CODEX ALIMENTARIUS COMMISSION

Food and Agriculture Organization of the United Nations

World Health Organization

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JOINT FAO/WHO FOOD STANDARDS PROGRAMME

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DISCUSSION PAPER ON THE ESTABLISHMENT OF MAXIMUM LEVELS FOR METHYLMERCURY IN ADDITIONAL FISH SPECIES

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

BACKGROUND

1. The full history of the discussion on methylmercury dating back to 1992 is contained in Information document CF/11 INF/1. A summary of the background leading up to the current discussion paper is given below.
2. The 11th Session of CCCF (CCCF11) (2017) agreed to the concept of establishing maximum levels (MLs) for methylmercury in fish species based on the ALARA principle (As Low As Reasonably Achievable), in line with the criteria for establishing MLs in the General Standard for Contaminants and Toxins in Food and Feed (GSCTFF) (CXS 193-1995).[1] CCCF 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[2] presented to CCCF11 by the previous EWG, other species were identified where further data collection was advised to establish if MLs were needed. Additionally, a recommendation[3] was 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.
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[4] species (1.2 mg/kg), alfonsino[5] (1.5 mg/kg), marlin[6] (1.7 mg/kg) and shark[7] (1.6 mg/kg). No consensus was achieved for an ML for swordfish[8] and it was agreed to discontinue work on an ML. Based on the new dataset used by the EWG it was established that mean and median concentrations of total and methylmercury in amberjack all fell below 0.3 mg/kg, the agreed selection criteria for selecting fish species for setting MLs, and therefore it was agreed to discontinue work on the ML for amberjack[9].
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.[10]

[1] REP 17/CF, para. 126
[2] CX/CF 17/11/12
[3] CX/CF 17/11/12, para. 15
[4] REP 18/CF, para 75
[5] REP 18/CF, para 77
[6] REP 18/CF, para 77
[7] REP 18/CF, para 77
[8] REP 18/CF, para 83
[9] REP 18/CF, para 78
[10] REP 18/CF, para 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.

7. Noting the recommendation[11] 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.[12]

8. Following CCCF12, a EWG was established, the participants of which are listed in Appendix V.

9. The recommendations of the EWG for consideration by CCCF are described in paragraphs 20-22 and 24-25 below. A project document on proposals for new work based on these recommendations is provided in Appendix II.

10. The full discussion paper is provided in Appendix III. This details the work process followed as well as all the data and information considered by the EWG to arrive at the recommendations in paragraphs 20–22 and 24–25. It is presented for information to Codex members, observers and CCCF when considering the conclusions and recommendations and the proposal for new work.

Discussions and conclusion:

Data grouping

11. The EWG discussed the complex nature of whether data grouping should be on taxonomy or common names. Members noted the complexity of grouping along taxonomic or common name lines. Two members supported grouping species along taxonomic lines, while one member suggested grouping along common name lines with more contextual information added on taxonomy and potentially a picture. A further submission did not settle on either grouping but recommended a more detailed examination of species within a grouping to ensure this was appropriate. As there was no consensus, the discussion paper and proposed work programme were completed with grouping based along taxonomic lines, with the FAO taxonomic coding added to provide clear distinctions of species within groupings. A detailed consideration of the variation between species in a grouping could form part of the ML evaluation in the proposed future work programme. Consideration could be given to recommending FAO taxonomic coding for fish species be included in GEMS/Food data submissions so that species can be consistently and clearly identified and grouped correctly.

Prioritization criteria

12. The EWG were asked to consider the criteria for prioritisation of species for ML setting. One member suggested that the criteria should include consumption data. However, it was noted that weekly consumption amounts for fish to exceed the provisional tolerable weekly intake (PTWI) for methylmercury had already been factored into the 0.3 mg/kg selection criteria.[13] One member supported that species with smaller datasets should not be considered due to variation in methylmercury concentrations. One member agreed with n=50 being an appropriate sample number criteria. Another member provided comments regarding the statistics of the sample size, presenting a table of required sample sizes based on the targeted rejection rate, this being n=59 for a 5% rejection rate. Given the n=50 value approached the statistical analysis provided, it was determined that the current prioritisation criteria would be retained to identify the species for which MLs could be progressed. Detailed consideration of the sample numbers against the targeted rejection rate for individual species could form part of the proposed future work programme.

Mackerel

13. The EWG were asked to consider whether excluding mackerel from the review of future MLs was appropriate. One member noted that a recommendation made to CCCF12 concluded further methylmercury analysis was required for Spanish mackerel to confirm the average levels. One member supported a repeat analysis to consider any new data. However, as no additional methylmercury results for Spanish mackerel were present in GEMS/Food, the determination would not have differed from that considered at CCCF12. As a result, mackerel were excluded from the fish species categorised in the present discussion document.

[11] CX/CF 17/11/12
[12] REP 18/CF, para. 93
[13] CX/CF 17/11/12 para. 26

Species where no ML required

14. The EWG were asked to consider if there was value in maintaining a list of species where there is confidence that the levels of methylmercury are below the selection criteria. One member noted that it was the preferred approach to maintain only the list of species for which MLs are required. One member recommended that listing species with low mercury should be more of a national responsibility that takes into account differences in seafood consumption between regions.

Geographical distribution of results and importance of species in trade

15. One member noted that for many of the species there was limited geographic distribution. While another member noted that MLs should only be set based on importance of the species in trade. In response to these discussion points additional consideration of marine distribution of species, production volumes and reported catch by countries in specific GEMS cluster diets was included into the discussion paper. A future work program has been established considering how significant a catch the species of taxonomic grouping is as a criteria for prioritisation. More detailed breakdown of production quantities and geographical distribution of results could form part of the future work programme.

Use of total mercury results against methylmercury results in deriving potential MLs

16. Members noted that a recommendation from CF/CX 18/12/7 was that MLs for future species would need to take into account the ratio of total mercury and methylmercury as this can vary largely between species. Reflecting these discussions, the ML proposals and species for which further data collection was recommended were revised to account for the need for ratios of total mercury to methyl mercury.

Clarity on countries in GEMS regions

17. One member suggested a reference to the GEMS cluster groups to enable easier identification of contributing countries. A supplementary table to outline data sources was included as Appendix IV.

Summary table

18. One member recommended a summary table of all the analyses be considered. This was agreed with and a summary table of the analysis of all fish species is provided in Appendix I.

Recommendations:

19. CCCF is invited to consider the following matters in relation to methylmercury in fish:

20. A proposed work programme for derivation of MLs based on prioritised fish species/ taxonomic grouping is presented below for consideration by CCCF.

Grouping (identified species)	**Timeframe for ML derivation**
Snake mackerel (Escolar) Toothfish (Patagonian toothfish) Ling (Cusk, Blue ling) Cusk-eel (Pink Cusk-eel, Kingklip) Sablefish	2019-2020
Anglerfish Barracuda Catfish (Channel catfish) Orange roughy Cutlassfish (Scabbardfish) Snapper (Russell's snapper, unspecified)	2020-2021
Cardinalfish Hapuku Short nosed chimera (Rat fish)	2021-2022

21. Consideration of MLs for the identified species is contingent on submission of further data on total mercury and methylmercury concentrations into GEMS/Food. Noting that the data collection could require considerable time to plan and undertake for members, the work programme could be postponed for a period if new data is not available to be submitted in 2019.

