CODEX ALIMENTARIUS COMMISSION

Food and Agriculture Organization of the United Nations

World Health Organization

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Agenda Item 13 **CX/CF 21/14/11**

March 2021

JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON CONTAMINANTS IN FOODS

14th Session

(virtual)

3-7 and 13 May 2021

DISCUSSION PAPER ON METHYLMERCURY IN FISH

(Prepared by the Electronic Working Group chaired by New Zealand and co-chaired by Canada)

BACKGROUND

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

2. The 11th Session of the Codex Committee on Contaminants in Foods (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 Foods (CXS 193-1995) (REP17/CF, paragraph 126). CCCF11 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/Food database (CX/CF 17/11/12, paragraph 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%. CCCF12 agreed upon MLs for tuna species (1.2 mg/kg; REP18/CF, paragraph 75), alfonsino (1.5 mg/kg; REP18/CF, paragraph 77), marlin (1.7 mg/kg; REP18/CF, paragraph 77) and shark (1.6 mg/kg; REP18/CF, paragraph 77). No consensus was achieved for an ML for swordfish and it was agreed to discontinue work on an ML (REP18/CF, paragraph 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, paragraph 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, paragraph 88).

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.

[1] 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

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, paragraph 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, paragraph 116).

10. CCCF13 agreed to request that the JECFA Secretariat 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, paragraph 127).

EWG PROCESS

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. Following CCCF13 an EWG was established, the participants of which are listed in Appendix V.

13. As CCCF14 was postponed from May 2020 to May 2021 due to the COVID-19 pandemic, and in view of the additional time at the disposal of the Committee, an interim report of the EWG was published as CX/CF 20/14/11. Comments on recommendations put forward in this paper were requested by means of a circular letter[2] CL 2020/52/OCS-CF issued by the Codex Secretariat for further consideration by the EWG. The comments received in reply to this CL were compiled in CX/CF 20/14/7-Add.1. Further data on species was also submitted through GEMS/Food through calls for data[3] issued by the JECFA Secretariat. The EWG further revised the paper based on comments and information received in reply to this CL and data calls, as well as those from the members of the EWG, and produced a revised document as presented in Appendix I to this document.

14. Working documents issued during 2020, which has been revised or updated in 2021 for consideration by CCCF14, can be found on the Codex website[4].

15. The recommendations of the EWG for consideration by CCCF are described in paragraphs 70-74 below. Discussions of the EWG from both 2019/20 (paragraphs 17-41) and 2020/21 paragraphs (42-77) are summarised below to record the development process for these recommendations. Changes or recommendations made in 2019/20 may have been superseded in the later work. A project document on proposals for new work based on these recommendations is provided in Appendix I.

16. The full discussion paper on establishing MLs for additional fish species is provided in Appendix III. The full discussion paper on developing a sampling plan is provided in Appendix IV. 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 78.

2020 Discussions and conclusions - Establishing MLs for additional fish species:

Use of total mercury datasets

17. The EWG provided comments on the interpretation of selection criterion and potential ML options based on total mercury. Although CCCF12 has confirmed that both methylmercury and total mercury were necessary for future ML development (REP18/CF, paragraph 88), the role both datasets would present in establishing the ML was not specifically defined, particularly where paired analysis was available to confirm the proportion of methylmercury present.

18. Options were presented to the EWG applying both total mercury and methylmercury datasets to the selection criterion and potential MLs.

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2 http://www.fao.org/fao-who-codexalimentarius/committees/committee/related-circular-letters/en/?committee=CCCF
3 http://www.fao.org/food-safety/scientific-advice/calls-for-data-and-experts-expert-rosters/en/
4 http://www.fao.org/fao-who-codexalimentarius/meetings/extra/cccf14-2020/en/

19. One member recommended the use of the ratio of methylmercury to total mercury to inform the interpretation. Taking on board this recommendation the datasets were re-reviewed to consider an option for combining methylmercury and unpaired total mercury data. Where paired analysis was deemed to be significantly correlated a regression equation was calculated to model the relationship between methylmercury and total mercury. By applying this equation to any unpaired total mercury for that species it was possible to adjust the data from which it can be modelled with the methylmercury dataset. This approach has the benefit of generating a larger dataset giving greater confidence in the interpretation against the selection criterion and the ML options available.

Interpretation of anglerfish dataset

20. The EWG were asked to consider how the anglerfish dataset should be interpreted and whether it should remain a species targeted for further data collection. The mean for total mercury falls below the selection criterion, however the mean of the much smaller methylmercury dataset exceeds the selection criterion. Members commented that use of the larger total mercury dataset would be beneficial, and that substantial numbers of methylmercury results may be necessary to resolve the difference seen. One member also noted that additional data collection for anglerfish was underway and would be submitted in 2020.

21. To enable the anglerfish datasets to be reconciled will require paired total mercury and methylmercury to be available to confirm the ratio.

Minimum sample numbers

22. The previous discussion paper (CX/CF 19/13/13) had used a simple screening method to identify minimum sample numbers to have confidence in identifying the need for MLs and the potential ML value that could be established. One member provided information on a statistical test to identify the sample number required to have confidence in certain rejection rates. The outputs of this model were incorporated to identify that a minimum of 74 samples were necessary to establish a 4% rejection rate. Considering the discussion on the use of total mercury data the minimum sample number was applied to methylmercury data or a combined modelled dataset as outlined in paragraph 18.

Trade information

23. One member noted the need to identify the significance of the species in trade. Export tonnage and monetary value recorded for each identified species for 2017 were extracted from the FAO yearbook Fishery and Aquaculture Statistics 2017. For reference, export tonnage and monetary value were also obtained for tuna, marlin and shark, these data were not available for alfonsino.

Selection criterion

24. One member noted that the selection criterion (of 0.3 mg/kg) should not be relied upon to identify additional fish species for ML setting as fish containing methylmercury below this concentration could contribute to overall dietary exposure. As a result, MLs should be established for all species where the data are sufficient.

25. The present discussion paper has been developed through aligning with the selection criterion accepted by CCCF12 to identify species where ML setting was not required (REP18/CF, paragraph 78). Review of this selection criterion has been considered out of scope of identifying whether it is feasible to proceed with establishment of MLs for additional fish species.

Proposed MLs

26. One member noted that the previously CCCF has used a violation rate of 2-3% in developing MLs. As minor fish species are expected to have an insignificant impact on health and could have limited fishing quotas available to enter into trade a lower violation rate would ensure no unnecessary economic loss. Violation rates of lower than 5% would require larger datasets to ensure confidence in the ML value being established.

27. For fish species/grouping identified to exceed the selection criterion the present discussion paper identifies hypothetical MLs covering a range of violation rates. For those species identified to be appropriate to proceed with establishment of MLs the specific violation rate applied could form part of the proposed new work.

2020 Discussions and conclusion – Sampling plan:

Variation of methylmercury within fish sampled at the same time

28. The EWG was asked to consider information presented to define methylmercury variation in the lot as a function of fish size (length or weight) and recommend samples drawn be representative of the size range in the lot. It was noted that the data had only been considered for orange roughy and pink cusk-eel and the extent of variability in other species could be different.

29. While members agreed that size was a factor in variation of methylmercury levels they noted the difficulty an approach to draw representative samples might have, notably in processed portions where inherent variation may not be controlled by size. One member commented that applying this criterion would likely require further information to define how to draw size representative samples. Two members recommended an approach to focus only on larger fish in a lot to establish ML compliance. Another member suggested that if the samples are truly representative of the size range then it would be likely that the methylmercury concentration from a size representative sample would reflect the midpoint of the range of methylmercury concentrations given the relationship with size. One member noted that fish traded internationally would be graded by size so variation would already be addressed.

30. The differences in sizes amongst the four species/groupings of fish for which MLs have been established is considerable (alfonsino typically <50 cm; Atlantic blue marlin up to 500 cm) and even within the groupings the variability in size may also be large (bullet tuna: ~50 cm; bluefin tuna ~ 200 cm). Defining typical size variation of the lot to encompass the species with MLs would therefore be difficult. Because of these differences using a general sampling plan to encompass the four species/groupings of fish with MLs may not be fit for purpose. An approach to develop specific annexes for each of the four species/groupings of fish with MLs is proposed to ensure that the species-specific variation is captured. The annexes would also consider sampling of processed portions of the fish species with MLs, where there is evidence for these in trade.

31. A member noted that for farmed fish the control of methylmercury in the feed would be more consistent than that for wild caught fish thus there would be reduced variation in the content of methylmercury.

<u>Should the whole fish be analysed or only specific fractions of edible portions</u>

32. The EWG was asked to consider information presented on total mercury and methylmercury concentrations in different lateral fractions of fish and the options to take a representative sample for a large fish. Two members provided further scientific studies around bluefin tuna which were added to the interpretation. One member provided a scientific study on Atlantic halibut.

33. There was support from most members for using a fraction of a large fish for sampling, one member noted that further data should be collected before agreeing on this point. Two members noted variability in the distribution of methylmercury in the carcass was minimal and any fraction could be used, which would limit economic loss. One member supported a composite of head and tail fractions. One member noted that additional information to support the sampling would be beneficial, such as presence/absence of skin and sample depth; as well as clarifying the exact location on the fish carcass the cuts would be made.

34. One member also noted that information on methylmercury distribution in small fish would also be useful.

35. As per paragraph 29 the use of a single approach to cover all of the fish species with MLs is unlikely to be fit for purpose. Development of a database to support identification of the most appropriate sampling fraction based on the properties of each of the species with MLs would be beneficial. The capture of such data would support the development of species-specific annexes of the sampling plan.

<u>Draft sampling plan</u>

36. The EWG was invited to comment on a draft of a sampling plan presented to CCCF13 (CF13/CRD15) reformatted to ensure harmonization with other sampling plans in CXS 193.

37. Members commented that the language in the sampling plans for mycotoxins, which was used as a reference to develop the sampling plan for mercury in fish, would need changing to better reflect terminology around trade in fish. There was agreement from members that sampling at retail was not appropriate within the sampling plan, as a result this section was removed.

<u>Further work</u>

38. Three members noted that further scientific interpretation or collection of a valid database to inform the sampling plan should be undertaken. One member noted that obtaining the evidence base and findings of sampling plans adopted by national authorities would also be of value.

39. It was concluded that further data collection will be essential to develop a robust sampling plan that covers the requirements of all of the fish species/groupings with MLs.

Other discussions

40. A member questioned whether focusing testing on larger fish in the lot would be consistent with reconditioning a lot by removing the larger fish rather than discarding the entire lot. This aspect could be considered within the species-specific information as it may not be feasible for some fish species if the larger fish were not easily identifiable in the lot.

41. It has also been noted that there is no consolidated source of risk management recommendations at the catch, sorting, and processing for methylmercury in fish, for example to cover reconditioning options. A cursory literature review suggested that there may be benefit in considering if a guidance paper would be feasible to develop.

Postponement of CCCF14 and reconvening of the EWG

42. Postponement of CCCF14 meeting from 2020 to 2021 enabled a further request for comments and call for data on the issues raised in the recommendations as summarized in paragraph 13 above and noted herebelow for ease of reference:

a. The proposal for new work on MLs for methylmercury for orange roughy and cusk-eel,

b. Whether to develop sampling plans with species-specific annexes,

c. Whether sufficient data can be gathered through available databases or datasets to enable sample plans to be developed for the species under consideration,

d. Alternatively, whether a call for data should be issued to assist the further development of the species-specific annexes.

e. Whether the evidence, or statistical basis, used by national authorities in the development of national sampling plans for methylmercury in fish can be provided to the EWG to further develop the sampling plans.

f. Whether there is need for a consolidated source of guidance for methylmercury to capture risk management recommendations at the catch, sorting and processing level.

43. A separate JECFA call for any new data on methylmercury and total mercury levels in fish to be submitted to GEMS/Food was also issued for 2020.

Codex circular letter responses and JECFA call for data

44. Sixteen responses were received in response to CL 2020/52/OCS-CF and the following general themes were presented:

a. MLs – Orange roughy and cusk-eel

i. Support for progressing MLs for orange roughy and cusk-eel, with one response supporting progressing with 0.8 mg/kg and 1.0 mg/kg respectively.

ii. Support for progressing an ML only for pink cusk-eel on the basis of lack of data for other cusk-eel species

iii. Orange roughy, or orange roughy and pink cusk-eel to not be subject to ML setting on the basis of low trade volume

iv. Orange roughy and pink cusk-eel to not be subject to ML due to lack of country data

v. Concluding the work on developing a sampling plan prior to progressing new work on ML setting for any new species

vi. Collecting additional data for the occurrence of methylmercury relative to total mercury

vii. Establishing a single restrictive level for all fish species

b. Sampling plans

i. Support for species specific sampling plan development if data are available to develop this.

ii. Support for a general sampling plan but with the possibility of specific provisions and/or exemptions depending on catch and economic factors or variation in methylmercury distribution.

iii. Consideration of the resource necessary to develop species specific annexes and the priority of this in the Committee’s workplan.

iv. Support for a call for data to help develop sampling plans, including to consider other factors such as age and geographical location.

v. Provision of additional literature references to total mercury distribution in fish tissues and clarifications to previously considered data.

vi. Provision of sampling guidance for toxic elements in Swordfish.

vii. Reference to the Annex II to Commission Regulation (EU) 2017/644 (2) for specific provisions to account for size variation in lots of fish species.

viii. Support to extend the sampling plan to fish throughout the whole chain, such as fish products and fish placed on the market for final consumers.

c. Risk management recommendations

i. Support for the development of a guidance paper through a review of available literature.

ii. Consideration of the resource necessary to develop guidance and the priority of this in the Committee’s workplan.

iii. Incorporation of sorting guidance into the sampling plan development.

d. Other comments

i. Support for continued data collection for other species identified as having the potential to exceed the selection criterion.

ii. Conclusion of the current work and not progressing with MLs for other species due to the proximity of average total mercury results to the selection criterion and negligible dietary risk as identified in the Joint FAO/WHO Expert Consultation on the Risks and Benefits of Fish Consumption[5].

iii. Suggested clarifications/amendments to the agenda paper, including the addition of sample numbers and standard deviations to Appendix II.

iv. Question regarding the consideration of cusk/tusk and blue ling data for ML setting

45. Additional data were available on total mercury and methylmercury in GEMS/Food which was incorporated into the review of datasets for identifying additional species for ML establishment.

2021 Update – Trade criterion

46. Although many members were in support of the progression of ML setting for orange roughy and cusk-eel there was some hesitancy over the significance of these species in trade.

47. To address how to interpret trade significance in establishing MLs for additional fish species an options paper considering general patterns of trade for finfish and different approaches to define trade significance was presented to the EWG, these included:

a. Benchmarking against fish species with current MLs.

b. Referring to precedent for consideration of trade significance for other commodities at CCCF or other Codex Committees.

c. Apportioning as a percentage of the total trade volumes for finfish, or classes of finfish.

d. Reference to the trade volume of a species that would be necessary to sustain exposure of an individual in an importing country to a level above the provisional tolerable weekly intake (PTWI) for methylmercury.

