CODEX ALIMENTARIUS COMMISSION

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Agenda Items 8 and 13 **CX/CF 22/15/8**

JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON CONTAMINANTS IN FOOD

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MAXIMUM LEVELS FOR METHYLMERCURY IN CERTAIN FISH SPECIES (ORANGE ROUGHY AND PINK CUSK EEL) AND ASSOCIATED SAMPLING PLAN (At Step 4) AND DISCUSSION PAPER ON METHYLMERCURY IN FISH: PATAGONIAN TOOTHFISH AND OTHER RISK MANAGEMENT RECOMMENDATIONS FOR METHYLMERCUY IN FISH

(Prepared by the Electronic Working Group led by New Zealand and Canada)

Codex members and observers wishing to submit comments on this document should do so as instructed in CL 2022/17-CF available on the Codex webpage[1]

BACKGROUND

1. The full history of the discussion on methylmercury dating back to 1992 is contained in Information document CF/11 INF/1[2]. A summary of the background leading up to the current discussion paper is given below.

2. CCCF11 (2017) agreed to the concept of establishing maximum levels (MLs) for methylmercury in fish species based on the As Low As Reasonably Achievable (ALARA) principle, in line with the criteria for establishing MLs in the *General Standard for Contaminants in Food and Feed* (CXS 193-1995) (REP17/CF, para 126). The committee agreed to establish an Electronic Working Group (EWG), chaired by The Netherlands, and co-chaired by New Zealand and Canada, to prepare proposals for MLs for tuna as a group, alfonsino, kingfish/amberjack, marlin, shark, dogfish and swordfish.

3. As part of the recommendations presented to CCCF11 by the previous EWG, contained in CX/CF 17/11/12, other species were identified where further data collection was advised to establish if MLs were needed. Additionally, a recommendation was made that discussion could be commenced on considering MLs for other species in the GEMS database (CX/CF 17/11/12, para 15), with a preliminary analysis presented in the supporting discussion paper.

4. CCCF12 (2018) agreed that consistent with the approach taken for the establishment of MLs for lead, the methylmercury ML proposal that would be agreed upon would be those based on the next higher ML resulting in a trade rejection rate lower than 5%. The Committee agreed upon MLs for tuna species (1.2 mg/kg; REP18/CF, para 75), alfonsino (1.5 mg/kg; REP18/CF, para 77), marlin (1.7 mg/kg; REP18/CF, para 77) and shark (1.6 mg/kg; REP18/CF, para 77). No consensus was achieved for an ML for swordfish and it was agreed to discontinue work on an ML (REP18/CF, para 83). Based on the new dataset used by the EWG it was established that mean and median concentrations of total mercury and methylmercury in amberjack all fell below 0.3 mg/kg, the agreed selection criterion for selecting fish species for setting MLs, and therefore it was agreed to discontinue work on the ML for amberjack (REP18/CF, para 78).

5. CCCF12 also noted that for future ML development, data on both methylmercury and total mercury would need to be available, as it was shown that for certain fish species the ratio of methylmercury to total mercury was very low and for the data analysis it could not always be assumed that total mercury would be mostly present as methylmercury (REP18/CF, para 88).

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1 Codex webpage/Circular Letters: http://www.fao.org/fao-who-codexalimentarius/resources/circular-letters/en/.
Codex webpage/CCCF/Circular Letters: http://www.fao.org/fao-who-codexalimentarius/committees/committee/related-circular-letters/en/?committee=CCCF

2 Working documents, including reports, conference room and information documents can be found on the CCCF webpage: http://www.fao.org/fao-who-codexalimentarius/committees/committee/related-meetings/en/?committee=CCCF

6. With the agreement of the MLs for tuna, alfonsino, marlin and shark, there was an established framework to apply an ALARA approach in the setting of future MLs for methylmercury in fish.

7. Noting the recommendation made in CX/CF 17/11/12 for discussion on considering MLs for other species CCCF12 agreed to establish an EWG chaired by New Zealand and co-chaired by Canada to prepare a discussion paper presenting a proposal for establishment of MLs for additional fish species. The paper was to clearly identify the fish species for which MLs should be established (REP18/CF, para 93).

8. The resulting discussion paper from the EWG was considered by CCCF13 (2019; CX/CF 19/13/13). The limited availability of methylmercury concentration data for additional fish species precluded establishing appropriate MLs. However, a number of species or taxonomic groups were identified where further data collection would be necessary to confirm ALARA or exceedance of the selection criterion.

9. CCCF13 considered a staggered timeline for ML derivation of species or taxonomic groups identified for further data collection, however it was recognised that the recommended programme was ambitious and contingent on data submission (REP19/CF para 116).

10. CCCF13 agreed to request that JECFA issue a call for new data to be submitted to GEMS/Food that would support revision of the discussion paper to consider whether it is feasible to proceed with establishment of MLs for additional fish species (REP19/CF para 127).

11. CCCF13 also agreed to consider issues related to sampling plans for methylmercury in fish as part of the re-established EWG examining the feasibility of MLs for additional fish species (REP19/CF).

12. Postponement of CCCF14 from 2020 to 2021 enabled the EWG to be reconvened to further consider the discussion paper and the updates made in response to a call for data in a Circular Letter (CL 2020/52-CF). Further species data was also submitted through GEMS/Food enabling an updated review.

13. A discussion paper from the EWG was considered CCCF14 (2021; CX/CF 21/14/11). Three species (orange roughy, pink cusk-eel and Patagonian toothfish) were identified for ML setting from 48 taxonomic groups of fish in total reviewed. However, in order to proceed with developing the ML for Patagonian toothfish, more data would be needed to set a robust ML (REP21/CF paras 149, 150).

14. CCCF14 agreed to discontinue the review of MLs for any other additional species (REP21/CF para 166).

15. CCCF14 agreed to submit a project document for new work on MLs for methylmercury in orange roughy and pink cusk eel (REP21/CF para 166). This new work was approved by CAC44 (2021, REP21/CAC para 46).

16. CCCF14 agreed to request that JECFA issue a call for new data to be submitted to GEMS/Food for orange roughy, pink cusk-eel and all toothfish that would support revision of the discussion paper to proceed with establishment of MLs for orange roughy and pink cusk-eel, and to consider whether it is feasible to set an ML for Patagonian toothfish (REP21/CF para 166). This call for data included all toothfish (i.e. Patagonian and Antarctic) as data gaps were also identified in the dataset for Antarctic toothfish (no methylmercury data and the total mercury data was below the selection criteria (REP21/CF para 148)).

17. CCCF14 also agreed to continue further work on the sampling plan (REP21/CF para 166) and that further work on the sampling plan could follow the approach proposed in Appendix III of CX/CF 21/14/11 and that further work should ensure the practicality of the sampling plan (REP21/CF para 164).

18. CCCF14 also agreed to conduct a literature review to assess the feasibility of developing guidance for the management of methylmercury levels in fish (REP21/CF para 166).

19. This paper presents the discussion and recommendations of the EWG.

20. The recommendations of the EWG for consideration by CCCF15 are described in paragraph 41 below. Discussions of the EWG from 2021-22 (paragraphs 19-40) are summarised below to record the development process for these recommendations.

21. The discussion paper on the MLs for methylmercury in orange roughy and pink cusk-eel and considering the feasibility of elaborating an ML for Patagonian toothfish is provided in Appendix I, and on the sampling plan, in Appendix II. The discussion paper on risk management measures for methylmercury in fish is provided in Appendix III. The discussion papers detail the work process followed as well as all the data and information considered by the EWG to arrive at the recommendations in paragraph 41.

