Appendix D

Report of the Co-conveners of the Workshop on the Ross Sea Data Collection Plan 2022
(Virtual Meeting 11 and 12 August 2022)

Report of the Co-conveners of the Workshop on the Ross Sea Data Collection Plan 2022
(Virtual Meeting, 11 and 12 August 2022)

1. The Workshop on the Ross Sea Data Collection Plan (WS-RSDCP) was held online on 11 and 12 August 2022. The Workshop was co-convened by Dr L. Ghigliotti (Italy) and Mr N. Walker (New Zealand) and supported by the CCAMLR Secretariat. Scientists from 11 Members attended the Workshop.

2. At the opening of the meeting, Mr Walker welcomed and acknowledged the 32 participants (Attachment I) and noted the Workshop was an informal meeting to review the progress against the previous medium-term research plan for the Ross Sea (WG-FSA-14/60, SC-CAMLR-XXXIII, paragraph 3.209), and refine a proposal for a new medium-term research plan and an accompanying data collection plan.

3. Accordingly, this report is not an adopted report, but is a summary by the Co-conveners for the consideration of the Scientific Committee and its working groups. The intent is that the recommendations outlined below will be reported to WG-FSA-2022 for further discussion and agreed at SC-CAMLR-41 according to the Scientific Committee Rules of Procedure.

4. The terms of reference for the Workshop are given in Attachment II, the agenda in Attachment III and the list of papers submitted to the workshop in Attachment IV.

5. This report was prepared by the Co-conveners with support from the Secretariat.

Identify fishery-based medium-term research objectives

6. WS-RSDCP-2022/01 presented a review on progress against the 2014 medium-term research plan for the Ross Sea toothfish fishery (WG-FSA-14/60).

7. The Workshop discussed the review presented in this paper and noted further refinements which will be incorporated into an updated version of the paper to be presented to WG-FSA-2022, alongside this report.

8. During the Workshop, a table was developed to summarise the progress against the 2014 medium-term research plan research objectives (Table 1). The approach used to complete this was analogous to that utilised in the Scientific Committee Symposium, which involved indicating the scale of progress against each objective, in addition to providing a brief description of the research undertaken. The Workshop noted good progress against the 20 objectives, with nine complete or with significant progress, seven with some progress and only four with no progress. Several of these objectives were carried forward into the new data collection plan.

9. WS-RSDCP-2022/02 presented a proposed medium-term research plan for the next five to seven years. The long-term goals of the Ross Sea fishery based on Article II of CCAMLR can be summarised as:

(i) the target fished population is above a level which ensures stable recruitment

(ii) the ecological relationships between harvested, dependent and related populations are maintained

(iii) changes in the marine ecosystem that are not potentially reversible over two or three decades are prevented or minimised, with the overall objective of the conservation of Antarctic marine living resources.

10. Table 2 presents a revised summary of the proposed research objectives. This table shows the 2014 medium-term research plan research objectives and progress against them (as in Table 1) along with revised research objectives for a new proposal for the medium-term research plan for the Ross Sea toothfish fishery. The table also summarises the discussions during the Workshop on the data collection needs for each new research objective and whether the objective would be met by data collected by the fishery under Conservation Measure (CM) 41-01 and CM 41-09, or non-Olympic fishery research (e.g. CM 24-01) and/or other national research programs.

Develop a sampling plan to obtain necessary data

11. Table 3 was developed during the Workshop to provide the basis for an update to the previous data collection plan (WG-FSA-15/40). Table 3 includes details of the data to be collected, frequency of collection, priority and relevant protocols for each type of data. Each type of data to be collected is indicated as either baseline (i.e. for all vessels in the Ross Sea toothfish fishery to collect), or research (which would be undertaken on a voluntary basis and data managed by Members). For proposed additional baseline data requirements, it is noted where these can be undertaken using current baseline data collection methods by all vessels, and whether data collection forms and manuals would require any changes to accommodate these requirements.

12. During the Workshop there was discussion about the relative merits of either rotational sampling of the by-catch species groups: macrourids, skates and other species, or consistent but lower levels of data collected on all species each year. The observer coordinators present at the Workshop noted that observers prefer the rotational approach as it provides a clear priority for their work each season. However, clear concise instructions and protocols would be needed specific to each year to enable communication of the sampling requirements to observers.

13. The Workshop requested the Secretariat to contact a wider range of observer coordinators in advance of WG-FSA-2022 for feedback on the data collection plan and confirm which sampling approach for the by-catch species is preferred by observers. This information will enable WG-FSA-2022 to verify the by-catch sampling approach and the data collection plan.

Identify high priority non-Olympic fishery research activities (e.g. CM 24-01)

14. WS-RSCDCP-2022/03 presented initial suggestions for high-priority non-Olympic fishery research activities. These suggestions included:

(i) assess the spatial extent of the distribution of the Ross Sea Antarctic toothfish (*Dissostichus mawsoni*) population in the northeast of Subarea 88.1

(ii) determine connectivity of Antarctic toothfish in small-scale research units (SSRUs) 882A–B and H

(iii) assess the spatial extent of Antarctic toothfish distribution in SSRUs 882A–B and H outside main fishing areas

(iv) conduct experiments to investigate and improve current estimates of tagging mortality rates, tag recapture reporting rates, tag shedding and tag-related growth retardation in toothfish and skates (e.g. WG-FSA-13/54)

(v) continue the Ross Sea shelf survey, noting the important recruitment data it provides to the Ross Sea stock assessment

(vi) conduct experiments to determine the early life history and ecology of Antarctic and Patagonian toothfish (*Dissostichus eleginoides*), including under different temperature regimes

(vii) improve biological and ecological knowledge of skates to improve risk assessment and monitoring approaches.

