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Update on SBT catch monitoring and capacity building for biological sampling of spawning ground catches in Indonesia

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The SBT sampling program in Indonesia would not be possible without the significant cooperation of the scientist team and enumerators involved in measuring SBT and collecting tissue and otolith samples in Indonesia over many years. The cooperation of the longline tuna industry (coordinated through Asosiasi Tuna Longline Indonesia) and the individual processing companies in providing access and facilities to carry out the sampling is much appreciated. We also appreciate the support and corporation of the Research Centre for Fisheries, National Research and Innovation Agency (BRIN) and the Directorate General of Capture Fisheries (DGCF) for coordinating and undertaking sampling of adult SBT in Indonesia. This work was funded by the Commission for the Conservation of Southern Bluefin Tuna and CSIRO Environment.

1. Abstract

Southern Bluefin Tuna (SBT) has traditionally been caught as bycatch in Indonesia's longline fishery. Accurate estimates of SBT landings, along with the collection of biological samples (i.e., muscle tissue for Close-Kin Mark-Recapture and otoliths for age estimation) are essential for monitoring the spawning population and providing robust inputs to the stock assessment and Management Procedure used by the CCSBT to recommend total allowable catch levels.

Recently, the SBT catch monitoring program in Bali was disrupted due to a combination of COVID-19 impacts, institutional restructuring within Indonesia, and shifts in the distribution of effort by the Indonesian fleet from Statistical Area 1 to Area 2. In response, the CCSBT initiated a review of the sampling program and supported a collaborative project with MMAF, RCF-BRIN, and CSIRO to rebuild monitoring capacity.

A series of capacity-building workshops and coordination meetings were held in Indonesia to re-establish catch monitoring and biological sampling activities. Training focused on strengthening enumerator skills, refining sampling protocols, and developing approaches to include frozen SBT from Area 2 to increase sample sizes, if necessary. Although low numbers of tissue and otolith samples were collected over three consecutive spawning seasons (2021/22–2023/24), the 2024/25 season marked a substantial increase, with 1,148 muscle tissue samples and 865 otoliths collected. Preliminary work was also undertaken to obtain and compare SBT length composition data from different sources and to explore reasons for the recent increases in SBT catches in Area 2. Continued investment in capacity building and quality control remains critical in Indonesia to consolidate the gains made through this project.

2. Introduction

Southern Bluefin Tuna (SBT) spawn from September to April between Indonesia and northwest Australia. In this region, Indonesian longline fisheries have historically targeted yellowfin and bigeye tuna, with SBT as a bycatch. Accurate estimates of the SBT landings are vital for population modelling, stock assessments, and the Close-Kin Mark-Recapture (CKMR) method used by the CCSBT to monitor spawning populations and as an input to the Cape Town Management Procedure (MP) used to recommend the Total Allowable Catch (TAC).

In recent years, shifts in the Indonesian longline fleet distribution from Statistical Area 1 to Area 2, combined with institutional restructuring, have impacted Indonesia's SBT catch and biological sampling monitoring program. No port monitoring or biological sampling of SBT occurred in the 2021/22 spawning season and sample sizes were low in 2022/23 (Table 1). Key contributing factors for the reduced sampling included: new administrative and permitting processes, loss of experienced staff and facility access, changes of responsibilities between the Ministry of Marine Affairs and Fisheries (MMAF) and the National Research and Innovation Agency (RCF-BRIN), and reduced resources for SBT monitoring.

In late 2023, the CCSBT supported a collaborative project with MMAF, RCF-BRIN, and CSIRO to rebuild monitoring capacity, focusing on:

1. Training and supervision of dedicated enumerators at key landing ports.

2. Analytical support for determining representative catch sampling, CKMR tissue collection, and interpretation of spatial shifts in catch and effort.

This paper outlines the progress made in addressing these key challenges to ensure the long-term sustainability of this essential monitoring program.

