wildlife Interaction Forms (WIFs)

In 2007, Wildlife Interaction Forms (WIFs: see Appendix 3) were introduced to all South Australian fisheries to meet a requirement of the EPBC Act; to document all contacts between fishing gear and ‘Threatened, Endangered and Protected Species’ (TEPS: i.e., cetaceans, pinnipeds, seabirds, and several sharks). The data include the date, logbook number, vessel, location, wildlife species, and wildlife status (e.g., alive, injured or dead). WIF data document dolphin interactions when observers are not present.

2.2. Data analyses

Inferential hypothesis tests

Data preparation was performed in Microsoft Excel with further processing and statistical analysis in the R statistical framework (version 4.5.0, R Core Team 2025). Statistical differences were assessed using *F*-tests and *t*-tests for parametric data, and Wilcoxon-tests for non-parametric data (Wickham et al. 2019). Parametric data were summarised as means ± standard errors.

Evaluations of Common Dolphin encirclement and mortality rates were based on events recorded on observer datasheets and fisher WIFs. Estimates of annual numbers of encirclements and mortalities were derived from the recorded rates multiplied by the total number of net-sets. A 5-year running mean was applied to the annual mortality data to smooth out inter-annual variability and reveal multi-year trends. The evaluation of the application of the CoP was based on observer records of when fishers actively searched for dolphins, fisher responses to dolphin sightings, and processes for releasing encircled dolphins.

To assess whether or not the observer data were representative for the entire fishery (i.e., that there were no significant observer effects), indices of fishing behaviour with and without an observer present were drawn from the data sets. The indices adopted were: 1) the number of net-sets per trip, 2) the number of net-sets with zero catch, 3) the sardine catch per net-set, and 4) the sardine catch per net-set excluding net-sets with zero catch. Estimated sardine catches retained per net-set in which dolphin encirclements or mortalities occurred were also compared between net-sets with and without an observer present. Data compiled for interpretations of fisher behaviour (such as net-sets per trip and net-sets with zero catch) were collected more ambiguously prior to 2010 than post 2010, so emphasis was placed on the more recent data.

Regression analyses - Generalised Additive Model (GAM)

To further examine relationships between predictor variables and response variables (observer presence, sardine catch retained, dolphin encirclement events, and dolphin mortality events), generalised additive models (GAMs) were constructed in R using the *mgcv* package (Wood et al. 2016; Wood 2017). GAMs allow both categorical (factorial) and continuous (numeric) predictor variables to be included in the same model, and enable the investigation of linear and non-linear relationships in continuous variables, rather than assuming purely linear effects. The models applied in 2025 were updated from those applied in previous years. For binomial response variables (presence/absence), including observer presence, encirclement events, and mortality events, GAMs with a binomial error distribution and logit link function were used. For sardine catch, which exhibited zero-inflated and highly skewed distributions, GAMs with a Tweedie error distribution and log link function were applied. These models were also fitted individually to data from previous years to assess temporal trends.

Factorial predictor variables, including observer, encirclement, mortality, and fishing zone were included directly as linear terms. ‘Vessel’ was only included as a predictor variable in GAMs investigating sardine catch, and were incorporated as a random factor because vessels in the fleet had different capacities. Additional predictor variables for water depth, time-of-day, and moon phase were obtained from the location, start time, and day of the year, respectively, and were fitted as non-linear terms.

An estimate of water depth at each net set was derived from geographic coordinates (latitude and longitude) by integrating spatial vector and raster datasets in R. Australian boundary data were sourced from the Australian Bureau of Statistics (ABS) administrative boundaries (ASGS), and converted into a simple feature object using the *sf* package. Bathymetry data were obtained from a high-resolution digital elevation model of the topography of the Australian seafloor (Geoscience Australia, *ausbath_09_v4*). The coordinates of net-sets were converted into spatial points and overlayed onto the bathymetry raster, allowing depth values to be extracted for each set.

A proportion of locations returned implausible depth values (e.g., positions on land, in very shallow depths, or beyond the continental shelf – where net setting does not occur), indicating possible errors in location entry, spatial mismatch or other resolution limitations in the datasets. This introduced uncertainty regarding the reliability of depth as a predictor variable. However, given the potential relevance of water depth for dolphin interaction rates, the variable was retained with filtering applied to exclude values <10 m and >200 m. Where no meaningful relationship with depth was detected, GAMs were re-run excluding depth, allowing all net sets to be included and strengthening inference from the full dataset.

Time-of-day and moon illumination are represented by circular data and were therefore incorporated into analyses using angular transformations. Time-of-day was converted from hours to radians by scaling values to the range 0–2π. To improve interpretability of the model and avoid discontinuities at the midnight boundary, since virtually all net sets are at night, a phase shift of π radians was applied and the values were re-wrapped within the 0–2π interval.

Moon illumination was calculated for each date using the *lunar* package in R, which provides the proportion of the moon illuminated (range 0–1). These values were categorised into eight standard lunar phase classes (New, Waxing Crescent, First Quarter, Waxing Gibbous, Full, Waning Gibbous, Last Quarter, and Waning Crescent) by dividing the illumination range into equal intervals. During modelling, however, use of illumination levels were adopted, as these enhanced non-linear interpretations.

The validity of each variable was checked through exploratory plots and summary statistics. For all included predictors in each GAM, the direction of the predictor–response relationship (positive or negative), the relative effect size, and the probability of significance (*p*-value) were assessed.

To further investigate these relationships, a model selection procedure was implemented. Alternative combinations of predictors were included, and model performance was compared using the Akaike Information Criterion (AIC). Models were then ranked using ΔAIC to identify the combination of variables that best balanced explanatory power and complexity.

3. RESULTS

3.1. Fishing effort

In 2025, a total of 1063 net-sets were recorded in industry logbooks (Table 1). The temporal and spatial spread of net-sets was comparable with recent years, with 51% of net-sets occurring in April to May. 69% of net-sets were in the SGZ, 28% in the Outside Zone (25% WCOZ, 3% SEOZ), and 3% in GSVZ. The frequency of net-sets in both the GSVZ and the SEOZ were lower than in recent years, largely in response to vessels avoiding these areas due to the persistence there of a harmful algal bloom (HAB) during 2025. Compared with 2024, SASF fishing effort in the GSVZ in 2025 was similar in February–March (16 net-sets compared with 18), extremely low in April (1 net-set compared with 70), and similar again in May–June (19 net-sets compared with 14).

3.2. Observer coverage

In 2025, observers were present for 220 net-sets (20.7%; Table 1). Coverage was consistent by month (13–22%, excluding August when there were just three net-sets; Figure 2a), across vessels (18–24% per vessel; Figure 2b), and by zone (20–22%; Figure 3, Table 2). All eight observed net-sets in the GSVZ were in March (eight of 15 net-sets that month), and in Investigator Strait near the SGZ boundary.

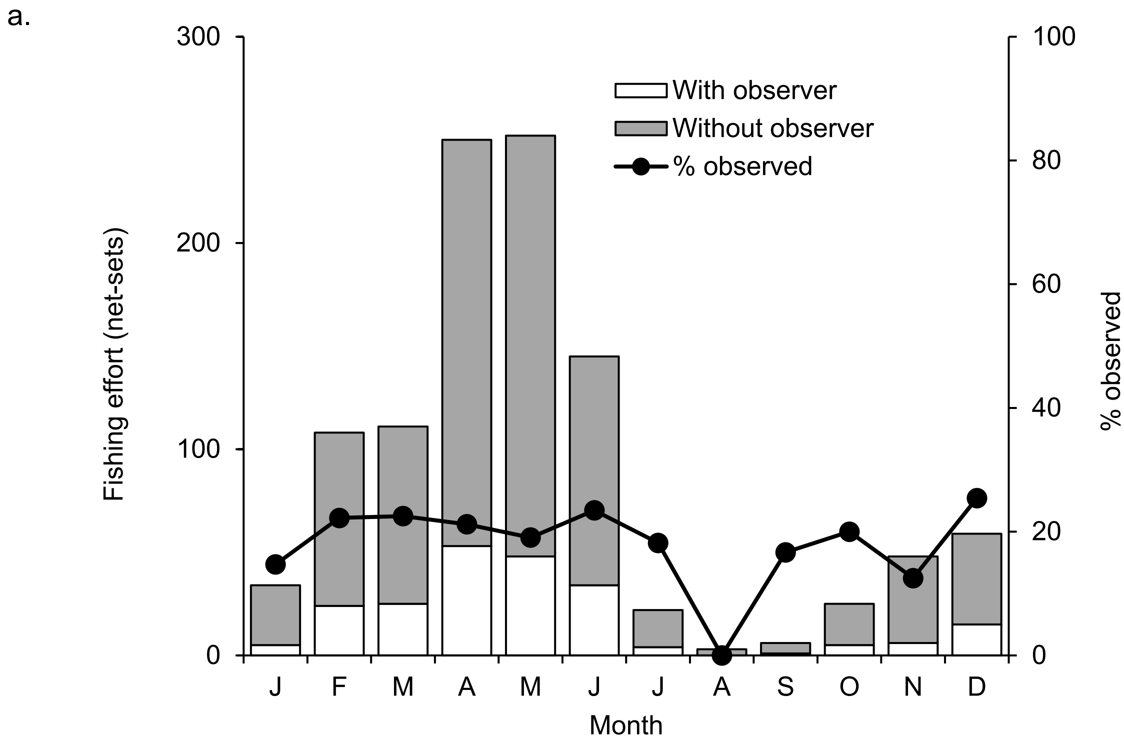
In 2025, observers reported that fishers consistently followed the industry CoP:

1) A search for dolphins was always conducted prior to net-setting,
2) When the crew saw dolphins, they clearly communicated this to the skipper,
3) If dolphins were sighted prior to setting, the set was always delayed and often relocated,
4) When dolphins were identified as encircled or entangled, the response to release them was always immediate (recognising that several minutes could be needed to complete a procedure before the front of the net could be released),
5) Release procedures were always in accordance with the CoP, that is, release the front of the net and if dolphins did not depart promptly, abort the set.

Table 1. Summary of fishing effort (net-sets), observer coverage, Common Dolphin encirclement and mortality events, and number of dolphins involved (in brackets) recorded in the South Australian Sardine Fishery (SASF), by calendar year from 2005 to 2025.

Year	Net-sets					Encirclements						Mortalities					
	Total	With obs.	No obs.	% obs.	% target	Events		With obs.		No obs.		Events		With obs.		No obs.	
2005	1297	87	1210	6.7	5	39	(115)	20	(92)	19	(23)	16	(24)	12	(20)	4	(4)
2006	856	82	774	9.6	10	38	(88)	10	(27)	28	(61)	4	(6)	0	(0)	4	(6)
2007	1011	97	914	9.6	10	54	(116)	18	(57)	36	(59)	7	(11)	6	(10)	1	(1)
2008	883	210	673	23.8	30	66	(183)	28	(93)	38	(90)	9	(12)	6	(8)	2	(3)
2009	989	212	777	21.4	30	58	(155)	17	(47)	41	(108)	5	(7)	4	(6)	1	(1)
2010	1022	253	769	24.8	30	64	(176)	26	(85)	38	(91)	4	(4)	1	(1)	3	(3)
2011	1079	74	1005	6.9	10	48	(148)	10	(37)	38	(111)	6	(6)	2	(2)	4	(4)
2012	1032	83	949	8.0	10	97	(283)	13	(48)	84	(235)	5	(6)	2	(2)	3	(4)
2013	762	71	691	9.3	10	92	(204)	6	(15)	86	(189)	3	(3)	0	(0)	3	(3)
2014	816	91	725	11.2	10	94	(245)	10	(35)	84	(210)	1	(1)	0	(0)	1	(1)
2015	847	93	754	11.0	10	73	(196)	8	(25)	65	(171)	4	(5)	2	(3)	2	(2)
2016	819	94	731	10.7	10	59	(176)	7	(27)	52	(149)	1	(1)	0	(0)	1	(1)
2017	1083	133	965	10.9	10	63	(213)	9	(35)	54	(178)	1	(1)	1	(1)	0	(0)
2018	901	103	797	11.5	10	89	(339)	12	(48)	77	(291)	0	(0)	0	(0)	0	(0)
2019	963	131	832	13.6	10	96	(379)	18	(81)	77	(296)	6	(16)	5	(15)	1	(1)
2020	1049	72	977	6.9*	20	118	(433)	7	(29)	111	(404)	3	(3)	0	(0)	3	(3)
2021	859	100	760	11.5	10	125	(409)	18	(64)	107	(345)	5	(5)	3	(3)	2	(2)
2022	997	113	884	11.3	10	112	(409)	11	(36)	101	(368)	4	(6)	2	(4)	2	(2)
2023	992	131	861	13.2	10-20	127	(423)	18	(63)	109	(360)	2	(2)	0	(0)	2	(2)
2024	928	200	728	21.3	20	52	(142)	7	(21)	45	(121)	2	(2)	0	(0)	2	(2)
2025	1063	220	843	20.7	20	55	(184)	12	(47)	43	(137)	3	(3)	1	(1)	2	(2)

* 2020 observer coverage affected by covid restrictions.