5 http://www.fao.org/in-action/globefish/news-events/details-events/en/c/338780/

48. Additionally, other factors, such as global sustainability and development initiatives were briefly reviewed to identity if there was benefit to considering measures to facilitate the trade in low catch/export volume fish species if these did not meet a trade criterion but could exceed the selection criterion.

49. Responses to the options for defining trade significance for finfish generally supported basing these values from a benchmark based off the fish species with current MLs. Although one response indicated this could be used for prioritisation of ML progression rather than a formal cut-off, while a second suggested it be supplemented with case-by-case consideration of the trade-related factors for that species, while a third suggested that species not exceeding this benchmark but for which may still present a methylmercury exposure concern due to high concentrations of weekly intakes in countries should still be considered. One response noted a preference for defining this value from a percentage of the total export volume for specific finfish classes while one response did not favour an approach but noted the importance that the value be easily determinable, consistent over time and consistently applied.

50. While responses noted the importance of other factors that favour an approach to protect trade in low volume species, there was the consideration that extending from this to promoting or facilitating trade was outside of the committee's mandate. An approach however that is transparent to informing when applying MLs for fish species is not necessary was supported in one response.

51. For the purposes of informing potential ML progression in the present discussion paper an analysis against the benchmark of species with current MLs was undertaken based upon the FAO yearbook: Fishery and Aquaculture Statistics 2018[6]. Further to the analysis in the options paper around export volume, an export value (in USD) is also recorded. An approach that focuses only on volume would not necessarily capture the economic loss caused by a known or expected problem in trade, particularly with smaller sized but higher value fish. Capture volume, as used previously in CX/CF 19/13/13 does not directly relate to trade since it also accounts for catch retained on a domestic market, hence this value is only used to identify the distribution of global catch of a species.

52. All export volume and export value figures were updated to represent an average for 2016-18, this approach being favoured in case of significant inter-year variation in catch or trade of species.

53. Of the fish species with current MLs, marlin have the lowest recorded export volume and value and are therefore used as the basis of informing potential ML progression. Alfonsino, although having the lowest capture production (average 2016-18: 8401 Metric Tonnes (MT)), was not individually listed in the export statistics thus export volumes and value could not be benchmarked against.

54. One response to the options paper raised that input on a trade criterion by the Codex Secretariat, ideally at CCCF14, would be of value to inform a standard approach for the methylmercury ML setting in additional species and more broadly, as such a discussion impacts, and will benefit, the work of all CCCF EWGs.

2021 Update –MLs for orange roughy and pink cusk-eel/ cusk-eel

55. Review of the methylmercury datasets submitted to GEMS/Food identified that the average methylmercury concentration in orange roughy would likely exceed the selection criterion. Orange roughy is the only notable traded species in its taxonomic group and thus an ML for this individual species is appropriate. Orange roughy have a greater trade value than marlin and thus meet the benchmark of species with current MLs.

56. Review of the methylmercury datasets submitted to GEMS/Food identified that the average methylmercury concentration in pink cusk-eel would likely exceed the selection criterion. Pink cusk-eel is the major species caught in the cusk-eel taxonomic group accounting for 80% of the catch volume (FAO, 2020). There is uncertainty that other cusk-eel species (kingklip, red cusk-eel and black cusk-eel) would exceed the selection criterion due to the absence of methylmercury data. Consequently, an ML for the individual species (i.e. pink cusk-eel) may be appropriate, as an alternative for a taxonomic group ML (i.e. all cusk-eels). Cusk-eel (all species) have a greater trade value and equivalent trade volume to marlin and thus meet the benchmark of species with current MLs.

[6] 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.

2021 Update – MLs for other species

57. Review of the methylmercury datasets submitted to GEMS/Food identified that the average methylmercury concentration in Patagonian toothfish would likely exceed the selection criterion. However, the dataset for all toothfish has low confidence that the average methylmercury would exceed the selection criterion. Based on likely exceedance of the selection criterion progressing an ML for the Patagonian toothfish may be appropriate, however it is not possible to confirm the average methylmercury concertation would exceed the selection criterion for the entire toothfish taxonomic group. As the paired dataset for Patagonian toothfish is all from fish at the lower end of the range of total mercury concentrations in this species it may not reflect the ratio in higher percentiles. Consequently, further data collection could be warranted to ensure an ML set at a <5% rejection rate is based on robust modelling. Toothfish (all species) have a greater trade value and equivalent trade volume to marlin and thus meet the benchmark of species with current MLs.

58. No other species/taxonomic groups were identified where there was sufficient confidence in exceeding the selection criterion to commence ML progression.

59. The GEMS/Food dataset for cusk/tusk (*Brosme brosme*) and blue ling (*Molva dypterygia*) was reviewed, no additional data was available that had not been considered in the 2019 review of these species (CX/CF 19/13/13). The recommendation therefore remained for further data collection for methylmercury occurrence in these species prior to any progression to ML setting.

2021 Update – Sampling plans

60. Members acknowledged the difficulty in having a single set of parameters for sampling whole fish to address the variation due to ranges of fish of different sizes in a batch, and also on informing sampling location for high value large fish. However, there was limited support for independent species-specific annexes in the sampling plan, with a more general set of provisions instead favoured that address these variables.

61. Consideration of newly submitted literature and available sampling plans that take into account differing fish sizes in a lot support the use of general weight/length provisions to identify how to take, or separate a lot to take, a representative sample. Such a processes also allows for reconditioning a lot in the event a certain weight/length class is in exceedance of the ML.

62. Consideration of newly submitted literature and available sampling plans that take into account sampled tissue for different sizes of fish support the use of weight/value class to define which tissue should be sampled for a lot of fish. This approach balances the need for a representative sample against minimising economic loss for large or high value fish through avoidance of damaging marketable cuts/carcasses.

63. A proposed sampling plan that incorporates the general provisions around length/weight and value to address different fish sizes in the lot, and sampled tissue for different size/value fish is outlined in Appendix IV.

2021 Discussions and Conclusions

<u>Establishing MLs for additional fish species</u>

64. The EWG commented on the updates added in this paper following the consideration of the circular letter responses, consideration of the methylmercury datasets and responses to the options paper on defining a trade criterion. Three members provided comments on the draft.

65. Two members commented that reference to the marlin export volume and value may not be an appropriate benchmark for establishing if further species are significant in trade to support progression to ML setting, with one member noting that justification for an ML also needs to consider that a fish species is a major contributor to total dietary exposure to methylmercury and that there could be compliance costs associated with monitoring a species that is not a major contributor. The other member noted that it was not clear that orange roughy or pink cusk-eels are traded at sufficient levels to warrant ML development.

66. Members considered that a taxonomic grouping ML for "all cusk-eel" was not appropriate based on the lack of availability of methylmercury data for cusk-eel species apart from pink cusk-eel. The previous approach has been that MLs would be considered for a taxonomic group (for example "all tuna" "all marlin" and "all shark" were applied to groupings of multiple genera; alfonsino and amberjack to species within specific genera; and although swordfish was considered as a single species it is monotypic to its family; CX/CF 18/12/7). The requirement on the present analysis that data on both methylmercury and total mercury would need to be available (REP18/CF, paragraph 88) means qualifying datasets for ML progression were usually limited to individual species within a taxonomic group. Progression with an individual species ML for pink cusk-eel is recommended considering the uncertainty in assigning an ML to the "all cusk-eel" taxonomic group. Revisiting the ML to consider any data collection for other cusk-eel species could be tracked in a process for regular reviews of MLs.

67. Members considered there was insufficient confidence that sablefish would exceed the selection criterion, noting the limited methylmercury dataset and limited knowledge on the methylmercury to total mercury ratio. Sablefish are concluded to require further data collection to identify if MLs are required.

68. Ten paired total mercury and methylmercury results for Patagonian toothfish were submitted to GEMS/Food after the draft discussion paper was distributed. The dataset was subsequently made available and able to be considered in the final discussion paper.

69. One member noted the concerns from the circular letter response that the working group should not identify other species as possible candidates for future ML development and data collection until the current work on the sampling plan was concluded.

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

71. Input on a trade criterion by the Codex Secretariat is sought to ensure the benchmarking approach to trade volume and value of marlin is suitable for methylmercury ML setting in additional species.

72. The Committee is invited to consider progression of MLs for orange roughy, Patagonian toothfish and pink cusk-eel, taking into account the discussion over trade significance.

73. Postponing consideration of Patagonian toothfish for a year to enable further data collection to support setting an ML at a <5% rejection rate. A new work proposal document is presented in Appendix I to support this programme of work.

74. New work to progress MLs for any other additional fish species is not recommended and the present review process should conclude.

Sampling plans

75. The consideration of the issues related to sampling plans for methylmercury in fish has identified that general set of provisions around length/weight and value is the favoured approach to ensure the utility of the sampling plan. A proposed format for the sampling plan is presented in Appendix IV based upon a basic consideration of the weight/value classes. The Committee is invited to consider progressing further development of the sampling plan based upon this approach.

Other risk management measures

76. At present it has been noted that there is no consolidated source of guidance for methylmercury to capture risk management recommendations at the catch, sorting, and processing level. Provided there is resourcing available for this in the Committee workplan there was support of a thorough review of the available literature. This would identify if there is sufficient information available to support the development of a guidance paper, or inclusion of additional information in the sampling plan, and provide a scope for what it might contain.

Further data collection

77. Analysis of the updated total mercury and methylmercury data in GEMS/Food for other species indicates there may be further species or taxonomic groups for which MLs could be derived however the current datasets preclude progressing to ML setting. Further data collection for these species could be beneficial to support any future review of additional fish species for ML setting. A summary table of the recommendations for each species from the present analysis and CX/CF 19/13/13 is presented in Appendix II.

Recommendations

78. CCCF is invited to agree to:

a. Maximum levels

i. start new work on MLs for orange roughy, Patagonian toothfish and pink cusk-eel, taking into account the discussion over trade significance (project document is presented in Appendix I).

ii. postpone consideration of Patagonian toothfish for a year to enable further data collection to support setting an ML at a <5% rejection rate and to request JECFA secretariat to issue a call for data.

iii. discontinue review of MLs for any other additional fish species.

b. Sampling plans

i. consider progressing further the development of the sampling plan based upon the approach in paragraph 75 above.

c. Other risk management measures

i. undertake a literature review of risk management measures in order to assess the feasibility to develop guidance for the management of methylmercury in fish.

d. **Establishment of the EWG**

Based on the replies to the points above, to re-establish the EWG to continue:

i. work on the establishment of MLs for orange roughy and pink cusk-eel;
ii. the consideration of an ML for Patagonian toothfish;
iii. the development of sampling plans;
iv. the literature review of risk management options and to provide proposals for consideration by CCC15 (2022)

APPENDIX I

PROJECT DOCUMENT FOR NEW WORK ON MLS FOR METHYLMERCURY IN ORANGE ROUGHY, PINK CUSK-EEL AND PATAGONIAN TOOTHFISH

(For consideration)

1. Purpose and Scope of the new work

This work aims to establish Maximum Levels (MLs) for methylmercury in orange roughy, pink cusk-eel and Patagonian toothfish.

2. Relevance and timeliness

The current MLs for methylmercury in fish (tuna: 1.2 mg/kg, alfonsino: 1.5 mg/kg, marlin: 1.7 mg/kg and shark: 1.6 mg/kg) were adopted in 2018[1]. These MLs replaced Guideline Levels (GLs) encompassing all predatory and non-predatory fish species, with the decision of the CAC that consideration should be given to establishment of MLs rather than GLs (REP18/CF, paragraph 81). A recommendation had been previously made that discussion could be commenced on considering MLs for other species in the GEMS/Food database, with a preliminary analysis presented in the supporting discussion paper (CX/CF 17/11/12, paragraph 15). With the establishment of an agreed upon framework at CCCF12 to apply the "as low as reasonably achievable" (ALARA) principle in the establishment of MLs for methylmercury in fish, it is timely to undertake work to derive MLs for additional fish species.

3. Main aspects to be covered

ML(s) for methylmercury in additional fish species, taking into account the following:

a. Results of discussions of the CCCF

b. Risk assessments by JECFA

c. Conclusions of the Joint FAO/WHO Expert Consultation on the Risks and Benefits of Fish Consumption

d. Achievability of the MLs

The following species of fish have been identified as having average levels of methylmercury sufficient to exceed the selection criterion of 0.3 mg/kg.

Orange roughy
Patagonian toothfish
Pink cusk-eel

4. Assessment against the criteria for the establishment of work priorities

Consumer protection from the point of view of health, food safety, ensuring fair practices in the food trade and taking into account the identified needs of developing countries.

The new work will derive ML(s) for methylmercury in fish species identified as having average levels of methylmercury sufficient to exceed the selection criterion of 0.3 mg/kg.

Diversification of national legislation and actual or potential impediments to international trade.

The international trade of fish and fishery products is increasing, and the new work will provide internationally-harmonized standards. The three fish species are of equivalent or grater trade value to species presently with MLs

Work already undertaken by other international organizations in this field and/or suggested by the relevant international intergovernmental body(ies).

The proposed work to establish MLs for methylmercury in the identified fish species globally has not been undertaken by any other international organizations nor suggested by any relevant international intergovernmental bodies.

Consideration of the global magnitude of the problem or issue

The consumption and international trade of fish and fishery products are increasing globally, thus this work is of worldwide interest and becoming increasingly significant.

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1 *General Standard for Contaminants in Food and Feed* (CXS 193-1995)

5. **Relevance to Codex Strategic Goals**

The proposed work falls under the following Codex Strategic Goals of the Codex Strategic Plan 2020-25

Strategic Goal 1: Address current, emerging and critical issues in a timely manner

This work was proposed in response to needs identified by Members in relation to food safety, nutrition and fair practices in the food trade. There is already significant trade in fish species which potentially have methylmercury levels that exceed the selection criterion of 0.3 mg/kg.

Strategic Goal 2: Develop standards based on science and Codex risk-analysis principles

This work will use the scientific advice of the joint FAO/WHO expert bodies to the fullest extent possible. Also, all relevant factors will be fully considered in exploring risk management options.

Strategic Goal 4: Facilitate the participation of all Codex Members throughout the standard setting process

Due to the international interest in the trade and consumption of fish, this work will support and embrace all aspects of this objective by requiring participation of both developed and developing countries to conduct the work.

6. **Information on the relationship between the proposal and other existing Codex documents**

This new work is recommended following the criteria for establishing MLs in food and feed as outlined in the *Standard for Contaminants in Food and Feed* (CXS 193-1995).

7. **Identification of any requirement for and availability of expert scientific advice**

Expert scientific advice has been already provided by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) and the Joint FAO/WHO Expert Consultation on the Risks and Benefits of Fish Consumption.

8. **Identification of any need for technical input to the standard from external bodies**

A need for additional technical input from external bodies has not been identified.