3. Training enumerators in biological sampling

2023/24 spawning season

As reported to the ESC last year, a capacity-building workshop was undertaken in Benoa (Bali) in January 2024 to support the SBT sampling program in Indonesia (CCSBT-ESC/2409/12). The work focused on coordinating with the MMAF, BRIN, and local fishing ports to resume the catch monitoring and tissue sampling program supervised by CSIRO. Practical training was undertaken for MMAF-DGCF enumerators, strengthening skills from earlier training held in January 2023. Activities included planning meetings and visits to fish processors with enumerators to examine sampling conditions, demonstrate the sampling methods, refine protocols and purchase equipment.

Sampling resumed during the January 2024 training workshop, and 236 and 21 muscle tissue and otoliths were sampled respectively by then end of the SBT sampling (i.e., spawning) season in April 2024 (Table 1). This number was below target partly due to a noted decline in fresh SBT landings, raising concerns about achieving the seasonal goal of 1,500 samples in the future.

Table 1. Number of muscle tissue and otoliths sampled from adult SBT in Indonesia by spawning season since 2014/15 when the CCSBT began funding the collection and archiving of SBT muscle tissue.

Sampling season	Muscles tissue	Otoliths
2014/15	1500	1346
2015/16	1500	2000
2016/17	1500	1499
2017/18	1500	1500
2018/19	1500	1500
2019/20	1500	1500
2020/21	1500	1500
2021/22	0	0
2022/23	148	148
2023/24	236	21
2024/25	1148	865

2024/25 spawning season

To address sampling shortfalls in the 2021/22 to 2023/24 seasons, a revised target of 3,000 fish was set for the 2024/25 season, with an emphasis on collecting higher numbers of muscle tissue (500 samples/month) relative to otoliths (50/month).

In preparation for the 2024/25 season, a training workshop was held in August 2024 in Benoa. As the number of SBT landed from CCSBT Statistical Area 1 (Figure 1) had been decreasing, falling near or below target level (Satria et al., 2024), the workshop explored the feasibility of sampling muscle tissue from frozen SBT landed from Area 2, aiming to improve sampling coverage. While some fish from Area 2 were unlikely to have travelled to/from the spawning grounds, the Cape Town MP and stock assessment models (i) do not compare juveniles/adults that are born/captured in the same year, and (ii) explicitly account for the probability that the captured adult *could* have been a parent (given its size) of a juvenile born in the years before its capture - thus maintaining the integrity of the CKMR data. During the workshop, sampling documentation was strengthened through the development of a Google online form to be updated weekly and revised data sheets to clearly identify those fish from Area 2.

An additional meeting was held in Benoa in December 2024, during the sampling season, to review progress. An important development was the direct contracting of Mr. Kiroan Siregar, a highly experienced SBT sampler who previously sampled from the monitoring program's inception up to the 2020/21 season. His involvement contributed to improved sampling consistency and coverage, and is expected to continue into the 2025/26 season and beyond, supporting long-term data continuity for stock assessment and CKMR analysis.

Sampling during the 2024/25 season was successfully conducted, with 1,148 muscle tissue samples and 865 otoliths collected by May 2025 (Table 1). Sampling rates increased steadily from December 2024 to March 2025, tapering off as expected toward the end of the spawning season (Figure 2). These outcomes reflected improved coordination, expanded sampling methods (fresh and frozen fish), and enhanced capacity across agencies, marking a significant recovery from the recent years and a promising trajectory for future monitoring.

Although, the higher target for muscle tissue was not met in 2024/25, the increased monthly sampling rate is expected to continue into the 2025/25 season, with potential to achieve higher tissue samples numbers than the normal annual target of 1,500.

A meeting was recently held with fishing companies and enumerators in Benoa (August 2025) to initiate sampling for the 2025/26 spawning season.