2021-22 Advancements in the work

Call for data:

22. A call for data was issued from July to October 2021 for methylmercury and total mercury in orange roughy, pink cusk-eel and all toothfish (Antarctic and Patagonian) which had not previously been submitted to GEMS/Food[3]. No new data for orange roughy or pink-cusk-eel was submitted to the GEMS/Food database in 2021, whereas for Patagonian toothfish a small number of new data was submitted to the GEMS/Food database.

23. The EWG commented on the updates to the discussion paper being prepared for CCCF15 that included the results of the 2021 call for data. Two EWG members provided comments on the draft discussion paper.

Proposed MLs for orange roughy and pink cusk-eel

24. MLs for orange roughy and pink cusk-eel were presented to the EWG members during the comment period, however no comments were received on the proposed MLs.

25. Although no specific recommendation was made in REP21/CF for this EWG to work with the EWG on data collection, analysis and presentation, one member noted that for recommendations from the EWG to be considered if possible, such as those relating to minimum sample size.

26. One member questioned whether the samples collected for both orange roughy and pink cusk-eel were of sufficient geographic variability, noting the samples were collected in either one to two locations within the region. Whereby 90% of capture production of orange roughy is from the one region.

27. One member indicated that there was no general acceptance with using combined regression modelled datasets and that it should be excluded from decision making.

28. Both members commented on the relevance of making comparisons between the trade value of marlin to orange roughy and pink cusk-eel and how this demonstrates protection against a trade issue.

29. One member reiterated that all cusk-eel is not pink cusk-eel and the trade comparator should be based only on pink-cusk eel, noting 80% of cusk-eels is represented by pink cusk-eel and not reflected in estimates.

30. General amendments and clarifications were suggested by members which were incorporated where possible.

Feasibility of an ML for Patagonian Toothfish

31. The EWG was asked if, and when, another call for data should be held for toothfish or if work to potentially elaborate ML for methylmercury in Patagonian toothfish be abandoned.

32. Both EWG members providing comments agreed the data continued to be insufficient to proceed to elaborate an ML for Patagonian toothfish.

33. One member indicated that it seemed appropriate to abandon establishment of an ML for Patagonian given that toothfish was proposed for ML elaboration by CCCF13 and there have been two calls for data from which sufficient data have not been obtained. This member also noted that the current methylmercury data do not meet the selection criteria.

34. The other member providing comments indicated that based on the mean and maximum total mercury levels in Patagonian toothfish, this species is as reasonable of a candidate for ML elaboration as pink cusk-eel and orange roughy, and suggested an additional call for data be held in a few years' time if there is a commitment from member countries to submit the required data.

35. One member also questioned why all toothfish data were considered in the discussion paper when the EWG was charged with reviewing the feasibility of establishing an ML for Patagonian toothfish. As the 2021 call for data included all toothfish (REP21/CF para 166) due to identified data gaps in the datasets for each Patagonian and Antarctic toothfish species (REP21/CF para 148), all toothfish data are presented in the discussion paper for completeness and discussion, which seemed reasonable given the work on toothfish remains at the data gathering stage.

[3] https://www.fao.org/3/cb5848en/cb5848en.pdf

Sampling Plan

36. Information on national sampling plans for mercury in fish or other contaminants, particularly tuna, shark, alfonsino, and marlin, orange roughy and pink cusk-eel was sought from EWG members. In response to this request one member reiterated that species-specific sampling plans are not the typical approach for sampling fish and this approach would need to be confirmed with data and suggested that the EWG consider the level of effort needed to develop species-specific annexes given the Committee's overall agenda.

37. One member reiterated support for seeking information on national plans for mercury or other contaminants in fish from CCCF member countries, particularly key exporting and importing countries of tuna, shark, alfonsino, and marlin, orange roughy and pink cusk-eel. They also noted that they were seeking this information from relevant authorities within their country and will aim to share it with the EWG for consideration once it's available.

38. One member noted that basing sampling plan criteria on monetary value could complicate the sampling plan, as monetary value can differ at any given point in time based on characteristics unique to each international market and may lead to further updates to the sampling plan when fish values fluctuate. It was also noted that at the point of sampling the market value of the carcass may not be precisely known, as the fish may be sampled at a point in the distribution chain prior to the carcass being priced.

Risk management measures for methylmercury in fish

39. The EWG were asked if they could provide any data to support the development of a guidance paper for the management of methylmercury levels in fish at catch, sorting and processing level. One member indicated they did not have any information available.

40. A review of the literature could not identify sufficient information to support the development of a guidance paper, consequently it is not feasible to develop guidance for the management of methylmercury in fish.

41. Alternatively, pending availability of sufficient information, the EWG were also asked to consider whether it would be reasonable to include any information on risk management approaches at the catch, sorting and processing levels in the sampling plan and not in a separate discussion paper. Both members who commented showed support for this approach, one member further stating when the inclusion of this information is relevant to the sampling plan.

Recommendations

42. CCCF15 is invited to consider taking into account the data, information and analysis provided in Appendices I, II and III:

    a. Proposed MLs for orange roughy and pink cusk-eel, based on the data analysis and information presented in Appendix I and considerations given in paragraphs 24-30:

        i. 0.8 mg/kg methylmercury for orange roughy;

        ii. 1.0 mg/kg methylmercury for pink cusk-eel; and

        iii. to advance these MLs for final adoption by the Codex Alimentarius Commission.

    b. Feasibility of ML for Patagonian toothfish based on the data analysis and information presented in Appendix I and considerations given in paragraphs 31-35:

        i. Abandon the elaboration of an ML for Patagonian toothfish as a species and toothfish as a taxonomic group; or

        ii. Hold another call for data for methylmercury and total mercury in toothfish provided that there is commitment from member countries to generate required data (timeline could be determined based on the countries collecting and submitting the data e.g. 2-3 years).

    c. Sampling plan based on information presented in Appendix II and considerations given in paragraphs 36-38:

        i. Progress further development of the sampling plan based on the approach referred to in Appendix II through the EWG; and

        ii. Request for a circular letter/call for data on the national sampling plans for mercury in fish, or other contaminants in fish.

d. Risk management measures based on the information presented in Appendix III and considerations given in paragraphs 39-41:

i. If information is sufficient, consider incorporating risk management measures of methylmercury in fish as part of the sampling plan, where inclusion is relevant; or

ii. Postpone assessing feasibility of developing a guidance paper for the management of methylmercury in fish for one year and request to issue a circular letter requesting for information; or

iii. Discontinue the development of a separate guidance paper for the management of methylmercury in fish.

APPENDIX I

DISCUSSION PAPERON THE ESTABLISHMENT OF MAXIMUM LEVELS FOR METHYLMERCURY IN ADDITIONAL FISH SPECIES (ORANGE ROUGHY AND PINK CUSK EEL)
(For information)
AND
PATAGONIAN TOOTHFISH
(For consideration by CCCF)

Background

1. The current maximum levels for methylmercury in the *General Standard for Contaminants in Food and Feed* (CXS 193-1995) are 1.2 mg/kg for tuna, 1.5 mg/kg for alfonsino, 1.7 mg/kg for marlin and 1.6 mg/kg for shark (CXS 193-1995). These MLs address the majority of the species of concern identified by the Joint FAO/WHO Expert Consultation on the Risks and Benefits of Fish Consumption[4]. An As Low As Reasonably Achievable (ALARA) approach was used for deriving these MLs, with the established limits set at the concentration value, reported to one significant figure, where the rejection rate was less than 5% (REP18/CF para 71).