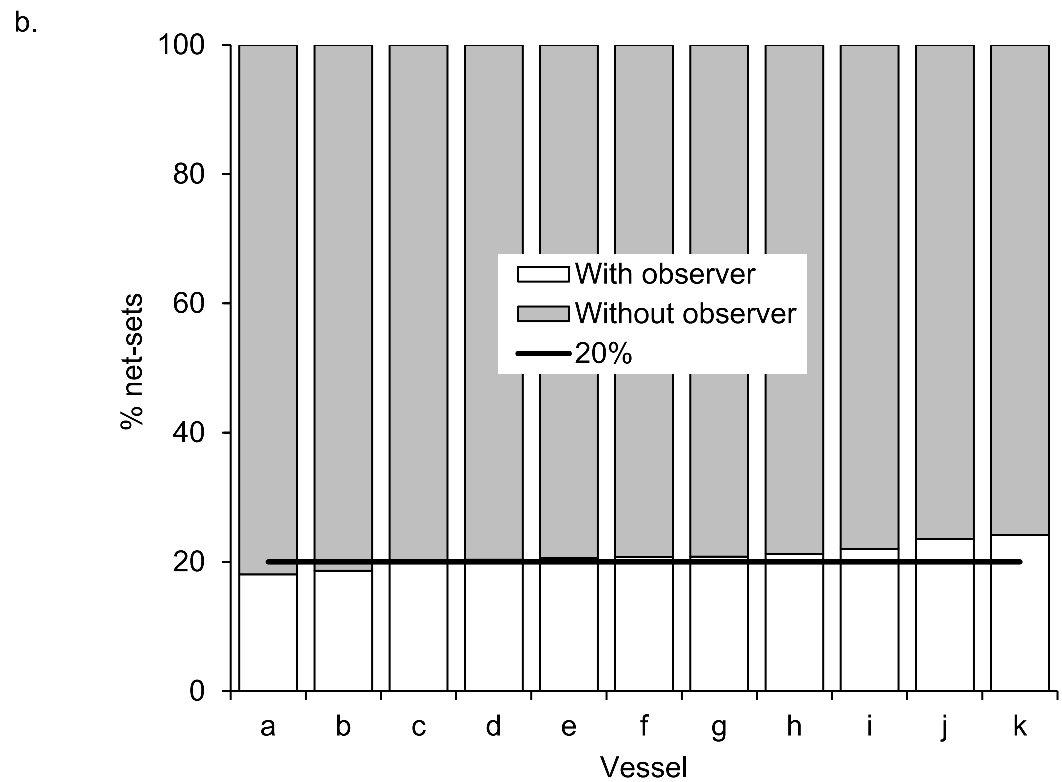


Figure 2. Observer coverage of the SASF in 2025, by (a) month and (b) vessel.

b.

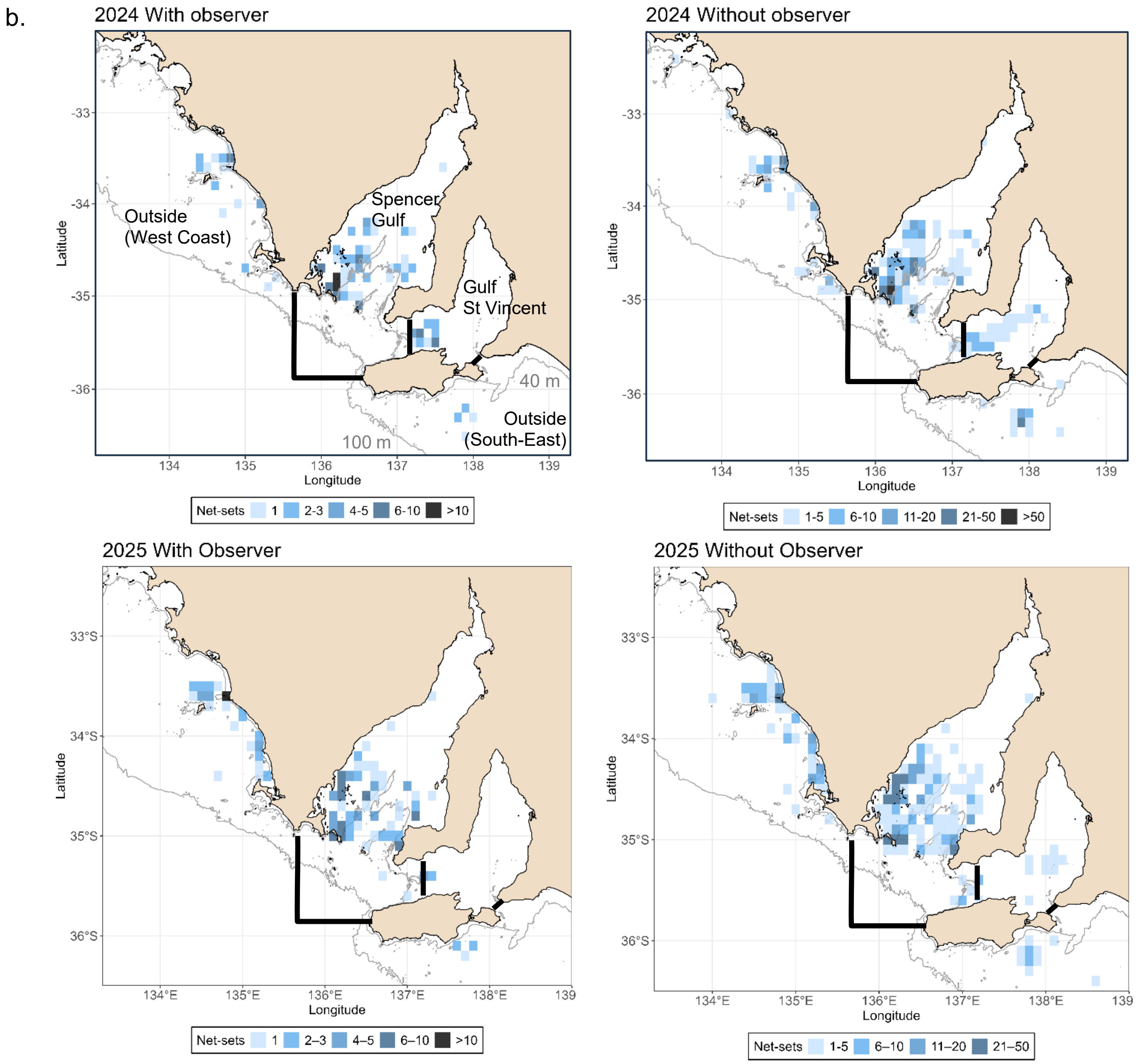


Figure 3. Gridded density plots (0.1° x 0.1°, equivalent to ~11 km^2) showing the distribution of SASF net-sets with and without observers present: (a) in 2024 and (b) in 2025. Fishing Zones delineated by black lines, 40 m and 100 m depth contours in grey.

Table 2. Frequency by fishing zone of net-sets and observer coverage, in the SASF in 2025.

Zones	Net-sets	%	Observer	%
Spencer Gulf (SGZ)	731	69	153	21
Gulf St Vincent (GSVZ)	36	3	8	22
West Coast Outside (WCOZ)	261	25	53	20
South-East Outside (SEOZ)	35	3	6	17

3.3. Wildlife interactions

In 2025, fishermen submitted WIFs for 69 TEPS interactions (compared to 75 in 2024 and 167 in 2023), 54 without an observer and 15 with an observer present. Of the 54 WIFs submitted by fishers when there was no observer, 44 documented encirclements of Common Dolphins (compared to 45 in 2024 and 109 in 2023). They documented similar rates of dolphin encirclement to observer reports and two mortality events.

Eleven encirclements reported by observers had matching WIFs. On ten occasions the reports were identical, and once the only difference was the WIF recorded 6–8 dolphins while the observer recorded 10 dolphins. One dolphin interaction record by an observer was not reported in a WIF. This was of a dolphin that entangled on the outside of the net, lifted out of the water, 'fell back into the water' and was then not seen again (i.e., 'fate unknown').

Also in 2025, 28 observed net-sets (19%) had up to three seals jumping in-and-out over the cork-line and feeding on fish. Australian Sea Lions (*Neophoca cinerea*) were identified 18 times, Long-nosed Fur Seals (*Arctocephalus forsteri*) three times and seal type was not provided nine times. A Great White Shark (*Carcharodon carcharias*) was encircled in one set and released unharmed.

3.4. Dolphin interactions

Dolphin presence

Observers were onboard for 236 occasions when a vessel was searching for sardines. No net-set was possible on 16 occasions, because a suitable school of sardines was not located (Table 3). Dolphin presence while approaching to set a net caused 11 sets, 5%, to be delayed. This rate was lower than in 2024, 6%, and continued a substantial downward trend in the frequency of dolphin-caused delays, from 24% of net-sets in 2020 (Table 3).

Observers recorded that Common Dolphins came to feed on sardines following net-sets on 106 occasions, i.e., 48% of net-sets, compared with 42% in 2024. In years since 2008, dolphins have been feeding outside 23 to 72% of net-sets (average 49%).

Estimates of the number of dolphins that came to feed on sardines following net-sets in 2025 ranged up to 200, with a median of 25 dolphins. This was high compared to previous years, for which median numbers ranged from 6 to 28 dolphins (average of the medians = 17).

Table 3. The frequency of delays to net-sets based on observer data annually from 2020 to 2025.

Year	Searches for sardines	No set due to other reasons*	Net-set possible	Dolphins caused delay	% sets delayed by dolphins	No set due to dolphins	Net-sets
2020	81	9	72	17	24	0	72
2021	108	5	103	22	21	3	100
2022	118	4	114	16	14	1	113
2023	138	4	134	17	13	3	131
2024	205	4	201	13	6	1	200
2025	236	16	220	11	5	0	220

* e.g., no suitable school located, poor weather or mechanical problem

Encirclements

In 2025, both with and without an observer present, dolphins were encircled in 5% of net-sets. Dolphin encirclement in 2025 was slightly lower than the rate in 2024 (6% of net-sets), and less than half of the annual rates recorded between 2020 and 2023 (11–15% of net-sets). There was an average of four dolphins in observed encirclements compared to three dolphins in unobserved encirclements. The total number of dolphins encircled was estimated to be 227 based on the observer rate and 173 based on the rate without an observer (Figure 4). The totals were higher than in 2024 (97 and 154 dolphins, respectively), but lower than rates recorded from 2020 to 2023 (mean 442 and 415 dolphins per year based on rates with and without an observer, respectively).

Mortalities

In 2025, two single dolphin mortality events were recorded when observers were not present (Table 5, Figure 5). No mortalities were recorded by observers; however, one mortality was interpreted here based on the accounts provided in a WIF and observer's report for the same event. In this, 12 minutes into hauling, two 'lifeless' dolphins were seen floating inside the net. Three minutes later, two more dolphins were sighted (initially recorded as injured but swimming freely), so the front end of the net was let go and the set was aborted. An abundance of shearwaters made observations difficult, but the two moving dolphins were seen to swim free. After 22 min., one of the 'lifeless' dolphins was seen to swim free. After 30 min., the second 'lifeless' dolphin was (last) sighted still floating. Both the WIF and the observer datasheet recorded the final status of the dolphins as all alive but two injured. Here, the dolphin seen floating and lifeless for 30 min. then not seen again is interpreted to have died. Another injury recorded was of a dolphin entangled on the outside of the net, with 'fate unknown' (see section 3.3).