9. **The proposed timeline for completion of the new work, including the starting date, proposed date of adoption at Step 5 and the proposed date for the adoption by the Commission, the timeframe for developing a standard should not normally exceed 5 years.**

Identified species	Timeframe
Pink cusk-eel Orange roughy	Step 5/8: CCCF15 (2022)
Patagonian toothfish	Step 5/8: CCCF16 (2023)

APPENDIX II

SUMMARY TABLE OF RECOMMENDATIONS (FOR CONSIDERATION BY CCCF)

Common name	Scientific name	Taxonomic grouping	FAO taxonomic code	Sample numbers for methylmercury [total mercury]	Mean methylmercury [total mercury] concentration (mg/kg ± standard deviation)	Date of review and recommendation
Anchovies	*Engraulidae sp.*	Family	1,21(06)xxx,xx	16 [143]	0.05 ± 0.05 [0.07 ± 0.14]	2019: No ML required
Anglerfish	*Lophius sp.*	Genus	1,95(01)001,xx	16 [190]	0.68 ± 0.67 [0.18 ± 0.35]	2021: Data collection beneficial- paired total mercury and methylmercury
Barracuda	*Sphyraena sp.*	Genus	1,77(10)001,xx	[13]	[0.69 ± 0.56]	2019: Data collection beneficial – low sample numbers and no methylmercury results
Blue moki	*Latridopsis ciliaris*	Species	1,70(71)309,01	[35]	[0.12 ± 0.10]	2019: No ML required
Butterfish	*Odax pullus*	Species	1,70(64)003,01	[60]	[0.02 ± 0.01]	2019: No ML required
Cardinalfish	*Epigonus telescopus*	Species	1,70(96)373,01	[70]	[1.27 ± 0.27]	2019: Data collection beneficial – no methylmercury results
Carp	*Cyprinidae*	Family	1,40(02)xxx,xx	134 [651]	0.03 ± 0.09 [0.13 ± 0.22]	2019: No ML required
Catfish	*Siluriformes sp.*	Order	1,41(xx)xxx,xx	[79]	[0.29 ± 0.75]	2021: Channel catfish: Data collection beneficial –low sample numbers and no methylmercury results 2021: Other catfish: No ML required
Codfish	*Gadinae sp.*	Sub-family	1,48(04)xxx,xx	474 [4946]	0.05 ± 0.08 [0.09 ± 0.10]	2019: No ML required
Cusk-eel	*Genypterus sp.*	Genus	1,58(02)001x,xx	120 [247]	0.46 ± 0.29 [0.46 ± 0.35]	2021: Pink cusk-eel: Average methylmercury exceeds selection criterion; proposed for ML setting 2021: Other cusk-eel: total mercury exceeds selection criterion but no methylmercury results
Cutlassfish	*Trichiuridae sp.*	Family	1,75(06)xxx,xx	[36]	[0.16 ± 0.26]	2019: Data collection beneficial – wide disparity in means for species, low sample numbers and no methylmercury results
Eels	*Anguilliformes sp.*	Order	1,43(xx)xxx,xx	12 [611]	0.18 ±0.14 [0.19 ± 0.21]	2019: No ML required

Common name	Scientific name	Taxonomic grouping	FAO taxonomic code	Sample numbers for methylmercury [total mercury]	Mean methylmercury [total mercury] concentration (mg/kg ± standard deviation)	Date of review and recommendation
Greenling	*Hexagrammidae*	Family	1,78(07)xxx,xx	[12]	[0.28 ± 0.19]	2021: Lingcod: Data collection beneficial – low sample numbers and no methylmercury results 2021: Other Greenling: No ML required
Grouper	*Epinephelus sp.*	Genus	1,70(02)042,xx	[34]	[0.27 ± 0.24]	2019: No ML required 2019: Data collection benefical as low sample numbers and no methylmercury results
Hapuku	*Polyprion oxygeneios*	Species	1,70(05)058,02	[70]	[0.33 ± 0.21]	2019: Data collection beneficial – low sample numbers and no methylmercury results
Herring	*Cupeidae sp.*	Family	1,21(05)xxx,xx	145 [1871]	0.04 ± 0.13 [0.04 ± 0.05]	2019: No ML required
Kahawai	*Arripis trutta*	Species	1,70(29)051,02	[60]	[0.24 ± 0.10]	2019: No ML required
Ling	*Lotidae sp.*	Sub-family	1,48(04)xxx,xx	[2340]	[0.28 ± 0.28]	2019: Cusk and blue ling: Data collection beneficial - no methylmercury results 2019: Other ling: No ML required
Mahi-mahi	*Coryphaena hippurus*	Species	1,70(28)071,01	[100]	[0.23 ± 0.17]	2019: No ML required
Medusafish	*Centrolophidae sp.*	Family	1,76(08)xxx,xx	[67]	[0.11 ± 0.12]	2019: No ML required
Merluccid hake	*Merlucciidae sp.*	Family	1,48(05)xxx,xx	45 [315]	0.20 ± 0.27 [0.13 ± 0.11]	2019: No ML required
Mullet	*Muglidae sp.*	Family	1,65(01)xxx,xx	8 [63]	0.02 ± 0.05 [0.14 ± 0.19]	2019: No ML required
Orange roughy	*Hoplostethus atlanticus*	Species	1,61(05)002,02	101 [249]	0.43 ± 0.16 [0.56 ± 0.19]	2021: Average methylmercury exceeds selection criterion; proposed for ML setting
Oreos	*Oreosomatidae sp.*	Family	1,62(04)xxx,xx	40 [40]	0.10 ± 0.10 [0.12 ± 0.11]	2021: No ML required
Pacific red gurnard	*Chelidonichthys kumu*	Species	1,78(02)003,01	[28]	[0.11 ± 0.12]	2019: No ML required
Perch	*Percidae sp.*	Family	1,70(14)xxx,xx	[871]	[0.20 ± 0.14]	2019: No ML required

Common name	Scientific name	Taxonomic grouping	FAO taxonomic code	Sample numbers for methylmercury [total mercury]	Mean methylmercury [total mercury] concentration (mg/kg ± standard deviation)	Date of review and recommendation
Phycid hake	*Phycidae*	Sub-family	1,48(04)xxx,xx	[61]	[0.13 ± 0.05]	2019: White hake: Data collection beneficial – low sample numbers and no methylmercury results 2019: Other phycid hake: No ML required
Pike	*Escoidae sp.*	Family	1,24(03)xxx,xx	[231]	[0.29 ± 0.18]	2021: No ML required
Pomfrets	*Brama sp.*	Genus	1,70(27)003,xx	[31]	[0.07 ± 0.05]	2019: No ML required
Porgies	*Sparidae sp.*	Family	1,70(39)xxx,xx	10 [79]	0.17 ± 0.09 [0.13 ± 0.16]	2019: No ML required
Rays and skate	*Rajiformes sp.*	Order	1,10(xx)xxx,xx	[72]	[0.18 ± 0.28]	2019: No ML required
Red cod	*Pseudophycis bachus*	Species	1,48(02)014,01	[23]	[0.06 ± 0.04]	2019: No ML required
Redbait	*Emmelichthys nitidus*	Species	1,70(30)010,01	[33]	[0.15 ± 0.07]	2019: No ML required
Right eyed flounder & sole	*Pleuronectidae sp./ Soleidae sp*	Family	1,83(02)xxx,xx and 1,83(03)xxx,xx	133 [2910]	0.11 ± 0.17 [0.21 ± 0.22]	2019: No ML required
Rockfish	*Sebastes sp.*	Genus	1,78(01)001,xx	[176]	[0.19 ± 0.19]	2019: No ML required
Sablefish	*Anoplopoma fimbria*	Species	1,78(08)004,01	27 [381]	0.35 ± 0.30 [0.43 ± 0.26]	2021: Data collection beneficial – insufficient methylmercury, or paired total mercury to methylmercury results
Salmonids	*Salmonidae sp.*	Family	1,23(01)xxx,xx	111 [2562]	0.03 ± 0.04 [0.04 ± 0.05]	2019: No ML required
Sea bass	*Unknown*	Unknown	Unknown	[94]	[0.21 ± 0.24]	2019: No ML required 2019: Data collection beneficial species not clearly identifiable
Short nosed chimera	*Chimaeridae sp.*	Family	1,12(01)xxx,xx	[229]	[0.38 ± 0.17]	2019: Data collection beneficial – no methylmercury results
Snake mackerel	*Gempylidiae sp.*	Family	1,75(05)xxx,xx	20 [146]	0.13 ± 0.09 [0.37 ± 0.29]	2021: Escolar: Data collection- no methylmercury results 2021: Other snake mackerel: No ML required

Common name	Scientific name	Taxonomic grouping	FAO taxonomic code	Sample numbers for methylmercury [total mercury]	Mean methylmercury [total mercury] concentration (mg/kg ± standard deviation)	Date of review and recommendation
Snapper	*Lutjanus sp.*	Genus	1,70(32)xxx,xx	[18]	[0.25 ± 0.39]	2021: Russell's snapper: Data collection beneficial – no methylmercury results 2021: Other snapper: No ML required 2021: Data collection beneficial as present data not clearly identifiable to a species.
Sturgeon	*Acipenseridae sp.*	Family	1,17(01)xxx,xx	[36]	[0.09 ± 0.12]	2021: No ML required
Temperate bass	*Moronidae sp.*	Family	1,70(04)xxx,xx	9 [152]	0.04 ± 0.04 [0.18 ± 0.36]	2019: No ML required
Tilapia	*Oreochromis sp.)*	Genus	1,70(59)051,xx	[29]	[0.01 ± 0.01]	2021: No ML required
Toothfish	*Dissostichus sp.*	Genus	1,70(92)015,xx	10 [240]	0.12 ± 0.07 [0.40 ± 0.37]	2021: Patagonian toothfish: Average methylmercury expected to exceed selection criterion; proposed for ML setting 2021: Antarctic toothfish: total mercury below selection criterion, no methylmercury results
Turbot	*Psetta maxima*	Species	1,83(05)092,01	[98]	[0.08 ± 0.06]	2019: No ML required
Typical smelt	*Osmeridae sp.*	Family	1,23(04)xxx,xx	1 [46]	0.07 [0.06 ± 0.06]	2019: No ML required
Wolffish	*Anarhichas sp*	Genus	1,71(02)001,xx	1 [152]	0.12 [0.10 ± 0.17]	2019: No ML required

APPENDIX III

DISCUSSION PAPER ON ESTABLISHING FURTHER MAXIMUM LEVELS FOR METHYLMERCURY IN FISH
(For information)

Introduction

1. The current maximum levels (MLs) 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. 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[1]. 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, paragraph 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 17/11/12). 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 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 Codex Alimentarius Commission (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 (2019) 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, paragraph 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, paragraph 127).

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.

1 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.

Work Process

Selection criterion

8. A process to derive selection criterion for fish species of concern requiring MLs for methylmercury was reported on in CX/CF 17/11/12.

9. 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/Food 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

10. 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 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).

11. 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.

12. The 0.3 mg/kg selection criterion for methylmercury has been used in the present consideration to identify further species or taxonomic groupings where MLs could be established.

Review data submitted to GEMS/Food

13. Data were extracted from GEMS/Food for total mercury and methylmercury in 'Fish and other seafood (including amphibians, reptiles, snails and insects)' for the sampling years of 2000-2020. As datasets in GEMS/Food can be updated for completeness the full dataset for total mercury and methylmercury in finfish was reconsidered.

14. Data were excluded that were not for fish species[2], were aggregated data, were unspecific categories, or were not for whole fish, muscle[3] or muscle-based portions. Data points for cooked fish were excluded. All data from tuna and bonito, alfonsino, kingfish/amberjack, sharks and selachoidae, marlin, dogfish and swordfish were excluded as the conclusions on these species were not being reconsidered. Data for species/taxonomic grouping of fish for which CX/CF 19/13/13 had identified that MLs were not required, were also excluded as they were outside of the scope of the present consideration, namely the suitability to proceed with establishment of MLs for additional fish species.

15. Data were only considered if they were clearly identifiable to a species or taxonomic grouping of fish, either through provision of a binomial name or a sufficiently unique common name[4]. Aligning with the grouping of "all tuna" and "all shark" results to generate group MLs for these species, where possible results for species were grouped within appropriate taxonomic groups (CX/CF 18/12/7).

16. Species[5] where previously insufficient sample size (≤10 results[6]) existed for analysis (CX/CF 19/13/13) were re-examined against for the availability of additional datapoints. Any species not previously considered in CX/CF 19/13/13 for which there was newly submitted data were also assessed.

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

18. 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.

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

20. The summary statistics were interpreted to provide recommendations as for which species/groups of fish MLs could potentially be set. The prior recommendation 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 (REP18/CF, paragraph 88). 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.

21. 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.

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[2] Clams, Crabs, Crustaceans, Lobsters, Marine Mammals, Molluscs, Mussels, Octopi, Oysters, Scallops, Shrimp and Prawns, Squid, Urchins and Sea Cucumber.

[3] For example fish paste, fish roe and fish livers.

[4] For example "Snapper- Unspecified species" was excluded as being generic of fish from multiple families, while "catfish – unspecified species" was incorporated into the consideration of catfish

[5] Atlantic smelt (1 sample) Barracudina (2 samples), Barramundi (4 samples), Black crappie (2 samples), Black sea bass (1 sample), Bluegill (1 sample), Buffalofish (1 sample), Chela pata (2 samples), Climbing perch (1 sample), Croaker (3 samples), Dories and allies (Zeomorphii; 6 samples), Featherback (1 sample), Goldeye (2 samples), Large-mouth bass (3 samples), Lingcod (9 samples), Lumpfish (2 samples), Nile perch (2 samples), Sailfish (1 sample), Snakehead (2 samples), Spearfish (1 sample), Tigerfish (2 samples), Tilapia (4 samples), Tilefish (2 samples) and White sucker (4 samples).

[6] 10 samples was a practical cut-off to best focus data analysis resources.

22. To appraise the significance in trade of those additional species determined to have a clear exceedance of the selection criterion for methylmercury, their FAO export volume and value for 2016-2018 were obtained[7]. As a reference, the 2016-8 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 values. The average values for the last three years available data (2016, 2017, 2018) were used to account for any recent year to year fluctuation.

23. Alfonsino is not recorded as it was not individually listed in the export statistics, thus export volumes and value could not be benchmarked against.

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

Species	Export volume (MT)	Export value (US$,000,000)
Marlin (all species in 1,75(04)xxx,xx)	4319	8

ML options

24. 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, paragraphs 71, 74 and 77). 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). Following the approach in CX/CF 18/12/7 identifying ML options for taxonomic groups of fish, where there was notable trade in multiple species within these groups, was seen as desirable where possible given that trade lots of fish may not distinguish down to a species level, relying instead on a genus/family name or a common name.

25. Hypothetical MLs were calculated 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.

Species for which MLs could be established

26. Analysis identified three species or taxonomic groupings of fish, orange roughy (a species in the slimehead family; *Trachichthyidae*), Patagonian toothfish (a species in the *Dissostichus* genus) and pink cusk-eel (a species in cusk-eel genus *Genypterus)*, for which there was sufficient confidence that average methylmercury concentrations would exceed the 0.3 mg/kg selection criterion.

27. Data for a number of other species had total mercury concentrations exceeding 0.3 mg/kg but the methylmercury data for these species were lacking, and as a result, there was insufficient information on the ratio of methylmercury to total mercury for these species to identify if the screening criterion for methylmercury would be exceeded.