15. Further suggestions for high-priority non-Olympic fishery research activities were identified during the Workshop and captured in Table 1. These suggestions included:

(i) winter survey sampling of the water column for toothfish eggs

(ii) use of acoustic data to explore distribution of toothfish at greater depths

(iii) estimating the buoyancy of developing eggs, larvae and juvenile Antarctic toothfish

(iv) directional swimming capabilities and behaviours of larvae and juveniles

(v) use of passive acoustics receivers to record marine mammal presence in the area

(vi) collection of additional data about the trophic relationships between Antarctic toothfish, killer whales (*Orcinus orca*) and Weddell seals (*Leptonychotes weddellii*) via biopsies and tags

(vii) post-release survival estimates for skates from pop-up satellite archival transmitting tags.

Identify voluntary programs to test novel data collection mechanisms

16. WS-RSCDCP-2022/03 presented some suggestions for voluntary Member-led programs to test novel data collection mechanisms on specific vessels. These suggestions were:

(i) collection of phytoplankton samples to aid in understanding phytoplankton distribution, seasonal abundance and impacts of climate change

(ii) Te Tiro Moana project – an ocean observation project that deploys temperature and depth sensors on fishing vessels.

17. Further suggestions were discussed during the Workshop and captured in Table 2. These included:

(i) measurement of physiological parameters (e.g. lactate) to indicate stress levels associated with the suitability evaluation process for tagging by-caught skates

(ii) inspection of sponges caught during Olympic fishing for fish eggs and recording data by scientific observers

(iii) photographic data collection for estimating abundance of cetaceans using photographic mark-recapture methods.

Next steps

18. The draft documents submitted to the Workshop and the tables produced during the workshop (Tables 1 to 3) will be combined to produce reports for submission to WG-FSA-2022 to discuss and agree a new medium-term research plan and the data required to progress it.

Table 1: Progress against the medium-term research plan for the Ross Sea toothfish fishery (WG-FSA-14/60). Comments on the work performed and suggestions for the 2023–2028 mid-term research plan are included (column 'notes'). Progress has been rated as: 0 – little or no progress; 1 – some progress; 2 – significant progress or complete. CPUE – catch per unit effort, MSE – management strategy evaluation, SPRFMO – South Pacific Regional Fisheries Management Organisation, SSRU – small-scale research unit.

Research objectives	Progress	Notes
3.1 Maintenance of the Antarctic toothfish population in the Ross Sea region above target levels		
3.1.1 Reduce uncertainty in toothfish model parameters		
(i) To spatially and temporally delineate toothfish spawning grounds	2	A spatial model of toothfish distribution by age and spawning state has been developed (SPM). This maps distributions of spawning toothfish by year and includes future projections. Hydrodynamic model with virtual toothfish eggs and larvae has been used to investigate early life-history strategies of toothfish, including the use of different spawning areas (published). Winter survey successfully found and measured buoyancy of developing toothfish eggs.
(ii) To delineate stock structure – especially in relation to SSRUs 882C–I	1	Research fishing in SSRUs 882A–B and in SPRFMO was undertaken to explore toothfish stock structure. A review of toothfish stock structure in Area 88 indicates two stocks for management purposes, a Ross Sea region stock and an Amundsen Sea region stock, which likely mixed during early life history but had limited mixing at the adult stages. Additional research in SSRUs 882C–H was considered necessary to develop and test stock hypotheses. Currently data quality is impacted by low spatial overlap between locations of released tagged fish and fishing effort in the subsequent year and reduction in fishing effort in the area.
(iii) To define and quantify fine-scale movement patterns, including by size and sex	2	Significant progress on spatial population modelling of toothfish to investigate movement and mixing. Analysis of movement patterns of recaptured toothfish and from pop-off satellite tags.
(iv) To improve estimates of initial (and longer-term) tagging mortality and tag detection	0	The effect of size and external factors (e.g. freezing or other extreme conditions) on the toothfish survivorship need to be investigated. Work had been undertaken on improved methods for estimating effective tagging survival and effective tagging rate, but this was not yet sufficient to provide updated parameter estimates used in the stock assessment model. Genetic mark-recapture techniques may provide an opportunity to estimate tagging mortality.