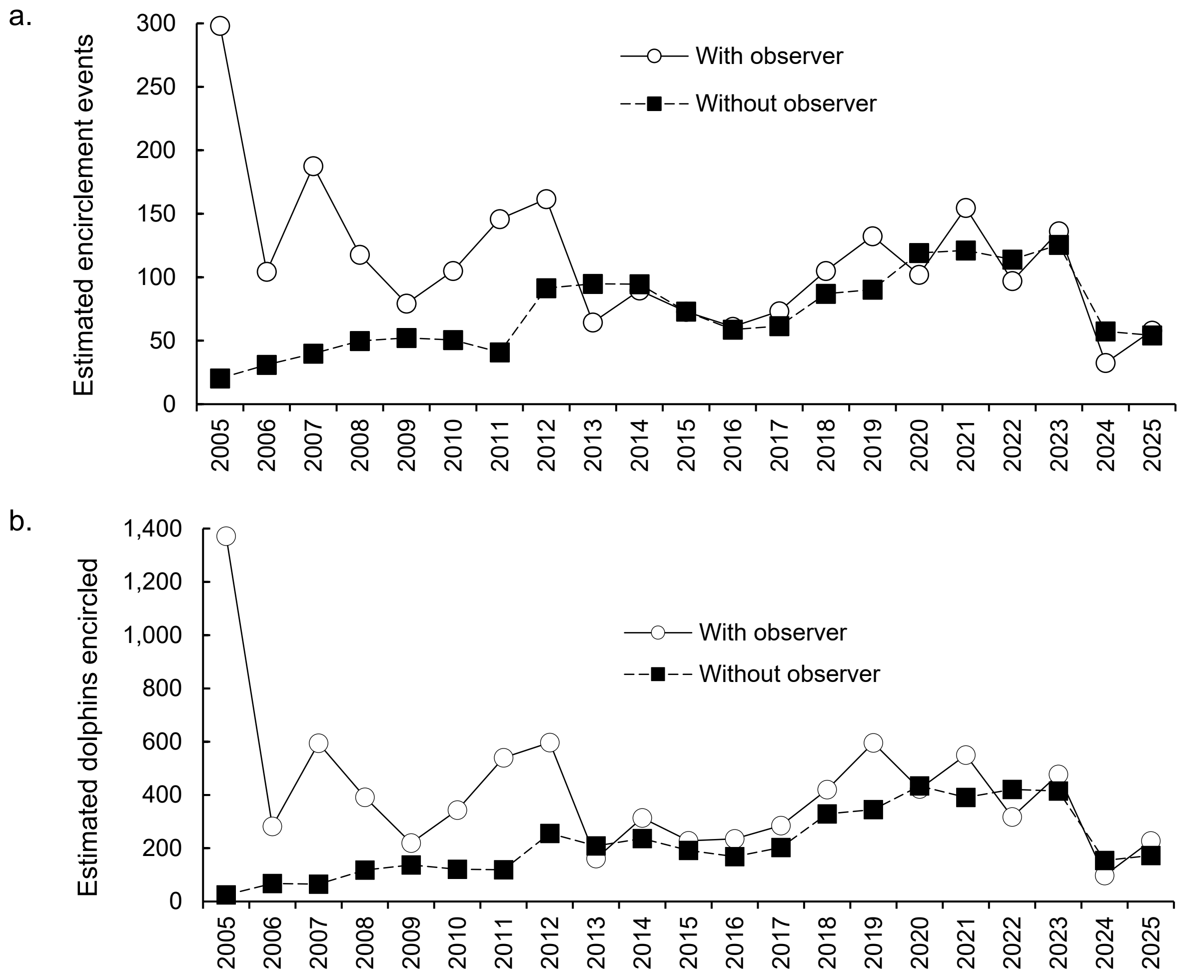


Figure 4. Time series of (a) estimated number of Common Dolphin encirclement events and (b) Common Dolphins encircled based on rates recorded with and without an observer present, from 2005 to 2025.

Table 4. Common Dolphin mortalities recorded in 2025.

Date	Time seen	Observer present	Zone	After a delay due to a dolphin sighting	Number	Comment
16-Feb	6:30	no	GSV	no	1	Floating alongside cork line
20-Mar	6:15	no	SG	no	1	1 or 3 encircled, found dead
9-Apr	23:11	yes	SG	no	1	Last seen floating & lifeless

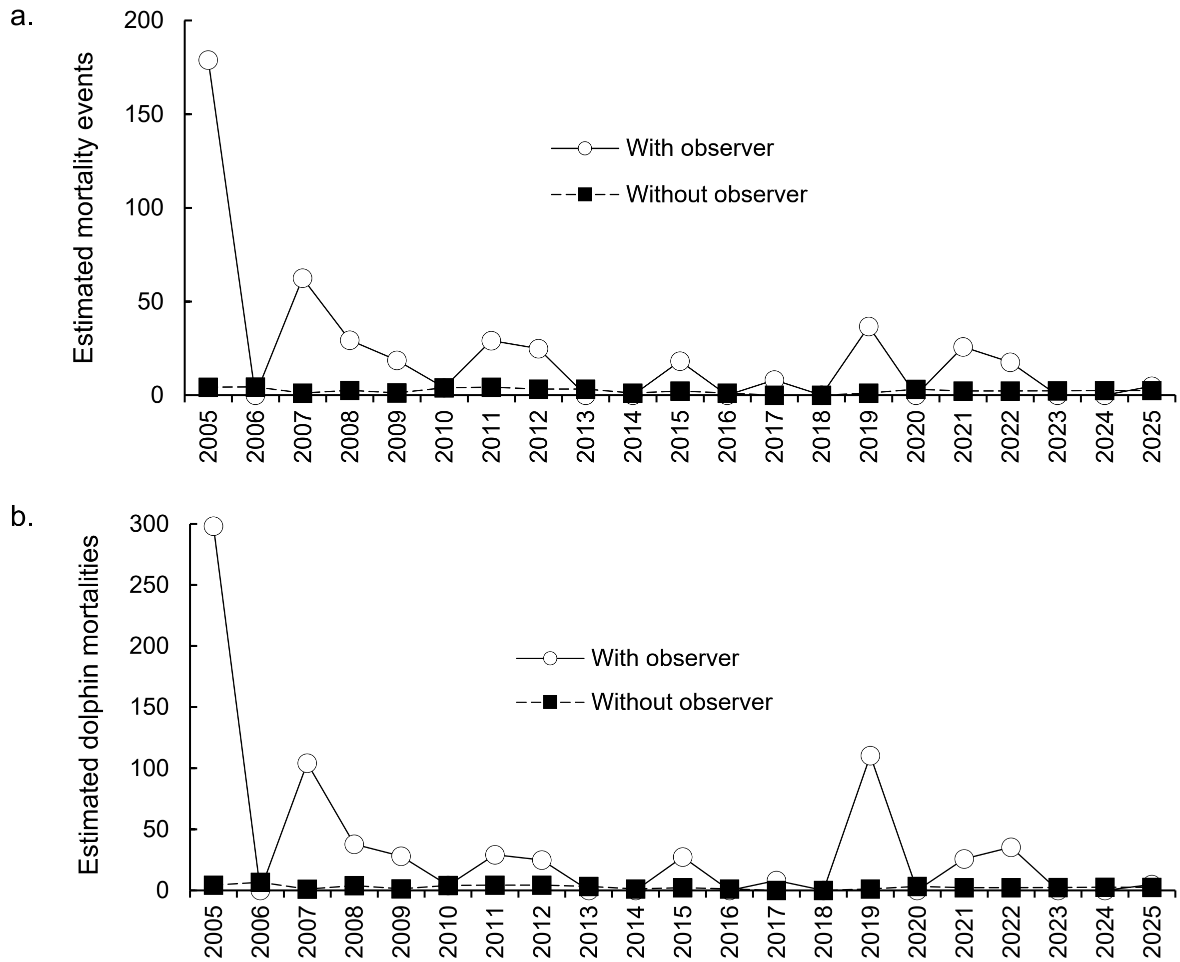


Figure 5. Time series of (a) estimated number of Common Dolphin mortality events, and (b) Common Dolphin mortalities based on rates recorded with and without an observer present, from 2005 to 2025.

For the period 2021–2025, the 5-year running-mean of dolphin mortalities per year estimated from observer data was 10 ± 7 (Figure 6). The running means had risen from 29 ± 22 per year for 2016–2020, to 40 ± 20 per year for 2019–2023, then dropped to 11 ± 8 per year for 2020–2024. The running means for dolphin mortalities in net-sets without observers present indicated 1 dolphin per year for 2016–2020 and 2017–2021, and ~2 dolphins per year then on, including for 2021–2025.

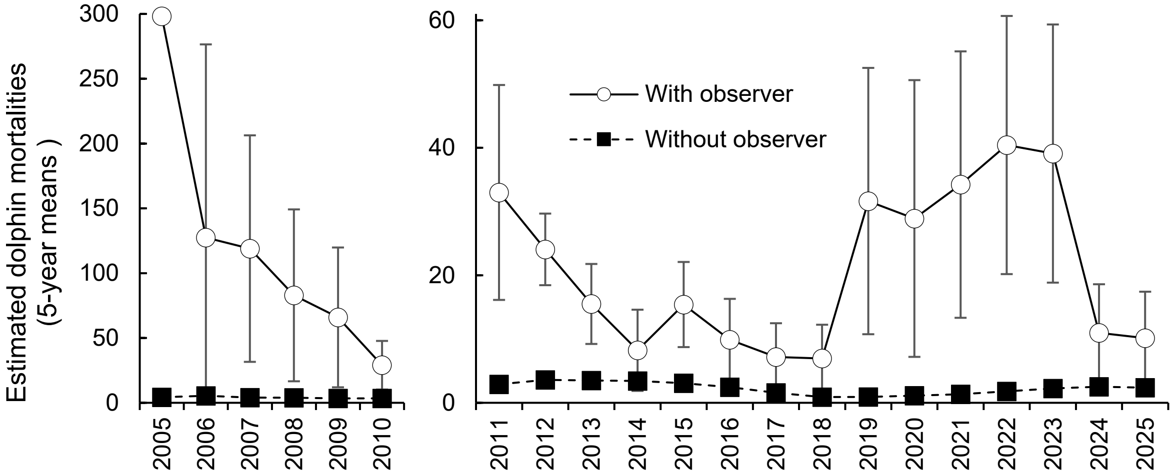


Figure 6. Time series as 5-year running-means of dolphin mortalities in the SASF from 2005 to 2025, estimated from annual rates recorded with and without an observer present. Note, y-axis expanded after 2010.

Common Dolphin interactions by zone

Assessing Common Dolphin interactions by SASF fishing zone, between 2005 and 2025, 81% of net-sets, 85% of encirclements and 90% of mortality events have occurred in the SGZ (Table 6). Highest interaction rates have occurred in GSVZ (encirclements in 11% of net-sets, mortalities in 0.6% of net-sets) and lowest interaction rates have been in the WCOZ (encirclements in 3% of net-sets, mortalities in 0.03% of net-sets). In the WCOZ, there was also the least chance a dolphin mortality would result from an encirclement (a mortality in 1.3% of encirclement events), with the highest chance of a mortality resulting from an encirclement in the SGZ (a mortality in 5.9% of encirclement events).

Table 5. Total numbers of net-sets and Common Dolphin interactions, encirclements and mortality events, from 2005 to 2025, by fishing zone. Indicates the frequency of occurrence of interactions as a percentage of net-sets in the zone, and the percentage of encirclements that resulted in a mortality.

Fishing zone	Net-sets		Encirclement		Mortality		
	N	%	N	% sets	N	% sets	% encirc.
Spencer Gulf (SGZ)	19328	81	1401	7	82	0.42	5.9
Gulf St Vincent (GSVZ)	818	3	94	11	5	0.61	5.3
West Coast Outside (WCOZ)	3012	12	78	3	1	0.03	1.3
South-East Outside (SEOZ)	857	4	83	10	3	0.35	3.6
Total	24015		1656	7	91	0.38	5.5

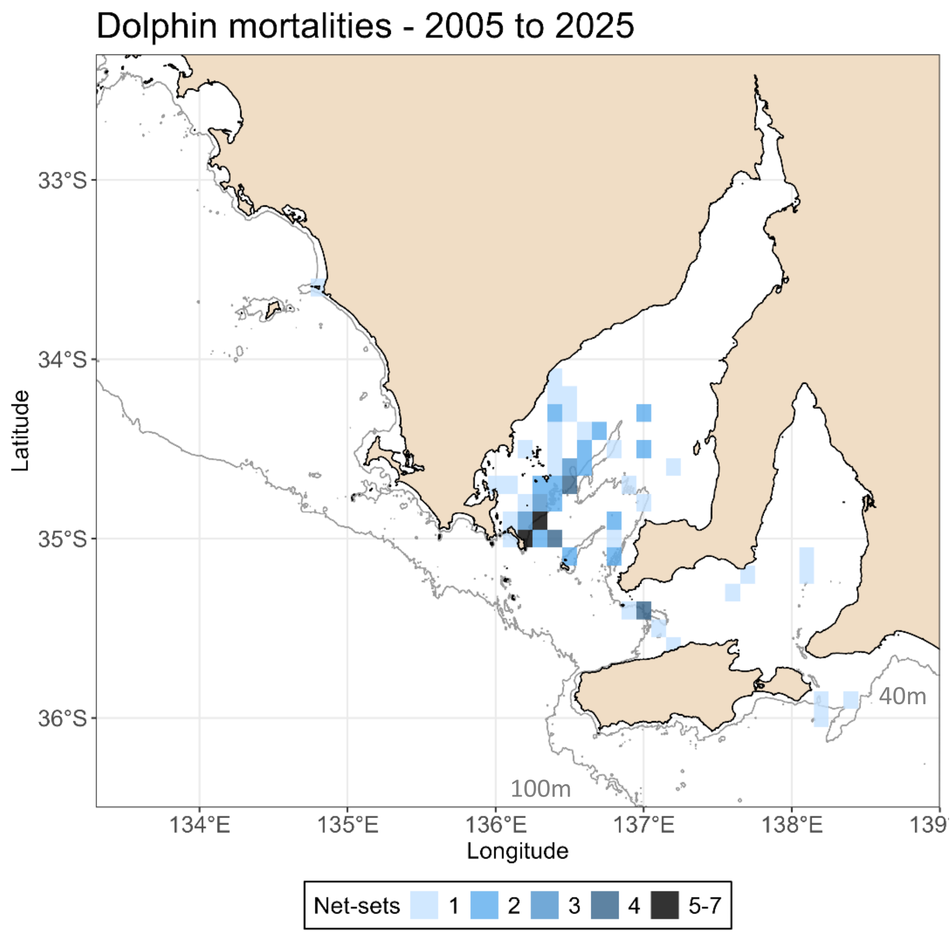


Figure 7. Gridded density plot (0.1° x 0.1°, equivalent to ~11 km^2) of the distribution of SASF net-sets in which Common Dolphin mortalities were recorded, from 2005 to 2025.