2. The agreed upon framework for identifying the selected species for possible ML elaboration was to use a screening concentration of 0.3 mg/kg average methylmercury (CX/CF 17/11/12).

3. For species with average methylmercury concentrations below this screening concentration, the benefits of fish consumption are expected to outweigh the risks when the fish was consumed (CX/CF 7/11/12). Using this screening concentration, CCCF agreed on a recommendation that amberjack did not require an ML (CX/CF 18/12/7).

4. A review of the WHO GEMS/Food database was undertaken in November 2018 of total mercury and methylmercury for those fish species for which MLs were not adopted by the CAC in 2018. The review was to identify further species that would meet the criterion for ML establishment. The full findings of the review were recorded in CX/CF 19/13/13. In brief, the limited availability of methylmercury concentration data for these fish species precluded establishing appropriate MLs. However, a number of species or taxonomic groups were identified where further data collection would be necessary to establish whether ML setting may be necessary (Table 1). Additionally, based on total mercury data falling below 0.3 mg/kg a broader range of fish species and groupings were confirmed to be unlikely to require MLs (CX/CF 19/13/13 Appendix 1).

Table 1: Identified fish species or taxonomic groupings for further data collection (*As presented in* CX/CF *19/13/13).*

Grouping (identified species)	
Anglerfish	Pike
Barracuda	Sablefish
Cardinalfish	Seabass
Catfish (Channel catfish)	Short nosed chimera (Rat fish)
Cusk-eel (Pink Cusk-eel, Kingklip)	Snake mackerel (Escolar)
Cutlassfish (Scabbardfish)	Snapper (Russell's snapper, unspecified)
Grouper (Yellowfin)	Sturgeon
Hapuku	Toothfish (Patagonian toothfish)
Ling (Cusk, Blue ling)	White hake
Orange roughy	

5. CCCF13 considered a staggered timeline for ML derivation of species or taxonomic groups identified for further data collection, however it was recognised that the recommended programme was ambitious and contingent on data submission (REP19/CF para 116).

6. As a result, CCCF13 agreed to request that JECFA issue a call for new data to be submitted to GEMS/Food that would support revision of the discussion paper to consider whether it is feasible to proceed with establishment of MLs for additional fish species (REP19/CF para 127).

[4] Report of the Joint FAO/WHO Expert Consultation on the Risks and Benefits of Fish Consumption. Rome, Food and Agriculture Organization of the United Nations; Geneva, World Health Organization, 2010.

7. With an agreed framework for selecting and deriving methylmercury MLs for fish species established, the GEMS/Food database was examined for new data for total mercury and methylmercury in fish to consider whether it is feasible to proceed with establishment of MLs for additional fish species.

8. At CCCF14 three species (orange roughy, pink cusk-eel and Patagonian toothfish) were identified for ML setting from 48 taxonomic groups of fish in total reviewed (CX/CF 21/14/11).

9. As a result, CCCF14 agreed to request that JECFA issue a call for new data to be submitted to GEMS/Food to proceed with establishment of MLs for orange roughy and pink cusk-eel, and to consider whether it is feasible to set an ML for Patagonian toothfish (REP21/CF para 166).

10. At CCCF14 it was also agreed upon to discontinue review of MLs for any other additional fish species, to develop the sampling plan and conduct a literature review to assess the feasibility of developing guidance for the management of methylmercury in fish (REP21/CF para 166).

11. At CCCF14 information was provided by the Codex Secretariat that no specific trade criterion has been defined on which to base ML setting and that CCCF should be guided overall by the dual mandate of Codex and more specifically by the principles established by CCCF, especially in the Preamble to the GSCTFF (REP21/CF para 156-158).

12. A call for data on methylmercury and total mercury in orange roughy, pink cusk-eel and all toothfish (Antarctic and Patagonian) was posted in July 2021 and data was requested to be submitted by October 2021 for data spanning approximately the last 12 years[5]. No new data for orange roughy or pink cusk-eel was submitted to the GEMS/Food database, whereas for Patagonian toothfish a small number of new data was submitted to the GEMS/Food database.

Work Process

Selection criterion

13. A process to derive selection criterion (0.3 mg/kg average methylmercury) for fish species of concern requiring MLs for methylmercury was reported on in CX/CF 17/11/12.

14. The selection criterion was derived through consideration of weekly fish consumption amounts, in g/person per week, that would be required to reach the Provisional Tolerable Weekly Intake (PTWI) of 1.6 µg/kg bw/day (Table 2).

Table 2: Weekly fish consumption amounts required to reach PTWI of 1.6 µg/kg bw/day at various methylmercury concentrations. (As presented in CX/CF 17/11/12).

Methylmercury concentration (mg/kg)	Fish consumption to reach PTWI (g/person per week)	GEMS Cluster Diets potentially exceeding PTWI (fresh/frozen fish)
0.1	960	0
0.2	480	0
0.3	320	0
0.4	240	G14, G17
0.5	192	G10, G14, G17
0.6	160	G10, G14, G17
0.7	137	G10, G11, G14, G17
0.8	120	G04, G07, G08, G10, G11, G14, G17
0.9	107	G02, G03, G04, G07, G08, G10, G11, G14, G15, G17
1.0	96	G02, G03, G04, G07, G08, G09, G10, G11, G12, G14, G15, G17

15. Through comparison of the calculated fish consumption amounts to the 95th percentile fresh fish consumption rate of 285 g/person per week for all GEMS/Food, and to fish consumption amounts in the individual WHO GEMS cluster diets, it was considered that a methylmercury concentration of greater than 0.3 mg/kg would be required to present a risk of exposures exceeding the PTWI (CX/CF 17/11/12). As a result, an average methylmercury concentration of 0.3 mg/kg was adapted as the selection criterion for identifying fish species that would present a concern for methylmercury (REP17/CF).

5 https://www.fao.org/3/cb5848en/cb5848en.pdf

16. It is important to note that fish containing an average of less than 0.3 mg/kg methylmercury may still contribute to overall dietary exposure to methylmercury and therefore contribute to a cumulative exceedance of the PTWI if fish with high methylmercury concentrations are also consumed.

17. The 0.3 mg/kg selection criterion for methylmercury continued to be used to evaluate whether it was appropriate to proceed with developing MLs for certain fish species or taxonomic groups. The present work focuses on orange roughy, pink cusk-eel, and toothfish, specifically Patagonian toothfish, which were determined to meet the 0.3 mg/kg selection criterion for methylmercury (REP21/CF paras 148-150).

Review of data submitted to GEMS/Food

18. Data were extracted from GEMS/Food for total mercury and methylmercury in orange roughy, pink cusk-eel and all toothfish (Patagonian and Antarctic) for the sampling years of 2000-2021. All other species/taxonomic groupings of fish were outside of the scope of the present work, as the 14th CCCCF agreed to discontinue the review of MLs for any other additional species (REP21/CF para 166).

19. Data were excluded that were aggregated data, were unspecific categories, or were not for whole fish, muscle[6] or muscle-based portions. Data points for cooked fish were excluded. Data were only considered if they were clearly identifiable to a species of fish, either through provision of a binomial name or a sufficiently unique common name.

20. To avoid any potential for double counting where samples in a survey have been analysed for both methylmercury and total mercury, survey results were analysed separately.