(continued)

Table 1 (continued)

Research objectives	Progress	Notes
(v) To continue monitoring the relative abundance of sub-adults and to estimate recruitment variability and autocorrelation	2	The Ross Sea shelf survey has been carried out every year since 2012 and is ongoing, providing an important early warning signal of changes in recruitment of Antarctic toothfish as well as a platform for ecosystem research.
(vi) To monitor key population-level parameters	2	Review of growth and length-weight parameters undertaken in 2019. These parameters will be monitored through the annual fishery characterisation, tag analysis and biennial stock assessment.
3.1.2 Reduce management uncertainty		
(i) To continue to improve the stock assessment	2	Ongoing refinement work on the stock assessment along with the development and validation of Casal2 in 2022.
(ii) To develop simple stock performance indicators/dashboard	1	A range of stock performance indicators are produced with the biennial stock assessment and made available through CCAMLR working groups. Also, information is published in New Zealand (Fisheries New Zealand stock assessment plenary). More work needed on a 'dashboard' which brings together stock performance indicators with environmental and ecosystem indicators.
(iii) To develop prioritised list of MSE scenarios and begin MSE testing of high priority issues	1	MSEs underlying the establishment of the trend analysis decision framework were listed as a priority topic of WG-SAM-2018. A range of sensitivity studies have been carried out as part of the biennial stock assessment.
(iv) To continue development of operating models as additional tag and fishery data are collected, through improved predictive layers, and better knowledge of life cycle	2	A spatially explicit age-structured population dynamics operating model (SPM) for Antarctic toothfish in the Ross Sea region was developed that allows exploration of spatial allocation factors, other than seabed area and CPUE. Other features should be included in the model, such as predator–prey overlap, ice dynamics, ecosystem features.

(continued)

Table 1 (continued)

Research objectives	Progress	Notes
3.2 Maintenance of ecosystem structure and function		
(i) To determine the temporal and spatial extent of the overlap in the distribution of toothfish and its key predators (in particular killer whales and Weddell seals)	2	Four field seasons of work on Weddell seals in the southwest Ross Sea have been carried out (Nov/Dec 2018; Feb/Mar 2019; Nov/Dec 2019; Feb/Mar 2020) to improve understanding of potential effects of fishing on Weddell seals and the role of the MPA in minimising any effects. This research includes the use of accelerometer tags, head-mounted cameras, satellite tags and bio tracers. Long-term moored hydrophones have been maintained at 3 locations in the Ross Sea region since 2018. Satellites have been used to map distributions of Weddell seals around the Antarctic coastline. Killer whales of ecotype C (TCKW) were studied in McMurdo Sound, Antarctica by dart biopsy sampling and photo identification (photo ID). By combining images with an existing catalogue compiled by the Orca Research Trust ('AKWIC') and photos submitted by 'citizen scientists', we created an expanded photo-identification catalogue for Antarctic killer whales. Preliminary analysis of the database provides evidence for long-distance migrations of TCKW between the Ross Sea and New Zealand waters.
(ii) To investigate the abundance, foraging ecology, habitat use, functional importance and resilience of key toothfish predators (in particular killer whales and Weddell seals)	2	As above, significant work on Weddell seals and type-C killer whales.
(iii) To develop methods of monitoring changes in relative abundance of key prey/by-catch species (in particular macrourids and icefish) on the Ross Sea slope and hence assess the potential impact of the toothfish fishery on these species	2	New bottom-trawl estimates of macrourids, icefish and other prey/by-catch species from the *Tangaroa* voyages in 2015, 2019. Underwater video collected from research voyages to investigate use as non-lethal survey method. Acoustic methods developed to estimate macrourid abundance. Spatio–temporal analysis of by-catch data (VAST).
(iv) To monitor diet of toothfish in key areas, especially on the Ross Sea slope	2	Analysis of toothfish stomach contents and stable isotopes for trophic investigation. Method for identifying species of macrourid from their otoliths developed (to be used for otoliths retrieved from toothfish stomachs, or to check species identification accuracy by observers from historical collections).

(continued)

Table 1 (continued)

Research objectives	Progress	Notes
(v) To simulate the effect of the fishery on populations of toothfish, its predators and its prey	1	New biological and modelling analyses completed, but the Minimum Realistic Model for simulating multispecies interactions between toothfish and prey/by-catch species is still being developed.
(vi) To develop quantitative and testable hypotheses as to the 'second-order' effects (such as trophic cascades, regime shift) and ensure data collection is adequate to monitor for any risks deemed reasonable	2	Modelling has simulated the trophic release (cascade) effect of reducing the abundance of toothfish on Antarctic silverfish in the Ross Sea region, and the corresponding potential trophic response of Adélie penguin populations (published). A range of satellite data have been analysed (and presented to CCAMLR) to investigate effects of climate variability/change in the Ross Sea region and look for regime shift. Changes in zooplankton distributions and habitat suitability in the Ross Sea have been modelled. Multifrequency acoustic data has been collected on multiple research voyages to the Ross Sea region to map and monitor mesopelagics (especially myctophids, silverfish, krill). Methods have been developed and published for monitoring primary productivity: (1) water column, (2) deep chlorophyll maxima, (3) production by sea-ice algae. Assessment of CMIP6 earth-system models for projecting future environmental change in the Ross Sea region.
(vii) To assess the impact of the toothfish fishery on Patagonian toothfish	0	Limited Patagonian toothfish caught in the Ross Sea fishery.
(viii) To estimate survivorship of released skates	1	Macroscopic categories of body injuries have been defined for skates to evaluate the likely survivorship before tagging and release. Relative rates of recapture of skates that had particular injuries were recorded for refining the survivorship evaluation criteria.