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.

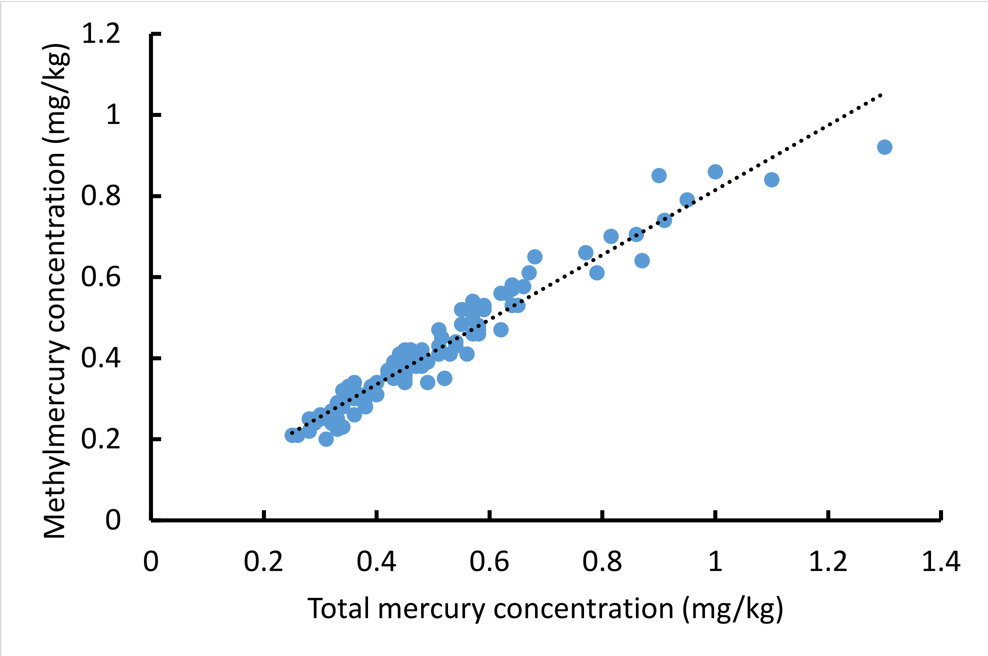
7 FAO. 2020. FAO yearbook. Fishery and Aquaculture Statistics 2018/FAO annuaire. Statistiques des pêches et de l'aquaculture 2018/FAO anuario. Estadísticas de pesca y acuicultura 2018. Rome/Roma.

Table 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]. The majority of the findings were supplemented with information on fish length and weight.

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



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.

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)	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: 0.46 mg/kg methylmercury (Table 5) for the 249 samples.

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

Table 6: Hypothetical MLs for orange roughy

Hypothetical ML	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 the paired data captured fish with total mercury concentrations across the range for this species fish in the upper percentiles of total mercury are modelled for.

36. Referring to the averages for 2016-2018 the orange roughy export volume was only slightly lower than marlin, while total value of the export was over double that of marlin (Table 7). Comparing the export value of orange roughy provides a basis to support that ML progression for orange roughy would provide comparable protection against an expected problem in trade as to marlin[9].

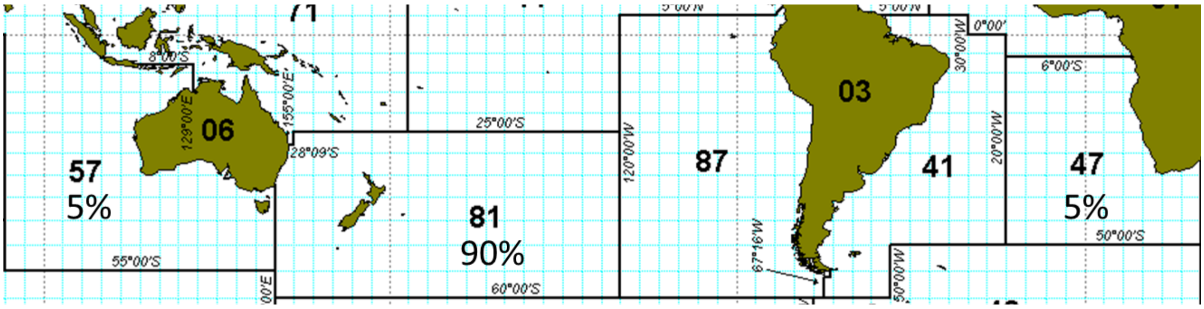
Table 7: Average global export volume and export value for marlin and orange roughy from 2016-18

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

37. Orange roughy are the predominant species of slimehead commercial 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.

9 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 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*)

38. 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.

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

40. 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.

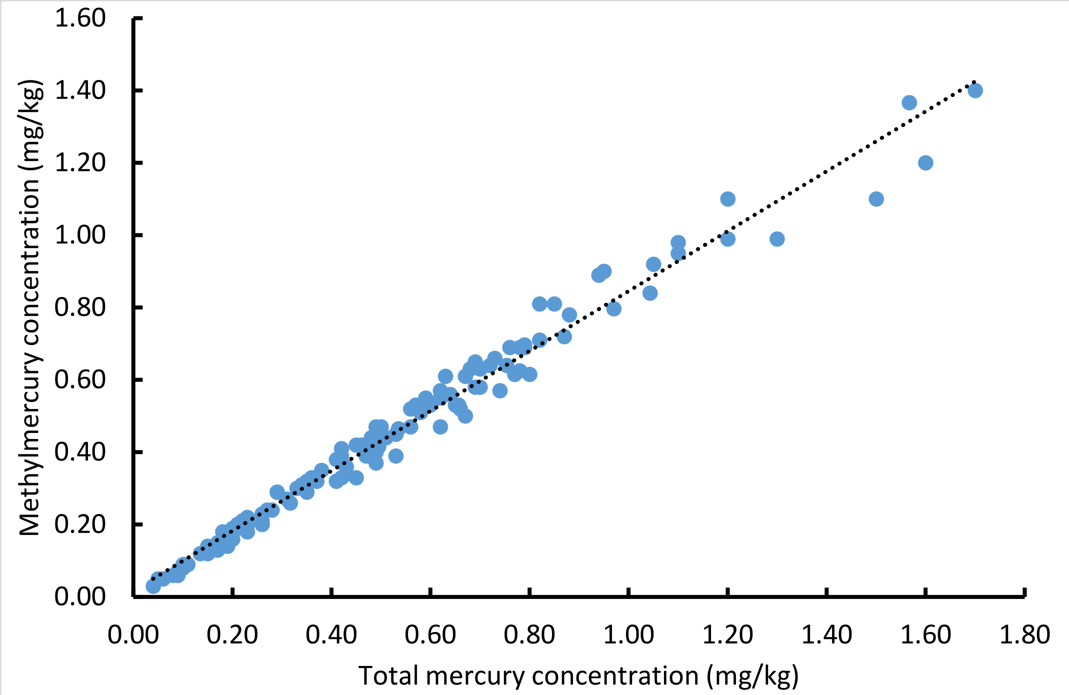
41. Samples were confirmed with the submitting country to have been caught from two fishery regions within that nation. The FAO fishing region (81) the samples were caught from represented 64% of the average pink cusk-eel global capture volume over 2016-18, and 51% of the total cusk-eel capture volume (Figure 4).[10] All results were supplemented with information on fish length and weight. Samples were recorded as total (edible + inedible) when the fillets were not deboned.

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

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.

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



42. 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.

43. 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 – Pink cusk-eel	120	0.46	0.29	0.99	1.40
Unpaired total mercury – Pink cusk-eel	114	0.36	0.35	0.98	1.98
Regression model adjusted total mercury– Pink cusk-eel	114	0.31	0.29	0.83	1.66
Modelled dataset (Regression model adjusted)- Pink cusk-eel	234	0.39	0.30	0.98	1.66

Table 10: Hypothetical MLs for Pink cusk-eel

Hypothetical ML	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.*

44. 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.

45. A single species ML for pink cusk-eel could be established using the regression model adjusted dataset, or methylmercury dataset (Table 10). As the paired data reports on total mercury concentrations across the total mercury range for this species the upper percentiles of total mercury are modelled for.

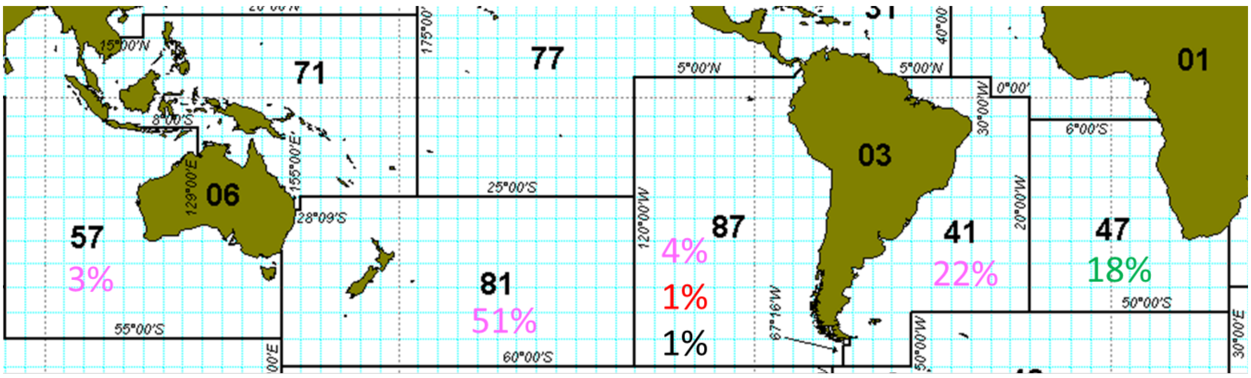
46. Referring to the 2016-2018 average export volume for cusk-eel (not specific to one species) this was comparable to marlin, while the total value of the export was over three times that of marlin (Table 11). Comparing the export value of cusk-eel provides a basis to support that ML progression for pink cusk-eel would provide comparable protection against an expected problem in trade as to marlin.

Table 11: 2016-18 Global capture production volume, export volume and export value for marlin and cusk-eel

Species	Export volume (MT)	Export value (US$,000,000)
Marlin	4319	8
Cusk-eel	4924	26

47. 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.



Toothfish (Genus: *Dissostichus*)

48. 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).

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

50. The present review of data in GEMS/Food identified 46 total mercury results were available for Antarctic toothfish; 183 total mercury results 10 and methylmercury results for Patagonian toothfish; and 11 results for unspecified toothfish. The data were recorded in GEMS/Food as being of domestic and imported provenance.

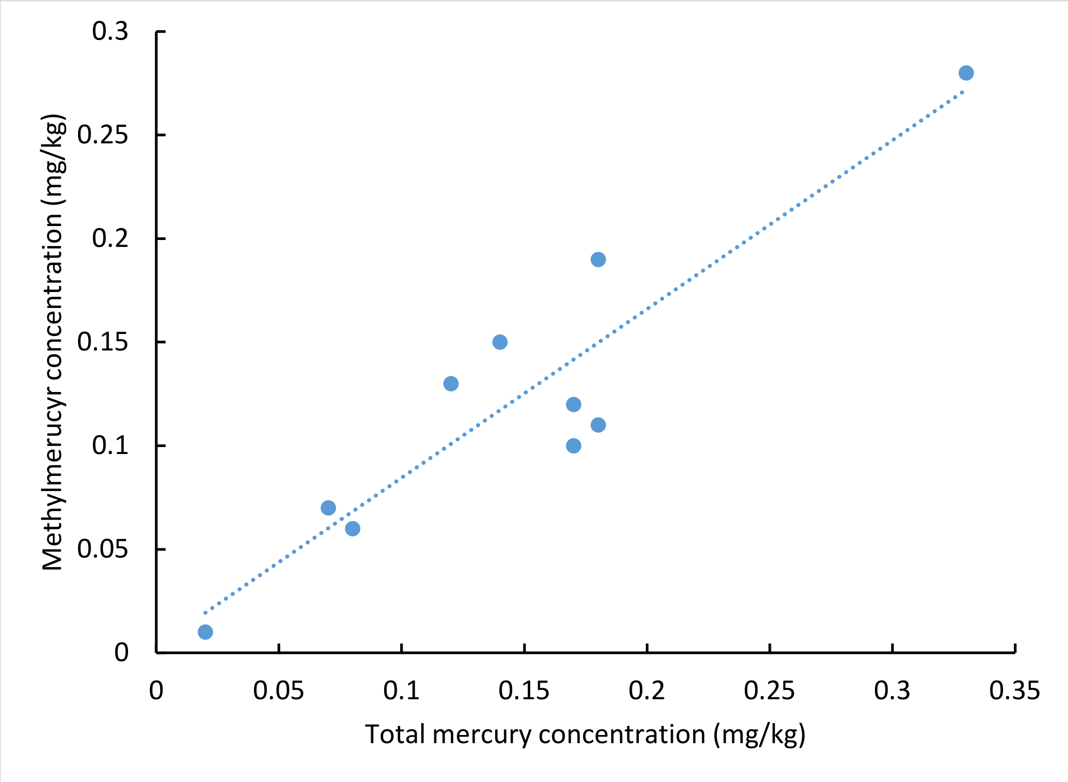
51. Between the two toothfish species a clear difference is seen in the average total mercury levels, with the level in the Antarctic species being below the selection criterion, and those of the Patagonian species above. The average of the 10 methylmercury results for Patagonian toothfish was below the selection criterion, although the paired total mercury values in these samples were at in the low end of the range relative to the existing total mercury dataset (0.02-0.33 mg/kg).

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 (15) G10 (31)	46	0	0.11	0.06	0.23	0.33
Toothfish (Patagonian)	*Dissostichus eleginoides*	Total	Yes	G07 (20) G10 (163)	183	0	0.48	0.38	1.08	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 (10)	10	0	0.12	0.07	0.24	0.28
All Toothfish	*Dissostichus sp.*	Total	No	G07 (35) G10 (205)	240	0	0.40	0.37	1.02	2.52

52. In 10 paired samples of Patagonian toothfish the average concentration ratio of methylmercury to total mercury was 82% (range 50-108%; Figure 5). The lower end of the range (50%) was likely affected by the analytical method sensitivity and reporting to only 2 decimal places (0.02 mg/kg total mercury: 0.01 mg/kg methylmercury). The average concentration ratio of methylmercury to total mercury was significantly positively correlated (Pearson Correlation Coefficient: 0.9207; $p < 0.05$), with a linear line of best fit.

Figure 5: Correlation of paired total mercury and methylmercury concentrations in 10 samples of Patagonian toothfish



53. A linear regression equation was calculated from the paired dataset: methylmercury = 0.8148 x total mercury + 0.00304. The regression equation was applied to the unpaired total mercury data for Patagonian toothfish (n= 173) to estimate the methylmercury range in the species. 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 13.