21. Where available, paired data were considered to confirm the ratio of methylmercury to total mercury. To establish if there was confidence in the calculated ratio the paired datasets were analysed for correlation (Pearson Correlation Coefficient) and confirmed for statistical significance (p= <0.05). Where the ratio of methylmercury to total mercury was statistically correlated, the unpaired total mercury dataset was adjusted by the calculated linear regression equation from the paired data to estimate the methylmercury concentration.

22. All datasets were statistically analysed for each fish species, with mean, standard deviation, 95th percentile and maximum results calculated.

23. The prior recommendation (REP18/CF) for future ML development was that data on both methylmercury and total mercury would need to be available as it could not always be assumed that total mercury would be mostly present as methylmercury (Para 88 - REP18/CF). On this basis, determination of a clear exceedance of the selection criterion was determined only from methylmercury occurrence data, or where the availability of paired total mercury to methylmercury data enabled the methylmercury value to be modelled from unpaired total mercury data. However, in the absence of methylmercury occurrence data, if the average total mercury value fell below the selection criterion it was considered sufficiently indicative to establish that the average methylmercury concentration would not exceed the selection criterion.

24. To ensure the dataset used to establish an ML was sufficiently robust, a minimum sample number of 74 (for either the methylmercury dataset alone or a combined regression modelled dataset) was required. This was determined based on a binomial distribution, where at a probability of detection of 95%, the required sample size to obtain one analytical value above the 96%ile (i.e., a 4% rejection rate) was 74 samples. This approach can be amended as per the recommendations of the EWG developing guidance on data collection, analysis and presentation for development of maximum levels, as appropriate.

25. The FAO 2016-2018[7] export volumes (in metric tonnes – MT) and export values for are presented for orange roughy, pink cusk-eel, and toothfish (all species) to demonstrate that are traded internationally. As a reference, the 2016-18 average export volumes and values attributed specifically to marlin are recorded in Table 3, this being the fish species with a current ML for methylmercury with the lowest of these export values. For each species, the average values for the last three years of available data (2016, 2017, 2018) are presented to account for any recent year-to-year fluctuation.

6 For example fish paste, fish roe and fish livers.

7 FAO. 2020. FAO yearbook. Fishery and Aquaculture Statistics 2018/FAO annuaire. Statistiques des pêches et de l'aquaculture 2018/FAO anuario. Estadísticas de pesca y acuicultura 2018. Rome/Roma.

Table 3: 2016-18 Average global export volume and export value for marlin.

Species	Export volume (MT)	Export value (US$,000,000)
Marlin	4319	8

MT – metric tonnes

Proposed MLs for orange roughy and pink cusk eel

26. The currently established MLs for fish species have been set at the concentration value, reported to one significant figure, where the rejection rate was less than 5% (REP18/CF para 71, 74 and 77).

27. Hypothetical MLs were calculated for orange roughy and pink cusk-eel applying the above principle to methylmercury, or combined regression modelled datasets where these met the minimum sample numbers. A third option using the combined dataset of methylmercury values and regression equation-adjusted unpaired total mercury values was also calculated to derive options for methylmercury MLs.

Orange roughy (*Hoplostethus atlanticus)*

28. Data for orange roughy were extracted from GEMS/Food (Table 4). No other species in the slimehead family (*Trachichthyidae*) were identified, as a result no grouping along taxonomic lines was possible.

29. Total mercury results for orange roughy (47 results) had been considered previously within CX/CF 19/13/13. Although the average total mercury result for orange roughy exceeded the selection criterion for establishing an ML, the limited sample numbers and absence of methylmercury data meant an ML could not be identified at that time.

30. The present review of data in GEMS/Food identified that 249 total mercury and 101 methylmercury results were available for orange roughy. No new data was received during call for data in 2021, therefore the results and analysis reported in CX/CF 21/14/11 remain current.

Table 4: Summary of occurrence data on total mercury and methylmercury in mg/kg in orange roughy samples, data taken from GEMS/Food.

Common name	*Species*	Total or methyl mercury	Includes data points without LOQs	Region	Total records	Non-detects	Mean	SD	P95	Max
Orange roughy	*Hoplostethus atlanticus*	Total	No	G10 (249)	249	0	0.56	0.19	0.92	1.30
Orange roughy	*Hoplostethus atlanticus*	Methyl	No	G10 (101)	101	0	0.43	0.16	0.74	0.92

31. Samples were confirmed with the submitting country to have been caught two locations in FAO fishing region 81. The FAO fishing region the samples were caught from represented 90% of the average global capture production over 2016-2018[8].

32. In 101 paired orange roughy samples the average concentration ratio of methylmercury to total mercury was 83% (range: 65-96%; Figure 1). The average concentration ratio of methylmercury to total mercury was significantly positively correlated (Pearson Correlation Coefficient: 0.97; $p < 0.05$), with a linear line of best fit. A linear regression equation was calculated from the paired dataset: methylmercury = 0.7983 x total mercury + 0.01603. The regression equation was applied to the unpaired total mercury data (n= 148) to estimate methylmercury. Descriptive statistics for the regression model adjusted total mercury dataset; and a modelled dataset of the methylmercury and unpaired regression model adjusted total mercury dataset are presented in Table 5.

[8] FAO. 2020. FAO yearbook. Fishery and Aquaculture Statistics 2018/FAO annuaire. Statistiques des pêches et de l'aquaculture 2018/FAO anuario. Estadísticas de pesca y acuicultura 2018. Rome/Roma.

Figure 1: Correlation of paired total mercury and methylmercury concentrations in 101 samples of orange roughy.

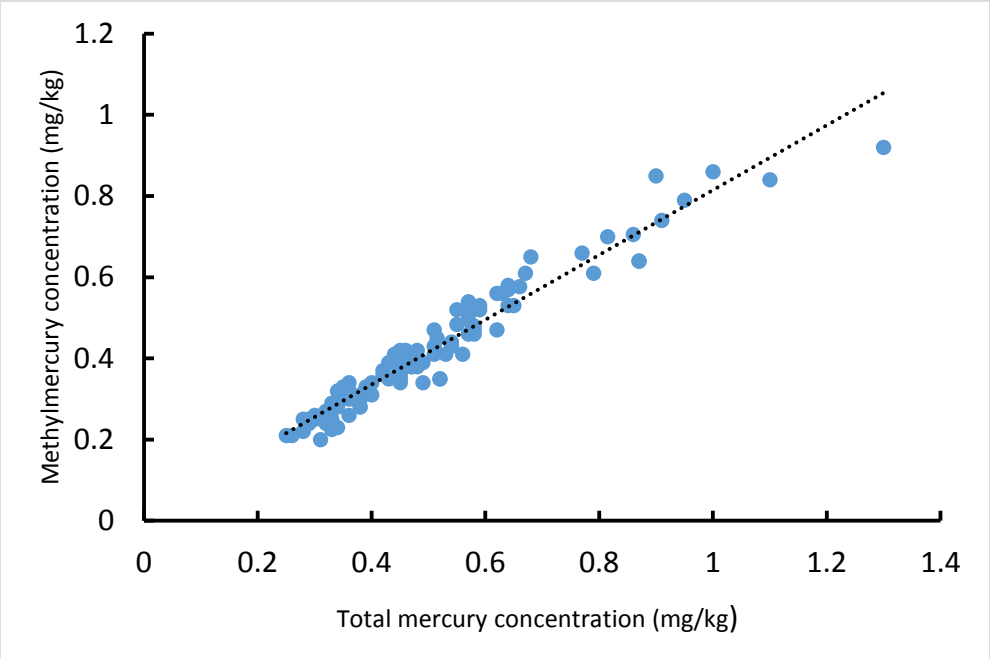


Table 5: Comparisons of descriptive statistics for methylmercury; regression model-adjusted unpaired total mercury and modelled datasets for orange roughy.