22. A new work proposal document is presented in Appendix II to support this programme of work.

Additional recommendations:

23. CCCF is invited to consider the following additional matters in relation to methylmercury in fish.

24. Although not within the proposed work programme in paragraph 20, the following species are recommended to be targeted for further data collection and potential inclusion at a later stage.

Grouping (identified species)	**Notes on data collection**
Sea bass	Data collection needs to identify specific species. Methylmercury data required
Spanish mackerel	Methylmercury data required
Phycid hake (white hake)	Methylmercury data required
Pike	Data collection needs broader geographic distribution Methylmercury data required.
Sturgeon	Data collection needs broader geographic distribution Methylmercury data required
Grouper	Data collection needs broader geographic distribution Methylmercury data required

25. For future data submission into WHO GEMS/Food, CCCF is invited to consider requesting binominal fish species or FAO taxonomic coding as an entry field to improve the consistency of data grouping.

Summary Table of Recommendations

26. In considering the recommendations in paragraphs 20–22 and 24-25, CCCF is invited to consider the summary table of recommendations in Appendix I.

APPENDIX I

SUMMARY TABLE OF RECOMMENDATIONS
(FOR CONSIDERATION BY CCCF)

Common name	Scientific name	Taxonomic grouping	FAO taxonomic code	Mean methylmercury [total mercury] concentration (mg/kg)	Recommendation
Anchovies	*Engraulidae sp.*	Family	1,21(06)xxx,xx	0.05 [0.07]	No ML required
Anglerfish	*Lophius sp.*	Genus	1,95(01)001,xx	0.62 [0.15]	Proposed work programme 2020-2021 Prioritised data collection- low sample numbers and wide disparity between methylmercury and total mercury
Barracuda	*Sphyraena sp.*	Genus	1,77(10)001,xx	[0.69]	Proposed work programme 2020-2021 Prioritised data collection – low sample numbers and no methylmercury results
Blue moki	*Latridopsis ciliaris*	Species	1,70(71)309,01	[0.12]	No ML required
Butterfish	*Odax pullus*	Species	1,70(64)003,01	[0.02]	No ML required
Cardinalfish	*Epigonus telescopus*	Species	1,70(96)373,01	[1.27]	Proposed work programme 2021-2022 Prioritised data collection– no methylmercury results
Carp	*Cyprinidae*	Family	1,40(02)xxx,xx	0.03 [0.13]	No ML required
Catfish	*Siluriformes sp.*	Order	1,41(xx)xxx,xx	[0.41]	Proposed work programme 2020-2021 Prioritised data collection – wide disparity in means for species, low sample numbers and no methylmercury results
Codfish	*Gadinae sp.*	Sub-family	1,48(04)xxx,xx	0.05 [0.07]	No ML required
Cusk-eel	*Ophidiidae*	Family	1,58(02)xxx,xx	[0.38]	Proposed work programme 2019-2020 Prioritised data collection – no methylmercury results
Cutlassfish	*Trichiuridae sp.*	Family	1,75(06)xxx,xx	[0.16]	Proposed work programme 2020-2021 Prioritised data collection – wide disparity in means for species, low sample numbers and no methylmercury results
Eels	*Anguilliformes sp.*	Order	1,43(xx)xxx,xx	0.18 [0.19]	No ML required
Grouper	*Epinephelus sp.*	Genus	1,70(02)042,xx	[0.27]	No ML required Ongoing data collection – limited geographic distribution and average approaching the selection criteria
Hapuku	*Polyprion oxygeneios*	Species	1,70(05)058,02	[0.33]	Proposed work programme 2021-2022 Prioritised data collection – low sample numbers and no methylmercury results

Common name	**Scientific name**	**Taxonomic grouping**	**FAO taxonomic code**	**Mean methylmercury [total mercury] concentration (mg/kg)**	**Recommendation**
Herring	*Cupeidae sp.*	Family	1,21(05)xxx,xx	0.04 [0.04]	No ML required
Kahawai	*Arripis trutta*	Species	1,70(29)051,02	[0.24]	No ML required
Ling	*Lotidae sp.*	Sub-family	1,48(04)xxx,xx	[0.28]	Proposed work programme 2019-2020 Data collection for individual species – cusk and blue ling
Mahi-mahi	*Coryphaena hippurus*	Species	1,70(28)071,01	[0.23]	No ML required
Medusafish	*Centrolophidae sp.*	Family	1,76908)xxx,xx	[0.11]	No ML required
Merluccid hake	*Merlucciidae sp.*	Family	1,48(05)xxx,xx	0.20 [0.13]	No ML required
Mullet	*Muglidae sp*	Family	1,65(01)xxx,xx	0.02 [0.14]	No ML required
Orange Roughy	*Hoplostethus atlanticus*	Species	1,61(05)002,02	[0.52]	Proposed work programme 2020-2021 Prioritised data collection– low sample numbers and no methylmercury results
Pacific red gurnard	*Chelidonichthys kumu*	Species	1,78(02)003,01	[0.11]	No ML required
Perch	*Percidae sp.*	Family	1,70(14)xxx,xx	[0.20]	No ML required
Phycid hake	*Phycidae*	Sub-family	1,48(04)xxx,xx	[0.13]	No ML required Ongoing data collection for individual species – white hake
Pike	*Escoidae sp.*	Family	1,24(03)xxx,xx	[0.29]	No ML required Ongoing data collection – limited geographic distribution and average approaching the selection criteria
Pomfrets	*Brama sp.*	Genus	1,70(27)003,xx	[0.07]	No ML required
Porgies	*Sparidae sp.*	Family	1,70(39)xxx,xx	[0.17]	No ML required
Rays and skate	*Rajiformes sp.*	Order	1,10(xx)xxx,xx	[0.18]	No ML required
Red cod	*Pseudophycis bachus*	Species	1,48(02)014,01	[0.06]	No ML required
Redbait	*Emmelichthys nitidus*	Species	1,70(30)010,01	[0.15]	No ML required

Common name	Scientific name	Taxonomic grouping	FAO taxonomic code	Mean methylmercury [total mercury] concentration (mg/kg)	Recommendation
Right eyed flounder & sole	*Pleuronectidae sp./ Soleidae sp*	Family	1,83(02)xxx,xx and 1,83(03)xxx,xx	0.11 [0.21]	No ML required
Rockfish	*Sebastes sp.*	Genus	1,78(01)001,xx	[0.19]	No ML required
Sablefish	*Anoplopoma fimbria*	Species	1,78(08)004,01	[0.43]	Proposed work programme 2019-2020 Prioritised data collection– no methylmercury results
Salmonids	*Salmonidae sp.*	Family	1,23(01)xxx,xx	0.03 [0.04]	No ML required
Sea bass	*Unknown*	Unknown	Unknown	[0.21]	No ML required Ongoing data collection – species not clearly identifiable
Short nosed chimera	*Chimaeridae sp.*	Family	1,12(01)xxx,xx	[0.38]	Proposed work programme 2021-2022 Prioritised data collection – no methylmercury results
Snake mackerel	*Gempylidiae sp.*	Family	1,75(05)xxx,xx	[0.39]	Proposed work programme 2019-2020 Prioritised data collection– no methylmercury results
Snapper	*Lutjanus sp.*	Genus	1,70(32)xxx,xx	[0.30]	Proposed work programme 2020-2021 Prioritised data collection– low sample numbers and no methylmercury results
Sturgeon	*Acipenseridae sp.*	Family	1,17(01)xxx,xx	[0.08]	No ML required Ongoing data collection – limited geographic distribution and low sample numbers
Temperate bass	*Moronidae sp.*	Family	1,70(04)xxx,xx	0.04 [0.18]	No ML required
Toothfish	*Dissostichus sp.*	Genus	1,70(92)015,xx	[0.44]	Proposed work programme 2019-2020 Prioritised data collection– no methylmercury results
Turbot	*Psetta maxima*	Species	1,83(05)092,01	[0.08]	No ML required
Typical smelt	*Osmeridae sp.*	Family	1,23(04)xxx,xx	0.07 [0.06]	No ML required
Wolffish	*Anarhichas sp*	Genus	1,71(02)001,xx	0.12[0.10]	No ML required

Based on the recommendations above, CCCF is also invited to consider the proposal for new work as presented in Appendix II.