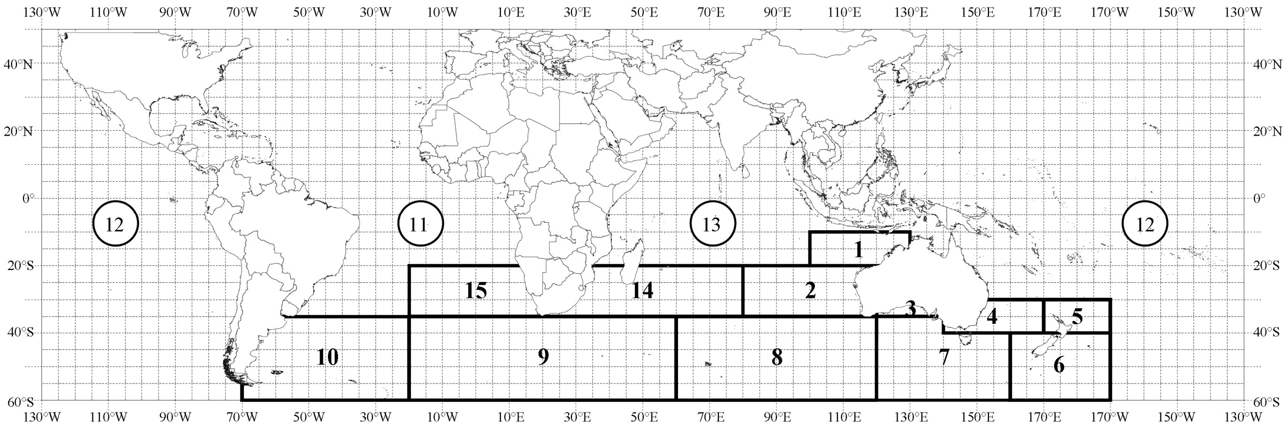

Figure 1. Map showing the CCSBT statistical areas. Source: https://www.ccsbt.org/sites/default/files/userfiles/file/docs_english/operational_resolutions/Resolution_CDS.pdf)

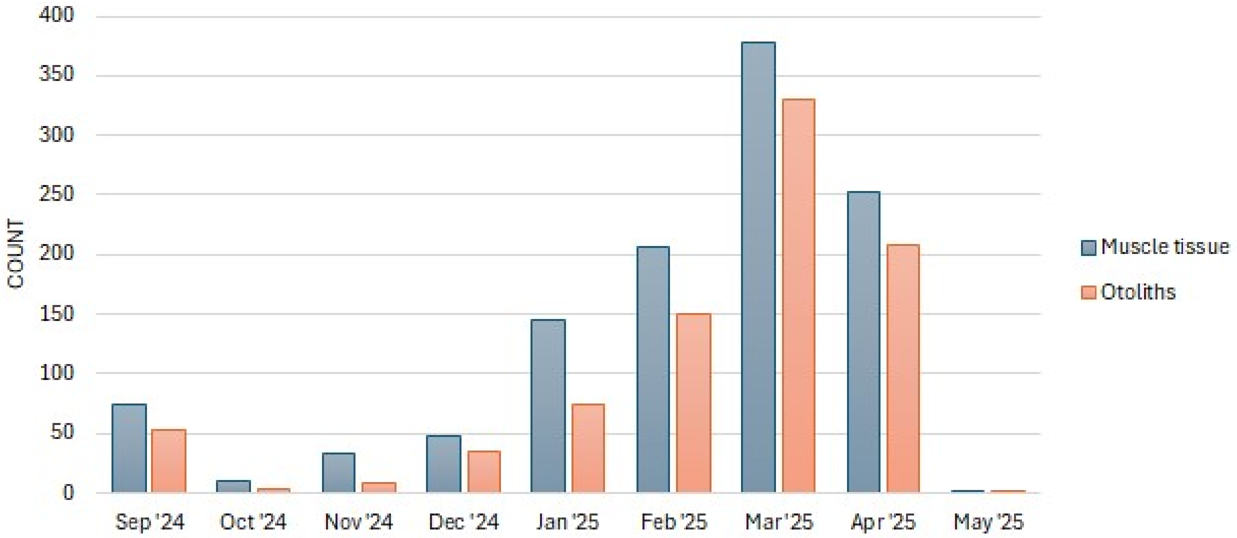

Figure 2. Number of SBT sampled in Benoa during the 2024/25 spawning season.

Implication of reduced muscle tissue and otolith samples (2021/22 to 2023/24)

Tissue samples for CKMR analysis and otoliths for ageing were collected in low numbers from adult SBT in Indonesia over three spawning seasons (2021/22 to 2023/24). These datasets are essential inputs to the MP. Shortfalls in adult CKMR sampling can be mitigated through increased sampling in later years, given adults span a wide age range and can be matched to juveniles across multiple cohorts. The absence of juvenile samples, however, would remove entire age classes from the CKMR analysis, significantly reducing the precision of abundance estimates. To address the shortfall in adult samples, targeted capacity-building efforts have been implemented in Indonesia to increase tissue sampling in the current season (2025/26) and future seasons to maintain continuity in CKMR-based monitoring.