Dataset	Total records	Mean	SD	P95	Max
Methylmercury	101	0.43	0.16	0.74	0.92
Unpaired total mercury	148	0.59	0.19	0.93	1.10
Regression model adjusted unpaired total mercury	148	0.49	0.15	0.76	0.89
Modelled dataset (Regression model adjusted)[9]	249	0.46	0.16	0.76	0.92

33. The average concentration of methylmercury in orange roughy (0.43 mg/kg) exceeds the selection criterion (0.3 mg/kg). There are sufficient sample numbers (101 samples for methylmercury) to be confident in proposing an ML. Analysis of the modelled dataset gives additional confidence to this decision: mean 0.46 mg/kg methylmercury (Table 6) for the 249 samples.

34. Based on a less than 5% rejection rate, hypothetical MLs were derived for orange roughy (Table 6).

Table 6: Proposed ML for orange roughy

Hypothetical ML (mg/kg)	Methylmercury (n=101)		Modelled dataset* (n=249)	
	Number of samples <ML	% of samples <ML	Number of samples <ML	% of samples <ML
0.7	93	92	225	90
0.8	97	96	241	97
0.9	100	99	248	99
1.0	101	100	249	100

**Based upon use of methylmercury data points and any non-paired total mercury data points adjusted with a linear regression model (methylmercury = 0.7983 x total mercury + 0.01603) to estimate methylmercury.*

35. As shown in Figure 1, the paired data captured fish with total mercury concentrations across the concentration range for this species fish in the upper percentiles of total mercury are modelled for.

[9] Modelled dataset = (methylmercury + model adjusted unpaired total mercury)

36. An ML of 0.8 mg/kg methylmercury is proposed for orange roughy as it falls within the target rejection rate based on the methylmercury dataset. The modelled dataset confirms that an ML of 0.8 mg/kg methylmercury in orange roughy is reasonable. The proposed ML is the closest hypothetical ML to the 95th percentile concentration of methylmercury (Table 5), and would be expected to reduce exposure to methylmercury more than a higher ML with correspondingly lower rejection rate.

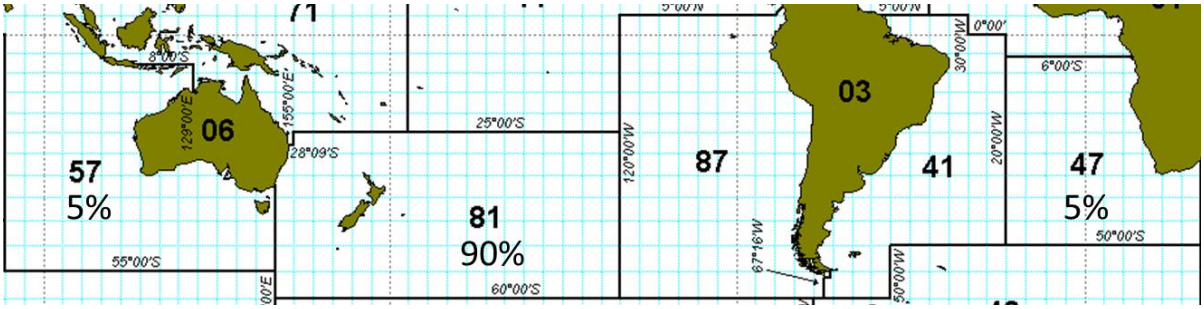
37. The 2016-2018 export volume average for orange roughy was only slightly lower than marlin, while total value of the export was over double that of marlin (Table 7). [10] The data on export volume and value in Table 7 demonstrates that orange roughy is a high value fish that is commonly traded internationally. This information supports the relevance of orange roughy in international trade and that elaborating an ML for methylmercury in orange roughy would help ensure consistent and fair trading practices worldwide.

Table 7: Average global export volume and export value for marlin and orange roughy from 2016-18.

Species	Export volume (MT)	Export value (US$,000,000)
Marlin	4319	8
Orange roughy	3289	20

38. Orange roughy are the predominant species of slimehead that is commercially fished, with the other species representing, in total, less than 1% of the capture volume. Catch volume distribution for orange roughy by FAO fishing region for 2016-18 is displayed in Figure 2.

Figure 2: Percentage of total global orange roughy capture production volume (averaged 2016-18) by FAO fishing region (0.7% caught in Region 27 (North East Atlantic) is not included). Figure adapted from FAO fishing region map; FAO, 2020.



Cusk-eels (Genus: *Genypterus*)

39. Data for pink cusk-eel (New Zealand Ling) were extracted from GEMS/Food (Table 8). Pink cusk-eel are within the cusk-eel genus *(Genypterus;* taxonomic code: 1,58(02)001) and have previously been considered at a grouping level with kingklip and unspecified cusk-eel (CX/CF 19/13/13). Although pink cusk-eel and kingklip are separate species it is noted that the term kingklip may also be seafood vernacular across cusk-eel species.

40. Total mercury results for all cusk-eels (127 results) had been considered previously within CX/CF 19/13/13.

41. The present review of data in GEMS/Food identified 234 total mercury and 120 methylmercury results were available for pink cusk-eel; 10 total mercury results for kingklip and 3 total mercury results for unspecified cusk-eel. No new data were received during call for data in 2021, therefore results and analysis reported in CX/CF 21/14/11 remain current.

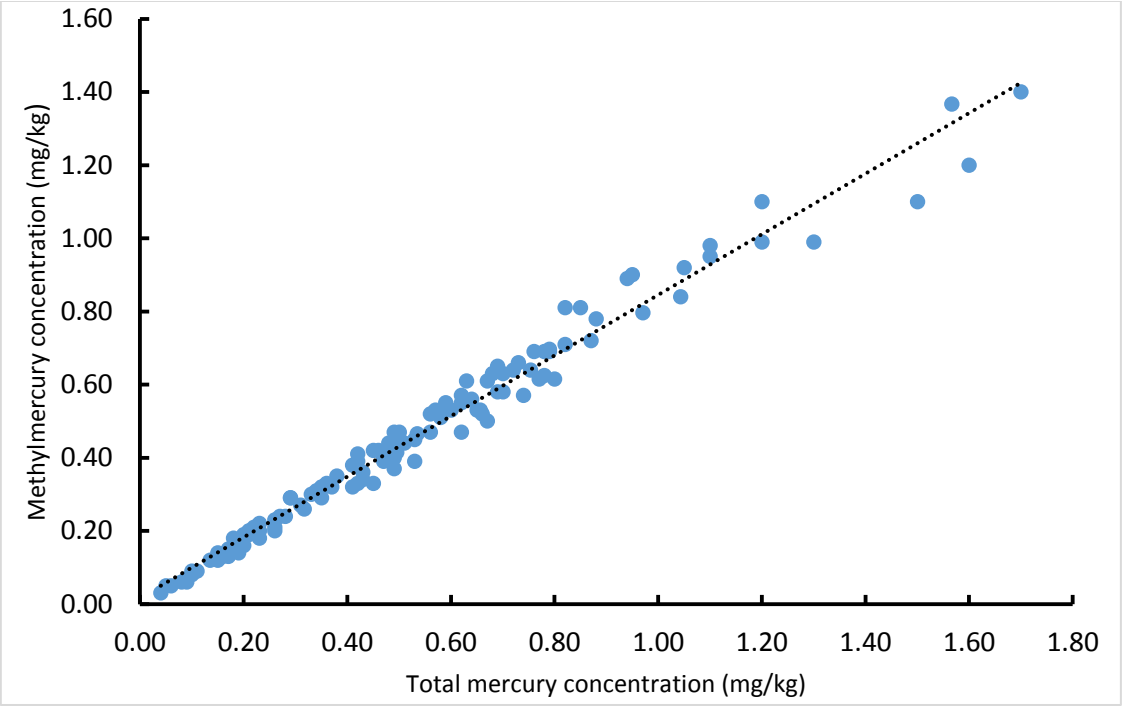
42. Samples were confirmed with the submitting country to have been caught from two fishery regions within that nation.