APPENDIX II

PROJECT DOCUMENT FOR NEW WORK ON MAXIMUM LEVELS FOR METHYLMERCURY IN ADDITIONAL FISH SPECIES

(FOR CONSIDERATION BY CCCF)

1. Purpose and Scope of the new work

This work aims to establish Maximum Levels (MLs) for methylmercury in additional fish species.

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 Codex Alimentarius Commission (CAC) that consideration should be given to establishment of MLs rather than GLs.[2] 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.[3] With the establishment of an agreed upon framework at CCCF12 to apply the ALARA principle ((As Low As Reasonably Achievable) 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 the Joint FAO/WHO Expert Committee on Food Additives (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 or taxonomic groupings of fish have been identified as having potential average levels of methylmercury sufficient to exceed the selection criteria of 0.3 mg/kg.

Snake mackerel (Escolar)
Cusk-eel (Pink Cusk-eel, Kingklip)
Sablefish
Anglerfish
Barracuda
Catfish (Channel catfish)
Orange roughy
Cutlassfish (Scabbardfish)
Snapper (Russell’s snapper, unspecified)
Cardinalfish
Hapuku
Short nosed chimera (Rat fish)
Ling (Cusk, Blue ling)
Toothfish (Patagonian toothfish)

A call for data for total mercury and methylmercury levels in fish would be needed to accurately identify exceedance of the selection criteria and establish an ML, based on the ALARA concentration, in the identified species.

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 or taxonomic groupings identified having potential average levels of methylmercury sufficient to exceed the selection criteria 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.

[1]:General Standard for Contaminants and Toxins in Food and Feed (GSCTFF) (CXS 193-1995)
[2] REP18/CF para 81
[3] CX/CF 17/11/12, para 15

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 ML(s) 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.

5. Relevance to Codex Strategic Goals

The proposed work falls under the following Codex Strategic Goals of the Codex Strategic Plan 2014- 2019:

Strategic goal 1: Establish international food standards that address current and emerging food issues

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 criteria of 0.3 mg/kg.

Strategic goal 2: Ensure the application of risk analysis principles in the development of Codex standards

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 5: Promoting maximum application of codex standards

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 GSCTFF.

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

Expert scientific advice has been already provided by 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.

Subject to the approval by CAC in 2019, a staged approach, dealing with few fish species or taxonomic groupings a year, for establishing the draft ML(s) for methylmercury is proposed.

Grouping (identified species)	Timeframe
Snake mackerel (Escolar) Toothfish (Patagonian toothfish) Ling (Cusk, Blue ling) Cusk-eel (Pink Cusk-eel, Kingklip) Sablefish	EWG:2019-2020 Step 5/8: CCCF14
Anglerfish Barracuda Catfish (Channel catfish) Orange roughy Cutlassfish (Scabbardfish) Snapper (Russell's snapper, unspecified)	EWG: 2020-2021 Step 5/8: CCCF15
Cardinalfish Hapuku Short nosed chimera (Rat fish)	EWG:2021-2022 Step 5/8: CCCF16

APPENDIX III

DISCUSSION PAPER ON THE ESTABLISHMENT OF MAXIMUM LEVELS FOR METHYLMERCURY IN ADDITIONAL FISH SPECIES (FOR INFORMATION TO CCCF)

Introduction

1. The current maximum levels for methylmercury in the General Standard for Contaminant and Toxins in Food and Feed (GCSTFF) 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 in 2010.
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.
3. For species with average methylmercury concentrations below this the benefits of fish consumption are expected to always outweigh the risks when the fish was consumed, even at up to seven servings of 100 grams per week. Using this screening concentration a recommendation that amberjack did not require an ML was agreed upon.
4. An As Low As Reasonably Achievable (ALARA) approach was used for deriving MLs, with the established limits set at the concentration value, reported to one significant figure, where the trade rejection rate was less than 5%.
5. With an agreed framework for selecting and deriving methylmercury MLs for fish species established, available data for mercury and methylmercury in fish in the GEMS/Food database was examined for further species that would meet the criteria for ML establishment.

Work Process

Selection criteria

6. A process to derive selection criteria for fish species of concern requiring MLs for methylmercury was reported in CX/CF 17/11/12.
7. The selection criteria was derived through consideration of weekly fish consumption amounts, in g/person per week, that would be required to reach the PTWI of 1.6 µg/kg bw/day (Table 1).

Table 1: Weekly fish consumption amounts required to reach PTWI of 1.6 µg/kg bw/day at various methylmercury concentrations (As presented in CX/CF 17/11/12)

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

8. Comparing the calculated fish consumption amounts to reach the PTWI to the global 95th percentile fresh, frozen and cured fish consumption rate of 285 g/person per week, and the fish consumption amounts in the individual WHO GEMS cluster diets, it was considered that a methylmercury concentration of greater than 0.3 mg/kg would be required to present a risk of exposures exceeding the PTWI. As a result, an average methylmercury concentration of 0.3 mg/kg was adapted as the selection criteria for identifying fish species that would present a potential need for an ML.
9. The selection criteria has been used in the present work to identify further species for which MLs could be established.

Deriving a priority scheme for ML development

10. Although a general selection criteria for identifying the species where methylmercury MLs could be derived has been established, in practice there are further details to be agreed before applying this to the species datasets in the GEMS/Food database. These consideration include:

- the number of samples required to be confident in a species being above, or below, the selection criteria,
- the use of species groupings at genus, family or order level, or alternatively for the common name applied in trade, and,
- the application of results to common names that are used generically for multiple species (for example, snapper).

11. Given the broad range of species for which MLs could be derived, a priority scheme was developed to identify species for which MLs could be progressed, those for which further data collection would be necessary to confirm an ALARA concentration or exceedance of the selection criteria and finally those species which the datasets are enable the conclusion that no ML is required.

Selection of fish species for prioritisation of ML setting.

12. In order to apply the selection criteria all data on total mercury and methylmercury in fish species from GEMS/Food was extracted, grouped where appropriate and analysed. The priority scheme, as stated in paragraph 11, was applied to derive recommendations on which species MLs could be considered, which species further data collection is beneficial and identifying species for which no further ML setting work is recommended.

Development of a priority scheme

13. A three year work plan was developed based on species/groups for which MLs could be established, taking into account the average annual capture production values and the confidence in the dataset demonstrating exceedance of the selection criteria.