Regression analyses - Generalised Additive Model (GAM)

Observer presence

A relationship between observer presence and sardine catch per net set, and the frequency of encirclement events or mortality events, could signal an observer effect. In 2025, binary GAMs indicated that the presence of observers did not significantly influence the tonnage of sardine retained per net-set (p = 0.25), the frequency of encirclement events (p = 0.91), or the frequency of mortality events (p = 0.71; Appendix 4.1). The only significant relationship found was between to moon illumination and observer presence (p = 0.02; Appendix 4.1). However, further testing indicated that this result was likely driven by overfitting. When the smoothness of this term was constrained (k = 4), the relationship was no longer significant. Also, a categorical representation of moon phase showed no consistent pattern across levels. In model ranking of predictor variable combinations, dolphin interactions did not contribute to any of the top five models, while catch per net set did contribute to several of the top 10 ranked. In all years since 2021, though, the combinations of the predictor variables have explained very little variation in observer presence. In 2025, for example, the deviance explained by each of the top 10 ranked models was <1%; see Appendix 4.1).

Encirclement events

In 2025, binary GAMs indicated that encirclement events were more likely to occur in the Gulf St Vincent Zone ($p = 0.016$) and less likely to occur in the West Coast section of the Outside Zone ($p = 0.007$; Appendix 4.1). None of the other variables tested indicated significant relationships with encirclement events. In general, the predictor variables for encirclement explain a small proportion of the variation in encirclement occurrences (deviance explained <6%).

Catch per net-set

The Tweedie GAM of estimated catch indicated that observer presence did not significantly influence catch size per net set ($p = 0.14$). Variables that significantly influenced catch size included encirclement events (lower catches when encirclement occurred; $p < 0.001$), depth (non-linear, with the smooth indicating a peak in catch around 30 m; $p = 0.003$), and time of day (non-linear, with higher catches generally occurring in the middle of the night; $p = 0.007$). Although 'peaks' were implicated in the modelled data, catches were highly variable and included many small and zero values in all depths and times of day. Vessel was also significant ($p < 0.001$) and was included as a random effect to account for differences in vessel capacity and fishing power. Restricting the analysis to night-time sets, given that most net sets occurred at night, did not clarify temporal patterns, with no distinct period of the night strongly associated with peak catch.

Overall, the model explained 30.9% of the deviance in estimated catch. This high level was largely due to the inclusion of vessel. In the equivalent model without vessel, 8.9% of the deviance was explained.

In model ranking, observer presences was a consistent predictor variable in the top models during 2021 to 2023, and an uncommon predictor variable in the top-ranked models in 2024 and 2025, although in 2025 it did contribute to the top-ranked model (see Appendix 4.1).

3.5. Fishing behaviour

In 2025 (as in 2024), there were no significant differences in any of the indices of fishing behaviour across the fleet (Table 7, Figure 8). In most previous years, the presence of an observer had been associated with higher numbers of net-sets per trip, a higher percentage of net-sets with zero sardine catch, and lower tonnages of sardine catch per net-set, even when zero-catch net-sets were excluded. In 2025 (as in most years), when dolphins were encircled, the mean retained sardine catch did not differ significantly between observed and unobserved net-sets (Table 7), indicating fishers did not increase their focus on retaining catch over dolphin safety when observers were absent.

Table 6. Probability (*p*) results from Wilcoxon-tests for similarity comparing indices of fishing behaviour with an observer present versus without an observer present; in annual data from 2005 to 2025. The dashed line separates less comparable (prior to 2011) and more comparable data (rationale provided in methods). All significant results (p <0.05, in bold) indicate that when an observer was present there were: more net-sets per trip, less sardine catch per net-set, or more catch per net-set when dolphins were encircled.

Year	Net-sets per trip	Catch per net-set including zero catch sets	Catch per net-set excluding zero catch sets	Catch per net-set with a dolphin encirclement
2005	**0.006**	**<0.001**	0.613	0.121
2006	0.187	**<0.001**	0.086	**0.046**
2007	**<0.001**	**0.004**	0.515	**0.009**
2008	**<0.001**	**0.003**	0.646	0.189
2009	**0.003**	**0.002**	**0.040**	0.535
2010	**0.009**	**<0.001**	**0.032**	0.126
2011	0.105	0.386	0.643	0.622
2012	0.085	0.263	0.532	0.375
2013	**<0.001**	**0.007**	**0.048**	0.219
2014	**0.043**	**0.004**	0.060	0.102
2015	**0.037**	**<0.001**	**0.003**	0.645
2016	**0.024**	**0.010**	**0.029**	0.249
2017	0.087	**<0.001**	**0.001**	0.282
2018	**0.002**	**<0.001**	**<0.001**	**0.008**
2019	0.128	**0.017**	0.288	0.861
2020	0.398	**0.003**	**0.002**	0.149
2021	0.160	**<0.001**	**0.019**	0.135
2022	**<0.000**	**<0.001**	**<0.001**	0.195
2023	0.085	**<0.001**	**<0.001**	0.878
2024	0.899	0.387	0.180	0.800
2025	0.695	0.164	0.252	0.577

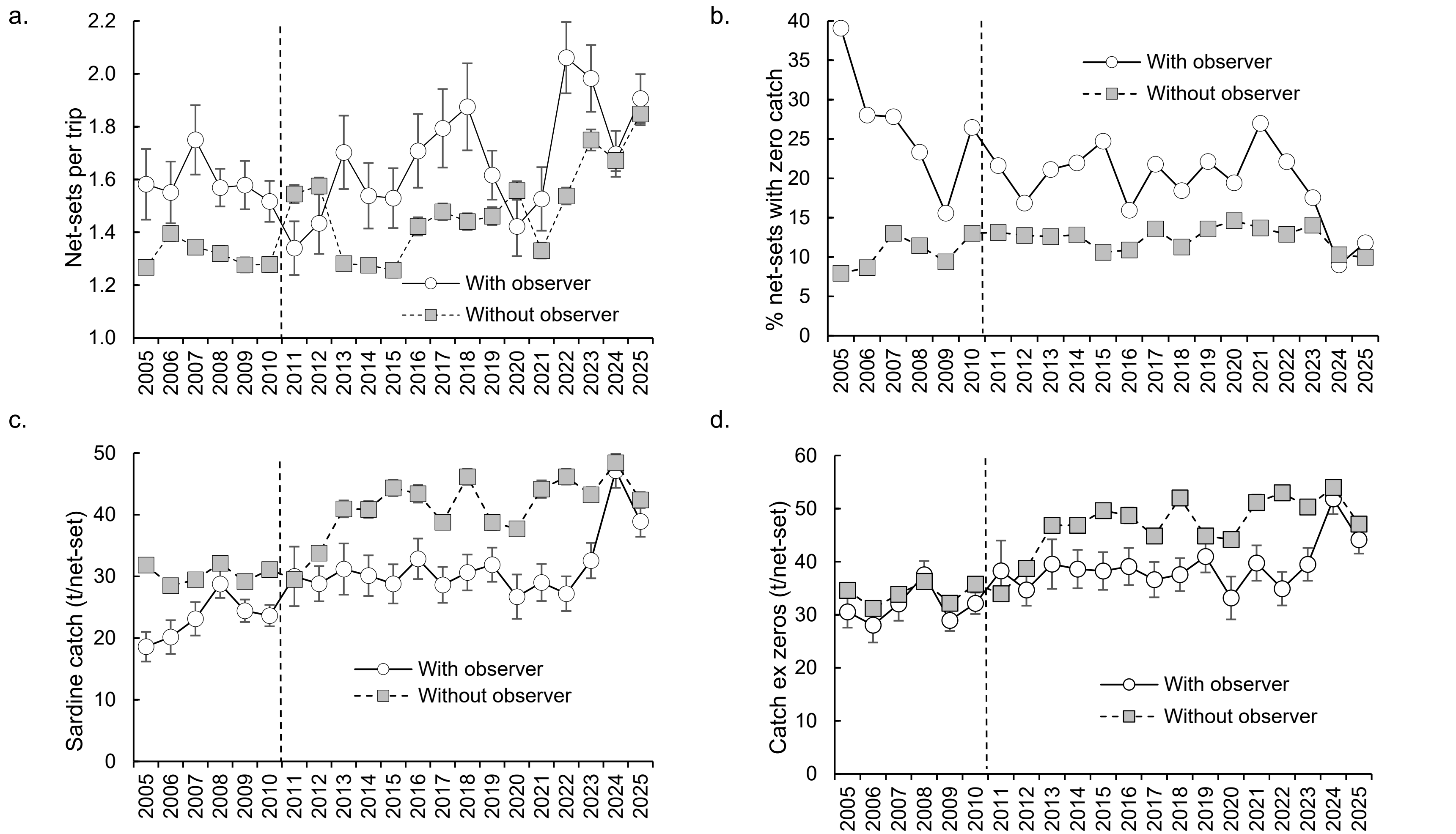


Figure 8. Comparison of indices of fishing behaviour with an observer (circles) and without an observer (squares), from 2005 to 2025: (a) net-sets per trip, (b) percentage net-sets with zero catch, (c) sardine catch per net-set (tonnes) including zero-catches, and (d) sardine catch per net-set excluding zero-catch net-sets. Dashed line separates less comparable (prior to 2011) and more comparable data (see methods).

In 2025 across the fleet, catch per net-set was not significantly influenced by observer presence ($p = 0.164$), although there was considerable variability among vessels. Mean catch per net-set by vessels ranged between 71% more and 42% less when an observer was present. In 2024, when there was also no significant difference across the fleet ($p = 0.387$), variability between vessels was less than in 2025, ranging between 22% more and 26% less catch per net-set when an observer was present. In 2023 and 2022, catches were significantly less when observers were present ($p < 0.001$). The ranges across vessels were from 6% more to 59% less catch with an observer present in 2023, and 21% to 73% less catch with an observer present in 2022.

Dolphin Deterrent Devices (DDD)

Although it was not a requirement in 2025, observers opportunistically recorded use of DDDs. Of 220 net-sets observed, DDD deployment was recorded for 171 (78%), non-deployed for 12 (5%) and deployment status was not recorded for 37 net-sets (17%). All vessels used DDDs to some extent, with at least three vessels deploying them on every net-set, and use was in all fishing zones. Nine of the 12 non-deployments occurred in the WCOZ, where dolphin interaction rates have been lowest.

4. DISCUSSION

The 1063 net-sets in SASF in 2025 was more than average, but within the range across previous years. The spatial distribution of net-sets was also similar to previous years, with the majority being in the SGZ. In 2025, as occurred in 2024, rates of Common Dolphin interactions, including dolphin presence delaying net-sets, dolphin encirclements and dolphin mortalities, were among the lowest levels recorded for the fishery since 2004. Also, for the second year in a row, all indices of fishing behaviour across the fleet indicated no significant differences between observed and unobserved net-sets. However, there was considerable variability between vessels in the level to which observer presence influenced catch per net-set.

4.1. Observer coverage

The 20.7% of net-sets observed in 2025 exceeded the target level of 20% coverage. The coverage was well distributed across months, vessels and zones, fulfilling the temporal and spatial requirements of the observer program (PIRSA 2020). Low coverage had been evident in the SEOZ in 2023 and 2024, but with 17% of net-sets observed there in 2025, that gap was corrected. In the GSVZ, however, all observed net-sets were in Investigator Strait and against the boundary with the SGZ, and none were in Gulf St Vincent itself. Low levels of observer coverage within Gulf St Vincent itself were also evident in 2023 and 2024. Considering the potential that Common Dolphins within Gulf St Vincent are semi-isolated from populations elsewhere in South Australia (Barceló et al. 2021, 2022), ensuring robust observer coverage of fishery-dolphin interactions in Gulf St Vincent proper should be prioritised.

Code of Practice (CoP) assessment

In 2025, observers reported that in their presence, fishers consistently adhered to the CoP. Fishers always checked for dolphins prior to net-setting and throughout fishing operations, delayed net-sets if dolphins were sighted, immediately reacted to free encircled or entangled dolphins, and released dolphins by opening the front of the net and aborting the set if dolphins did not release immediately.