[10] FAO. 2020. FAO yearbook. Fishery and Aquaculture Statistics 2018/FAO annuaire. Statistiques des pêches et de l'aquaculture 2018/FAO anuario. Estadísticas de pesca y acuicultura 2018. Rome/Roma.

Table 8: Summary of occurrence data on total mercury and methylmercury in mg/kg in cusk-eel samples, data taken from GEMS/Food.

Common name	*Species*	Total or methyl mercury	Includes data points without LOQs	Region	Total records	Non-detects	Mean	SD	P95	Max
Cusk-eel (unspecified)	*Genypterus sp.*	Total	No	G10 (3)	3	0	0.45	0.23	0.64	0.66
Kingklip	*Genypterus capensis*	Total	No	G10 (10)	10	0	0.62	0.25	1.07	1.16
Pink cusk-eel	*Genypterus blacodes*	Total	No	G10 (234)	234	0	0.45	0.36	1.12	1.98
Pink cusk-eel	*Genypterus blacodes*	Methyl	No	G10 (120)	120	0	0.46	0.29	0.99	1.40
All cusk-eels (all data)	*Genypterus* sp.	Total	No	G10 (247)	247	0	0.46	0.35	1.14	1.98

Figure 3: Correlation of paired total mercury and methylmercury concentrations in 120 samples of Pink cusk-eel.



43. In 120 paired Pink cusk-eel samples the average concentration ratio of methylmercury to total mercury was 86% (range: 67-100%; Figure 3). The average concentration ratio of methylmercury to total mercury was significantly positively correlated (Pearson Correlation Coefficient: 0.9896; $p < 0.05$), with a linear line of best fit. A linear regression equation was calculated from the paired dataset of: methylmercury = 0.82904 x total mercury + 0.01681. The regression equation was applied to the unpaired total mercury data for pink cusk-eel (n= 114) to estimate methylmercury. Descriptive statistics for the ratio adjusted total mercury dataset; and a combined dataset of the methylmercury and unpaired ratio adjusted total mercury dataset are presented in Table 9.

44. The average concentration of methylmercury in pink cusk-eel (methylmercury: 0.46 mg/kg); exceed the selection criterion (0.3 mg/kg). There are sufficient sample numbers (120 samples for methylmercury) to be confident in identifying an ML. Analysis of the modelled dataset gives additional confidence to this decision: Pink cusk-eel modelled dataset: 0.39 mg/kg (n=234). Based on a less than 5% rejection rate, hypothetical MLs were derived for pink cusk-eel (Table 10).

Table 9: Comparisons of descriptive statistics for methylmercury; regression equation-adjusted unpaired total mercury and modelled datasets for pink cusk-eel.

Dataset	Total records	Mean	SD	P95	Max
Methylmercury	120	0.46	0.29	0.99	1.40
Unpaired total mercury	114	0.36	0.35	0.98	1.98
Regression model adjusted total mercury	114	0.31	0.29	0.83	1.66
Modelled dataset (Regression model adjusted)	234	0.39	0.30	0.98	1.66

Table 10: Proposed ML for pink cusk-eel

Hypothetical ML (mg/kg)	Methylmercury (n=120)		Modelled dataset* (n=234)	
	Number of samples <ML	% of samples <ML	Number of samples <ML	% of samples <ML
0.9	110	92	218	93
1.0	116	97	225	96
1.1	116	97	227	97
1.2	118	98	229	98
1.3	119	99	231	99

** Based upon use of methylmercury data points and any non-paired total mercury data points adjusted with a linear regression model (methylmercury = 0.82904 x total mercury + 0.01681) to estimate methylmercury.*

45. Current MLs for "all tuna" and "all shark" had combined datasets for individual species that had average total mercury or methylmercury results above and below the selection criterion (CX/CF 18/12/7). The present "all cusk-eel" dataset has an average total mercury result (n= 247; 0.46 mg/kg) that exceeds the selection criterion and the other identified species (kingklip) has an average total mercury result that exceeds the selection criterion (0.62 mg/kg). However, as there is no methylmercury data for other species apart from pink cusk-eel there is uncertainty that the methylmercury is present at the same ratio to total mercury for other cusk-eels.

46. A single species ML for pink cusk-eel could be established using the regression model adjusted dataset together with the methylmercury dataset (Table 9). As the paired data reports on total mercury concentrations across the range for this species, the upper percentiles of total mercury are modelled for.

47. An ML of 1.0 mg/kg methylmercury is proposed for pink cusk-eel as it falls within the target rejection rate based on the methylmercury dataset. The modelled dataset confirms that an ML of 1.0 mg/kg methylmercury in pink cusk-eel is reasonable. The proposed ML is the closest hypothetical ML to the 95th percentile concentration of methylmercury (Table 9), and would be expected to reduce exposure to methylmercury somewhat more than a higher ML with a correspondingly lower rejection rate. Nonetheless, an ML of either 1.1 mg/kg or 1.2 mg/kg could also be considered.

48. The 2016-2018 average export volume for cusk-eel (species not specified) was comparable to marlin, while the total value of the export was over three times that of marlin (Table 11). The data on export volume and value in Table 11 demonstrates that cusk-eel is a high value fish that is commonly traded internationally. This information supports the relevance of cusk-eel in international trade and that elaborating an ML for methylmercury in cusk-eel would help ensure consistent and fair trading practices worldwide.

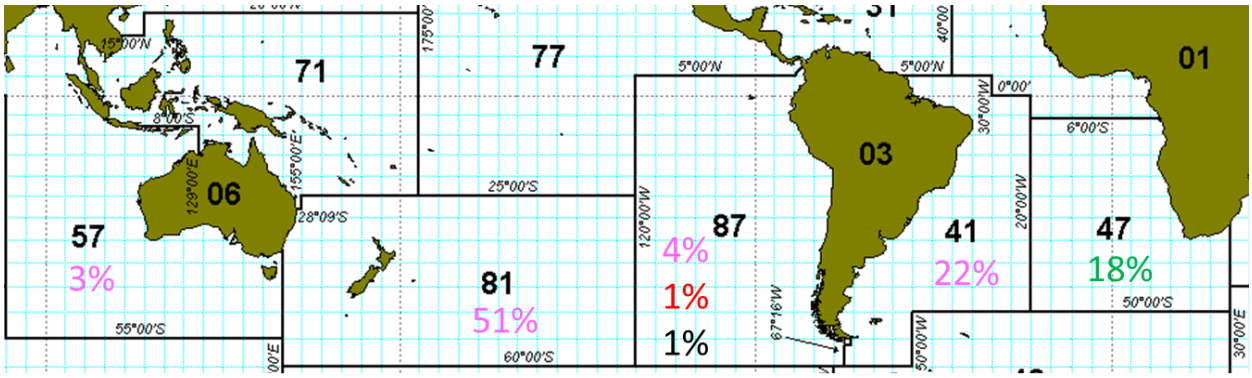
Table 11: Average global export volume and export value for marlin and cusk-eel from 2016-18.