Table 13: Comparisons of descriptive statistics for methylmercury; regression equation-adjusted unpaired total mercury and modelled datasets for Patagonian toothfish

Dataset	Total records	Mean	SD	P95	Max
Methylmercury – Patagonian toothfish	10	0.12	0.07	0.24	0.28
Unpaired total mercury – Patagonian toothfish	173	0.48	0.38	1.08	2.52
Regression model adjusted total mercury– Patagonian toothfish	173	0.41	0.31	0.88	2.06
Modelled dataset (Regression model adjusted) Patagonian toothfish	183	0.39	0.31	0.88	2.06

54. The modelled dataset identifies that methylmercury would likely exceed the selection criterion (0.3 mg/kg) and there are sufficient sample numbers (183 samples) to be confident in identifying an ML. Based on a less than 5% rejection rate, hypothetical MLs were derived for Patagonian toothfish (Table 14). However, as the paired samples used in the regression modelling are from Patagonian toothfish with total mercury at the lower end of the range (0.01-0.33 mg/kg) evident in the total mercury dataset (0.01- 2.52 mg/kg) there is some uncertainty on whether the ratio would remain consistent in fish with total mercury values in the upper percentiles of the range, which places uncertainty on the specific ML that would be required

Table 14: Hypothetical MLs for Patagonian toothfish

Hypothetical ML	Modelled dataset* (n=183)	
	Number of samples <ML	% of samples <ML
0.8	168	92
0.9	175	96
1.0	176	96
1.1	176	96
1.2	178	97

* *Based upon use of methylmercury data points and any non-paired total mercury data points adjusted with a linear regression model (methylmercury = 0.8148 x total mercury + 0.00304) to estimate methylmercury.*

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= 240; 0.4 mg/kg) that exceeds the selection criterion there is uncertainty in concluding the toothfish family grouping would exceed the selection criterion.

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 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. As the selection criterion (0.3mg/kg) is considered likely to be exceeded using the regression model adjusted dataset a single species ML for Patagonian toothfish could be progressed.

59. Further data collection may still be warranted given the uncertainty over applying the regression model to setting an ML based around a <5% rejection rate given it is based on a regression calculation from fish with lower total mercury values.

60. Should a taxonomic group ML be sought there is low confidence given the total mercury range in Antarctic toothfish that the taxonomic group would meet the selection criterion and that an ML would be also suitable for applying ALARA across the taxonomic group.

61. Referring to the average values for 2016-2018, toothfish (all species) has a considerably lower capture production volume than marlin, however export volume and value was considerably greater than that of marlin (Table 15). Comparing the export volume and value of toothfish provides a basis to support that ML progression for Patagonian toothfish would provide comparable protection against an expected problem in trade as to marlin.

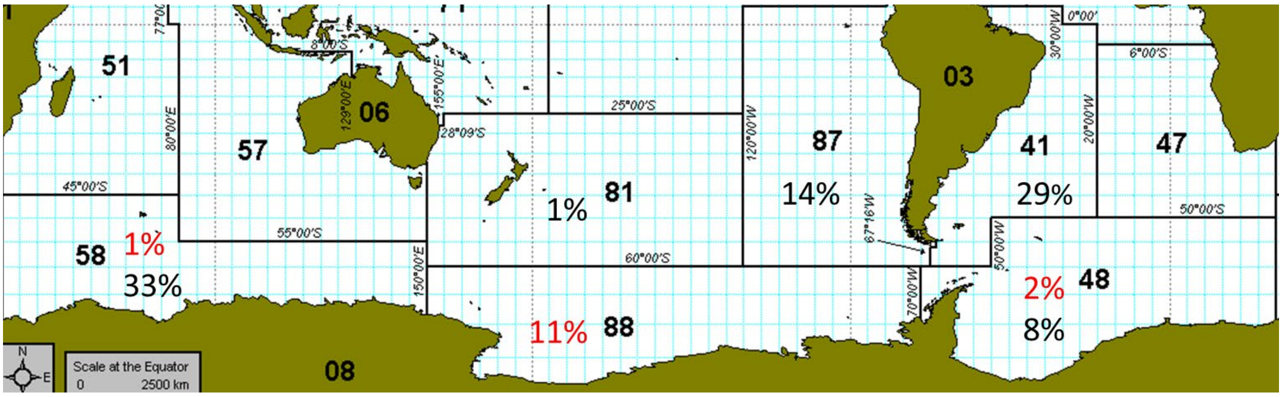
Table 15: 2016-18 Global capture production volume, export volume and export value for marlin and toothfish

Species	Capture production volume (MT)	Export volume (MT)	Export value (US$,000,000)
Marlin	76,138	4319	8
Toothfish	28,434	29,207	435

62. Catch volume distribution for toothfish by FAO fishing region for 2016-18 is displayed in Figure 6.

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)

Figure 6: 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.



Species recommended for continued data collection

63. Analysis of the dataset in GEMS/Food identified that new results were available for eight of the species or taxonomic groupings identified for further data collection (Table 1). These were anglerfish, snake mackerel, sablefish, sturgeon, pike, snapper, and catfish. With the exception of sturgeon and pike the updated datasets for these species had insufficient data on methylmercury concentrations for identifying an ML and continued data collection would still be necessary. For sturgeon and pike, the updated datasets were sufficient to conclude the average methylmercury concentration was unlikely to exceed the selection criterion and an ML would not be required.

64. For other species or taxonomic groupings identified for further data collection (barracuda, blue ling, cardinalfish, cusk/tusk, cutlassfish, grouper, hapuku, seabass, short nosed chimera and white hake) the GEMS/Food dataset review did not identify any further results were available over those considered in CX/CF 19/13/13.

Anglerfish/ monkfish (Genus: *Lophius*)

65. Data for anglerfish (also commonly termed monkfish) were extracted from GEMS/Food (Table 16). The interpretation of results in CX/CF 19/13/13 had included the broader *lophiiformes* data as only *lophius* species (taxonomic code: 1,95(01)001) were expected to be commercially harvested.

66. Total mercury (92 results) and methylmercury results (18 results) for anglerfish had been considered previously within CX/CF 19/13/13.

67. The present review of data in GEMS/Food identified 190 total mercury results and 16 methylmercury result were available for anglerfish. The new data was recorded in GEMS/Food as being of domestic and imported provenance.

68. Considering the present dataset, the mean for total mercury in anglerfish is below 0.3 mg/kg. However, when the smaller methylmercury dataset is reviewed it can be seen the mean values are greater than double the selection criterion. Interpretation of the methylmercury dataset shows 11 out of the 16 results exceed the selection criterion (range of the 11 results: 0.53- 3.0 mg/kg). Although the 3.0 mg/kg result is an outlier from the rest of the data (all <1 mg/kg) even when this outlier is excluded the average methylmercury concentration (0.52 mg/kg) would exceed the selection criterion.

Table 16: Occurrence data on total mercury and methylmercury in mg/kg in anglerfish 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
Anglerfish	*Lophius sp.*	Total	No	G10 (34) ER (156)	190	26	0.19	0.35	0.69	3.00
Anglerfish	*Lophius sp.*	Methyl	Yes	ER (16)	16	0	0.68	0.67	1.49	3.00

69. No paired data was available from which to derive a ratio of methylmercury to total mercury for anglerfish. Consequently, sufficient sample numbers (n= 74) to assign exceedance of the selection criterion are not available for methylmercury.

70. Further data collection for anglerfish would be beneficial to confirm the ratios of methylmercury to total mercury and establish whether future ML setting may be necessary.

Sablefish/ black cod *(Anoplopoma fimbria)*

71. Data for sablefish were extracted from GEMS/Food (Table 17). No other species in the same family (*Anoplopomatidae;* taxonomic code 1,78(08)) were identified; as a result no grouping along taxonomic lines was possible.

72. Total mercury results for sablefish (352 results) had been considered previously within CX/CF 19/13/13.

73. The present review of data in GEMS/Food identified 381 total mercury results were available for sablefish and 27 methylmercury results. The data were recorded in GEMS/Food as being of domestic and imported provenance. The methylmercury samples were separate and not paired to the total mercury dataset.

74. The average methylmercury concentration for sablefish was above the 0.3 mg/kg selection criterion for ML setting. A study undertaken in Canada established the proportion of methylmercury to total mercury ranged between 80-94% (n=4)[12]. Applying this ratio range to the dataset for total mercury for sablefish results in an estimate of 0.34-0.40 mg/kg which aligns with the average methylmercury values reported in the 27 samples analysed for this form

Table 17: Summary of occurrence data on total mercury and methylmercury in mg/kg in sablefish 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
Sablefish	*Anoplopom a fimbria*	Total	No	G10 (381)	381	0	0.43	0.26	0.91	2.33
Sablefish	*Anoplopom a fimbria*	Methyl	No	G10 (27)	27	0	0.35	0.30	0.98	1.14

75. However, in the absence of paired data and with only 4 literature results to identify the ratio of methylmercury to total mercury there was low confidence in adjusting the total mercury dataset to supplement the 27 methylmercury results. Consequently, sufficient sample numbers (n= 74) to assign exceedance of the selection criterion are not available for methylmercury.

76. Further data collection for sablefish would be beneficial to confirm the ratios of methylmercury to total mercury and establish whether future ML setting may be necessary.

[12] Canadian Food Inspection Agency. 2003. Draft Sablefish Mercury Report - Investigation of mercury in B.C. Sablefish sampled between October 2002 and November 2003.

Snake mackerel species (Family: *Gempylidiae)*

77. Data for barracouta, escolar and gemfish were extracted from GEMS/Food (Table 18). These species are within the snake mackerel family (*Gempylidiae*; taxonomic code 1,75(05)).

78. Total mercury results for barracouta (59 results) and escolar (62 results) had been considered previously within CX/CF 19/13/13.

79. The present review of data in GEMS/Food identified 64 total mercury results were available for escolar, 59 total mercury and 10 methylmercury results for barracouta; and 10 total mercury and methylmercury results for gemfish. The data for escolar were recorded in GEMS/Food as being of imported or unknown provenance. The data for barracouta and gemfish were recorded in GEMS/Food as being of domestic provenance.

80. The average methylmercury concentration in barracouta and gemfish did not exceed the selection criterion of 0.30 mg/kg, supporting that ML setting for these species is not necessary. However, escolar has a clear difference in the average total mercury levels from that in barracouta and gemfish.

81. Certain species of snake mackerel (escolar and oilfish; *Ruvettus pretiosus*) contain high proportions of indigestible wax esters in the flesh, termed gempylotoxin, which can cause adverse gastrointestinal effects (Keriorrhoea) in some, but not all, consumers. The presence of gempylotoxin may limit consumption and consequently the potential methylmercury exposure, although as the prevalence of populations who are susceptible to its adverse effects is not well quantified it would be difficult to incorporate this into an exposure assessment. Gempylotoxin has not been identified as a hazard in other snake mackerel species[13].

Table 18: Summary of occurrence data on total mercury in mg/kg in snake mackerel 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**
Barracouta	*Thyrsites atun*	Total	No	G10 (59)	59	0	0.19	0.18	0.67	0.71
Escolar	*Lepidocybium flavobrunneum*	Total	No	G10 (64)	66	1	0.60	0.26	1.04	1.41
Gemfish	*Rexea solandi*	Total	No	G10 (10)	10	0	0.24	0.07	0.33	0.35
Barracouta	*Thyrsites atun*	Methyl	No	G10 (10)	10	1	0.05	0.02	0.08	0.09
Gemfish	*Rexea solandi*	Methyl	No	G10 (10)	10	0	0.22	0.05	0.28	0.28
All snake mackerel	*Gempylidiae sp.*	Total	No	G10 (146)	146	1	0.37	0.29	0.91	1.41
All snake mackerel	*Gempylidiae sp.*	Methyl	No	G10 (20)	20	1	0.13	0.09	0.27	0.28

82. In nine paired barracouta samples (1 further sample was ND for methylmercury) the average concentration ratio of methylmercury to total mercury was 87% (range: 75-100%; Figure 7). The average concentration ratio of methylmercury to total mercury was significantly positively correlated (Pearson Correlation Coefficient: 0.9684; $p < 0.05$).

83. In ten paired gemfish samples the average concentration ratio of methylmercury to total mercury was 92% (range: 79-108%; Figure 7). The average concentration ratio of methylmercury to total mercury was significantly positively correlated (Pearson Correlation Coefficient: 0.9524; $p < 0.05$).

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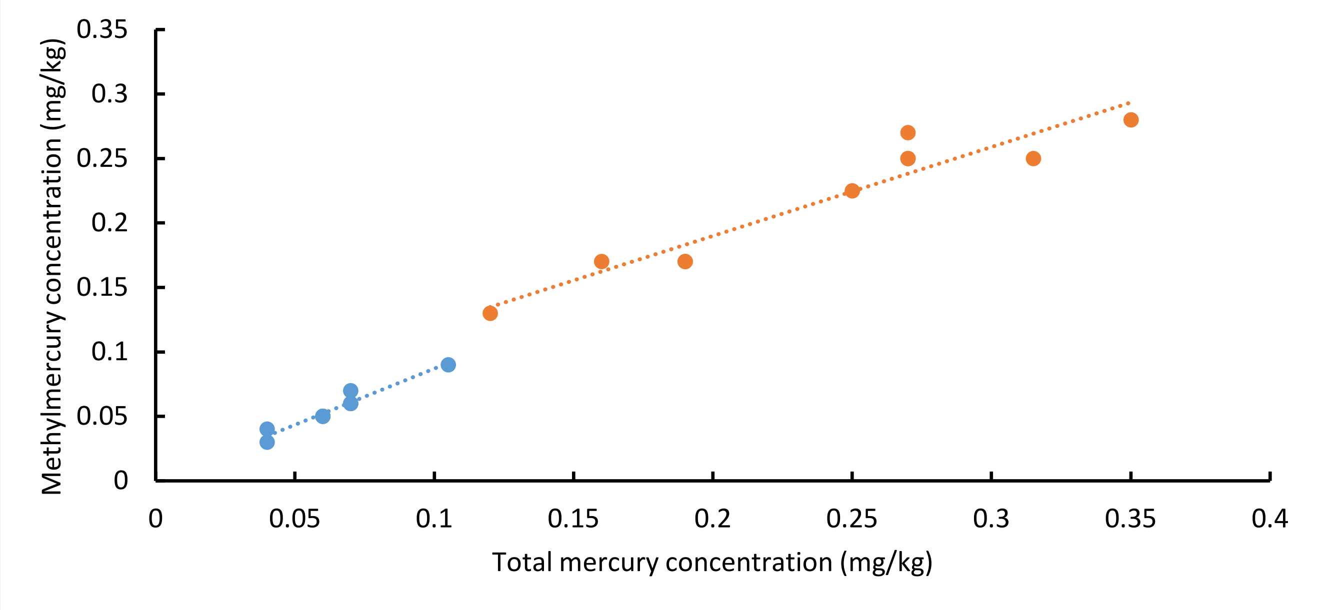
Figure 7: Correlation of paired total mercury and methylmercury concentrations in 9 samples of barracouta (blue) and 10 samples of gemfish (orange). Some datapoints overlap on the same values.



84. Applying the average ratio of methylmercury to total mercury seen in gemfish and barracouta (87-92%) to escolar would result in an estimated methylmercury concentration of 0.52 – 0.55 mg/kg which would suggest this species would exceed the selection criterion if the ratio was consistent in the family, although this cannot be assumed.