14. To establish significance in trade the average annual capture production and aquaculture production values for each species for the years 2010-2016 were referenced from the FAO yearbook of Fishery and Aquaculture Statistics 2016[1]. Of the species with current MLs established for methylmercury, alfonsino has the lowest average annual production at 9000 tonnes[2]. As a result species that exceeded an average of 9000 tonnes, between the years 2010-2016, were considered to have the potential to be significant in trade. Any information as to whether species were caught in limited areas or by a low number of nations were also reported to provide context on how geographically representative the dataset for each species may be.

15. To ensure the dataset to establish exceedance of an ML was sufficiently robust, two requirements were used to identify species recommend to have MLs progressed. Either a minimum dataset of 100 samples[3], or between 50 and 100 samples when the value of the lower-bound of the standard deviation around the mean methylmercury or total mercury concentration exceeded the selection criteria, providing sufficient confidence that the majority of the consumed fish would exceed the selection criteria.

16. Datasets of less than 50 samples would need further data before ML consideration to ensure an ALARA concentration can be identified clearly to one decimal point. Where possible analysis would be undertaken on individual species and the relevant taxonomic grouping, as the latter would have greater sample numbers. An analysis was not conducted where sample numbers were less than 10 in a grouping.

17. For species or fish groups not meeting the dataset requirements, but for which there was indication the selection criteria value of 0.3 mg/kg could be exceeded, a recommendation for further data collection was made. This included cases where there were difficulties interpreting the dataset or with small sample numbers of a species in a grouping above the selection criteria.

18. Determination of a clear exceedance of the selection criteria was determined only from average methylmercury concentrations, or from total mercury if average ratios were comparable to total mercury.

19. The species proposed to be reviewed in the first year (2019-2020) were those for which there dataset gave confidence that the selection criteria was exceeded based on total mercury results and had average annual capture production values above 9000 tonnes.

20. The second year (2020-2021) was for species where the selection criteria appeared to be exceeded based on total mercury results and that had an average annual capture production values above 9000 tonnes, however supplementation with further results was required.

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[1] FAO. 2018. FAO yearbook. Fishery and Aquaculture Statistics 2016/FAO annuaire. Statistiques des pêches et de l'aquaculture 2016/FAO anuario. Estadísticas de pesca y acuicultura 2016. Rome/Roma. 104pp.

[2] 2010-2016 average for sum of species totals of alfonsino, splendid alfonsino and alfonsino not elsewhere identified was 8976 tonnes as recorded in FAO. 2018. http://www.fao.org/fishery/static/Yearbook/YB2016_USBcard/root/capture/b34.pdf (accessed online Jan 2019)

[3] A determination was able to be made previously on Spanish mackerel with 101 samples (CX/CF 18/12/7)

21. An optional third year review (2021-2022) could include species where the selection criteria was exceeded but had average annual capture production values below 9000 tonnes, if there was agreement that there would be benefit in proceeding with ML setting for these lower catch species.

22. For species and/or groupings where average total mercury and/or methylmercury values were below 0.3 mg/kg a conclusion was made that no ML would be required. Continuing data collection may still be beneficial for these species, in particular those with smaller sample numbers, however based on the analysis a risk to fish consumers is not expected.

Selection of fish species for prioritisation of ML setting.

23. The data analysis detailed in the discussion paper CX/CF 17/11/12 was used as a basis for the current derivation of the proposed draft MLs.

24. 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 2000-2018. This resulted in 42,911 records. In the results, EFSA FoodEx codes were replaced by the descriptions of the corresponding food categories. After this, categories that were not fish species[4], or were aggregated data, or were unspecific categories (e.g. Fish fillet), or were not for whole fish or muscle[5] were excluded. Data from before the year 2000 have been excluded as they would not be considered representative of current levels. Finally all data from tuna and bonito, alfonsino, kingfish/amberjack, sharks and selachoidae, marlin, mackerel[6], dogfish and swordfish were excluded as the MLs for these species were not being reconsidered. This left a total database of 23,309 records for mercury in fish, of which 1332 were for methylmercury.

25. Fish were categorized by species; where this was unclear based on the common name, the classification code was used to refine likely species based on freshwater, diadromous or marine coding. Katta (1 sample), Lakka (1 sample), Lasso (1 sample), Rani (1 sample) were unable to be assigned to a species. Additionally, mudfish (1 sample) was not specific enough a common name for any fish species or family and would need further information to interpret.

26. Where possible, fish species were grouped as a dataset according to genus, sub-family, family or order, using taxonomic code descriptors taken from the FAO's Aquatic Sciences and Fisheries Information System[7]. There were 59 records in the dataset extracted from GEMS/Food which could not be categorized as these data had less than 10 data points per grouping[8].

27. All results were converted to mg/kg and non-detects were treated as zeros.

28. For some fish species, many individual data points lacked information on LOD/LOQ (limit of detection/limit of quantification). In addition, discrepancies were noted in the entry of LOD/LOQ data, with potential transcription errors noted (such as values within the same survey being 10-fold different, or datasets being entered in µg/kg but LOD/LOQs being in mg/kg). The influence of the data points were evaluated by undertaking the analysis on the dataset with and without data with no stated LOD/LOQ.

29. 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.

30. Cooking is not expected to have a significant impact on the methylmercury level, as a result data points for cooked fish were analysed alongside fresh and frozen fish. This approach was taken to remain consistent with the data analysis approach used for species with MLs currently established in the GCSTFF.

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

[5] For example fish roe and fish livers.

[6] Although mackerel as a taxonomic grouping had previously been analysed as not requiring an ML for methylmercury, further analysis had been recommended on Spanish/king mackerel (CX/CF 18/12/7 para 21.1). However no additional data over that previously considered was available on methylmercury concentrations in this species, as a result mackerel were excluded.

[7] As recorded in FAO. 2018. FAO yearbook. Fishery and Aquaculture Statistics 2016/FAO annuaire. Statistiques des pêches et de l'aquaculture 2016/FAO anuario. Estadísticas de pesca y acuicultura 2016. Rome/Roma. 104pp.

[8] Species with too few data points (<10 samples): 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 sample).

31. The dataset was statistically analysed for each fish species, with mean, standard deviation, 95th percentile and maximum results calculated. The summary statistics were interpreted to provide recommendations as for which species/groups MLs could be set and those for which further data collection would be beneficial and finally identifying species/groups for which no further work is needed.

Results of ML Prioritisation

Species for which MLs could be recommended based on available data

32. Analysis identified no species of fish for which there was sufficient confidence that average methylmercury concentrations would exceed the 0.3 mg/kg selection criteria. While a number of species had total mercury concentrations exceeding 0.3mg/kg there was insufficient information on the ratio of methylmercury to total mercury for these species.

Species for which MLs could be set (2019-2020)

Antarctic toothfish (*Dissostichus mawsoni*), Patagonian toothfish (*Dissostichus eleginoides*), and all Toothfish (*Dissostichus sp.*)

33. Data for toothfish (Antarctic, Patagonian and unspecified) was extracted from GEMS/Food. Data points for Chilean sea bass were included in Patagonian toothfish as being the North American market term for Patagonian toothfish. The results are shown in Table 2. Only results for total mercury were considered as no methylmercury data was present for toothfish, all results had recorded LOD/LOQ values.

34. No other data points for species within the cod icefish family (*Nototheniidae;* taxonomic code: 1,70(92)) were identified in the GEMS/Food database, as a result it was only possible to group data to a genus level (*Dissostichus*; taxonomic code: 1,70(92)015).