(continued)

Table 1 (continued)

Research objectives	Progress	Notes
(ix) To develop semi-quantitative and spatially explicit risk assessments for macrourids and Antarctic skates, especially in the slope fishery of the Ross Sea	1	New data and modelling analyses have been collected as necessary precursors to developing a Minimum Realistic Model for simulating multispecies interactions between toothfish and prey/by-catch species. These components include: • New biological data on macrourids • New biological data and analysis for icefish • Spatio–temporal modelling (VAST) of by-catch species (macrourids, icefish, skates, eel cods, deep-sea cods) • Spatial population modelling of toothfish • Multiple methods to estimate/monitor macrourid abundance (trawl surveys, video, acoustic). Discrimination between the two most common macrourid species using otoliths has been achieved. The Minimum Realistic Model is not yet complete. Skates: Risk assessment for skates is underway based on previous risk assessment framework, but using the larger set of tag-release-recapture data, and new biological information on skates. Identification areas of importance for skates and macrourids such as egg laying, nursery or nesting grounds is needed in the future.
(x) To develop methods to assess whether the potential impacts of the toothfish fishery on the ecosystem are likely to be reversible in two to three decades	0	No progress

Table 2: A proposed set of research priorities for a new medium-term research plan for the Ross Sea toothfish fishery based on the 2014 medium-terms research plan (WG FSA-14/60) and progress against them. Progress has been rated as: 0 – little or no progress; 1 – some progress; 2 – significant progress or complete. Research priorities that include elements that also lead to the understanding of the impacts of climate change are indicated by (-> **CLIMATE CHANGE**). CPUE – catch per unit effort, MSE – management strategy evaluation, SSRU – small-scale research unit, n/a – not applicable.

MTRP 2014 Research objectives	Progress	MTRP 2022 – Research priorities	Data collection needs	Geographic area of particular interest	Fishery-based research objectives	Non-Olympic fishery research and voluntary programs
1. Maintenance of the Antarctic toothfish population in the Ross Sea region above target levels						
a(i) To spatially and temporally delineate toothfish spawning grounds	2	Determine the early life history of toothfish, including under different temperature regimes (-> CLIMATE CHANGE)	Data on toothfish maturity (gonad stage, gonad weight), body condition (especially young fish). Also winter survey sampling of the water column for eggs.		x	x
a(ii) To delineate stock structure – especially in relation to SSRUs 882C–I	1	To assess the spatial extent of toothfish distribution in the northeast of Subarea 88.1 To determine connectivity of toothfish in SSRUs 882B, C and H Assess the spatial extent of toothfish distribution in SSRUs 882B, C and H outside main fishing areas	Size, sex distribution, CPUE data in water deeper than 2 000 m, acoustic data		x	x
a(iii) To define and quantify fine-scale movement patterns, including by size and sex	2	Use of specialized tags to better resolve the spatial and temporal distribution of toothfish	Fine-scale movement data from electronic tags			x
a(iv) To improve estimates of initial (and longer-term tagging) mortality, and tag detection	0	To improve estimates of relative rates of tag detection	Conventional tagging data from fishery or dedicated experiments		x	x
		To improve estimates of tag survival through a dedicated study or analysis of the residuals that include factors such as size, depth and weather	Data from the conventional tagging program (specific experiments might also be done).		x	x

(continued)

Table 2 (continued)

MTRP 2014 Research objectives	Progress	MTRP 2022 – Research priorities	Data collection needs	Geographic area of particular interest	Fishery-based research objectives	Non-Olympic fishery research and voluntary programs
a(v) To continue monitoring the relative abundance of sub-adults and to estimate recruitment variability and autocorrelation	2	To collect more information about the eggs of toothfish (to run the models about the egg distribution and advection). To continue monitoring to test the assumptions of the stock-recruitment relationship and steepness parameters using MSEs (-> CLIMATE CHANGE)	Age composition data to estimate recruitment-related parameters (mean recruitment, recruitment variability, stock recruitment relationship). Buoyancy estimate of developing eggs, larvae and juveniles. Directional swimming capabilities and behaviours of juveniles.		x	x
a(vi) To monitor key population-level parameters	2	To continue monitoring key population-level parameters (-> CLIMATE CHANGE)	Basic biology data (age at maturity, growth, length-weight relationship, sex ratio), mortality (natural mortality, total mortality depredation mortality)		x	
b(i) To continue to improve the stock assessment	2	To continuously improve the stock assessment (e.g. improve diagnostics, estimation of year-class strength, etc.) (-> CLIMATE CHANGE)	Length and otoliths. Population definition (stock affinity, location of spawning sites, spawning site fidelity), genetics		x	
b(ii) To develop simple stock performance indicators/dashboard	0	To improve communication and understanding of the stock assessment outputs	n/a			
b(iii) To develop prioritised list of MSE scenarios and begin MSE testing of high priority issues	1	To improve the stock assessment (e.g. improve diagnostics, estimation of year-class strength, etc.)	n/a			
b(iv) To continue development of operating models as additional tag and fishery data are collected, through improved predictive layers, and better knowledge of life cycle	1	Implementation of a spatially explicit age-structured population dynamics operating model (SPM) for Antarctic toothfish in the Ross Sea that includes ecosystem features (e.g. predator–prey, ice dynamics, etc.)	n/a			x