85. Further data collection for methylmercury occurrence in escolar would be beneficial to confirm the ratios of methylmercury to total mercury and establish whether future ML setting may be necessary.

Catfish species (Order: *Siluriformes*)

86. Data for brown bullhead (*Ameiurus nebulosus*), yellow bullhead (*Ameiurus natalis*), basa catfish/pangasius (*Pangasius bocourti*), channel catfish (*Ictalurus punctatus*), walking catfish (*Clarias batrachus*) and unspecified catfish (*Siluriformes sp.*) were extracted from GEMS/Food (Table 19). The unspecified catfish samples could include fish from a wide number of families in the diverse catfish order (taxonomic code: 1,41), as the previous consideration in CX/CF 19/13/13 had grouped all catfish by order (*Siluriformes*).

87. Total mercury results for brown bullhead (6 results), basa catfish/pangasius (11 results), channel catfish (20 results), walking catfish (1 result) and unspecified catfish (17 results*)* had been considered previously in CX/CF 19/13/13.

88. The present review of data in GEMS/Food identified 27 total mercury results were available for basa catfish, 6 total mercury results for brown bullhead, 2 total mercury results for yellow bullhead, 20 total mercury results for channel catfish, 1 total mercury result for walking catfish and 20 total mercury results for unspecified catfish. The data were recorded in GEMS/Food as all being of imported provenance.

89. The average total mercury values for all of the individual species, except channel catfish, and for the unspecified catfish samples fell below 0.3 mg/kg indicating the average methylmercury concentration was unlikely to exceed the selection criterion. The mean total mercury for channel catfish was far in excess of the selection criterion, however as noted in CX/CF 19/13/13, the dataset is notably bimodal with 11 out of 20 samples containing less than 0.06 mg/kg and 8 out of 20 samples ranging from 1.59 to 3.66 mg/kg mercury. No data on methylmercury was available to confirm the ratios of methylmercury to total mercury.

Table 19: Summary of occurrence data on total mercury in mg/kg in catfish 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
Brown bullhead	*Ameiurus nebulosus*	Total	No	G10 (6)	6	0	0.12	0.07	0.23	0.25
Catfish (basa)	*Pangasius bocourti*	Total	No	G10 (27)	27	13	0.01	0.02	0.05	0.05
Catfish (channel)	*Ictalurus punctatus*	Total	No	G10 (20)	20	4	0.98	1.22	3.17	3.66
Catfish (walking)	*Clarias batrachus*	Total	No	G10 (1)	1	1	0	0	0	0
Yellow bullhead	*Ameiurus natalis*	Total	No	G10 (2)	2	0	0.01	0.01	0.01	0.01
Catfish (unspecified)	*Siluriformes sp.*	Total	No	G10 (20)	20	2	0.11	0.15	0.56	0.57
All catfish	*Siluriformes sp.*	Total	No	G10 (79)	79	19	0.29	0.75	2.21	3.66

90. Further data collection for methylmercury occurrence in channel catfish, would be beneficial to support identification and setting of MLs.

Pike (Genus: *Esox)*

91. Data for pike were extracted from GEMS/Food (Table 20). The pike family (*Escoidae*; taxonomic code: 1,24(03)) is monotypic so no further grouping was possible

92. Total mercury results for pike (227 results) had been considered previously within CX/CF 19/13/13. Although the average total mercury concentration was below the selection criterion further data collection was identified as be beneficial for pike to establish the ratio of methylmercury to total mercury and confirm the occurrence dataset is geographically representative.

93. The present review of new data in GEMS/Food identified 231 total mercury results were available for pike. The average total mercury concentration for pike was 0.29 mg/kg, falling below the selection criterion of 0.3 mg/kg. It can be concluded that no ML is necessary. As a result, pike can be removed from the species for which further data collection would be beneficial.

Table 20: Summary of occurrence data on total mercury in mg/kg in pike 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
Pike	*Esox sp.*	Total	Yes	G07 (11) G10 (220)	231	1	0.29	0.18	0.63	1.40

Sturgeon *(*Family: *Acipenseridae)*

94. Data for Atlantic sturgeon (*Acipenser oxyrinchus*), Shortnose sturgeon (*Acipenser brevirostrum)* sturgeon (unspecified) were extracted from GEMS/Food (Table 21).

95. Total mercury results for Atlantic sturgeon (1 result), Shortnose sturgeon (3 results) and unspecified sturgeon (6 results) had been considered previously within CX/CF 19/13/13.

96. Although not prioritised for data collection, further data submission for sturgeon had been seen as beneficial given the limited number of results and potential for a wider inherent variation in the methylmercury levels (CX/CF 19/13/13).

97. The present review of data in GEMS/Food identified 3 total mercury results were available for shortnose sturgeon, 1 total mercury result for Atlantic sturgeon and 30 total mercury results for unspecified sturgeon. The new data were recorded in GEMS/Food as being of domestic, imported or unknown provenance.

Table 21: Summary of occurrence data on total mercury in mg/kg in sturgeon 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**
Sturgeon (Atlantic)	*Acipenser oxyrinchus*	Total	No	G10 (1)	1	0	0.13	0	0.13	0.13
Sturgeon (shortnose)	*Acipenser brevirostrum*	Total	No	G10 (3)	3	0	0.11	0.01	0.13	0.13
Sturgeon (unspecified)	*Acipenseridae sp.*	Total	No	G10 (2) ER (30)	30	2	0.09	0.12	0.30	0.63
Sturgeon	*Acipenseridae sp.*	Total	Yes	G10 (6) ER (30)	36	2	0.09	0.12	0.26	0.63

98. The mean values for total mercury for the sturgeon family grouping falls below 0.3 mg/kg indicating that the average methylmercury concentration would not exceed the selection criterion. It can be concluded that no ML is necessary. As a result, sturgeon can be removed from the species for which further data collection would be beneficial.

Snapper species (Family: *Lutjanidae)*

99. Data for Lane snapper, Pacific red snapper, red snapper, green jobfish and snapper (unspecified) were extracted from GEMS/Food (Table 22). All the data points were interpreted to be from snapper species from within the *Lutjanidae* family, for which a previous grouping of data points had been undertaken (CX/CF 19/13/13).

100. Total mercury data points for Pacific red snapper (3 results), red snapper (4 results), Russell's snapper (1 result), vermillion/beeliner snapper (1 result); *Lutjanidae sp.* snapper (1 result) and unspecified snapper (assumed *Lutjanus sp.; 2* results) had been considered previously within CX/CF 19/13/13.

101. The present review of data in GEMS/Food identified 1 total mercury result was available for lane snapper, 4 total mercury results for Pacific red snapper, 5 total mercury results for red snapper, 1 total mercury result for Russell's snapper, 1 total mercury result for green jobfish, 1 total mercury result for vermillion/beeliner snapper; 1 total mercury results for *Lutjanidae sp.* Snapper and 3 total mercury results for unspecified snapper (assumed *Lutjanus sp.*). The new data were recorded in GEMS/Food as being of imported provenance.

102. With the exception of Russell's snapper and unspecified snapper all of the total mercury data points fell below the 0.3 mg/kg selection criterion. When all of the new and previously considered data for total mercury in snapper is grouped the average total mercury fell below the selection criterion of 0.3 mg/kg. As Russell's snapper could exceed the selection criterion of 0.3 mg/kg and with the difficulty in assigning the unspecified species results further data collection for identified species of snapper could remain prudent.

Table 22: Summary of occurrence data on total mercury in mg/kg in snapper 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
Lane snapper	*Lutjanus synagris*	Total	No	G10 (1)	1	0	0.11	-	-	-
Green jobfish	*Aprion virescens*	Total	No	G05 (1)	1	0	0.24	-	-	-
Pacific red snapper	*Lutjanus peru*	Total	No	G10 (4)	4	0	0.23	0.21	0.53	0.59
Red snapper	*Lutjanus campechanus*	Total	No	G10 (5)	5	1	0.08	0.06	0.17	0.19
Russell's snapper	*Lutjanus russellii*	Total	No	G10 (1)	1	0	0.70	-	-	-
Ruby snapper	*Lutjanus etelis*	Total	No	G05 (1)	1	1	-	-	-	-
Vermillion snapper	*Rhomboplites aurorubens*	Total	No	G10 (1)	1	0	0.05	0	0.05	0.05
Snapper (*Lutjanidae*)	*Lutjanus sp.*	Total	No	G10 (1)	1	0	0.11	-	-	-
Snapper (unspecified)	*Lutjanus sp.*	Total	No	G10 (3)	3	1	0.55	0.78	1.49	1.65
All snapper (all data)	*Lutjanidae sp.*	Total	No	G05 (1) G10 (17)	18	3	0.25	0.39	0.84	1.65

Newly reviewed species

103. Analysis of the dataset in GEMS/Food identified that datasets sufficient for consideration (n= ≥10)were now available for three fish groupings, greenling (a family grouping containing atka mackerel and lingcod; 12 results for total mercury), oreos (a family grouping containing black oreo and smooth oreo; 40 results each for total mercury and methylmercury) and tilapia (29 results for total mercury).

104. Dories and allies (*Zeomorphi*), climbing perch, croaker, large-mouth bass, white sucker, and barramundi had additional data available, however, the updated datasets were still too few for consideration (n= <10).

105. No other fish or taxonomic groups for which CX/CF 19/13/13 had identified as data poor, or were not part of a taxonomic grouping considered in CX/CF 19/13/13, had new data submitted.

106. New data was submitted for opahs (Genus: *Lampris*; three results); sky emperor (*Lethrinus mahsena*; two results), spangled emperor (*Lethrinus nebulosus*; three results) and parrotfish (reported as blue-barred or marbled; Family Scaridae; two results), however the datasets were too few for consideration (n= <10).

Greenling species (Family: *Hexagrammidae)*

107. Data for lingcod and atka mackerel were extracted from GEMS/Food (Table 23). Both species are in the greenling family (*hexagrammidae* taxonomic code: 1,78(07)) as a result a grouping to family level was possible. All data points were for total mercury and had the assay LOD/LOQ values recorded.

108. Total mercury (9 results) for lingcod had been insufficient for consideration within CX/CF 19/13/13. The present review of GEMS/Food identified 11 total mercury results were available for lingcod and 1 total mercury result for atka mackerel. The data were recorded in GEMS/Food as being of domestic and imported provenance.

Table 23: Summary of occurrence data on total mercury in mg/kg in greenling 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
Atka mackerel	*Pleurogrammus monopterygius*	Total	No	G10 (1)	1	0	0.05	-	-	-
Lingcod	*Ophiodon elongates*	Total	No	G10 (11)	11	0	0.30	0.19	0.57	0.67
All greenling	*Hexagrammidae*	Total	No	G10 (12)	12	0	0.28	0.19	0.56	0.67

109. The average total mercury for lingcod was 0.3 mg/kg indicating that there is potential for the average methylmercury concentration to meet the selection criterion. The single results for atka mackerel did not exceed 0.3 mg/kg indicating that the average methylmercury concentration would not exceed the selection criterion. No data on methylmercury were available to confirm the ratios of methylmercury to total mercury.

110. Further data collection for methylmercury and total mercury occurrence in greenling would be beneficial to confirm the ratios of methylmercury to total mercury and establish whether ML setting may be necessary.

Oreos (Family: *Oreosomatidae*)

111. Data for black oreo and smooth oreo were extracted from GEMS/Food (Table 24). Both species are in the oreo family (*Oreosomatidae* taxonomic code: 1,62(04)) as a result a grouping to family level was possible.

112. No data on oreos had been available to review in CX/CF 19/13/13. The present review of GEMS/Food identified 20 paired total and methylmercury results for black oreo, and 20 paired total and methylmercury results for smooth oreo. All data points were recorded as being of domestic provenance.

Table 24: Summary of occurrence data on total mercury and methylmercury in mg/kg in oreo 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
Black oreo	*Allocyttus niger*	Total	No	G10 (20)	20	1	0.10	0.14	0.42	0.51
Smooth oreo	*Pseudocyttus maculatus*	Total	No	G10 (20)	20	0	0.15	0.08	0.27	0.28
Black oreo	*Allocyttus niger*	Methyl	No	G10 (20)	20	5	0.08	0.11	0.33	0.42
Smooth oreo	*Pseudocyttus maculatus*	Methyl	No	G10 (20)	20	1	0.13	0.07	0.25	0.25
All oreo	*Oreosomatidae*	Total	No	G10 (40)	40	1	0.12	0.11	0.29	0.51
All oreo	*Oreosomatidae*	Methyl	No	G10 (40)	40	6	0.10	0.10	0.25	0.42

113. In 15 paired black oreo samples (5 samples were ND for methylmercury) the average concentration ratio of methylmercury to total mercury was 85% (range: 57-100%). The average concentration ratio of methylmercury to total mercury was significantly positively correlated (Pearson Correlation Coefficient: 0.9976; $p < 0.05$).

114. In 19 paired smooth oreo samples (1 sample was ND for methylmercury) the average concentration ratio of methylmercury to total mercury was 92% (range: 74-133%). The average concentration ratio of methylmercury to total mercury was significantly positively correlated (Pearson Correlation Coefficient: 0.9844; $p < 0.05$).

115. Average methylmercury concentrations in black and smooth oreo fall below the 0.3 mg/kg selection criterion. Consequently, no ML is necessary for these oreo species.

Tilapia (Genus: *Oreochromis)*

116. Data for tilapia were extracted from GEMS/Food (Table 25). Commercial tilapia is typically Mozambique or Nile tilapia, however because species were not identified the data were grouped under the broader *oreochromis* genus (Taxonomic code 1,70(59)051). All data points were for total mercury and had the LOD/LOQ values recorded.

117. The dataset for total mercury (4 results) for tilapia had been insufficient for consideration within CX/CF 19/13/13.

118. The present review of GEMS/Food identified 29 results for total mercury were available for tilapia. The data were recorded in GEMS/Food as being of imported or unknown provenance.

Table 25: Summary of occurrence data on total mercury in mg/kg in tilapia 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
Tilapia	*Oreochromis sp.*	Total	No	G09 (1) G10 (28)	29	11	0.01	0.01	0.03	0.05

119. The mean value for total mercury for tilapia fell far below 0.3 mg/kg indicating that the average methylmercury concentration would not exceed the selection criterion. As a result, there is confidence no ML is necessary.

APPENDIX IV

DISCUSSION PAPER ON ESTABLISHING A SAMPLING PLAN FOR METHYLMERCURY IN FISH.

1. The conclusions of CCCF11 (2017) in terms of progressing MLs for methylmercury in fish identified that MLs should be accompanied by sampling plans (REP17/CF, paragraph 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. The 39th Session of the Codex Committee on Methods of Analysis and Sampling (CCMAS39, 2018) was unable to respond to the questions raised in relation to the sampling plan as the questions were outside the remit of CCMAS (REP19/CF, paragraphs 124-126, CX/CF 19/13/2). CCMAS endorsed the performance criteria for methods of analysis for methylmercury when amended to meet formatting requirements. However, CCMAS 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 (2019) 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 CXS 193 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. The Committee 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.