4.2. Dolphin interactions

Dolphin presence

The reduction in the rate of dolphin-caused delays in net-setting evident since 2020 continued into 2025. In 2020, observers recorded that in 24% of approaches to set a net around a school of sardines, the sighting of dolphins around the vessel or the sardine school delayed the immediate net-setting opportunity. The rate of dolphin-caused delays dropped to 21% in 2021, 14% in 2022, 13% in 2023, 6% in 2024, then to 5% in 2025. Such a significant and sustained reduction may have been influenced by either ongoing changes to fishing practices, declines in dolphin numbers, a reduction in dolphin attraction to net-setting, or a combination of these factors.

However, in 2025, dolphins arrived frequently after net-setting and fed on sardines on the outside of the net. The arrival of dolphins after 48% of net-sets approximated the long-term average (since 2008) of dolphins arriving after 49% net-sets. In 2024, dolphin attendance had been lower, after 42% of net-sets, but this had followed seven years of attendances following >50% of net-sets (max. of 72% in 2021). The average level of dolphin attendance after net-sets in 2025 suggests that reductions in dolphin numbers or reduced attraction to fishing operations were not the primary cause behind the reduced rates of delays to net-setting.

Encirclements

Along with the low rate of dolphin-caused delays to net-setting, the rate of dolphin encirclement in 2025 was also reduced compared with previous years. Estimates based on observer data (32 encirclement events involving 97 dolphins) were the lowest annual levels recorded for the fishery. There was also no difference between the encirclement rates recorded by observers and the rates recorded when observers were absent, which has been consistently the case.

Mortalities

Dolphin mortality rates recorded in 2025 were similar to those recorded in recent years. Two mortalities were recorded in net-sets without an observer present, and one was interpreted from the information provided for an observed net-set. The latter event was the first recorded mortality in three years to coincide with when an observer was aboard a vessel.

The 5-year running-mean of dolphin mortalities continued to indicate higher rates with an observer present than without an observer (10 dolphins compared with 2 dolphins per year, respectively for the period 2021 to 2025). This was largely due to several mortality events which occurred with an observer present in 2021 and 2022. Since 2022, however, there have been six mortality events recorded in unobserved net-sets and only one (in 2025) in an observed net-set. With a 20% observer coverage (for 2024 and 2025), these results indicate no apparent difference in dolphin mortality rates related to observer presence. Thus, under-reporting of dolphin mortalities has not been evident in recent years.

4.3. Fishing behaviour

In 2025, as was the case in 2024, indices of fishing behaviour were not significantly different in data collected with and without an observer present. In years from 2005 to 2023, overarching trends revealed that with an observer present, there were more net-sets per night, more net-sets with zero sardine catch, and lower sardine catch rates (even when excluding zero-catches). There were differences between vessels, though, with some catching significantly more sardines per net-set when observers were not present.

4.4. Regression analyses – GAMs

The GAM analyses provided a flexible framework for examining both linear and non-linear relationships between operational, environmental, and temporal variables and key fishery responses, including observer presence, dolphin encirclement, and sardine catch. The models indicated that several predictors, particularly time-of-day, moon illumination, and fishing location variables, influenced response patterns in ways that would not have been captured using standard linear approaches. Not all variables could be tested in all models, in some cases due to their intrinsic links with the response variables. In addition, depth-related effects could not be assessed well due to spatial resolution mismatches, which introduced uncertainty into the derived water depth estimates. Despite these limitations, the GAM approach improved understanding of the factors associated with fishing performance and dolphin interactions, and how the contributions of predictor variables to response variables have changed over time. In particular, the analyses further clarified the recent changes in relationships between observer presence and both dolphin mortality events and sardine catch.

4.5. Management considerations

Observer effect and under-reporting

In 2025, as in 2024, the observer and catch data provided no evidence of a significant observer effect or under-reporting of dolphin mortalities. Several factors may have contributed to these results. There has been progressive adaptation within the fishery, potentially encouraged by the higher observer coverage in 2024 and 2025 (20% compared with 10% in previous years). Also implementation and uptake of DDDs across the fleet in 2025 was likely to have reduced dolphin presence when net-setting and dolphin encirclement rates. Oceanographic conditions, which vary between years, also potentially influence dolphin abundance and distributions, and therefore availability to interact with SASF operations.

Oceanography

Important drivers of interannual variations in Common Dolphin distributions in South Australian coastal waters likely include water temperature and currents, and impacts of these on prey availability (Bilgmann et al. 2014, Peters et al. 2020, Zanardo et al. 2016). There is considerable spatial and temporal variability in the oceanographic conditions in the SASF region (Figure 9). For example, the partially enclosed and shallow gulfs heat up each summer resulting in strong thermohaline gradients in their southern regions (O'Connell et al. 2016). Also during January to March, upwelling events routinely bring cold (<15°C) bathyal waters onto the continental shelf (Lewis 1981). This upwelling is initiated by easterly winds blowing surface coastal-waters from west-facing coastlines away from the coast (Schahinger 1987, McClatchie et al. 2006). The volume of cold water drawn onto the shelf, and its expression on the surface, varies among years depending on the strength and persistence of the easterly winds (Shute et al. 2022).

In 2022, summer-autumn warming of the gulfs and upwelling of cold water in the southeast was evident in February and March (Figure 9). Strengthening of the surface coastal current driven by westerly winds occurred in May. In 2023, the gulfs heated to a lesser degree than they had in 2022 and there was minimal cold-water upwelling expression in surface waters. The westerly wind driven current gained strength in April rather than May. In 2024, there was a late heating of the gulfs in March. The strongest feature in 2024, however, was an extreme, broad, and persistent upwelling event that continued into winter. As Common Dolphins are known to avoid water temperatures <15°C (Jefferson et al. 2009, Murphy et al. 2013), the upwelling of cold water and its persistence on the shelf potentially reduced Common Dolphin abundance in SASF fishing zones in 2024 (Kirkwood et al. 2025).

In 2025, there was a mild upwelling evident in February that was expressed at the surface to the southeast of the SEOZ. Overall, though, surface waters were warmer than average, with heat wave conditions in some areas. The gulfs and coastal waters were warmer than they had been in the previous three autumn periods. Common Dolphins are recorded to be more tolerant of warmer than cooler waters (Jefferson et al. 2009, Murphy et al. 2013). As for the colder than average temperatures in 2024, though, the warmer than average temperatures in 2025 also may have modified Common Dolphin distributions and influenced the reduced interaction rates.

Harmful algal bloom

In April 2025, a harmful algal bloom (HAB) was detected in the SEOZ and the GSVZ of the SASF, and persisted in the Gulf for the rest of the year (Kämpf 2025, Murray et al. 2025). The bloom triggered catastrophic mortality events that affected hundreds of species of flora and fauna (Murray et al. 2025). SASF fishing in the affected zones was markedly reduced. It is unclear how the HAB event influenced Common Dolphin distributions and dolphin interaction rates with the SASF. Undoubtedly, though, Common Dolphin prey abundance was reduced in the HAB affected areas, and many dolphins would have sought prey elsewhere.

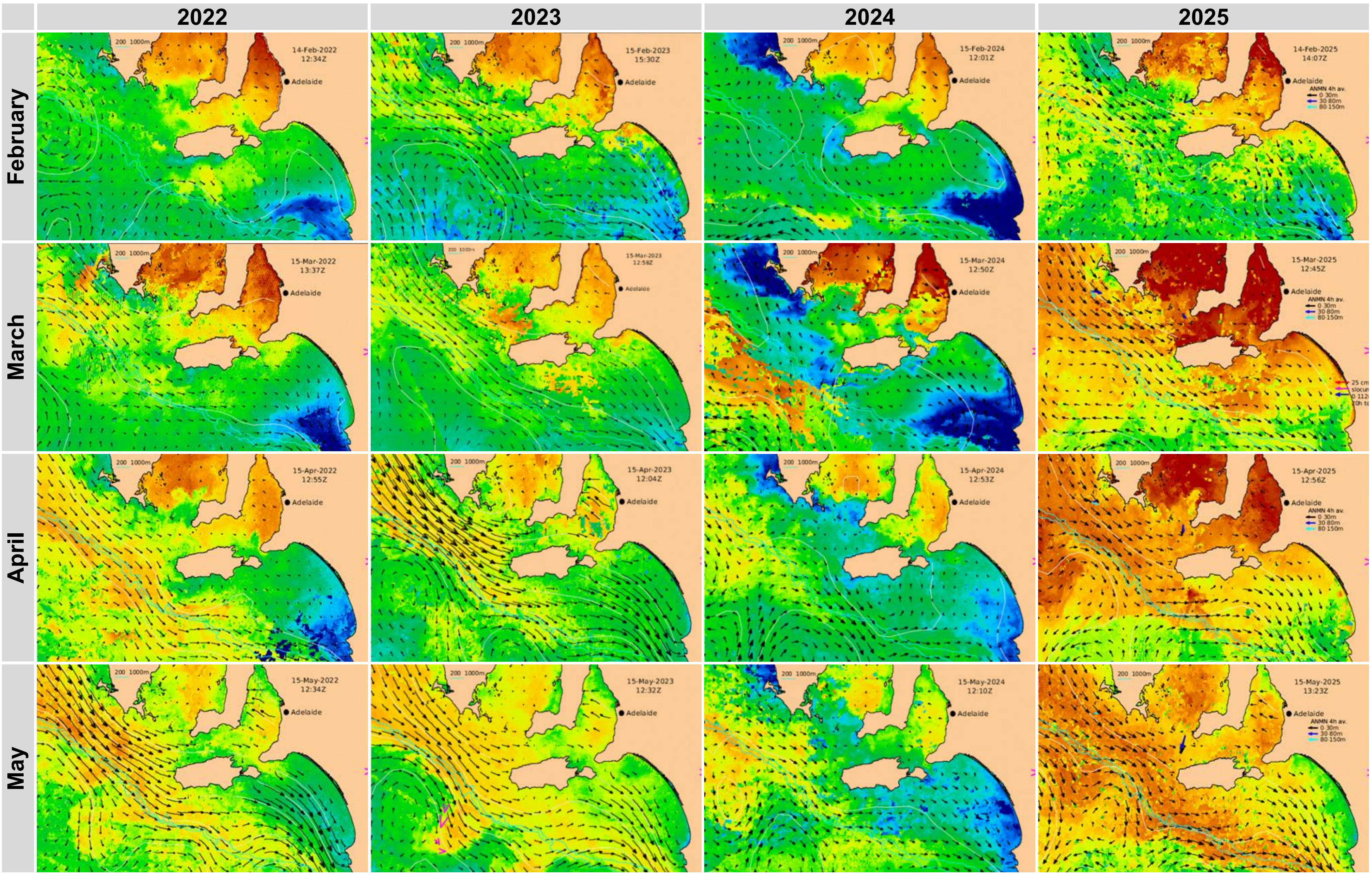


Figure 9. IMOS sea-surface temperature data (blue = 14–15°C, dark-green = 17°C, red = 22°C) off South Australia, for the middle day of the month, February to May, 2022 to 2025 (black arrows show surface current, IMOS Ocean Current data available at https://oceancurrent.aodn.org.au/).

4.6. Conclusion

Analyses of observer and logbook data collected for the SASF in 2025 indicated no evidence of a significant observer effect or under-reporting of dolphin mortalities. These findings likely reflect progressive changes and adaptations within the fishery and its management that have aimed to minimise dolphin interactions.

It remains unclear how external factors, including changing oceanographic conditions and the unprecedented HAB event, impacted Common Dolphin distributions, prey populations including sardines, as well as fishing effort. There are no data on variability of distribution and movement patterns of Common Dolphins in response to annual cycles and oceanographic conditions in South Australian waters.

The efficacy of the DDDs was not assessed. However, the frequent use of the DDDs by fishers in 2025 suggested that they felt the devices reduced dolphin interactions and improved fishing efficiency. The deterrent value of the devices may change over time as dolphins become either sensitised to the acoustics or habituate to them. Different deployment techniques may influence efficacy, such as use of multiple devices, modes of deployment (e.g., depth, attached to the net, deployment from a skiff, or a drogue) and deployment durations prior to and post net-setting.

REFERENCES

Archer, F., Gerrodette, T., Dizon, A., Abella, K. and Southern, S. (2001). Unobserved kill of nursing dolphin calves in a tuna purse-seine fishery. *Marine Mammal Science* 17: 540–554.

Bailleul, F., Ivey, A., Grammer, G.L. and Earl, J. (2025). Stock assessment of Australian Sardine (*Sardinops sagax*) off South Australia 2025. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000765-10. *SARDI Research Report Series* No. 1276. 98 pp.

Barceló, A., Sandoval-Castillo, J., Brauer, C.J., Bilgmann, K., Parra, G.J., Beheregaray, L.B. and Möller, L.M. (2022). Seascape genomics of common dolphins (*Delphinus delphis*) reveals adaptive diversity linked to regional and local oceanography. *BMC Ecology and Evolution* 22(1): 88.

Barceló, A., Sandoval-Castillo, J., Stockin, K.A., Bilgmann, K., Attard, C.R M., Zanardo, N., Parra, G.J., Hupman, K., Reeves, I.M., Betty, E.L., Tezanos-Pinto, G., Beheregaray, L B. and Möller, L.M. (2021). A matter of scale: population genomic structure and connectivity of fisheries at-risk common dolphins (*Delphinus delphis*) from Australasia. *Frontiers in Marine Science* 8: 616673.