(continued)

Table 2 (continued)

MTRP 2014 Research objectives	Progress	MTRP 2022 – Research priorities	Data collection needs	Geographic area of particular interest	Fishery-based research objectives	Non-Olympic fishery research and voluntary programs
2. Maintenance of ecosystem structure and function						
Top predators						
(i) To determine the temporal and spatial extent of the overlap in the distribution of toothfish and its key predators (in particular killer whales and Weddell seals)	1	(i) To determine the temporal and spatial extent of the overlap in the distribution of toothfish and its key predators (in particular killer whales and Weddell seals)	Use of passive acoustics receivers to record whale presence in the area. Sightings from the vessels. Opportunistic observation of Weddell seals on the sea-ice. Collect photographs of killer whales (for photo identification). Additional data could include biopsies and tags.			x
(ii) To investigate the abundance, foraging ecology, habitat use, functional importance and resilience of key toothfish predators (in particular killer whales and Weddell seals)	1	(ii) To investigate the abundance, foraging ecology, habitat use, functional importance and resilience of key toothfish predators (in particular killer whales and Weddell seals)	Use of passive acoustics receivers to record whale presence in the area. Sightings from the vessels. Opportunistic observation of Weddell seals on the sea-ice. Collect photographs of killer whales (for photo identification). Additional data could include biopsies and tags.			x
By-catch species						
(iii) To develop methods of monitoring changes in relative abundance of key prey/by-catch species (in particular macrourids and icefish) on the Ross Sea slope and hence assess the potential impact of the toothfish fishery on these species	2	To continue to collect data on by-catch species to determine their productivity, basic life-history parameters, and develop methods of monitoring changes in relative abundance of key prey/by-catch species (in particular macrourids and icefish) and hence assess the potential impact of the toothfish fishery on these species (-> CLIMATE CHANGE)	By-catch species ID, location, biology, toothfish diet		x	

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Table 2 (continued)

MTRP 2014 Research objectives	Progress	MTRP 2022 – Research priorities	Data collection needs	Geographic area of particular interest	Fishery-based research objectives	Non-Olympic fishery research and voluntary programs
Ecosystem effects of fishing						
(iv) To monitor diet of toothfish in key areas, especially on the Ross Sea slope	2	To continue monitoring diet of toothfish (-> CLIMATE CHANGE)	Stomach sampling			x
(v) To simulate the effect of the fishery on populations of toothfish, its predators and its prey	2	Ecosystem modelling	n/a			
(vi) To develop quantitative and testable hypotheses as to the 'second-order' effects (such as trophic cascades, regime shift) and ensure data collection is adequate to monitor for any risks deemed reasonable	0	Ecosystem modelling	n/a			
(vii) To assess the impact of the toothfish fishery on Patagonian toothfish	0	To assess the impact of the toothfish fishery on Patagonian toothfish	Distribution and age data		x	

(continued)

Table 2 (continued)

MTRP 2014 Research objectives	Progress	MTRP 2022 – Research priorities	Data collection needs	Geographic area of particular interest	Fishery-based research objectives	Non-Olympic fishery research and voluntary programs
Skates						
(viii) To estimate survivorship of released skates	1	To estimate survivorship of released skates To estimate population abundance of skates To evaluate other 'hard structures' in skates for ageing purposes	Post-release survival estimates from pop-up satellite archival transmitting tags. Physiological stressors of capture and their influence on survival. Skate diet. Age composition by species. Identification of areas of importance to skate life history, including egg laying and size data. Evaluation of the accuracy of cryptic skate species identification.		x	
(ix) To develop semi-quantitative and spatially explicit risk assessments for macrourids and Antarctic skates, especially in the slope fishery of the Ross Sea	1	To continue to collect data on by-catch species to determine their productivity and basic life-history parameters (-> CLIMATE CHANGE)	Information to reduce uncertainty in life history and inform ecosystem models (e.g. length- and age-at-maturity, growth, length-weight relationships, and sex ratios, mortality rates). Validation of age estimates. Fishery selectivity. Spatial distributions. Population definition: stock structure, locations of spawning sites and spawning site fidelity. Obtaining information on the diet of by-catch species (macrourids in particular). Better species identification (especially for macrourids).		x	

(continued)

Table 2 (continued)

MTRP 2014 Research objectives	Progress	MTRP 2022 – Research priorities	Data collection needs	Geographic area of particular interest	Fishery-based research objectives	Non-Olympic fishery research and voluntary programs
(x) To develop methods to assess whether the potential impacts of the toothfish fishery on the ecosystem are likely to be reversible in two to three decades	0	Not specified	n/a			
Marine debris						
Not specified	Not specified	Quantify the effect of marine debris on the ecosystem and on toothfish populations	Data on density and distribution of marine debris including plastics and microplastics		x	
Alien species						
Not specified	Not specified	To monitor for new, unusual and rare species (-> CLIMATE CHANGE)	Record data and preserve example specimens for further analyses		x	

Table 3: Draft data collection plan for the Ross Sea toothfish fishery. V – vessel lead, O – observer lead, TOA – Antarctic toothfish, TOP – Patagonian toothfish, CHW – icefish spp., ANT – blue antimora, MRL – moray cod spp., TL – total length, SL – standard length, PL – pelvic length, WS – wingspan, SRZ – special research zone, SSRU – small-scale research unit, SIOFA – Southern Indian Ocean Fisheries Agreement.