Sample plan question 1: Can methylmercury vary widely between individual fish sampled at the same time?

6. A number of studies have identified that the mercury concentration in freshly caught fish is positively correlated with the fish length (McKinney et al., 2016, Nilsen et al., 2016; Polak-Juszczak, 2017; Vega-Sánchez et al., 2017; Bergés-Tiznado et al., 2019; Houssard et al., 2019). Houssard and colleagues (2019) calculated that total mercury in albacore, bigeye and yellowfin tuna had a log power relationship with fish length. While other properties such as environmental factors may influence methylmercury concentration broadly across a species' geographical distribution (Nilsen et al., 2016; Azad et al., 2019; Houssard et al., 2019), the impact of this on a traded lot of fish is unlikely if the lot was sourced from catch taken in a single fishery region.

7. In a study of sharks (n=339) in the Indian Ocean a principal component analysis of factors influencing the total mercury concentration identified the size (fork length) and habitat/trophic level of an individual species explained the majority of the variance(Le Bourg et al., 2019). The longitude from where oceanic pelagic species were caught in the Indian Ocean showed no relationship to total mercury concentration (Le Bourg et al., 2019).

8. As a result, the variation in methylmercury in fish sampled at the same time and from a single fishery region is likely to be contingent on the variation of fish sizes in the lot. Schooling behaviour for specific species means that fish of a similar size and age will inhabit specific ocean depths, for example the FAO has compiled a number of studies that indicate as alfonsino age and grow in size as they move into deeper waters (FAO, 2016). Consequently, fishing vessels targeting alfonsino at specific depths could expect to have a haul of similar sized fish, although this may not be universal for all fish species and for the various fishing methods. Finally, a lot may also combine the catches from multiple vessels and thus different length/weight classes of a species.

9. Grading whole fish (defined as fish as captured, ungutted; FAO and WHO. 2020) is an identified initial step in fish perpetration in the Code of Practice for Fish and Fishery Products (FAO and WHO. 2020), although this may not necessarily equate to sorting fish by length or weight. Subsequently, fish may undergo preparation, in a fresh, chilled, or frozen state, on vessel or once landed through a variety of stages, at its basic this may be:

   a. Gutting

   b. Dressing (Heading and gutting; FAO and WHO. 2020)

   c. Fillets, skin on

   d. Fillets, skin off

10. The FAO report on alfonsino identified current practice was commonly to dress fish through removal of the head and pectoral fin and gutting, particularly in larger sizes (FAO, 2016). Examples are provided indicting alfonsino are graded in some producing countries.

11. For fisheries resource management reasons for many species there are often published conversion factors for fork length to fish weight, and for fresh(round) weight to dressed weight or fillet weight (FAO, 2016; ICCAT, 2020; Kopf et al., 2005; Prager et al., 1995).

12. Fish that are graded by length or weight prior to export as whole or further processed fish, would be expected to show smaller variations in methylmercury. Where grading does not occur further processed fishery products that are drawn from a broad range of fish sizes and catches from different regions may have larger variation in the methylmercury concentration in the lot. Where such products are sold by portions it may not be possible to address methylmercury variation through sampling of different weight or length classes given this information is unlikely to be available.

13. Two sampling plans were identified that address the potential for size variation in whole fish across a lot.

14. The impact of size variation amongst a lot of swordfish sampled for heavy metals (including mercury) in the United States is addressed though separation of dressed, head removed whole fish into three weight classes (<36.4 kg; 36.4-54.5 kg; >54.5 kg). 12 subsamples are then proportionally allocated from the number of fish in each weight class in the lot to make up the representative sample (US FDA, 2021). The same approach is required for swordfish loins (slabs or sides cut from dressed whole fish which has been boned or trimmed) sized by classes 9.1-18.2kg; 18.2-36.4 kg; 36.4 kg. Swordfish steaks and canned swordfish are sampled at random across the lot.

15. Size variation in sampling for whole fish for dioxins and dioxin-like-PCBs (polychlorinated biphenyl) and non-dioxin-like PCBs in Europe is addressed in Commission Regulation (EU) 2017/644. Fish are considered of comparable size and weight where either parameter does not vary more than 50% across the lot, with the accompanying guidance suggesting the percentage variation be estimated from the lower bound of the range. Where fish size varies more than this but 80% or more of the fish in lot are within the same size or weight class then this weight class is considered representative and thus the incremental samples are taken only from fish in this class. Where there is no predominant weight or size class then the lot is separated into either two weight or size classes, where overall variation across the lot in weight/size is 50-100%; or three weight or size classes, where overall variation in weight/size is >100%. Separate aggregate samples are composited from incremental sampling of each weight or size class. The guidance also refers to sequential analysis of the aggregate samples from the largest size class first before descending to smaller size classes to establish conformity of the whole or parts of the lot. Should a size class be compliant with the ML then smaller size classes are also considered compliant.

16. Considering that lots/sub-lots of whole fish or dressed fish may show considerable length/weight variation and consequently variation in methylmercury across the lot, an approach that accounts for this variation at sampling is favoured. The EU sampling regulation targets sampling to a length or weight class that is either representative of the lot/sub-lot, or in the case of notable variation to separate the lot to provide representative samples of each weight/size range. Adopting this would ensure sampling for ML compliance is either representative of the lot/sub-lot, or of each weight/length class.

17. Such an approach also allows for reconditioning a lot/sub-lot to remove the non-compliant weight/length classes in the event the methylmercury concentration exceeds the ML.

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Sample plan question 2: Should the whole fish should be analysed or only specific fractions of edible portions?

18. Commercially traded lots of whole fish may involve individual fish of considerable size. For example pink cusk-eel caught in the New Zealand survey recorded a number of individuals greater than 10 kg in weight (Figure 1). The fish groupings with MLs for methylmercury include marlin, tuna and shark both of which contain individual species commonly weighing greater than 100 kg. Alfonsino are the smallest of the species with MLs, typically ranging up to 70 cm in length and up to 4 kg (FAO, 2016).

19. Homogenisation of a whole fish to obtain a sample representative of the methylmercury concentration for any of the species/groupings with MLs would be expected to be a significant undertaking for a laboratory, and could result in significant wastage over that required for testing needs. As a result, the question has been raised over whether a fraction of the edible portion could be representative of the methylmercury concentration in the whole fish.

20. A further subset of this question relates to high value fish species for which carcass integrity is important for retail. A representative sample for these species from the centre of the carcass may cause considerable economic loss. There is also value therefore in establishing whether an alternative fraction could be sampled and still be representative of the whole fish methylmercury concentration.

21. A request for information was issued for any studies identifying any distribution of total or methylmercury in muscle sampled from different areas from fish. Three studies considering distribution of mercury concentrations in tuna were identified.

22. Ando and colleagues (2008) reported the statistical analysis of total mercury results for seven different portions of farmed bluefin tuna (dorsal front, middle and rear; ventral front, middle and rear, and tail). Of the averages for the different portions across nine individual fish, the largest difference occurred between the ventral front (0.49 mg/kg) and dorsal front (0.72 mg/kg). The other five tissue portions, fell within these ranges (0.58-0.67 mg/kg) and were not significantly different from each other. Analysis of the tail portion for total mercury across 98 farmed bluefin tuna identified no correlation between the body weight of the fish and the total mercury concentration in either ordinary or dark muscle, although for both male and female fish the concentrations in each muscle type were significantly different. There were no significant differences in the total mercury concentrations between different sexes. As farmed fish the variation between tissues may be less pronounced than might be expected for wild caught fish with more variable dietary sources of methylmercury.

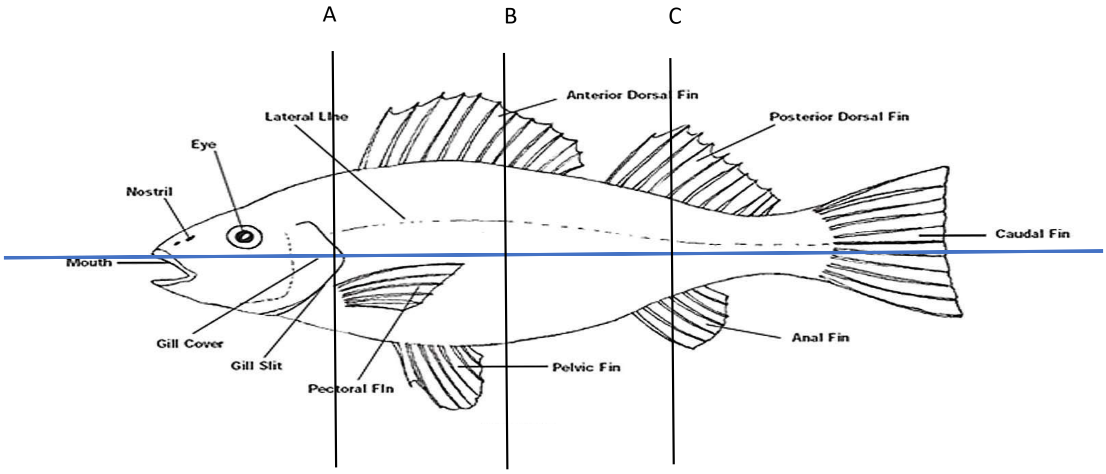
23. A similar analysis of different portions of tuna was reported by Japan's Ministry of Agriculture, Forestry and Fisheries. This used the same sampled portions as Ando and colleagues (2008), with the exception that the tail value was not reported. The mean values across nine individual fish identified little variation between the portions (range: total mercury 0.6-0.75 mg/kg methylmercury 0.52-0.65 mg/kg). For both total mercury and methylmercury the middle portions had marginally higher concentrations than the front or rear (MAFF, 2007; 2008; 2009)

24. A further survey considered the variation in total mercury content between the different tissue cuts of bluefin tuna (akami, chu-toro and o-toro; Balshaw et al., 2008). Composite samples of the different tissue cuts taken from each of the six dorsal and ventral portions in the tuna as per the previous studies, with the exception of o-toro that is only present in ventral front and middle. Akami had consistently higher total mercury (0.36 mg/kg), followed by chu-toro (0.28 mg/kg) and o-toro (0.23 mg/kg). Analysis identified a negative correlation of total mercury with the lipid content of the tissue, with a linear regression fit of -0.00476 mercury (mg/kg)/% lipid). It was proposed that sub-samples of chu-toro would most accurately represent the mercury and lipid content of the fish white muscle.

25. Published studies report tissues variation for total mercury and methylmercury in a range of other fish species. Although these are not species for which MLs are currently established the results for these species are reported below as they provide contextual information on lateral tissue distribution of methylmercury.

26. The lateral variation of total mercury and methylmercury concentrations was investigated in the results from New Zealand surveys of orange roughy, smooth oreo and pink cusk-eel (Cressey et al., 2020). A small proportion of fish weighing greater than 1 kg were sampled separately at three locations to allow comparison of the methylmercury and total mercury concentrations (Table 1, 2 and 3; Figure 1).

Figure 1. Sampling locations and instructions for determination of lateral variation of total and methylmercury in orange roughy, smooth oreo and pink cusk-eel



Measuring from the mouth to the start of the caudal fin (tail), divide fish lengthwise into four equal parts as depicted by the solid lines A, B and C. Cut ~2 cm either side of the lines A, B and C to obtain sufficient tissue for the analytical method.

Table 1: Analysis of total mercury and methylmercury concentrations in different lateral sampling sites of pink cusk-eel (Genypterus blacodes)

Sample	Fish length (cm)	Total mercury (mg/kg) at sample site				Methylmercury (mg/kg) at sample site			
		A	B	C	Mean	A	B	C	Mean
1	100	0.88	0.84	0.65	0.79	0.83	0.73	0.53	0.70
2	113	1.00	0.97	0.94	0.97	0.85	0.83	0.71	0.80
3	104	0.33	0.31	0.31	0.32	0.25	0.28	0.25	0.26
4	115	1.20	1.00	0.93	1.04	0.97	0.85	0.7	0.84
5	115	0.71	0.65	0.61	0.66	0.58	0.54	0.47	0.53
6	114	0.84	0.76	0.66	0.75	0.67	0.67	0.58	0.64
7	128	1.80	1.60	1.30	1.57	1.60	1.40	1.10	1.37
Mean	112	0.97	0.88	0.77	0.87	0.82	0.76	0.62	0.73

Table 2: Analysis of total mercury and methylmercury concentrations in different lateral sampling sites of orange roughy (Hoplostethus atlanticus)

Sample	Fish length (cm)	Total mercury (mg/kg) at sample site				Methylmercury (mg/kg) at sample site			
		A	B	C	Mean	A	B	C	Mean
1	41	0.65	0.72	0.61	0.66	0.53	0.69	0.51	0.58
2	38	0.46	0.42	0.47	0.45	0.36	0.32	0.37	0.35
3	40	0.59	0.57	0.49	0.55	0.52	0.54	0.39	0.48
4	37	0.56	0.52	0.51	0.53	0.41	0.35	0.47	0.41
Mean	39	0.57	0.56	0.52	0.55	0.46	0.48	0.44	0.46

Table 3: Analysis of total mercury and methylmercury concentrations in different lateral sampling sites of smooth oreo (Pseudocyttus maculatus)

Sample	Fish length (cm)	Total mercury (mg/kg) at sample site				Methylmercury (mg/kg) at sample site			
		A	B	C	Mean	A	B	C	Mean
1	38	0.19	0.16	0.21	0.19	0.14	0.15	0.17	0.15
2	48	0.26	0.21	0.28	0.25	0.25	0.17	0.25	0.22
Mean	43	0.23	0.19	0.25	0.22	0.20	0.16	0.21	0.19

27. The relative ratio of the total mercury to methylmercury result for each sampling region to the average whole fish total mercury to methylmercury result was calculated for the three species (Table 4).

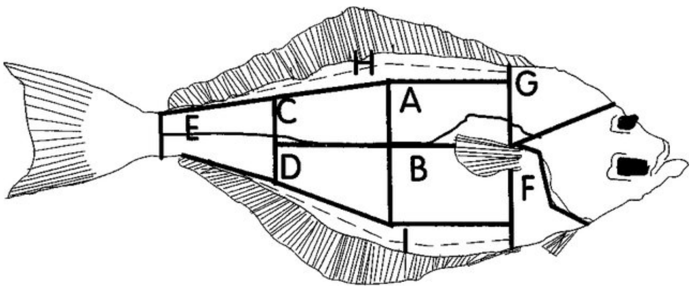
28. Results for both pink cusk-eel and orange roughy indicate that a sample taken from the lateral centre of the fish is the closest to the average concentration of the whole fish total mercury or methylmercury value. For smooth oreo a sample taken near the gill cut was closest to the concentration of the whole fish total mercury or methylmercury value. However, the variation in total or methylmercury between the sampling sites was generally less than 10% that of the average whole fish total mercury or methylmercury for each of the three species.