Table 2: 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	No	G10 (31)	31	0	0.10	0.06	0.22	0.33
Toothfish (Patagonian)	*Dissostichus eleginoides*	Total	No	G10 (159)	159	0	0.52	0.40	1.10	2.52
Toothfish (unspecified)	*Dissostichus sp.*	Total	No	G10 (11)	11	0	0.34	0.28	0.82	0.82
Toothfish (All)	*Dissostichus sp.*	Total	No	G10 (201)	201	0	0.44	0.39	1.06	2.52

35. The average Patagonian toothfish production over 2010-2016 exceeded 9000 tonnes. The catch was distributed across all FAO southern hemisphere fishing regions by countries within several different WHO GEMS cluster diet groups (including G10).

36. Between the two toothfish species a clear difference can be seen in the average total mercury levels, with the level in the Antarctic species being below the selection criteria, and those of the Patagonian species above. As a grouped fish type, which includes any samples not specified between the two species, the average for all toothfish would be above the selection criteria. No data on methylmercury was available to confirm the ratios of methylmercury to total mercury. A cited study reported the average ratio of methylmercury to total mercury in the muscle of Antarctic toothfish was 40%.[9]

37. Further data collection for methylmercury occurrence in toothfish is recommended to confirm the ratios of methylmercury to total mercury and establish whether ML setting may be necessary. Data from other GEMS cluster diet regions could be of value to confirm the dataset as representative of geographical representation.

[9] Yoon, M., Jo, M.R., Kim, P.H., Choi, W.S., Kang, S.I., Choi, S.G., Lee, J.H., Lee, H.C., Son, K.T., Mok, J.S. 2018. Total and Methyl Mercury Concentrations in Antarctic Toothfish (Dissostichus mawsoni): Health Risk Assessment. Bull Environ Contam Toxicol.;100(6):748-753

Barracouta (*Thyrsites atun*), Escolar (*Lepidocybium flavobrunneum*), and all snake mackerel (*Gempylidiae sp.)*

38. Data for barracouta/snoek and for escolar were extracted from GEMS/Food (Table 3). As these two species are within the snake mackerel family (*Gempylidiae*; taxonomic code 1,75(05)) a grouping was undertaken. All data points were for total mercury and had the LOD/LOQ values recorded.

Table 3: 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	0.18	0.17	0.62	0.70
Escolar	*Lepidocybium flavobrunneum*	Total	No	G10 (62)	62	1	0.59	0.26	0.96	1.41
All snake mackerel	*Gempylidiae sp.*	Total	No	G10 (121)	121	1	0.39	0.30	0.92	1.41

39. The average barracouta production over 2010-2016 exceeded 9000 tonnes. The majority of the catch of barracouta was reported from a single FAO fishing region by a country in the WHO GEMS G10 cluster diet region. Oilfish, an additional species in the snake mackerel family, was also produced above an average of 9000 tonnes.

40. Between the two snake mackerel species a clear difference can be seen in the average total mercury levels, with the mean level in the barracouta being below the selection criteria, and those of escolar above. Although escolar had less than 100 samples in its dataset, when the standard deviation around the mean is subtracted from the mean total mercury concentration, the resulting concentration exceeds the selection criteria. As a grouped fish type, the average concentration of mercury for all snake mackerel would be above the selection criteria. No data on methylmercury was available to confirm the ratios of methylmercury to total mercury.

41. Further data collection for methylmercury occurrence in escolar and other snake mackerel is recommended to confirm the ratios of methylmercury to total mercury and establish whether ML setting may be necessary.

Cusk/tusk (*Brosme brosme*), common ling (*Molva molva*), blue ling (*Molva dypterygia*) and all ling (*Lotida*e)

42. Ling is a common name term applying to species within two different families, Common ling/ white ling and blue ling are within the ling sub-family (*Lotida*e) of codfish (Gadidae; taxonomic code 1,48(04)) which also contains cusk. New Zealand ling, also termed pink-cusk eel, is within the unrelated cusk-eel family and was considered separately below. Data for cusk and ling (blue, white and unspecified) were extracted from GEMS/Food (Table 4). Unspecified ling, based on the country of reporting, was assumed to refer to a *Lotidae* species.

43. Samples from an additional species, lingcod, were identified in the dataset; lingcod is a common name for the freshwater burbot (*Lota lota*), a species in the ling family, but also the unrelated lingcod (*Ophiodon elongates)*; based on the metadata lingcod was assigned to the latter and excluded from the current analysis. The extracted samples were grouped as ling family species. All data points were for total mercury and did not report any LOD/LOQ values.

44. The averages for production of cusk and common ling over 2010-2016 exceeded 9000 tonnes. The majority of the catch for cusk, common ling and blue ling originated from one FAO fishing region and for cusk and common ling largely by countries in the WHO GEMS G07 cluster diet, as a result the data is considered geographically representative.

Table 4: Summary of occurrence data on total mercury in mg/kg in ling family 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	*Brosme brosme*	Total	Yes	G07 (1449)	1449	0	0.33	0.32	0.97	2.70
Ling (blue)	*Molva dypterygia*	Total	Yes	G07 (50)	50	0	0.45	0.36	1.10	1.70
Ling (common)	*Molva molva*	Total	Yes	G07 (827)	827	0	0.19	0.14	0.48	1.10
Ling (unspecified)	*Molva (unspecified)*	Total	Yes	G07 (14)	14	0	0.26	0.27	0.49	0.53
All ling subfamily	Lotidae sp.	Total	Yes	G07 (2340)	2340	0	0.28	0.28	0.79	2.70

45. The average total mercury concentration for common ling was below the selection criteria. It can be concluded that no ML is required for this species. However, the average total mercury concentrations for cusk and blue ling were above the selection criteria of 0.3 mg/kg. Considered as a family grouping, the average total mercury concentration was below the selection criteria. No data on methylmercury was available to confirm the ratios of methylmercury to total mercury.

46. Further data collection for methylmercury occurrence in blue ling and cusk is recommended to confirm the ratios of methylmercury to total mercury and establish whether ML setting may be necessary.

Pink Cusk Eel/ New Zealand Ling (*Genypterus blacodes*), Kingklip (*Genypterus capensis*), and all Cusk-eels (*Ophidiidae sp.)*

47. Pink cusk-eel and kingklip are within the cusk-eel family *(Ophidiidae*; taxonomic code: 1,58(02)). Data for cusk-eel (unspecified), kingklip and New Zealand ling were extracted from GEMS/Food (Table 5). The extracted samples were grouped together as a cusk-eel family. All data points were for total mercury with LOD/LOQ values reported.

Table 5: Summary of occurrence data on total mercury in mg/kg in cusk-eel family 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)	*Ophidiidae 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 (114)	114	0	0.36	0.35	0.98	1.98
All cusk-eels	Ophidiiae sp.	Total	No	G10 (127)	127	0	0.38	0.34	0.99	1.98

48. The average production of pink cusk-eel over 2010-2016 exceeded 9000 tonnes. The majority of the catch for pink cusk eel originated from two FAO fishing regions, with approximately 50% being caught by a country in the WHO GEMS G10 cluster diet region.

49. The average total mercury concentrations for unspecified cusk-eel, kingklip, pink cusk-eel, and the cusk-eel family grouping were all above the selection criteria. No data on methylmercury was available to confirm the ratios of methylmercury to total mercury.