Lead	Data collected	Frequency	Priority	Protocol	Current requirement	Change form	Change manual	Research/ baseline	Processing overhead
	Catch and effort data								
V	C2 and catch and effort data	Every set	Mandatory	CM-41/01(2019)	Yes			Baseline	Low
O	Observer tally period catch	ID to species group	Very High		Yes			Baseline	
	Ongoing yearly toothfish biological data (based on updated data collection plan in WG-FSA-2022/45)								
O	Length, sex, gonad stage	**TOA and TOP**: 35 per haul, target 7 per 1 000 hooks everywhere. TL and SL are requested	Very High	BIO-01, BIO-01a	Yes			Baseline	Low
O	Length, weight, sex, gonad stage and weight, axe handle	**TOA**: First 20 fish sampled per set	Very High	BIO-01, BIO-01a				Research	Low
O	Otoliths	**TOA and TOP**: 10 per set for each species.	Very High	BIO-01	Yes			Baseline	Medium
O	Genetics	**TOA**: 1 fin clip in ethanol per set from otolith fish, max of 50 combined **TOP**: 1 fin clip in ethanol per set, max of 50	Medium	BIO-04	No	Minor change	Minor change	Research	Medium
O	Liver weights	**TOA/TOP**: Record liver weight from first 10 fish sampled	Medium	BIO-05	No	Yes	Yes	Research	Low
O	Onboard stomach sampling: stomach weights, fullness, contents, digestive state	**TOA/TOP**: Record stomach weight, contents from first 10 fish sampled	Medium	BIO-05	No	Yes	Yes	Research	Low
O	Stomach samples (retained)	**TOA/TOP**: Freeze first 10 stomachs for analysis on shore	Medium	BIO-05	No	Yes (sample label)	Yes	Research	High
O	Muscle tissue	**TOA/TOP**: Freeze small sample of muscle tissue for stable isotope analysis	Medium	BIO-05	No	Yes (sample label)	Yes	Research	Medium
O	Conversion factors	**TOA/TOP**: Refer to WG-FSA-2022/01	High	BIO-03	Yes	No	Update	Baseline	Low

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Table 3 (continued)

Lead	Data collected	Frequency	Priority	Protocol	Current requirement	Change form	Change manual	Research/ baseline	Processing overhead
	Tagging								
V	Toothfish tagging	One per tonne (in Subarea 88.1 and SSRUs 882A–B), double tagged, overlap statistic >60%. Three fish per tonne (SRZ).	Very High	BIO-02, BIO-02a, BIO-19	Yes			Baseline	Low
V	Skate tagging	Vessel decision to tag skates. If tagging, only tag skates in good condition (include measurement of physiological parameters (lactate)). Record wingspan, any injury codes in comments.	Very High	BIO-07, BIO-07a, BIO-07b	No	Yes – if physio parameters are made baseline	No	Research (physiological parameters)	Low
V	Toothfish recaptures	**TOA and TOP**: Scan every fish for tags. Photograph tags with number readable. Keep stomach and muscle tissue sample. Length, weight, sex, gonad stage, gonad weight and otoliths.	Very High	BIO-05	Yes			Baseline	Low
V/O	Skate tag recaptures	Scan every skate for tags, identify species, photograph tags, bag and return first 10 tagged skates for the trip whole to NIWA with tag in situ, otherwise, sample biologically (PL, WS, TL, sex, stage, weight), collect thorns and freeze with label including tag number. If easier to send whole skate than thorns, feel free to do that. Note: all skates even if frozen whole must have PL, WS, TL, sex, stage, weight entered in eLongline form.	Very High	BIO-02, BIO-07	Yes			Baseline	Low
	Ongoing yearly bottom fishing effects								
V	Mid-point latitude and longitude of segment and total weight of any VME-indicator taxa	All segments. A segment is 1000 hooks or 1200m line.	Very High	BIO-11, BIO-11a	Yes			Baseline	Low
V	Mid-point latitude and longitude of segment, weight and ID VME-indicator taxa	Any segment where 5kg or more is caught, and 30% of other segments	Very High		Yes			Research	Low

(continued)

Table 3 (continued)