Table 4: Ratios of total mercury and methylmercury concentrations in different lateral sampling sites of orange roughy and pink cusk-eel to whole fish concentrations

Species	Ratio of average total mercury at sample site to whole fish total mercury			Ratio of average methylmercury at sample site to whole fish methylmercury		
	A	B	C	A	B	C
Pink cusk-eel	1.12	1.01	0.89	1.12	1.04	0.85
Orange roughy	1.04	1.02	0.95	1.00	1.04	0.96
Smooth oreo	1.05	0.86	1.14	1.05	0.84	1.11

29. For Atlantic halibut (*Hippoglossus hippoglossus*) it was reported that the b-cut (Figure 2) was taken for mercury analysis due its lower lipid content (Nilsen et al., 2016).

Figure 2: Different cuts from Atlantic halibut (Reproduced from Nortvedt and Tuene, 1998*)*



30. For freshwater fish a relatively uniform distribution of mercury within fish muscle was observed by Cizdziel et al. (2002) They investigated total mercury levels at 27 different locations of the skeletal muscle for six fish species from a lake in the United States, including trout, stripped and largemouth bass, tilapia, catfish and bluegill. and found no significant difference in mercury levels among of sample sites ($p > 0.05$).

31. A study of total mercury in freshwater Amazonian fish (pacu, jaraqui, curimatã and sardinha) reported different profiles of tissue distribution across the sample sites of dorsal (head, middle and tail) and belly (head, middle and tail) (Soares et al., 2018). Pacu reported a significantly lower level of total mercury in the front and middle belly, while in comparison there was no significant difference in the tissue distribution of total mercury in sardinha.

32. Distribution of total mercury along the fish muscle tissue of four catfish species (*Pimelodus maculatus, Rhinelepis aspera, Pterygoplichthys pardalis* and *Hypostomus* sp.) was reported by. Andrade et al. (2015). Only in Pimelodus maculatus did total mercury level vary notably along dorsal and lateral area. Higher values were observed in dorsal part near tail and in lateral area in the middle and near the head.

Concluding points

33. For bluefin tuna there was little variation between different sections of farmed fish, although between different muscle tissues that have varying lipid contents there was notable variation. There are limited data for other species so it is not possible to confirm that this would be the case for marlin, alfonsino and shark.

34. A difficulty in establishing the sampling plan is that the datasets from which species MLs have been established will not be standardised in terms of sampling location, with this differing based on national sampling protocol. Consequently, the datasets from which MLs have been derived likely encompass the different forms of sampling in the variation in methylmercury concentrations. The role of the sampling location thus will be difficult to anticipate.

35. The sampling requirement for whole swordfish in the United States targets a 500 g edible steak sample from the nape of the neck, advising to take care avoid mutilation of the carcass (US FDA, 2021).

36. The sampling requirements in Commission Regulation (EU) 2017/644 advise to stratify sampling location based upon the size of the fish:

   a. For fish sizes below 1 kg the whole fish is taken, unless this causes the aggregate sample to be too large (>3 kg) in which case the middle part is used.

   b. For fish of around 1 kg the middle part of the fish is taken for the incremental sample (of at least 100 g).

   c. For fish of 1-6 kg the incremental sample is taken from a midline strip form backbone to belly.

   d. For fish > 6kg the sample is taken from the right side dorso-lateral muscle meat in the middle of the fish, except if this will result in significant damage whereby the aggregate sample can be made up of three incremental samples of 350 g taken equally from the muscle close to the head, and close to the tail.

37. As the data available indicates, in general, limited variation across different tissues, and with the uncertainty in understanding how sampling locations have been represented in the ML setting datasets it may be advisable to balance the need for a representative sampling approach with limiting any damage to the carcasses of higher value larger fish. An approach that stratifies the sampling location based on fish weight and value (which can be standardised from the FAO reported US$/kg for each species; FAO, 2020) ensures that sampling is targeted to those tissues most representative of the whole fish except for (the typically largest) species where this would cause significant loss of value to the whole carcass.

38. A brief review of the commercial catch weight of species for which MLs are set identifies stratification in the weight classes of 1-10 kg (alfonsino, small tuna species and dogfish) and >10 kg (marlin, large tuna species, large shark species) could be a useful approach to target the sampling and could limit wastage of larger fish if the sampling leads to damage of the carcass making it unmarketable. Further examination of commercial catch weights could be beneficial to ensure this separation of weight classes adequately captures the species with MLs.

39. The value for the species with MLs based on the 2016-2018 FAO average export value ranges up to 14 US$/kg for bluefin tuna (FAO, 2020).

40. A sampling scheme separating both weight and value classes into three categories (<1kg; 1-10 kg; >10kg and <5US$/kg; 5-10US$/kg; >10 US$/kg) could provide a simple graduated approach to balancing the intent to derive a representative sample against limiting economic loss from sampling damaging high value marketable cuts or carcasses. The sampling location would range from whole fish for small, low value fish, to the tail only for the highest value and largest fish.

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Proposed Sampling Plan

41. In the consideration of the two questions considered by the EWG although species-specific parameters are not favoured, capturing methylmercury variation in size ranges across a lot, and reducing unnecessary damage of large and high value fish tissue in the sampling could be addressed with an approach to derive provisions for different weight/values classes in the sampling plan.

42. To outline how the provisions could fit in a sampling plan a proposed draft format has been outlined. 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 from the sample site.

43. There is the opportunity to refine the specific values in both approaches if, in general, they are viewed as an acceptable way to progress the sampling plan. This would include through review of typical commercial weights for species with MLs in either fresh/chilled or frozen form to ensure the separation of weight classes adequately captures the different species.

44. Refinement of the sampling plan could occur through consideration of the results of national sampling plans for tuna, shark, alfonsino, and marlin, including where possible, indication on how and where the material has been sampled and classification 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

PROPOSED SAMPLING PLAN FORMAT FOR METHYLMERCURY CONTAMINATION IN FISH

GENERAL CONSIDERATIONS

DEFINITION

Lot	An identifiable quantity of a food commodity delivered at one time and determined by the official to have common characteristics, such as origin, variety, type of packing, packer, consignor, or markings. A lot of whole fish should consist of one species and the length and/or weight should be comparable. In case the length and/or weight of the fish is not comparable, the consignment may still be considered as a lot but a specific sampling procedure has to be applied.
Sublot	Designated part of a larger lot in order to apply the sampling method on that designated part. Each sublot must be physically separate and identifiable.
Sampling plan	It is defined by a methylmercury test procedure and an accept/reject level. A methylmercury test procedure consists of three steps: sample selection, sample preparation and methylmercury quantification. The accept/reject level is a level usually equal to the Codex maximum level (ML). Countries or importers may decide to use their own screening when applying the ML for methylmercury in fish by analysing total mercury in fish.
Incremental sample	The quantity of material taken from a single random place in the lot or sublot.
Aggregate sample	The combined total of all the incremental samples that is taken from the lot or sublot. The aggregate sample has to be at least as large as the laboratory sample or samples combined.
Laboratory sample	The smallest quantity of fish muscle, or whole fish, comminuted in a mill. The laboratory sample may be a portion of or the entire aggregate sample. If the aggregate sample is larger than the laboratory sample(s), the laboratory sample(s) should be removed in a random manner from the aggregate sample.
Test portion	A portion of the comminuted laboratory sample. The entire laboratory sample should be comminuted in a mill. A portion of the comminuted laboratory sample is randomly removed for the extraction of the mercury for chemical analysis

MATERIAL TO BE SAMPLED

1. Each lot or sublot which is to be examined must be sampled separately.

2. Fresh or frozen whole or dressed fish, and other non-bulk fishery products of lots greater than or equal to 15 MT should be subdivided in to sublots of 15-30 MT.

3. Lots of fishery products traded as bulk commodities of greater than 100 MT should be subdivided into sublots in accordance with Table 1 to be sampled separately.

Table 1. Subdivision of sublots according to bulk consignment lot weight

Commodity	Lot weight (MT)	Weight or number of sublots
Fishery products (traded as bulk consignments)	≥ 1500	500 Mt
	>300 and <1500	3 sublots (minimum 100 t)
	≥ 100 and ≤300	100 t
	<100	-

4. Taking into account that the weight of the lot is not always an exact multiple of the weight of the sublots, the weight of the sublot may exceed the mentioned weight by a maximum of 20%.

INCREMENTAL SAMPLE

5. The minimum number of incremental samples taken from the lot or sublot is dependent on the size of the lot or sublot as specified in Table 2:

6. The suggested minimum weight of the incremental sample should be an approximate division of the minimum aggregate sample based on the number of incremental samples taken from the lot/sub-lot as specified in Table 2 (100-333g). Incremental samples taken from a lot or sublot should be of comparable weight.

Table 2. Number of incremental samples to be taken depending on the weight of the lot/sublot

Lot/sublot weight (MT)	Number of incremental samples	Minimum aggregate sample weight (kg)
≤ 0.05	3	1
>0.05 - ≤0.5	5	1
>0.5	10	1

7. Whole fish are considered to be of comparable length and weight class where the differences in size and weight do not exceed about 50%.

8. For lots where fish are not of comparable length and/or weight the following approaches are to be applied to taking the incremental samples:

   a. Where a length or weight class/category is predominant (80% or more of the fish lot or sublot are within the same length and weight class), the aggregate sample is combined only from incremental samples of fish within the predominant category and outliers are excluded. This aggregate sample is to be considered as being representative for the whole lot/sublot.

   b. Where there is no predominant weight or size class and where the overall length and/or weight of the fish present in the lot or sublot varies by more than 50% but less than 100%, the lot or sublot is separated into two length or weight classes and separate aggregate samples are composited from incremental samples taken independently from each length or weight class.

   c. Where there is no predominant weight or size class and where the overall length and/or weight of the fishes present in the lot differ more than 100%, the lot or sublot is separated into three length or weight classes and separate aggregate samples are composited from incremental samples taken independently from each length or weight class.

9. For lots or sublots of whole fish the part of the fish where the incremental sample is taken is informed by the weight and the value of the whole fish as specified in Table 3.

Table 3. Tissue area the incremental sample is taken from for whole fish based on weight and value classes

Weight grade	Value	Sampled part
<1 kg	All values	Whole fish (after removing the digestive tract). For lots of 0.05MT or greater where the aggregate sample would exceed 3 kg the midline (halfway between the gill opening and the anus) strip from backbone to belly should be sampled
1-10 kg	<10 USD/kg	Midline (halfway between the gill opening and the anus) strip from backbone to belly
1-10 kg	>10 USD/kg	Equal composite of muscle from behind the head and close to the tail
>10 kg	<5 USD/kg	Midline dorso-lateral muscle
>10 kg	5-10 USD/kg	Equal composite of muscle from behind the head and close to the tail
>10 kg	>10 USD/kg	Muscle from close to the tail

PACKAGING AND TRANSPORTATION OF SAMPLES

10. Each laboratory sample should be placed in a clean, inert container offering adequate protection from contamination, loss of analytes by adsorption to the internal wall of the container and against damage in transit. All necessary precautions, for example temperature control and storage in airtight containers, should be taken to avoid any change in composition of the sample which might arise during transportation or storage (for example avoiding excess heat or the sample drying out).

11. Each laboratory sample taken for official use shall be sealed at the place of sampling and identified. A record must be kept of each sampling, permitting each lot, or sublot, to be clearly identified and giving the date and place the sampling occurred, together with any additional information likely to be of assistance to the analyst.

SAMPLE PREPARATION

PRECAUTIONS

12. In the course of sampling, precautions, such as correct-sampling technique and limitation of cross contamination, should be taken to avoid any changes which would affect the levels of methylmercury, adversely affect the analytical determination, or make the aggregate samples unrepresentative.

13. Wherever possible, apparatus and equipment coming into contact with the sample should not contain mercury and be made of inert materials, e.g. plastics such as polypropylene, polytetrafluoroethylene (PTFE) etc. These should be acid cleaned to minimise the risk of contamination. High quality stainless steel may be used for cutting edges.

HOMOGENIZATION – GRINDING

14. The complete aggregate sample should be finely ground (where relevant) and thoroughly mixed using a process that has been demonstrated to achieve complete homogenization. Depending on the equipment available frozen samples may need to be thawed prior to homogenisation.

TEST PORTION

15. Procedures for selecting the test portion from the comminuted laboratory sample should be a random process. Following homogenization, the test portion can be selected from any location throughout the comminuted laboratory sample.

16. It is suggested that three test portions be selected from each comminuted laboratory sample. The three test portions will be used for enforcement, appeal, and confirmation if needed.

ANALYTICAL METHODS

17. A criteria-based approach, whereby a set of performance criteria is established with which the analytical method used should comply, is appropriate. The performance criteria-based approach has the advantage that, by avoiding setting down specific details of the method used, developments in methodology can be exploited without having to reconsider or modify the specific method.

18. Refer to the Procedural Manual of the Codex Alimentarius Commission for principles for the establishment of methods of analysis.

19. Possible performance criteria are detailed for the species of fish in Annex 1. Utilizing this approach, laboratories would be free to use the analytical method most appropriate for their facilities.

20. Countries or importers may decide to use their own screening when applying the ML for methylmercury in fish by analysing total mercury in fish. If the total mercury concentration is below or equal to the ML for methylmercury, no further testing is required and the sample is determined to be compliant with the ML. If the total mercury concentration is above the ML for methylmercury, follow-up testing shall be conducted to determine if the methylmercury concentration is above the ML (REP18/CF).

RECONDITIONING LOTS/SUB-LOTS

21. A lot or sub-lot where fish are not of comparable length and/or weight that is separated in to 2-3 length/weight classes should be analysed sequentially from the largest class first.

22. A lot or sub-lot where fish are not of comparable length and/or weight and the aggregate sample is taken from the highest length/weight class can be considered in compliance if the methylmercury concentration is below the ML.

23. Where the methylmercury concentration in the aggregate sample taken from a length/weight class is above the ML then the next largest length/weight class should be analysed. If the methylmercury concentration in this sample is below the ML the lot or sub-lot can be reconditioned to remove length/weight classes that exceed the ML to ensure the remaining fish are in compliance.

24. For a lot or sub-lot separated into three length or weight classes paragraph 23 should be repeated for the smallest length/weight classes if the methylmercury concentration in the aggregate sample taken from the middle length/weight class is also above the ML.

ANNEX I: Possible method criteria for methods of analysis of methylmercury for species with MLs.

Species	ML (mg/kg)	Min Appl. Range (mg/kg)	LOD (mg/kg)	LOQ (mg/kg)	Precision (%) Not more than	Recovery (%)	Examples of applicable methods that meet the criteria	Principle
Alfonsino	1.5	0.82 - 2.2	0.15	0.30	30	80-110	AOAC 988.11 EN 16801	GC-EC GC-ICP/MS
Marlin (all species)	1.7	0.95 – 2.5	0.17	0.34	30	80-110	AOAC 988.11 EN 16801	GC-EC GC-ICP/MS
Shark (all species)	1.6	0.88 - 2.3	0.16	0.32	30	80-110	AOAC 988.11 EN 16801	GC-EC GC-ICP/MS
Tuna (all species)	1.2	0.64 – 1.8	0.12	0.24	31	80-110	AOAC 988.11 EN 16801	GC-EC GC-ICP/MS

APPENDIX V

LIST OF PARTICIPANTS

Chair
Andrew Pearson
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