Species	Export volume (MT)	Export value (US$,000,000)
Marlin	4319	8
Cusk-eel (species not specified)	4924	26

MT- metric tonnes

49. Four species of cusk-eel are reported to be commercially caught (Pink, Red, Black and Kingklip). Catch volume distribution for cusk-eel by FAO fishing region for 2016-18 is displayed in Figure 4.

Figure 4: Percentage of total global cusk-eel capture production volume (averaged 2016-18) by FAO fishing region and species (Pink: Pink cusk-eel; Red: Red cusk-eel; Black: Black cusk-eel; Green: Kingklip). Figure adapted from FAO fishing region map; FAO, 2020.



Feasibility of elaborating an ML for Toothfish (Genus: *Dissostichus*)

50. The CCCF is tasked to consider if it is feasible to set an ML for Patagonian toothfish (REP21/CF para 166). However, the 2021 call for data was for all toothfish as data gaps were identified for both Patagonian and Antarctic toothfish species (REP21/CF paras. 148-149). Therefore, for completeness and discussion at this data gathering stage, data for toothfish (Antarctic and Patagonian) were extracted from GEMS/Food (Table 12). Both species can be grouped to a genus level (*Dissostichus*; taxonomic code: 1,70(92)015).

51. Total mercury results for Patagonian toothfish (159 results) and all toothfish (201 results) had been considered previously within CX/CF 19/13/13.

52. The following data was then considered within CX/CF 21/14/11, 46 total mercury results were available for Antarctic toothfish; 183 total mercury results and 10 methylmercury results for Patagonian toothfish; and 11 total mercury results for unspecified toothfish. The data were recorded in GEMS/Food as being of domestic and imported provenance (CX/CF 21/14/11).

53. A small number of additional samples for Antarctic toothfish (n=10 total mercury only) and Patagonian toothfish (n=6 for each total and methylmercury) were submitted as part of the 2021 call for data. Therefore, the present review of data in GEMS/Food identified 56 total mercury results for Antarctic toothfish; 189 total mercury results and 16 methylmercury results for Patagonian toothfish (Table 12).

Table 12: Updated summary of occurrence data on total mercury in mg/kg in toothfish samples, data taken from GEMS/Food.

Common name	*Species*	Total or methyl mercury	Includes data points without LOQs	Region	Total records	Non-detects	Mean	SD	P95	Max
Toothfish (Antarctic)	*Dissostichus mawsoni*	Total	Yes	G07 (25) G10 (31)	56	0	0.12	0.06	0.25	0.33
Toothfish (Patagonian)	*Dissostichus eleginoides*	Total	Yes	G07 (26) G10 (163)	189	0	0.48	0.38	1.07	2.52
Toothfish (unspecified)	*Dissostichus sp.*	Total	No	G10 (11)	11	0	0.34	0.28	0.82	0.82
Toothfish (Patagonian)	*Dissostichus eleginoides*	Methyl	Yes	G07 (16)	16	0	0.16	0.09	0.29	0.33
All Toothfish	*Dissostichus sp.*	Total	No	G07 (35) G10 (205)	240	0	0.40	0.37	1.02	2.52

54. No available paired samples of Patagonian toothfish could be identified from the data submitted in GEMS/Food, including the 10 paired data of Patagonian toothfish which was used to confirm the ratio of methylmercury to total mercury in CX/CF 21/14/11.

55. Current MLs for "all tuna" and "all shark" had combined datasets for individual species that had average total mercury or methylmercury results above and below the selection criterion (CX/CF 18/12/7). Although the present "all toothfish" dataset has an average total mercury result (n= 256; 0.4 mg/kg) that exceeds the selection criterion there is uncertainty in concluding the toothfish family grouping would exceed the selection criterion, as described below.

56. Firstly, there is no methylmercury data for Antarctic toothfish from which to provide comparable data to that for Patagonian toothfish. It is noted that a study by Yoon and colleagues (2018) undertaken on Antarctic toothfish identified the proportion of methylmercury to total mercury was 29.8-51.3% (n=102)[11], hence applying the linear regression equation calculated for Patagonian toothfish as reported in CX/CF 21/14/11 would likely overestimate the methylmercury in Antarctic toothfish.

57. Secondly, the "All toothfish" total mercury dataset is heavily weighted to Patagonian toothfish data and thus overestimates the total mercury of the taxonomic grouping as the lower mercury- Antarctic toothfish is underrepresented.

58. Previously identified paired samples for Patagonian toothfish would need to be reconfirmed to GEMS/Food (if available for the years 2000-2021) and these samples clearly specified. However, the potential availability of 10 paired samples does not meet the minimum sample requirement of 74 samples for either the methylmercury dataset alone or a combined regression modelled dataset. More data on methylmercury occurrence in all toothfish, particularly paired samples, are needed to confirm the ratios of methylmercury to total mercury and to establish whether ML setting may be necessary.

59. The 2016-2018 average capture production volume for toothfish (all species; 28, 434 MT) is considerably lower than marlin, however export volume and value were considerably greater than those of marlin (76, 138 MT). The data on export volume and value in Table 13 demonstrates that toothfish are high value fish that are commonly traded internationally. This information supports the relevance of toothfish in international trade and that elaborating an ML for methylmercury in relevant species of toothfish would help ensure consistent and fair trading practices worldwide.

[11] Yoon, M., Jo, M.R., Kim, P.H. et al. Total and Methyl Mercury Concentrations in Antarctic Toothfish (Dissostichus mawsoni): Health Risk Assessment. Bull Environ Contam Toxicol 100, 748–753 (2018)

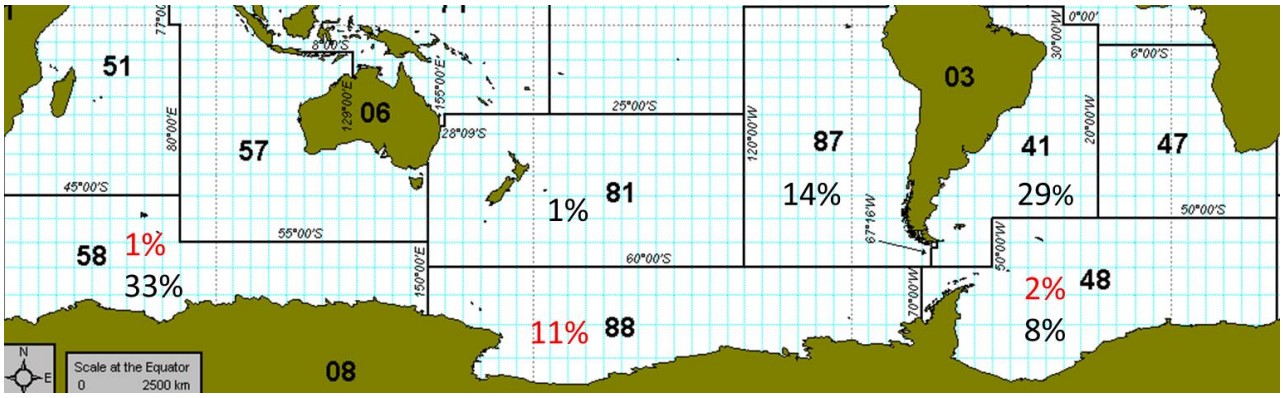
Table 13: 2016-18 Global capture production volume, export volume and export value for marlin and toothfish.