Bartholomew, D.C., Mangel, J.C., Alfaro-Shigueto, J., Pingo, S., Jimenez, A. and Godley, B.J. (2018). Remote electronic monitoring as a potential alternative to on-board observers in small-scale fisheries. *Biological Conservation* 219: 35–45.

Benoît, H.P. and Allard, J. (2009). Can the data from at-sea observer surveys be used to make general inferences about catch composition and discards? *Canadian Journal of Fisheries and Aquatic Sciences* 66(12): 2025–2039.

Bilgmann, K., Möller, L.M., Harcourt, R.G., Gales, R. and Beheregaray, L.B. (2008). Common dolphins subject to fisheries impacts in Southern Australia are genetically differentiated: implications for conservation. *Animal Conservation* 11: 518–528.

Bilgmann, K., Parra, G.J., Zanardo, N., Beheregaray, L.B. and Möller, L.M (2014). Multiple management units of short-beaked common dolphins subject to fisheries bycatch off southern and south-eastern Australia. *Marine Ecology Progress Series* 500: 265–279.

Bilgmann, K., Parra, G.J. and Möller, L.M. (2017). Occurrence, distribution and abundance of cetaceans off the western Eyre Peninsula in the Great Australian Bight. *Deep Sea Research Part II* 157-158: 135–145.

Burns, R.J. and Kerr, G.N. (2008). Observer effect on fisher bycatch reports in the New Zealand ling (*Genypterus blacodes*) bottom longlining fishery. *New Zealand Journal of Marine and Freshwater Research* 42(1): 23–32.

Edwards, E.F. (2006). Duration of unassisted swimming activity for spotted dolphin (*Stenella attenuata*) calves: implications for mother-calf separation during tuna purse-seine sets. *Fisheries Bulletin* 104: 125–135.

Emery, T.J., Noriega, R., Williams, A.J. and Larcombe, J. (2019). Changes in logbook reporting by commercial fishers following the implementation of electronic monitoring in Australian Commonwealth fisheries. *Marine Policy* 104: 135–145.

Forney, K.A., St Aubin, D.J. and Chivers, S.J. (2002). Chase encirclement stress studies on dolphins involved in eastern tropical Pacific Ocean purse-seine operations during 2001. *NOAA Administrative Report* LJ-02-32. 26 pp.

Filby, N.E., Bossley, M., Sanderson, K.J., Martinez, E. and Stockin, K.A. (2010). Distribution and population demographics of common dolphins (*Delphinus delphis*) in the Gulf St. Vincent, South Australia. *Aquatic Mammals* 36: 33-45.

Gilman, E., Suuronen, P., Hall, M. and Kennelly, S. (2013). Causes and methods to estimate cryptic sources of fishing mortality. *Journal of Fish Biology* 83(4): 766–803.

Goldsworthy, S.D. (2018). Effectiveness of the industry Code of Practice in mitigating Interactions between short-beaked common dolphins and the South Australian Sardine Fishery: 2017-18 Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. F2010/000726-9. *SARDI Research Report Series* No. 1000. 36 pp.

Goldsworthy, S.D., Ferguson, G.J. and Ward, T.M. (2019). Assessment of dolphin interactions, effectiveness of Code of Practice and fishing behaviour in the South Australian Sardine Fishery: 2018-19. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. F2010/000726-10. *SARDI Research Report Series* No. 1041. 36 pp.

Goldsworthy, S.D., Kirkwood, R., Kemper, C., Bilgmann, K. and Bailleul, F. (2025). Abundance, population modelling, and potential biological removal estimates for Common Dolphins in Spencer

Gulf: implications for the South Australian Sardine Fishery, Adelaide. *Final Report to FRDC* 2019-063. 64 pp.

Hamer, D.J. and Ward, T.M. (2007). Operational interactions between the South Australian Sardine Fishery and common dolphins in 2006/07: assessing the effectiveness of the industry Code of Practice. SARDI Aquatic Science Publication No. F2007/00198-1. *SARDI Research Report Series* No. 252. 30 pp.

Hamer, D.J., Ward, T.M., Goldsworthy, S.D., McGarvey, R. and Rogers, P.J. (2007). Measurement, management and mitigation of operational interactions between common dolphins and the South Australian Sardine Fishery. SARDI Aquatic Science Publication No. F2006/00212. *SARDI Research Report Series* No. 174. 38 pp.

Hamer, D.J., Ward, T.M. and McGarvey, R. (2008). Measurement, management and mitigation of operational interactions between the South Australian Sardine Fishery and short-beaked common dolphins (*Delphinus delphis*). *Biological Conservation* 141: 2865–2878.

Hamer, D.J., Ivey, A. and Ward, T.M. (2009). Operational Interactions of the South Australian Sardine Fishery with the common dolphin: November 2004 to March 2009. SARDI Aquatic

Heinemann, D. (2017). Cryptic mortality correction factors, In: National Marine Fisheries Service. Proceedings of the First National Protected Species Assessment Workshop. *NOAA Technical Memorandum* NMFS-F/SPO-172. pp 60–63.

Ivey, A. R., Grammer, G. L. and Earl, J. (2025). Spawning biomass of Sardine, *Sardinops sagax*, in waters off South Australia in 2025. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2022/000000-1. *SARDI Research Report Series* No. 1271. 33 pp.

Jaiteh, V.F., Allen, S.J., Meeuwig, J.J. and Loneragan, N.R. (2013). Subsurface behavior of bottlenose dolphins (*Tursiops truncatus*) interacting with fish trawl nets in northwestern Australia: Implications for bycatch mitigation. *Marine Mammal Science* 29(3): E266–E281.

Jefferson, T.A., Fertl, D., Bolaños-Jiménez, J. and Zerbini, A.N. (2009). Distribution of common dolphins (*Delphinus* spp.) in the western Atlantic Ocean: a critical re-examination. *Marine Biology* 156(6): 1109–1124.

Johnson, D.R., Yeung, C. and Brown, C.A. (1999). Estimates of marine mammal and marine turtle bycatch by the US Atlantic pelagic longline fleet in 1992-1997. *NOAA Technical Memorandum* NMFS-SEFSC-418. 70 pp.

Kämpf, J. (2025). Prediction of the spreading of an unprecedented harmful algal bloom in South Australian gulfs. *Continental Shelf Research* 105631.

Kennelly, S. (2020). Australia’s First National Bycatch Report. *FRDC Project Report* ISBN: 978-0-6488217-0-0. 128 pp.

Kemper, C., Tomo, I., Bovari, G., Hamer, D., Gibbs, S. and Fellowes, T.S. (2023). Characterising injuries and pathologies of common dolphin *Delphinus delphis* mortalities in the South Australian Sardine Fishery. *Diseases of Aquatic Organisms* 156: 99–114.

Kirkwood, R. and Goldsworthy, S.D. (2021). Assessment of dolphin interactions, effectiveness of Code of Practice and fishing behaviour in the South Australian Sardine Fishery: 2020-21. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000726-12. *SARDI Research Report Series* No. 1116. 31 pp.

Kirkwood, R. and Goldsworthy, S.D. (2022). Assessment of dolphin interactions, effectiveness of Code of Practice and fishing behaviour in the South Australian Sardine Fishery: 2021-22. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000726-13. *SARDI Research Report Series* No. 1154. 34 pp.

Kirkwood, R. and Goldsworthy, S.D. (2024a). Assessment of dolphin interactions, effectiveness of Code of Practice and fishing behaviour in the South Australian Sardine Fishery: 2022. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic and Livestock Sciences), Adelaide. SARDI Publication No. F2010/000726-14. *SARDI Research Report Series* No. 1209. 58 pp.

Kirkwood, R. and Goldsworthy, S.D. (2024b). Assessment of dolphin interactions, effectiveness of Code of Practice and fishing behaviour in the South Australian Sardine Fishery: 2023. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic and Livestock Sciences), Adelaide. SARDI Publication No. F2010/000726-15. *SARDI Research Report Series* No. 1220. 48 pp.

Kirkwood, R, and Goldsworthy, S.D. (2025). Assessment of dolphin interactions, effectiveness of Code of Practice and fishing behaviour in the South Australian Sardine Fishery in 2024. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic and Livestock Sciences), Adelaide. SARDI Publication No. F2010/000726-16. SARDI Research Report Series No. 1254, 47 pp.

Kirkwood, R.J., Goldsworthy, S.D. and Ward, T.M. (2020). Assessment of dolphin interactions, effectiveness of Code of Practice and fishing behaviour in the South Australian Sardine Fishery: 2019-20. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000726-11. *SARDI Research Report Series* No. 1077. 34 pp.

Luck, C., Jessopp, M., Tully, O., Cosgrove, R., Rogan, E. and Cronin, M. (2020). Estimating protected species bycatch from limited observer coverage: A case study of seal bycatch in static net fisheries. *Global Ecology and Conservation* 24: p.e01213.

McClatchie, S., Middleton, J.F., Ward, T.M. (2006). Water mass analysis and alongshore variation in upwelling intensity in the eastern Great Australian Bight. *Journal of Geophysical Research: Oceans* 111(C8).

Mackay, A.I. and Goldsworthy, S.D. (2016). Mitigating operational interactions with short-beaked common dolphin (*Delphinus delphis*): application of the South Australian Sardine Fishery industry Code of Practice 2015-16. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. F2010/000726-7. *SARDI Research Report Series* No. 934. 39 pp.

Mackay, A.I. and Goldsworthy, S.D. (2017). Mitigating operational interactions with short-beaked common dolphin (*Delphinus delphis*): application of the South Australian Sardine Fishery industry Code of Practice 2016-17. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. F2010/000726-8. *SARDI Research Report Series* No. 970. 44 pp.

Moore, J.E., Heinemann, D., Francis, T.B., Hammond, P.S., Long, K.J., Punt, A.E., Reeves, R.R., Sepúlveda, M., Sigurðsson, G.M., Siple, M.C. and Víkingsson, G.A. (2021). Estimating bycatch mortality for marine mammals: concepts and best practices. *Frontiers in Marine Science* 8: p.752356.

Murphy, S., Pinn, E.H. and Jepson, P.D. (2013). The short-beaked common dolphin (*Delphinus delphis*) in the North-East Atlantic: distribution, ecology, management and conservation status. *Oceanography and Marine Biology: An annual review* 51: 193–280.

Murray, S.A., Bolch, C.J., Brett, S., Chan, C.X., Doubell, M., Farrell, H., Gaiani, G., Greenhough, H., Hallegraeff, G., Harding, T.S. and Harwood, D.T. (2025). A catastrophic marine mortality event caused by a complex algal bloom including the novel brevetoxin producer, *Karenia cristata* (Dinophyceae). *bioRxiv* 2025–10.

O'Connell, L.G., James, N.P., Doubell, M., Middleton, J.F., Luick, J., Currie, D.R. and Bone, Y. (2016). Oceanographic controls on shallow-water temperate carbonate sedimentation: Spencer Gulf, South Australia. Sedimentology, 63(1): 105–135.

Perrin, W. (2017). Common Dolphins. In: Encyclopedia of Marine Mammals: Third Edition (eds B Würsig, J.G.M. Thewissen and K.M. Kovacs) Academic Press, Elsevier. pp 205–209.

Parra, G.J., Bilgmann, K., Peters, K.J. and Möller, L.M. (2021). Abundance and potential biological removal of common dolphins subject to fishery impacts in South Australian waters. *Frontiers in Marine Science* 8:1237.

Peters, K. J., Bury, S. J., Betty, E. L., Parra, G. J., Tezanos-Pinto, G. and Stockin, K. A. (2020). Foraging ecology of the common dolphin *Delphinus delphis* revealed by stable isotope analysis. *Marine Ecology Progress Series* 652: 173–186.

PIRSA (2014). Paper number 68: Management plan for the South Australian Commercial Marine Scalefish Fishery, Part B– management arrangements for the taking of sardines South Australian Fisheries Management Series. 88 pp.

PIRSA (2020). Sardine Fishery Operator User Guide. Government of South Australia. 21 pp.

R Core Team (2025). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.Rproject.org/ .

SASIA (2021). Code of practice for mitigating the interactions of the South Australian Sardine Fishery with wildlife. South Australian Sardine Industry Association (SASIA). Port Lincoln. 16 pp.

Schahinger, R.B. (1987). Structure of coastal upwelling events observed off the south-east coast of South Australia during February 1983–April 1984. *Australian Journal of Marine and Freshwater Research* 38(4): 439–459.

Shute, A., Kämpf, J., Doubell, M., Rodriguez, A.R., Möller, L., Baring, R. and Newman, M. (2022). Variability of surface and subsurface phytoplankton blooms in a seasonal coastal upwelling system. *Continental Shelf Research* 246. p.104832.