50. Further data collection for methylmercury occurrence in cusk-eels is recommended to confirm the ratios of methylmercury to total mercury and establish whether ML setting may be necessary.

Sablefish/ black cod *(Anoplopoma fimbria)*

51. Data for sablefish were extracted from GEMS/Food (Table 6). No other species in the same family (*Anoplopomatidae;* taxonomic code 1,78(08)) were identified; as a result no grouping was possible. All data points were for total mercury and had the assay LOD/LOQ values recorded.

Table 6: Summary of occurrence data on total mercury 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	*Anoplopoma fimbria*	Total	No	G10 (352)	352	0	0.43	0.25	0.88	2.33

52. The average sablefish production over 2010-2016 exceeded 9000 tonnes. One FAO fishing zone accounted for 92% of the total production and catch was only reported by countries in the WHO GEMS G10 cluster diet region.

53. The average total mercury for sablefish was above the 0.3 mg/kg agreed as the selection criteria for ML setting. No data on methylmercury was available to confirm the ratios of methylmercury to total mercury.

54. Further data collection for methylmercury occurrence in sablefish is recommended to confirm the ratios of methylmercury to total mercury and establish whether ML setting may be necessary.

Species for which MLs could be set (2020-2021)

Anglerfish/ monkfish (*Lophius sp.*)

55. Data for anglerfish/monkfish and *lophiiformes* was extracted from GEMS/Food, (Table 7). Of the *lophiiformes* family (taxonomic code: 1,95(01)) only *lophius* species (taxonomic code: 1,95(01)001) are expected to be commercially fished and no data for other species in the same family were identified. The *lophiiformes* data was therefore combined with that specified as anglerfish or monkfish. Data points were for both total mercury and methylmercury, with a proportion having no assay LOD/LOQ values recorded.

Table 7: Summary of 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	G07 (1) G08 (17) G10 (31)	49	19	0.06	0.06	0.17	0.23
Anglerfish	*Lophius sp.*	Total	Yes	G07(6) G08 (45) G10 (31) G15(8)	92	19	0.15	0.33	0.42	2.90
Anglerfish	*Lophius sp.*	Methyl	No	G08 (1) ER (13)	14	1	0.75	0.69	1.69	3.00
Anglerfish	*Lophius sp.*	Methyl	Yes	G08 (3) ER (15)	18	1	0.62	0.66	1.29	3.00

Footnote. ER: WHO European Region

56. The average production of anglerfish, American angler, devil angler and unspecified monkfish all exceeded 9000 tonnes over the 2010-2016 period. The majority of the catch of the different species was from three FAO fishing regions by countries in the G07, G08, G10 and G15 WHO GEMS cluster diet regions, thus the data is considered geographically representative.

57. Although the mean for total mercury in anglerfish fell below the selection criteria of 0.3 mg/kg, when the smaller methylmercury dataset is reviewed it can be seen the mean values are greater than double the selection criteria. A cited study reported methylmercury to total mercury concentrations in anglerfish were within the 70-100% range[10]

58. Further data collection for methylmercury occurrence in anglerfish/monkfish is recommended to refine the mean concentration and establish whether ML setting may be necessary.

Barracuda (*Sphyraena sp.)*

59. Data for barracuda was extracted from GEMS/Food (Table 8). The genus *Sphyraena* (taxonomic code: 1,77(10)001) is the only genus in the family *Sphyraenidae*, as result no further grouping is possible. All data points were for total mercury with a proportion with no assay LOD/LOQ values reported.

Table 8: Summary of occurrence data on total mercury in mg/kg in barracuda 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
Barracuda	*Sphyraena sp.*	Total	No	G10 (11)	11	0	0.60	0.55	1.43	1.63
Barracuda	*Sphyraena sp.*	Total	Yes	G07 (2) G10 (11)	13	0	0.69	0.56	1.53	1.63

60. The average production of great barracuda and unspecified barracuda species over 2010-2016 exceeded 9000 tonnes. The catch was widely distributed across FAO fishing regions and by countries in various WHO GEMS cluster diets, as a result the occurrence data is unlikely to be geographically representative.

61. Mean total mercury levels in barracuda exceeded the selection criteria of 0.30 mg/kg, however only 13 data points were available for consideration.

62. In view of the low sample size, further data collection is recommended to allow an ALARA concentration to be clearly identified.

Catfish (*Siluriformes*)

63. Data for brown bullhead (*Ameiurus nebulosus*), basa catfish/ pangasius (*Pangasius bocourti*), channel catfish (*Ictalurus punctatus*), walking catfish (*Clarias batrachus*) and unspecified catfish (*Siluriformes sp.)* was extracted from GEMS/Food (Table 9). The unspecified catfish samples could include fish from a wide number of families in the diverse catfish order (taxonomic code: 1,41), as a result grouping by families was not possible and a broad grouping by order has been undertaken. All data points were for total mercury and had the assay LOD/LOQ values recorded.

64. None of the identified catfish species had capture production quantities that exceed 9000 tonnes over the 2010-2016 period. For channel catfish and brown bullhead the majority of the catch was from countries in the WHO GEMS G10 cluster diet region. In contrast aquaculture production of a number of the identified catfish species was significant, with channel catfish having a large production volume contributed to by countries in the G09 and G10 cluster diet regions and basa catfish by a country in the G09 cluster diet region. A variety of other species of catfish are caught or produced in aquaculture and many had average annual production values exceeding 9000 tonnes.

65. The average total mercury values for most of the individual species and for the unspecified catfish samples fell below the selection criteria, albeit all of these had low sample numbers. In contrast, the mean total mercury for channel catfish was far in excess of the selection criteria, however 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. Given the wide disparity noted between species a grouped ML for the full catfish order may not be appropriate and further work could be undertaken to refine consideration down to groupings of families. In addition no methylmercury results were available to establish ratios against total mercury.

[10] Storelli, M.M., Giacominelli-Stuffler, R., Storelli, A., D'Addabbo, R., Palermo, C., Marcotrigiano, G.O. 2003. Survey of total mercury and methylmercury levels in edible fish from the Adriatic Sea, Food Additives & Contaminants, 20:12, 1114-1119.

Table 9: 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 (11)	11	8	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
Catfish (unspecified)	*Siluriformes sp.*	Total	No	G10 (17)	17	2	0.12	0.17	0.56	0.57
All catfish	*Siluriformes sp.*	Total	No	G10 (55)	55	15	0.41	0.86	2.44	3.66

66. Further data collection of identified species of catfish in trade is recommend to further develop the catfish dataset to support identification and setting of MLs.

Orange roughy (*Hoplostethus atlanticus*)

67. Data for orange roughy were extracted from GEMS/Food (Table 10). No other species in the slimehead family (*Trachichthyidae;* taxonomic code: 1,61(05)) were identified, as a result no grouping was possible. All data points were for total mercury with a proportion with no assay LOD/LOQ values reported.

Table 10: Summary of occurrence data on total mercury 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 (47)	47	0	0.52	0.17	0.78	0.89

68. The average production of orange roughy over 2010-2016 exceeded 9000 tonnes. An average of 92% of the catch was reported from one FAO fishing region by a country in the WHO GEMS G10 cluster diet region, thus the data was considered geographically representative for this species in trade.

69. Mean total mercury levels in orange roughy exceeded the selection criteria of 0.3 mg/kg, however only 47 data points were available for consideration. No methylmercury results were available from which to confirm the ratio of total mercury to methylmercury.