In a previous instance where age data were missing, such as in 2011/12, an Age-Length-key (ALK) was developed using data from the preceding two seasons and applied to the corresponding length frequency data. A similar approach can be adopted for the current data gap: age data from adjacent seasons (either preceding or following) can be combined to construct an ALK, which can then be applied to the corresponding length frequency data for each season once available (see below).

4. Analytical support for determining representative catch sampling, CKMR tissue collection, and interpretation of spatial shifts in catch and effort

A collaborative team (BRIN, MMAF and CSIRO) was established to obtain and analyse the various sources of size data and information available for SBT caught in Indonesian's longline fishery to determine the most appropriate method for obtaining representative length and age frequency data and CKMR samples for the spawning ground catches. They key issues were (i) identifying SBT caught in Area 1 and Area 2; (ii) understanding the differences length (and age) composition data of the catch from different data sources; and (iii) interpreting recent increases in SBT catches in Area 2.

1. *Identifying SBT caught in Area 1 and Area 2*

Through discussion with enumerators (port samplers) and fishing companies, it was confirmed that fresh fish measured and sampled through the catch monitoring program are exclusively from Area 1, while frozen fish originate from Area 2. Catch locations recorded in the Catch Documentation Scheme (CDS) are obtained via direct inquiry with vessel captains and, when necessary, verified using Vessel Monitoring System (VMS) data. Further work will be undertaken to determine if this approach has been used consistently since 2011.

2. *SBT size data and sources*

Differences in the estimated length and age composition of SBT caught in Indonesia have highlighted the need for improved understanding of data sources and collection methods (Farley et al., 2021). For this paper, length data were compiled from four primary sources, where available, spanning the 2011–2025 calendar year: CDS; port sampling (RITF and RCF/DGCF); observer data – RITF; and observer data – DGCF (Table 2). Additional individual SBT weight data were obtained directly from fishing companies in 2023 and 2024. These weight data were converted to length using CCSBT-agreed weight-to-length conversion parameters (Anon, 1994).

Table 2. Number of SBT length measurements obtained by data source since 2011 (calendar year).

Year	CDS			Port Sampling[1] RITF & RCF/DGCF		Observer RITF		Observer DGCF		Fishing company data	
	Area 1	**Area 2**	**% Area 1**	**Area 1**	**Area 2**	**Area 1**	**Area 2**	**Area 1**	**Area 2**	**Area 1**	**Area 2**
2011	5,509	1,008	84.5	621		9					
2012	6,250	3,900	61.6	1,259		20	5				
2013	10,738	4,345	71.2	1,878		24					
2014	7,398	2,032	78.5	2,316		17					
2015	5,941		100.0	3,825		12					
2016	6,414		100.0	2,242		4					
2017	7,738	1,877	80.5	2,445			197				
2018	7,517	3,424	68.7	1,773		83	77				
2019	10,681	2,151	83.2	1,663		20	61				
2020	10,896	2,674	80.3	1,187		71	14	2			
2021	5,276	7,176	42.4	1,577		26	87	4	73		
2022	1,389	9,816	12.4						45		
2023	2,023	9,041	18.3						157	9	173
2024				153	12					11	97
2025				914	69						
Total	87,770	47,444	64.9	21,853	81	286	441	6	275	20	270

[1] *Port sampling by RITF occurred in 2011 – 2021 and by RCF/DGCF in 2024 – 2025.*

The length distribution from each data source by area are shown in (Appendix Figure A1). In summary:

Area 1: Across all years, length distributions are relatively consistent, with most SBT measuring between 120–200 cm fork length (FL). There is some overlap between datasets, particularly between port sampling and RITF observer program data. CDS data often show slightly larger modal lengths compared to port sampling and RITF observer data. Fishing company size data are consistent with CDS data, as expected, given they likely originate from the same source.