St Aubin, D.J., Forney, K.A., Chivers, S.J., Scott, M.D., Danil, K., Romano, T.A., Wells, R.S. and Gulland, F.M. (2013). Haematological, serum, and plasma chemical constituents in pantropical spotted dolphins (*Stenella attenuata*) following chase, encirclement, and tagging. *Marine Mammal Science* 29(1): 14–35.

Ward, T.M., Attwood-Henderson, I. and Kirkwood, R. (2023). Monitoring and mitigating interactions between small pelagic fisheries and dolphins: literature review and analysis of fishery data. Fisheries Research and Development Corporation Project No. 2020-049, *Final Report to FRDC* 46 pp.

Ward, T.M., Ivey, A.R. and Burch, P. (2010). 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*). South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000726-1. *SARDI Research Report Series* No. 439. 38 pp.

Ward, T.M., Ivey, A., Hamer, D.J. and Burch, P. (2011). 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*). South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000726-2. *SARDI Research Report Series* No. 583. 32 pp.

Ward, T.M., Ivey, A.R. and Burch, P. (2012). 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*). South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000726-3. *SARDI Research Report Series* No. 666. 27 pp.

Ward, T.M., Ivey, A.R. and Burch, P. (2013). 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*). South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000726-4. *SARDI Research Report Series* No. 743. 32 pp.

Ward, T.M., Ivey, A. and Carroll, J. (2015a). 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*). Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000726-5. *SARDI Research Report Series* No. 821. 35 pp.

Ward, T.M., Ivey, A. and Carroll, J. (2015b). 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*). Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000726-6. *SARDI Research Report Series* No. 876. 35 pp.

Ward, T.M., Ivey, A. and Carroll, J. (2018). Code of practice for reducing accidental mortality of dolphins in purse-seine fisheries. *Marine Policy* 87: 203–211.

Wakefield, C.B., Hesp, S.A., Blight, S., Molony, B.W., Newman, S.J. and Hall, N.G. (2018). Uncertainty associated with total bycatch estimates for rarely-encountered species varies substantially with observer coverage levels: Informing minimum requirements for statutory logbook validation. *Marine Policy* 95: 273–282.

Wickham, H., François, R., Henry, L., Müller, K. and Wickham, M.H. (2019). Package ‘dplyr’. A grammar of data manipulation. R package version 8.

Wood, S.N., Pya, N. and Säfken, B. (2016). Smoothing parameter and model selection for general smooth models. *Journal of the American Statistical Association* 111(516): 1548–1563.

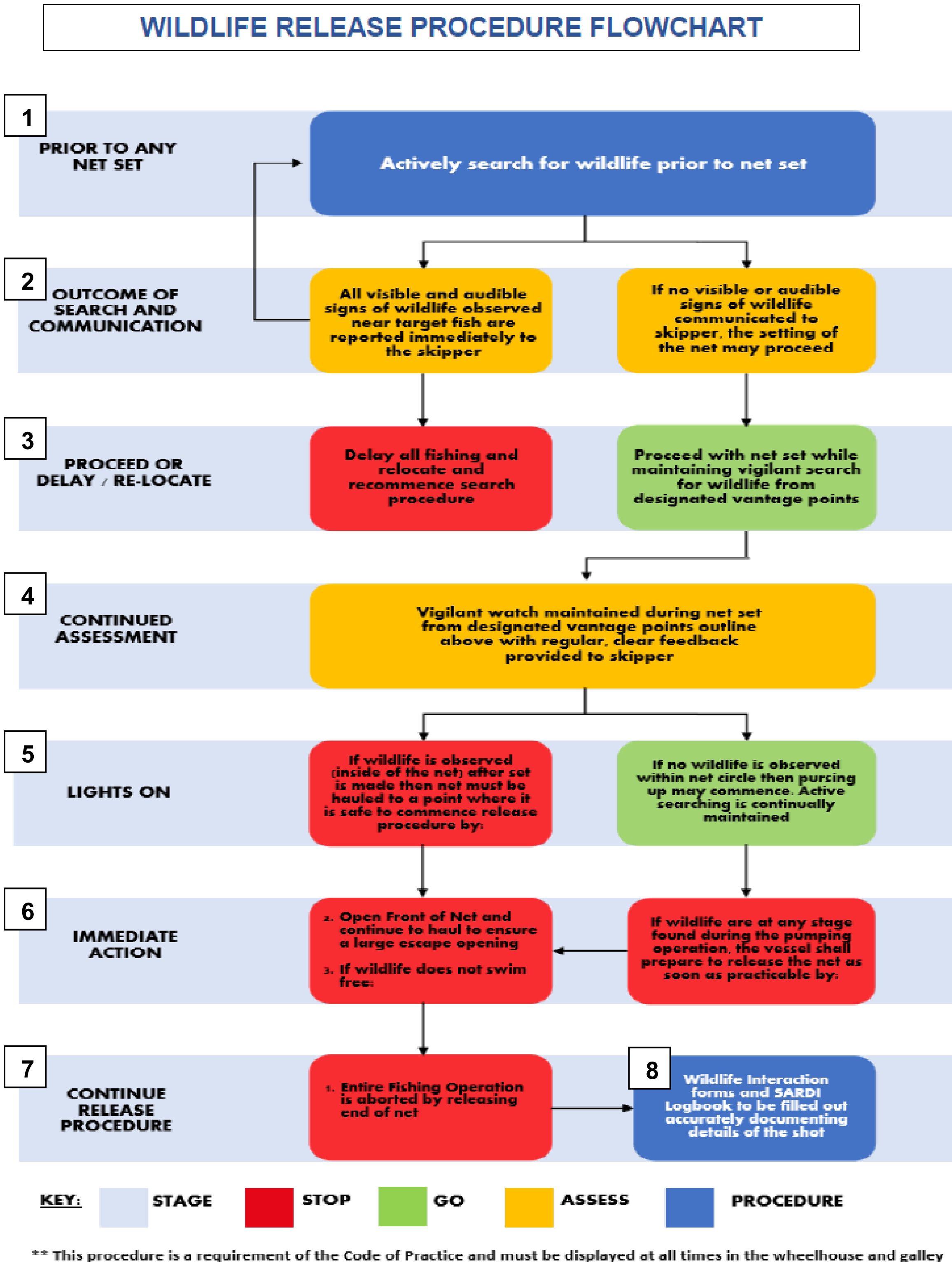
Wood, S.N. (2017). *Generalized additive models: an introduction with R, 2nd edition*. CRC press, Bristol, UK.

Zanardo, N., Parra, G. J. and Möller, L. M. (2016). Site fidelity, residency, and abundance of bottlenose dolphins (*Tursiops* sp.) in Adelaide's coastal waters, South Australia. *Marine Mammal Science* 32(4): 1381–1401.

Zollett, E.A., Trumble, R.J., Swasey, J.H. and Stebbins, S.B. (2015). Guiding principles for development of effective commercial fishery monitoring programs. *Fisheries* 40(1): 20–25.

APPENDIX 1. CODE OF PRACTICE FLOWSHEET

Operational steps to mitigate interactions with Common Dolphins in the South Australian Sardine Fishery (SASF), Code of Practice (CoP) (SASIA 2021).



APPENDIX 2. OBSERVER DATASHEET

SASF TEPS OBSERVER DATASHEET

SARDI Logbook No.		Observer name and signature	
Trip Start Date			
Trip End Date		Time of each fishing stage	Time (24:00 hr)
Skipper name		1. Start net-set	
Vessel name and Licence no.		2. Begin pursing	
Shot date		3. Begin hauling	
Shot no.		4. End hauling	
Wind (knots)		5. Begin pumping	
Swell height (m)		6. Finish net-set	

Code of Practice Assessment	Y/N	No. of times	Comments (details of application of CoP)
Active search from designated vantage points			
Dolphins present – delay			
Dolphins present – relocate			
Active search after setting			
Immediate action to encirclement			

Dolphin encirclement details

Species	
Time first observed (24:00hr)	
Time release commenced (24:00hr)	
Stage first observed	Setting ☐ Pursing ☐ Hauling ☐ Pumping ☐
Stage release commenced	Setting ☐ Pursing ☐ Hauling ☐ Pumping ☐
Release method used	Open front of net ☐ Herd with skiff ☐ Other (describe): Abort shot ☐ Cut out of net ☐

Initial condition of dolphins		Nature of encirclement		Condition of released dolphins	
No. alive		No. free in net		No. alive	
No. injured		No. entangled inside net		No. injured	
No. dead		No. entangled outside net		No. dead	

Comments

IF NO FISH CAUGHT THIS SHOT PLEASE √ BOXES

No Fish Seen	Shot Missed School	Too Rough	Break Down	Net Damage	Dolphins	Fish Not Schooling	Other

Wildlife interactions	Species	No. of individuals	Behaviour / nature of interaction
Dolphins (outside net)			
Seals			
Sharks			
Other			

APPENDIX 3. WILDLIFE INTERACTION FORM

SOUTH AUSTRALIAN SARDINE FISHERY WILDLIFE INTERACTION FORM

Date of interaction	Observer On Board (tick)	Licence Number	Corresponding Logbook No.
	Yes ☐ No ☐		

Shot No.	Time (24:00 HR)	Location		Common species name (see species list and identification guide)	Number of Animals	Nature of interaction				Status			Fate		Band or tag #
		Latitude	Longitude			Caught	Entangled	Impact/ collision	Other	Alive	Dead	Injured	Released / discarded	Retained	

CODE OF PRACTICE ASSESSMENT – FILL IN WHEN A DOLPHIN IS SIGHTED DURING SEARCHING AND/OR ENCIRCLEMENT OCCURS

Actively search prior to setting: No ☐	**Dolphins present – delay**	**No** ☐	**Yes** ☐	**No. of times:** ________	**Actively search after setting:** No ☐
Yes ☐	**and/or Dolphins present – relocate**	**No** ☐	**Yes** ☐	**No. of times:** ________	**Yes** ☐

Time (24:00HR) first observed		**Stage first observed**	Setting ☐	Pursing ☐	Hauling ☐	Pumping ☐
Time (24:00HR) release commenced		**Stage release commenced**	Setting ☐	Pursing ☐	Hauling ☐	Pumping ☐
Release method used	**Open front of net** ☐	**Herd with skiff** ☐	**Other (describe):**			
	Abort shot ☐	**Cut out of net** ☐				

Initial condition of dolphins		**Nature of encirclement**		**Condition of released dolphins**	
No. alive		No. free in net		No. alive	
No. injured		No. entangled inside net		No. injured	
No. dead		No. entangled outside net		No. dead	

Comments:

I certify this form to be complete and accurate ....(Signature of Licence Holder/Master)

APPENDIX 4. GAM RESULTS

Relationship	Variable	Data type	Description
Linear	observer	factor	observer present: yes, no
	en_event	factor	encirclement event: 0, 1 (no, yes)
	m_event	factor	mortality event: 0, 1 (no, yes)
	zone	factor	Spencer Gulf (1sg), Gulf St Vincent (2gsv), South-East (3se), West Coast (4wc)
Smoothed non-linear	s(vessel)	random factor	only used in GAMs for catch (random factor due to range of vessel capacities)
	s(catch)	numeric	estimated sardine catch in tonnes
	s(time)	numeric	derived from start time, converted to radians to accommodate circular nature of occurrence
	s(moon)	numeric	Moon illumination, derived from day of the year and converted to radians to accommodate circular nature of occurrence
	s(depth)	numeric	water depth at the location of the net set – in metres with increasing depth as an increasing negative from a minimum of -10 m

Appendix 4.1 Results from Generalised Additive Models (GAMs) of annual data for SASF net-sets between 2021 and 2025.