Species	Export volume (MT)	Export value (US$,000,000)
Marlin	4319	8
Toothfish	29,207	435

MT- metric tonnes

60. Catch volume distribution for toothfish by FAO fishing region for 2016-18 is displayed in Figure 5.

Figure 5: Percentages (rounded) of total global toothfish capture production volume (averaged 2016-18) by FAO fishing region and species (Red: Antarctic toothfish; Black: Patagonian toothfish). Figure adapted from FAO fishing region map; FAO, 2020.



Questions to and information sought from the EWG

Should another call for data be held for all toothfish, either in 2022, or in 2-3 years' time to allow for more time for data collection?

Or should work to potentially elaborate ML for methylmercury in Patagonian toothfish be abandoned?

APPENDIX II

DISCUSSION PAPER ON ESTABLISHING A SAMPLING PLAN FOR METHYLMERCURY IN FISH

(For consideration by CCCF)

1. The conclusions of CCCF11 in terms of progressing MLs for methylmercury in fish identified that MLs should be accompanied by sampling plans (REP17/CF para 140).
2. A general sampling plan for methylmercury in fish was developed using European Union: Commission Regulation (EC) No 333/2007 as a basis. The draft sampling plan was discussed and presented to CCCF12 accompanying the proposed MLs for various fish species (CX/CF 18/12/7).
3. Following editorial amendments CCCF12 agreed to send the sampling plans to CCMAS for endorsement and to request advice on:
    a. The necessary performance criteria for the MLs;
    b. Whether there is evidence that methylmercury can vary widely between individual fish sampled at the same time. How this would apply to large fish sold as individual units and whether the sampling plan provides enough basis to deal with this; and
    c. Whether the whole fish should be analysed or only specific fractions of edible portions. Currently only mention is made that the mid-section should be sampled for some large fish (REP18/CF).
4. CCMAS39 was unable to respond to the questions raised in relation to the sampling plan as the questions were outside the remit of CCMAS (CX/CF 19/13/2). CCMAS endorsed the performance criteria for methods of analysis for methylmercury when amended to meet formatting requirements. However, CCMAS39 did not endorse the sampling plan for MLs for methylmercury in fish and agreed to return the sampling plan to CCCF for further consideration.
5. At CCCF13 the chair of the EWG informed the Committee that a revised sampling plan would not be presented for approval as there were areas of inconsistency with other sampling plans in the GSCTFF that needed to be addressed. In addition, the two remaining questions CCMAS was unable to respond to were not discussed as further consideration was necessary, these questions had also not been discussed by the EWG in advance of CCCF13. CCCF13 agreed to consider issues related to sampling plans for methylmercury in fish, through the consideration of contemporary scientific literature and national monitoring data, as part of the re-established EWG examining the feasibility of MLs for additional fish species (REP19/CF). It was agreed that the EWG would present these findings for consideration at CCCF14.
6. At CCCF14 it was agreed to continue further work on the sampling plan following the approach proposed in Appendix IV of CX/CF 21/14/11 and that further work should ensure the practicality of the sampling plan (REP21/CF para 164).

Proposed Sampling Plan

7. An approach to including provisions for different weight and values classes in the sampling plan was proposed in Appendix IV of CX/CF 21/14/11. This captures the potential approach to ensuring a representative sample in a lot of fish with large weight and/or length differences and a weight and value classification approach to reduce economic loss in large, and/or high value fish.
8. There is the opportunity to refine the specific values like weight and length, in general, if weight and length are viewed as an acceptable way to progress the sampling plan and are confirmed to be practical by member countries.
9. Refinement of the sampling plan could occur through consideration of the information from national sampling plans for tuna, shark, alfonsino, and marlin, as well as orange roughy and pink cusk-eel, in anticipation of MLs potentially being elaborated for these two latter species. Information that would aid in refining the sampling plan includes, but is not limited to, indication on how and where the material has been sampled and if and how the relevant fish species are classified into weight/length classes. Consideration of commercial weight and value ranges for the individual species covered by the methylmercury MLs would also be of value.

Questions to and information sought from the EWG

The following information is sought from EWG members to further the sampling plan. In particular, input from key exporting and importing countries of tuna, shark, alfonsino, and marlin, orange roughy and pink cusk-eel would be of great value.

1. National sampling plans available for mercury in fish, or other contaminants in fish, in particular: tuna, shark, alfonsino, and marlin, orange roughy and pink cusk-eel?

   The following types of details from national sampling plans are sought:

   i. how lots of fish that are not of comparable length or weight are sub-divided into sub-lots for sampling

   ii. how samples are taken

   iii. where on the fish the sample is taken, both laterally and top (dorsal) to bottom (ventral)

   iv. the tissues included in the sample (e.g. skin is removed, red muscle tissue should not be sampled, deboned)

   v. typical ranges of commercial lot sizes

   vi. typical size ranges of commercially harvested fish for which Codex MLs are and will be established

   vii. typical range in monetary value (in USD per kilogram)

   viii. if reconditioning sub-lots is practical and feasible; reconditioning involves removing the length/weight class(es) that exceed the ML so that the remainder of the lot of smaller fish are in compliance

2. If adequate information addressing the above questions is not obtained through the EWG, does the EWG support this information being sought from CCCF members?

   The EWG Chair would seek guidance from the Codex Secretariat as to the appropriate tool to request such data (e.g. call for data, circular letter).

3. Input regarding the feasibility of basing any sampling plan provisions on monetary value, which can differ at a given point in time based on characteristics unique to each international market and will also lead to potentially regular, and resource intensive, updates to the sampling plan when fish values fluctuate.

4. Data or studies from the primary literature available on the distribution of mercury laterally and from top (dorsal) to bottom (ventral) for tuna, shark, alfonsino, and marlin, orange roughy and pink cusk-eel is needed. Information is available for tuna but appears to be lacking for other fish species for which Codex MLs are or may be developed.

APPENDIX III

DISCUSSION PAPER ON RISK MANAGEMENT MEASURES FOR METHYLMERCURY IN FISH

(For consideration by CCCF)

1. The EWG noted there is no consolidated source of risk management recommendations at the catch, sorting, and processing for methylmercury in fish (CX/CF 21/14/11).
2. The 14th CCCF agreed to conduct a literature review to assess the feasibility of developing guidance for the management of methylmercury in fish (REP21/CF para 166).
3. A present review of the available literature could not identify enough information to support the development of a guidance paper. It is consequently not feasible to develop standalone risk management guidance for the management of methylmercury in fish.

Questions to and information sought from the EWG

1. Please provide any data available to support the development of a guidance paper for the management of methylmercury levels in fish at catch, sorting and processing level.
2. If sufficient and relevant information is provided, a discussion paper could be considered. Alternatively, would the EWG find it reasonable to include any relevant information on how risk management relating to catch, sorting and processing are taken under consideration in the sampling plan and not in a separate discussion paper?

For example, sorting may be covered in the sampling plan if lots are sorted into sub-lots by size and if reconditioning is supported.

APPENDIX IV

List of Participants to the Electronic Working Group

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