70. In view of the low population size of less than 50 samples and absence of a confirmed the ratio of total mercury to methylmercury, prior to ML setting further data collection is recommended, to allow the ALARA concentration to be clearly identified.

Silver scabbardfish/frostfish (*Lepidopus cadatus*) and all Cutlassfish (*Trichiuridae sp.)*

71. Data for silver scabbardfish/frostfish and unspecified scabbard fish/cutlass fish were extracted from GEMS/Food (Table 11). These species are within the cutlass fish family (*Trichiuridae*; taxonomic code 1,75(06)) so grouping was possible. All data points were for total mercury and had the assay LOD/LOQ values recorded.

Table 11: Summary of occurrence data on total mercury in mg/kg in cutlassfish 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
Scabbardfish (silver)	*Lepidopus caudatus*	Total	No	G10 (30)	30	0	0.07	0.04	0.17	0.21
Scabbardfish	*Trichiuridae sp*	Total	No	G10 (6)	6	0	0.62	0.43	1.02	1.02
All cutlass fish	*Trichiuridae sp*	Total	No	G10 (36)	36	0	0.16	0.26	1.01	1.02

72. The average production of silver scabbardfish, black scabbardfish and unspecified scabbardfish and haritails all exceeded 9000 tonnes over the 2010-2016 period. The catch was widely distributed across FAO fishing regions and by countries in various WHO GEMS cluster diets, as a result the occurrence data is unlikely to be geographically representative. Largehead hairtail was a further species in the scabbardfish family with very large production quantities (>1 million tonnes/year).

73. The six samples for unspecified scabbardfish show a much larger average total mercury value than silver scabbardfish. Due to low sample numbers a conclusion on meeting the selection criteria is not possible.

74. The mean total mercury in silver scabbardfish was below the selection criteria and would not require an ML. However, due to the large difference in mean concentrations between the two cutlass fish species and the greater weighting of silver scabbardfish in the sample numbers, a conclusion on the family being below the ML cannot be made. Further data collection for total and methylmercury in species in the cutlass fish family is recommended to determine whether an ML may be necessary.

Pacific red snapper (assumed *Lutjanus peru*), red snapper (assumed *Lutjanus campechanus*), Russell's snapper (*Lutjanus russellii*) vermillion/beeliner snapper (*Rhomboplites aurorubens*) and all snapper (*Lutjanus)*

75. Data for Pacific red snapper, red snapper, Russell's snapper, vermillion/beeliner snapper) and unspecified snapper (assumed *Lutjanus sp.)* were extracted from GEMS/Food (Table 12). Snapper, red snapper and Pacific red snapper are common name terms that may refer to various unrelated species, including *Lutjanus peru*, *Pagrus auratus* (considered separately below in porgies/sea bream family), *Centroberyx affinis* (analysed previously for the alfonsino ML) and members of the *Sebastes* family (considered below as rockfish). For the purposes of this analysis all samples recorded as red, pacific red and unspecified snapper were assumed to be within the snapper family (*Lutjanus*; taxonomic code 1,70(32)) to allow sufficient sample numbers alongside Russell's and vermillion snapper for a grouping. All data points were for total mercury and had the assay LOD/LOQ values recorded.

76. The average production of unspecified snapper exceeded 9000 tonnes over the 2010-2016 period. The catch was widely distributed across FAO fishing regions and by countries in various WHO GEMS cluster diets, as a result the occurrence data is unlikely to be geographically representative.

77. The average for total mercury in the unspecified snapper was above the selection criteria, however as only two samples were available, one of which was a high value of 1.65 mg/kg, it is not possible to be conclusive on the need for an ML. For all other individual species, with the exception of Russell's snapper, the average total mercury results were below the selection criteria, although low sample numbers result in uncertainty on this conclusion.

Table 12: 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**
Pacific red snapper	*Lutjanus peru*	Total	No	G10 (3)	3	0	0.25	0.24	0.54	0.59
Red snapper	*Lutjanus campechanus*	Total	No	G10 (4)	4	1	0.08	0.07	0.17	0.19
Russell's snapper	*Lutjanus russellii*	Total	No	G10 (1)	1	0	0.70	0	0.70	0.70
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	0	0.11	0.11
Snapper (unspecified)	*Lutjanus sp.*	Total	No	G10 (2)	2	1	0.83	0.83	1.57	1.65
All snapper	*Lutjanus sp.*	Total	No	G10 (12)	12	2	0.30	0.46	1.13	1.65

78. The mean mercury concentration of the grouping of all snapper meets the selection criteria level of 0.3 mg/kg. However, as assumptions have been made that the samples grouped are all within the snapper family, and due to low sample numbers and absence of methylmercury results, it is not conclusive whether snapper would require an ML.

79. Further data collection is recommended for total mercury and methylmercury concentrations within individual snapper species, with clear distinction as to the scientific name, or the species being within the *Lutjanus* family.

Species for ML review (2021-2022)

Cardinalfish/ black cardinalfish *(Epigonus telescopus)*

80. Data for cardinalfish were extracted from GEMS/Food (Table 13). No other species in the deepwater cardinalfish family (*Epigonidae;* taxonomic code 1,70(96)) were identified, as a result no grouping was possible. All data points were for total mercury and had the assay LOD/LOQ values recorded.

Table 13: Summary of occurrence data on total mercury in mg/kg in cardinalfish 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**
Cardinalfish	*Epigonus telescopus*	Total	No	G10 (70)	70	0	1.27	0.27	1.82	2.13

81. The average cardinalfish production over 2010-2016 did not exceed 9000 tonnes. For all but one year 80% of the catch was from one FAO fishing region by a single country in the G10 cluster diet region. As a result the data was considered geographically representative for this species in trade.

82. The average total mercury for cardinalfish was far above the 0.3 mg/kg agreed as the selection criteria for ML setting. Although sample numbers were less than 100 the dataset was tightly grouped and the lower bound of the standard deviation from the mean would still exceed the selection criteria. However, no data on methylmercury was available to confirm the ratios of methylmercury to total mercury.

83. Further data collection for methylmercury occurrence in cardinalfish is recommended to confirm the ratios of methylmercury to total mercury to enable an appropriate ML to be identified.

Hapuku/ New Zealand Groper (*Polyprion oxygeneios*)

84. Data for hapuku was extracted from GEMS/Food (Table 14). No other species in the wreckfish family (*Polyprionidae;* taxonomic code: 1,70(05)) were identified, as a result no grouping was possible. All data points were for total mercury and had the assay LOD/LOQ values recorded.

Table 14: Summary of occurrence data on total mercury in mg/kg in hapuku 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
Hapuku	*Polyprion oxygeneios*	Total	No	G10 (70)	70	0	0.33	0.21	0.74	0.98

85. The average production of hapuku did not exceed 9000 tonnes over the 2010-2016 period. The majority of the catch was from a single FAO fishing region by a country in the WHO GEMS G10 cluster diet region, as a result the occurrence data is considered geographically representative for this species in trade.

86. The average for total mercury in hapuku is slightly in excess of the selection criteria of 0.3 mg/kg. It was determined that as there were less than 100 samples available, and the lower bound of the standard deviation from the mean fell below the selection criteria, there was sufficient uncertainty in the average to preclude progressing to setting MLs. In addition no methylmercury results were available to establish ratios against total mercury.