Lead	Data collected	Frequency	Priority	Protocol	Current requirement	Change form	Change manual	Research/ baseline	Processing overhead
V	VME samples	Retain a small subsample of VME specimens for all segments where 5 l/kg or more caught in a segment AND taxonomic ID is in question.	High	BIO-11, BIO-11a	No			Research	Low
O	VME (sponges)	Inspect sponges for presence of fish eggs and do something (counts, photos, and size of sponge; or collect eggs and sponge). Coordinate where samples go.	High	Protocol needed (Italy?)		If baseline	If baseline, (add protocol)	Research	
	Year-specific fish biological data – skates								
O	Skate biologicals: Species, length, (total/pelvic/disc width), weight, sex, gonad stage, condition, thorns on recaptures	On any dead or tag recapture skates only. Identify to species, measure PL, TL and WS, weight, sex, condition, stage. Thorns (at least 10) on recaptures.	Very High	BIO-12 SC-CAMLR-39/ BG/31	No (currently only required to sample up to 10 per line)	No	Yes		Low
	Year-specific fish biological data – CHW, ANT, MRL (focus species group season XX, season YY)								
O	ID to species, length, weight, sex, gonad stage and weight	All fish up to 10, every set (mixture) x-ref WG-FSA-10/32 and WG-FSA-15/40	Very High	BIO 2016/14	Yes except for gonad stage and sex	No	Yes if gonad stage and sex required		Low
O	Otoliths	5 otolith pairs every set	High	BIO2016/14	No	No	If baseline		Medium
	Year-specific fish biological data – Macrourids (Focus species group season XX, season YY)								
O	ID to species, length (TL and PAL), weight, sex, gonad stage and gonad weight	All fish up to 10, every set (mixture)	Very High	BIO 2015/12	Yes except for gonad stage and sex	No	Yes if gonad stage and sex required		Low
O	Stomach, isotope sample	Up to 50 but only non-everted stomachs from each species Isotope: from all fish with retained stomachs	High	BIO2015/12	No	Yes if baseline	Yes		High
O	Otoliths	5 otolith pairs every set (matched to fish with biological data)	High		No	No	Yes if baseline		

(continued)

Table 3 (continued)

Lead	Data collected	Frequency	Priority	Protocol	Current requirement	Change form	Change manual	Research/ baseline	Processing overhead
	Other data								
O	Squid beaks	Opportunistic from toothfish stomachs	Low	BIO-06	No	Yes	Yes	Research	
O	Squids	Up to 20 squids of any species with hooked tentacles, frozen whole (including from stomachs)	Low	BIO-16, BIO-16a, BIO-16b	No	Yes	Yes	Research	
O	Colossal Squid	Tissue samples (mantle, ink sac, digestive gland, beak)	Medium	BIO-16, BIO-16a	No	Yes	Yes	Research	
O	Fish specimens	Various opportunistic specimen collection for museum – see protocol	Low	BIO-09	No	Yes	Yes	Research	
V	Underwater camera	Longline autonomous camera. Every set possible	High	BIO-08	No	Yes	Yes	Research	
V	Acoustic data (e.g. for toothfish, macrourids)	Record data within the CCAMLR area (e.g. on ES60 echosounder)	High	Vessel			Yes	Research	
O	Sea lice observations	Subsample each line on form, link to vessel B grade	Low	BIO-15			Yes	Research	
V	Toothfish tagging training videos	Opportunistic video recordings of tagging and release methods used	High	BIO-19			Yes	Research	
O	Alien species	Freeze unusual specimens for museum	Very High				Yes	Research	
V	Zooplankton and microplastics (CPR)	Towing the CPR to collect zooplankton and microplastic samples. Requires the vessel to have gear and CPR expertise, and have filters fitted to all waste-water outlets on the vessel (to avoid plastic contamination)	Low	Plankton e-group = protocols			Yes	Research	
V	Passive acoustic recorder (tow)	Potential to deploy underwater hydrophones while on station (for sperm whales)	Low				Yes	Research	
V	Temp/salinity profilers on longline	Self-logging mini depth-temperature sensors on longlines to measure mixed layer depths	Medium				Yes	Research	

(continued)

Table 3 (continued)

Lead	Data collected	Frequency	Priority	Protocol	Current requirement	Change form	Change manual	Research/ baseline	Processing overhead
V	Minnow trap	Baited small traps deployed on freeline; one per set. Contents to be identified to lowest resolution possible. Count and weigh total amount of each species/species group. Freeze entire sample for museum. Ensure label includes 'trap' and haul number.	Medium	BIO-20			Yes	Research	
O	Air sampling	(Weather dependent.) Fill containers during steam down and return from range of latitudes: 45°S, 50°S, 53°S, 56°S, 59°S, 61°S, 64°S, 70°S, 75°S	Medium	Air samples_GNS			Yes	Research	
O	Cetaceans	Opportunistic whale sightings. Photographic data collection for estimating abundance of animals with notable marks. (Biopsies, tagging-noting specialised staff may be required.)	Medium	Cetaceans_2022; (SIOFA template, SIOFA CMM 2021/02 Annex E)	Sightings currently collected during tally period. Photography and biopsies really require specialist researchers		Yes	Research	
O	Seawater (acidity)	Fill small sampling bottle.	Medium				Yes	Research	
O	Plankton community sampling	Fill small sampling bottle with fixative	Medium	Plankton e-group = protocols			Yes	Research	

Attachment I

List of Registered Participants

Workshop on the Ross Sea Data Collection Plan 2022
(Virtual Meeting, 11 and 12 August 2022)