Area 2: Length distributions are more variable across years, with broader peaks ranging from 100 cm (occasionally smaller) up to 200 cm FL. Data sources diverge more noticeably than in Area 1, with CDS data showing wider and sometimes bimodal distributions, particularly in earlier years. DGCF observer data show smaller fish (~100–140 cm FL) in 2021–2023, raising questions about species identification and measurement accuracy.

Preliminary discussions suggest that length data from port sampling and the RITF observer program are likely the most reliable, given the training provided to enumerators and scientific observers in species identification and accurate measurement. However, the RITF observer dataset is relatively limited, as SBT is a bycatch species with low numbers recorded per trip. CDS data provide larger sample sizes, but further investigation is needed to understand discrepancies in size estimates across data sources.

Further work will be undertaken to:

- Compare the size of reject vs. export fish across years using CDS and fishing company data for selected recent years, to assess whether catch monitoring data, which only samples reject fish, may be biased toward smaller SBT.
- Convert CDS weight data to length (using CCSBT-agreed Length–Weight parameters or parameters specific to SBT landed in Benoa) and compare with CDS length data.
- Investigate DGCF observer data to determine why SBT measurements are smaller than those from CDS in Area 2.
- Assess whether expanded spatial coverage of SBT size monitoring is needed in other ports, such as Cilacap and Muara Baru.

3. *Recent increases in SBT catches in Area 2*

Since 2021, a shift in the spatial distribution of Indonesian SBT catches has been observed, with Area 2 accounting for the majority of catch by weight - rising from 57% in 2021 to over 80% between 2022 and 2024 (Satria et al., 2025). Although vessels have historically operated in Area 2 (Sadiyah et al., 2014), the trend appears to reflect evolving fishing strategies, including increased investment in larger vessels equipped with freezing capacity, enabling operations further south. This has led to increased catches of albacore, although yellowfin and bigeye tuna continue to be targeted. Fishing companies with onboard freezing capability benefit from more stable fish prices, as the cold chain can be maintained from catch to sale, both for export and 'reject' fish, compared to vessels landing fresh fish, where maintaining quality is less certain.

5. Summary

This report highlights the progress made in re-establishing Indonesia's SBT monitoring program following disruptions between 2021/22 to 2023/24. Key achievements include:

Capacity Building: Training workshops in Benoa strengthened enumerator skills and re-established the catch monitoring and biological sampling program.

Sampling Outcomes: A total of 1,148 muscle tissue samples and 865 otoliths were collected in 2024/25, marking a significant improvement over the preceding three years.

Data gaps: Higher targets for CKMR tissue sampling in 2025/26 and later years to compensate for the shortfalls in preceding years. This is possible due to the broad age range of adults sampled that can be matched to juveniles across multiple cohorts. For age data, ALKs from adjacent seasons can be used to maintain continuity in monitoring the age distribution of the catch.

Data Analysis: Preliminary length frequency data from CDS, port sampling, observer programs, and fishing companies were compared across Statistical Areas 1 and 2. Port sampling and RITF observer data were deemed most reliable but further work is required.

Spatial Shifts in Fishing Effort: Since 2021, the majority of SBT catch has shifted to Area 2, driven by increased use of freezer vessels and changing fishing strategies.

These efforts represent a critical step toward restoring Indonesia’s contribution to SBT monitoring. Continued training and supervision are recommended to ensure consistent, high-quality data for stock assessment and CKMR analysis.