GAMs for dependent variables 'Observer' & 'Encirclement' used Family binary & logit functions
GAMs for dependent variable 'Catch' used Family Tweedie & log functions

	2021		2022		2023		2024		2025	
Observer	z	p	z	p	z	p	z	p	z	p
en_event	-1.33	0.18	-2.71	**0.01**	-0.94	0.35	-1.54	0.12	-0.12	0.91
m_event	2.62	**0.01**	2.36	**0.02**	0.00	1.00	0.00	1.00	0.37	0.71
zone2gsv	2.23	**0.03**	-1.87	0.06	0.74	0.46	2.78	**0.01**	0.50	0.62
zone3se	-0.87	0.38	1.77	0.08	-1.78	0.08	-2.14	**0.03**	-0.36	0.72
zone4wc	0.66	0.51	0.69	0.49	1.02	0.31	0.30	0.76	-0.36	0.72
	Chi_2	p	Chi_2	p	Chi_2	p	Chi_2	p	Chi_2	p
s(catch)	13.85	**0.02**	33.17	**0.00**	11.25	**0.00**	2.56	0.29	1.30	0.25
s(time)	0.00	0.42	7.27	0.09	0.73	0.24	0.94	0.22	0.00	0.90
s(moon)	0.00	0.66	14.19	**0.04**	1.96	0.18	0.00	0.93	15.48	**0.02**
% Deviance explained	6.10		11.63		3.32		2.33		1.83	
n	859		997		992		928		1063	
Encirclement	z	p	z	p	z	p	z	p	z	p
observer	0.80	0.42	-0.22	0.83	0.47	0.64	-1.48	0.14	0.12	0.91
zone2gsv	2.63	0.01	1.17	0.24	-1.21	0.23	-0.30	0.76	2.40	**0.02**
zone3se	-0.27	0.79	-0.18	0.86	-0.66	0.51	-0.24	0.81	0.00	1.00
zone4wc	-1.96	0.05	-3.71	**0.00**	-2.61	**0.01**	0.00	1.00	-2.69	**0.01**
	Chi_2	p	Chi_2	p	Chi_2	p	Chi_2	p	Chi_2	p
s(time)	5.77	0.13	9.76	**0.05**	0.00	0.48	8.39	0.13	0.00	0.76
s(moon)	1.25	0.21	0.00	0.59	0.00	0.97	1.04	0.23	1.22	0.22
% Deviance explained	3.26		5.78		1.19		8.30		5.32	
n	859		997		992		928		1063	
Catch	z	p	z	p	z	p	z	p	z	p
observer	-5.04	**0.00**	-6.63	**0.00**	-2.95	**0.00**	-0.76	0.45	-1.47	0.14
en_event	-13.06	**0.00**	-14.03	**0.00**	-15.04	**0.00**	-8.48	**0.00**	-6.94	**0.00**
m_event	4.13	**0.00**	2.59	**0.01**	5.13	**0.00**	0.84	0.40	0.76	0.44
zone2gsv	-1.61	0.11	1.93	**0.05**	-1.05	0.29	-0.64	0.52	-1.10	0.27
zone3se	1.76	0.08	-0.50	0.62	-1.66	0.10	-0.02	0.98	0.93	0.35
zone4wc	-4.33	**0.00**	-1.24	0.22	-5.06	**0.00**	-0.57	0.57	0.34	0.74
	Chi_2	p	Chi_2	p	Chi_2	p	Chi_2	p	Chi_2	p
s(vessel)	31.58	**0.00**	35.21	**0.00**	31.57	**0.00**	31.01	**0.00**	35.99	**0.00**
s(time)	4.73	**0.00**	10.89	**0.01**	0.40	0.20	0.60	0.39	4.27	**0.01**
s(moon)	0.00	0.51	0.07	0.29	0.00	0.93	0.01	0.39	0.23	0.22
s(depth)	6.91	**0.01**	0.70	0.51	3.43	**0.01**	4.89	**0.03**	5.20	**0.00**
% Deviance explained	46.55		44.32		42.46		32.99		30.91	
n	836		953		955		882		1022	

Observer presence - the 10 top-ranked models within each year, with Akaike Information Criteria (AIC), delta AIC, and % deviance explained.

		Predictor variables for observer presence								
Rank	**Year**	**en_event**	**m_event**	**zone**	**s(catch)**	**s(time)**	**s(moon)**	**AIC**	**dAIC**	**% dev. expl.**
1	2021		+		+			601.87	0	3.58
2	2021		+		+		+	601.87	0.00	3.58
3	2021		+	+	+		+	602.15	0.28	4.51
4	2021		+	+	+			602.15	0.28	4.51
5	2021		+	+	+	+	+	602.15	0.29	4.51
6	2021		+	+	+	+		602.16	0.29	4.51
7	2021		+		+	+	+	602.33	0.46	3.68
8	2021		+		+	+		602.33	0.46	3.69
9	2021	+	+	+	+		+	603.10	1.23	4.68
10	2021	+	+	+	+	+	+	603.19	1.32	4.69
1	2022	+	+	+	+			664.53	0	8.15
2	2022	+	+	+	+	+		664.53	0.00	8.15
3	2022	+	+	+	+	+	+	664.53	0.00	8.15
4	2022	+	+	+	+		+	664.53	0.01	8.15
5	2022	+		+	+			667.53	3.01	7.44
6	2022	+		+	+	+		667.53	3.01	7.44
7	2022	+		+	+		+	667.54	3.01	7.45
8	2022	+		+	+	+	+	667.54	3.01	7.45
9	2022	+	+		+			669.01	4.48	6.63
10	2022	+	+		+	+		669.02	4.49	6.63
1	2023			+	+			766.29	0	2.51
2	2023			+	+	+		766.87	0.59	2.65
3	2023			+	+		+	766.95	0.66	2.83
4	2023				+			767.18	0.90	1.62
5	2023	+		+	+			767.35	1.07	2.74
6	2023			+	+	+	+	767.54	1.25	3.00
7	2023				+	+		767.77	1.48	1.76
8	2023	+			+			767.80	1.52	1.93
9	2023				+		+	767.89	1.60	1.79
10	2023		+	+	+			767.90	1.61	2.55
1	2024	+		+				961.52	0	1.63
2	2024	+		+			+	961.52	0.00	1.63
3	2024			+				961.83	0.30	1.39
4	2024			+			+	961.83	0.31	1.39
5	2024	+		+	+			962.11	0.59	2.10
6	2024	+		+	+		+	962.11	0.59	2.10
7	2024	+		+		+		962.12	0.60	1.76

Rank	Year	Predictor variables for observer presence						AIC	dAIC	% dev. expl.
		en_event	m_event	zone	s(catch)	s(time)	s(moon)			
8	2024	+		+		+	+	962.13	0.60	1.76
9	2024			+		+		962.42	0.90	1.55
10	2024			+		+	+	962.42	0.90	1.55
1	2025					+		1086.06	0	0.00
2	2025				+	+		1086.48	0.43	0.15
3	2025				+			1086.48	0.43	0.15
4	2025						+	1086.75	0.69	0.14
5	2025					+	+	1086.75	0.69	0.14
6	2025				+		+	1087.18	1.12	0.29
7	2025				+	+	+	1087.18	1.12	0.29
8	2025		+					1087.79	1.74	0.02
9	2025		+			+		1087.80	1.74	0.02
10	2025	+						1088.01	1.95	0.00

<u>Dolphin encirclements</u> - the 10 top-ranked models within each year, with Akaike Information Criteria (AIC), delta AIC, and % deviance explained.

Rank	Year	Predictor variables for encirclements				AIC	dAIC	% dev. expl.
		observer	zone	s(time)	s(moon)			
1	2021		+			708.14	0	1.77
2	2021		+	+		708.14	0.00	1.77
3	2021	+	+			708.82	0.68	2.01
4	2021	+	+	+		708.82	0.68	2.01
5	2021		+	+	+	709.45	1.32	1.86
6	2021		+		+	709.45	1.32	1.86
7	2021	+	+		+	710.14	2.00	2.11
8	2021	+	+	+	+	710.14	2.00	2.11
9	2021	+	+			714.62	6.48	0.55
10	2021	+	+	+		714.62	6.48	0.55
1	2022	+	+			680.48	0	4.02
2	2022	+	+	+		680.48	0.00	4.02
3	2022	+	+	+	+	680.48	0.00	4.02
4	2022	+	+		+	680.48	0.00	4.02
5	2022		+			682.39	1.92	4.03
6	2022		+	+		682.39	1.92	4.03
7	2022		+		+	682.39	1.92	4.03

Rank	Year	Predictor variables for encirclements: observer	zone	s(time)	s(moon)	AIC	dAIC	% dev. expl.
8	2022		+	+	+	682.39	1.92	4.03
9	2022	+	+			702.64	22.17	0.00
10	2022	+	+	+		702.64	22.17	0.00
1	2023		+	+		758.30	0	1.16
2	2023		+	+	+	758.31	0.00	1.16
3	2023	+	+	+		758.31	0.00	1.16
4	2023	+	+	+	+	758.31	0.00	1.16
5	2023		+			760.09	1.78	1.19
6	2023		+		+	760.09	1.79	1.19
7	2023	+	+			760.09	1.79	1.19
8	2023	+	+		+	760.09	1.79	1.19
9	2023		+	+		761.11	2.80	0.00
10	2023		+	+	+	761.48	3.18	0.07
1	2024	+	+			389.78	0	5.23
2	2024	+	+	+		390.08	0.30	4.65
3	2024		+			390.10	0.32	5.82
4	2024		+	+		390.35	0.58	5.27
5	2024	+	+		+	390.44	0.66	5.65
6	2024	+	+	+	+	390.74	0.97	5.05
7	2024		+		+	390.75	0.97	6.13
8	2024		+	+	+	390.99	1.21	5.54
9	2024	+	+			402.37	12.59	0.59
10	2024	+	+	+		402.87	13.09	1.02
1	2025		+			419.87	0	4.85
2	2025		+		+	419.87	0.00	4.85
3	2025		+	+		420.58	0.70	5.31
4	2025		+	+	+	420.58	0.70	5.31
5	2025	+	+			421.85	1.98	4.86
6	2025	+	+		+	421.85	1.98	4.86
7	2025	+	+	+		422.56	2.69	5.31
8	2025	+	+	+	+	422.56	2.69	5.31
9	2025		+			434.87	15.00	0.00
10	2025		+	+		435.27	15.40	0.70

Estimated sardine catch - the 10 top-ranked models within each year, with Akaike Information Criteria (AIC), delta AIC, and % deviance explained.

Rank	Year	Predictor variables for catch								AIC	dAIC	% dev. expl.
		observer	en_event	m_event	zone	s(depth)	s(vessel)	s(time)	s(moon)			
1	2021	+	+	+	+	+	+	+	+	7031.60	0	46.54
2	2021	+	+	+	+	+	+	+		7031.69	0.09	46.54
3	2021	+	+	+	+	+	+	+		7039.17	7.57	45.66
4	2021	+	+	+	+	+	+			7039.20	7.59	45.66
5	2021	+	+		+	+	+	+	+	7043.75	12.15	45.70
6	2021	+	+		+	+	+	+		7043.78	12.18	45.70
7	2021	+	+	+		+	+	+		7050.79	19.19	45.48
8	2021	+	+	+		+	+	+	+	7050.86	19.25	45.48
9	2021	+	+		+	+	+		+	7051.90	20.30	44.75
10	2021	+	+		+	+	+			7051.91	20.30	44.75
1	2022	+	+	+		+	+	+		8148.73	0	43.93
2	2022	+	+	+		+	+	+	+	8148.74	0.01	43.93
3	2022	+	+	+	+	+	+	+		8149.82	1.10	44.26
4	2022	+	+	+	+	+	+	+	+	8150.41	1.68	44.32
5	2022	+	+			+	+	+		8152.60	3.88	43.60
6	2022	+	+			+	+	+	+	8152.61	3.89	43.60
7	2022	+	+		+	+	+	+		8153.78	5.05	43.93
8	2022	+	+		+	+	+	+	+	8154.42	5.69	43.99
9	2022	+	+	+	+	+	+			8161.30	12.57	43.26
10	2022	+	+	+	+	+	+		+	8161.31	12.58	43.26
1	2023	+	+	+	+	+	+			8087.52	0	42.33
2	2023	+	+	+	+	+	+		+	8087.54	0.02	42.33
3	2023	+	+	+	+	+	+	+		8088.77	1.25	42.46
4	2023	+	+	+	+	+	+	+	+	8088.78	1.26	42.46
5	2023		+	+	+	+	+			8094.33	6.81	41.83
6	2023		+	+	+	+	+		+	8094.35	6.83	41.83
7	2023		+	+	+	+	+	+		8095.57	8.05	41.96
8	2023		+	+	+	+	+	+	+	8095.59	8.07	41.96
9	2023	+	+		+	+	+			8106.71	19.19	41.10
10	2023	+	+		+	+	+		+	8106.73	19.21	41.10
1	2024		+			+	+	+		7983.52	0	32.83
2	2024		+			+	+	+	+	7983.56	0.05	32.84
3	2024		+			+	+			7984.07	0.55	32.49
4	2024		+			+	+		+	7984.45	0.93	32.52
5	2024	+	+			+	+	+		7984.82	1.30	32.88
6	2024	+	+			+	+	+	+	7984.86	1.34	32.88
7	2024		+	+		+	+	+		7984.93	1.41	32.87

Rank	Year	Predictor variables for catch								AIC	dAIC	% dev. expl.
		observer	en_event	m_event	zone	s(depth)	s(vessel)	s(time)	s(moon)			
8	2024		+	+		+	+	+	+	7984.98	1.46	32.87
9	2024	+	+			+	+			7985.26	1.74	32.55
10	2024		+	+		+	+			7985.41	1.89	32.53
1	2025	+	+			+	+	+		9070.64	0	30.48
2	2025		+			+	+	+		9070.93	0.30	30.34
3	2025	+	+			+	+	+	+	9071.11	0.47	30.68
4	2025		+			+	+	+	+	9071.55	0.91	30.52
5	2025	+	+	+		+	+	+		9072.16	1.52	30.51
6	2025		+	+		+	+	+		9072.49	1.85	30.37
7	2025	+	+	+		+	+	+	+	9072.65	2.01	30.70
8	2025		+	+		+	+	+	+	9073.11	2.47	30.54
9	2025	+	+		+	+	+	+		9075.48	4.84	30.71
10	2025		+		+	+	+	+		9075.57	4.93	30.59