Co-Conveners	Dr Laura Ghigliotti National Research Council of Italy (CNR), Institute for the study of the anthropic impacts and the sustainability of the marine environment (IAS)
	Mr Nathan Walker Ministry for Primary Industries
European Union	Dr Sebastián Rodríguez Alfaro European Union
Germany	Ms Rebecca Konijnenberg Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research
Italy	Dr Marino Vacchi IAS – CNR
Japan	Mr Kyo Uehara Taiyo A&F Co., Ltd.
	Dr Takehiro Okuda Fisheries Resources Institute, Japan Fisheries Research and Education Agency
Korea, Republic of	Mr Hyun Joong Choi TNS Industries Inc.
	Dr Jeong-Hoon Kim Korea Polar Research Institute (KOPRI)
	Dr Haewon Lee National Institute of Fisheries Science
	Dr Eunhee Kim Citizens' Institute for Environmental Studies
	Mr Sang Gyu Shin National Institute of Fisheries Science (NIFS)
	Dr Sangdeok Chung National Institute of Fisheries Science (NIFS)

New Zealand	Dr Jennifer Devine National Institute of Water and Atmospheric Research Ltd. (NIWA)
	Mr Alistair Dunn Ocean Environmental
	Mr Jack Fenaughty Silvifish Resources Ltd
	Dr Brittany Finucci National Institute of Water and Atmospheric Research Ltd. (NIWA)
	Dr Bradley Moore National Institute of Water and Atmospheric Research Ltd. (NIWA)
	Dr Matt Pinkerton National Institute of Water and Atmospheric Research Ltd. (NIWA)
	Mr Enrique Pardo Department of Conservation
Norway	Dr Cecilie von Quillfeldt Norwegian Polar Institute
Russian Federation	Mr Oleg Krasnoborodko FGUE AtlantNIRO
	Mr Aleksandr Sytov FSUE VNIRO
	Dr Svetlana Kasatkina AtlantNIRO
South Africa	Mr Sihle Victor Ngcongo Imvelo Blue Environment Consultancy (Pty) LTD
	Mrs Melanie Williamson CapMarine Environmental
	Mr Christopher Heinecken Capricorn Fisheries Monitoring
Ukraine	Mr Pavlo Zabroda Institute of Fisheries and Marine Ecology (IFME) of the State Agency of Fisheries of Ukraine

	Mr Illia Slypko Institute of Fisheries and Marine Ecology (IFME) of the State Agency of Fisheries of Ukraine
United States of America	Dr George Watters National Marine Fisheries Service, Southwest Fisheries Science Center
CCAMLR Secretariat	Isaac Forster Fisheries and Observer Reporting Coordinator
	Daphnis De Pooter Science Data Officer
	Dr Steve Parker Science Manager
	Claire van Werven Research, Monitoring and Compliance Analyst

Attachment II

Terms of Reference for the Workshop on the Ross Sea Data Collection Plan (WS-RSDCP)

Date and location

11 and 12 August 2022

Co-conveners

Laura Ghigliotti (Italy) and Nathan Walker (New Zealand)

Objective

To develop research objectives to support the information needs of the Ross Sea region marine protected area and management of the Ross Sea toothfish fishery, with an emphasis on by-catch and ecosystem sampling requirements. At the same time, develop a fisheries-based data collection plan for fishing vessels and observers, including sampling procedures and supporting documentation.

Target attendees

CCAMLR Members (including observer program coordinators, and fishing industry operators) and the CCAMLR Secretariat.

Format

A hybrid format with an e-group for document review and discussion, followed by a virtual meeting to enable a live discussion and development of additional research activities. To be arranged with Secretariat support.

Outputs

To be developed as a Co-conveners report to WG-FSA-2022:

(i) identify medium-term research objectives
(ii) develop an associated data collection plan to meet the research objectives
(iii) identify high-priority fishery surveys or research activities
(iv) identify voluntary programs to test novel data collection mechanisms.

Financial requirements

A virtual meeting is proposed. Financial support for Secretariat participation and meeting support is requested.

Attachment III

Agenda

Workshop on the Ross Sea Data Collection Plan 2022
(Virtual Meeting, 11 and 12 August 2022)

1. Identify fishery-based medium-term research objectives

    1.1 Review 2014 plan progress
    1.2 Identify the fisheries-based research objectives to inform data collection needs

2. Develop a sampling plan to obtain necessary data

    2.1 Sampling plans and timetables for individual species/species groups or sample types for fishing vessels with clear, rationalised observer data requirements
    2.2 Develop sampling protocols required
    2.3 Identify any revisions necessary for forms or instructions

3. Identify high priority non-Olympic fishery research activities (e.g. CM 24-01)

    3.1 Research on the effects of the MPA on fish abundance (inside/outside comparisons)
    3.2 Out of season surveys (winter)
    3.3 Targeted sampling (e.g. tagging survival)

4. Identify voluntary programs to test novel data collection mechanisms

    4.1 Fishery target sampling activities (e.g. electronic monitoring)
    4.2 Ecosystem sampling activities (e.g. automated data collection methods)
    4.3 Physical oceanographic measurements (e.g. mixed layer).

Attachment IV

List of Documents

Workshop on the Ross Sea Data Collection Plan 2022
(Virtual Meeting, 11 and 12 August 2022)

WS-RSDCP-2022/01	Review of progress against the medium-term research plan for the Ross Sea toothfish fishery Delegation of New Zealand
WS-RSDCP-2022/02	Proposed medium-term research plan for the Ross Sea toothfish fishery Delegation of New Zealand
WS-RSDCP-2022/03	Research activities and voluntary programs for the Ross Sea region toothfish fishery Delegation of New Zealand