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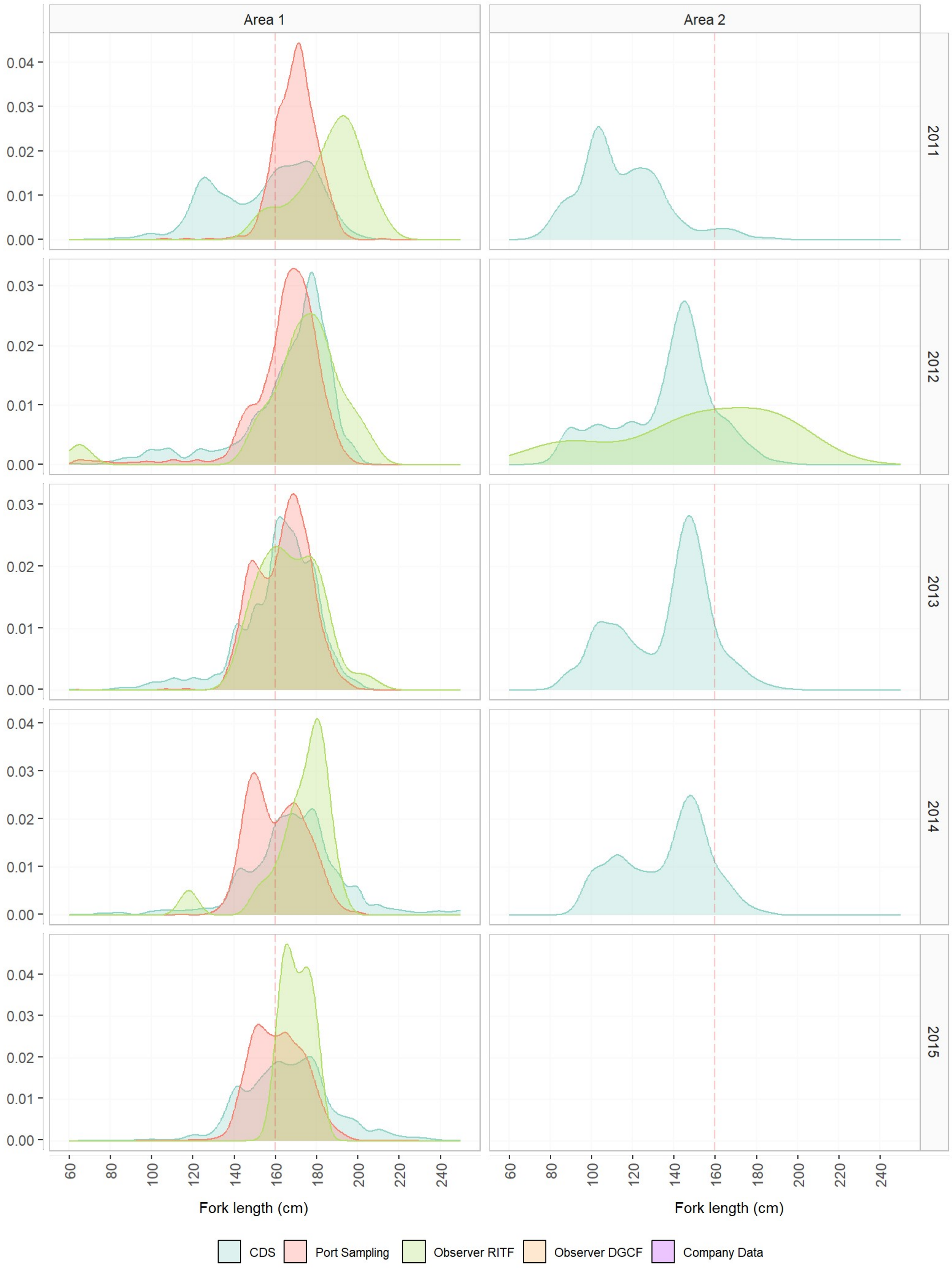

Figure A1. Length frequency distributions of SBT landed by data source and year (2011–2025). Area 1 (left) and Area 2 (right). Port sampling data is for RITF (2011-2021) and RCF & DGCF (2023-2024). Graphs continue on the following page. In this figure, the number of SBT measurements obtained by source are: CDS = 47,121; Port sampling = 9,899; Observer RITF = 87; Observer DGCF = 0; Company Data = 0.

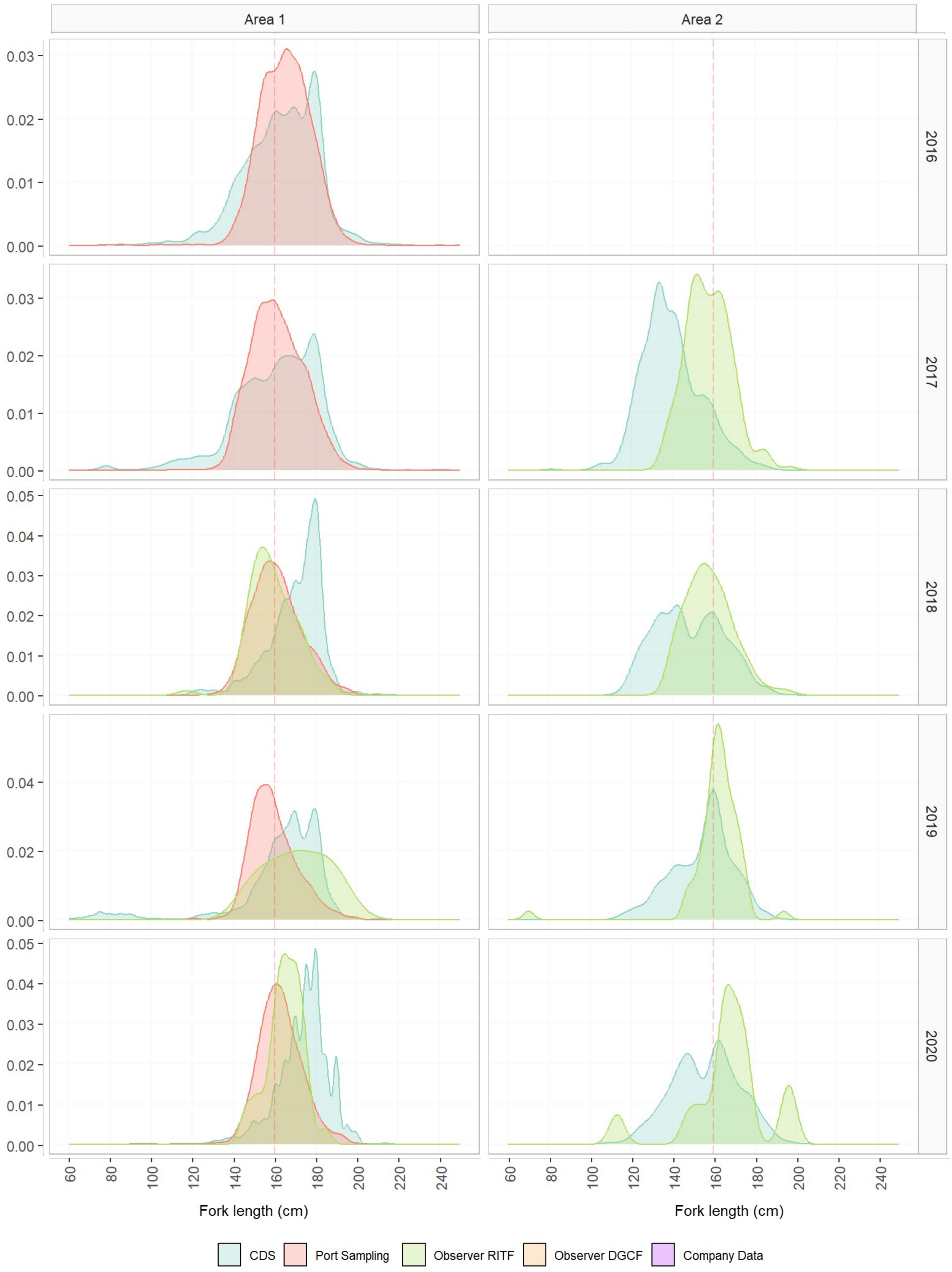

Figure A1 (cont.) Length frequency distributions of SBT landed by data source and year (2011–2025). Area 1 (left) and Area 2 (right). Port sampling data is for RITF (2011-2021) and RCF & DGCF (2023-2024). Graphs continue on the following page. In this figure, the number of SBT measurements obtained by source are: CDS = 53,372; Port sampling = 9,310; Observer RITF = 527; Observer DGCF = 2; Company Data = 0.

Figure A1 (cont.). Length frequency distributions of SBT landed by data source and year (2011–2025). Area 1 (left) and Area 2 (right). Port sampling data is for RITF (2011-2021) and RCF & DGCF (2023-2024). In this figure, the number of SBT measurements obtained by source are: CDS = 34,721; Port sampling = 2,725; Observer RITF = 113; Observer DGCF = 279; Company Data = 290.

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