87. Further data collection for hapuku is recommended to confirm if the selection criteria are met for methylmercury.

Rat fish/Rabbit fish (*Chimaera monstrosa*) and all short nosed chimera (*Chimaeridae*)

88. Data for rat fish was extracted from GEMS/Food (Table 15). Rat fish are within the short nosed chimera family (*Chimaeridae;* taxonomic code: 1,12(01)). Two other species of the short nosed chimera family: ghost shark (*Hydrolagus sp.*) and pale ghost shark (*Hydrolagus bemisi*), had been included within the dataset to establish the ML for shark, representing approximately a quarter of the overall dataset extracted for shark. The previously considered data on ghost shark was grouped with rat fish to assess it as a separate classification from shark. Data for other shark and dogfish were not reanalysed. All data points were for total mercury with a proportion with no assay LOD/LOQ values reported.

89. No short nosed chimera species had production quantities that exceeded 9000 tonnes over the 2010-2016 period. The majority of ghost shark was caught by a country in the WHO GEMS G10 cluster diet region and ratfish by countries in the G07 and G10 regions cluster diet regions, as a result the occurrence data is likely to be geographically representative for this species in trade.

90. The average total mercury value for rat fish exceeded the selection criteria of 0.3 mg/kg. However, as there were only 25 samples in the dataset, prior to ML setting further data collection would be recommended to better refine which value was ALARA. Furthermore no data on methylmercury was available to confirm the ratios of methylmercury to total mercury.

91. The average total mercury value for the short nosed chimera group also exceeded the selection criteria when data points for ghost shark were reconsidered separate from shark.

Table 15: Summary of occurrence data on total mercury in mg/kg in short nosed chimera 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
Ghost shark	*Hydrolagus sp.*	Total	No	G10 (102)	102	0	0.32	0.15	0.57	0.70
Pale ghost shark	*Hydrolagus bemisi*	Total	No	G10 (102)	102	0	0.39	0.16	0.71	0.79
Rat fish	*Chimaera monstrosa*	Total	Yes	G07 (25)	25	0	0.58	0.14	0.75	0.83
All short nosed chimera	*Chimaeridae sp.*	Total	No	G10 (204)	204	0	0.35	0.16	0.64	0.79
All short nosed chimera	*Chimaeridae sp.*	Total	Yes	G07 (25) G10 (204)	229	0	0.38	0.17	0.70	0.83

92. It is considered that the dataset for rat fish could be combined, either with ghost shark to set a separate ML for short nosed chimera, or within the shark grouping. The shark ML at present would be adequate to cover the recorded levels in rat fish. Either option may need reconsideration of the shark ML to establish if the new data alters the ALARA based ML established for shark.

Species below selection criteria, but for which future data collection would be beneficial

Bass (assumed *Dicentrarchus labrax),* white perch (*Morone americana)*, white bass (*Morone chrysops)*, striped bass (*Morone saxatillis)* all temperate bass (*Moronidae)* and seabass

93. Bass and sea bass are common names often applied to a variety of fish species within different families. Species specific data was available in GEMS/Food for white perch, white bass, stripped bass and unspecified marone bass, within the *Morone* genus, part of the temperate bass (*Moronidae;* taxonomic code: 1,70(04)) family (Table 16). A dataset of unspecified bass was also available, based on the countries of origin and the coding as a freshwater fish this was assumed to be European bass (*Dicentrarchus labrax*) which is also a species in the temperate bass family, as a result a grouping of temperate bass was undertaken. The extracted data included both total mercury and methylmercury data and has a proportion of the dataset with no LOD/LOQ values.

94. Further data was also available for unspecified sea bass, a term that could cover species in the Asian seabass (*Lateolabracidae;* taxonomic code: 1,70(08)), temperate bass, *serranidae* (taxonomic code: 1,70(02)) and wreckfish (*polyprionidae;* taxonomic code: 1,70(05)). Patagonian toothfish may also be marketed as Chilean sea bass. Given the uncertainty this dataset was not combined with that for large-mouth bass or the temperate bass grouping. Species specific data was also available in GEMS/Food for large-mouth bass (*Micropterus salmoides*) however this sits within the sunfish (*Centrarchidae;* taxonomic code: 1,70(10)) family and was not considered.

95. For the identified bass species, none of the capture production quantities exceed 9000 tonnes over the period of 2010-2016. For white bass, striped bass and white perch all production was from WHO GEMS G10 cluster diet countries. European bass however were a significant aquaculture species, with countries in the G06 and G08 cluster diet regions producing large volumes. As the dataset for temperate bass encompass a number of producing regions the current occurrence data for these species is therefore considered geographically representative.

96. The mean values for total mercury for all identified species of bass fell below the selection criteria. The data is sufficient to identify the moronidae grouping of bass would all fall below the selection criteria. However, as the sea bass entries could encompass different species and the mean total mercury was not greatly below the selection criteria there could be species grouped within this that may individually exceed the selection criteria.

97. Further data collection for sea bass, where possible recording the specific species tested, would be beneficial to confirm that no ML is necessary for this group, or individual species within it.

Table 16: Summary of occurrence data on total mercury and methylmercury in mg/kg in bass 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
Bass (European)	*Dicentrarchus labrax*	Total	No	G06(1) G07(1) G08(6)	8	8	0	0	0	0
Bass (European)	*Dicentrarchus labrax*	Total	Yes	G06(1) G07(12) G08(48) G10(1) G15(4)	78	8	0.20	0.5	0.59	4.20
Bass (European)	*Dicentrarchus labrax*	Methyl	No	G08(3)	3	3	0	0	0	0
Bass (European)	*Dicentrarchus labrax*	Methyl	Yes	G08(5)	5	3	0.03	0.05	0.09	0.10
Bass (white)	*Morone chrysops*	Total	No	G10 (26)	26	0	0.21	0.09	0.37	0.46
Bass (striped)	*Morone saxatillis*	Total	No	G10 (15)	15	3	0.11	0.10	0.31	0.35
White perch	*Morone americana*	Total	No	G10 (33)	33	0	0.13	0.12	0.37	0.59
Bass (morone unspecified)	*Morone sp.*	Methyl	No	ER (4)	4	0	0.06	0.03	0.08	0.08
All temperate bass	*Moronidae sp.*	Total	No	G10 (74)	82	11	0.14	0.12	0.35	0.59
All temperate bass	*Moronidae sp.*	Total	Yes	G10 (74)	152	11	0.18	0.36	0.50	4.20
All temperate bass	*Moronidae sp.*	Methyl	No	G08(3)	3	3	0	0	0	0
All temperate bass	*Moronidae sp.*	Methyl	Yes	G10 (74)	9	3	0.04	0.04	0.10	0.10
Bass (sea)	unknown	Total	No	G07 (2) G10 (51)	53	9	0.29	0.29	0.87	1.25
Bass (sea)	unknown	Total	Yes	G07 (43) G10 (51)	94	9	0.21	0.24	0.72	1.25

Footnote. ER: WHO European Region

Forkbeard *(Phycis sp.)*, White hake (*Urophycis tenuis)* and all Phycid hake (*Phycidae*)

98. Data for forkbeard (greater and unspecified) and white hake was extracted from GEMS/Food (Table 17). As these species are within the phycid hake subfamily (*Phycidae*) of the codfish family (*Gadidae*; taxonomic code 1,48(04)) a grouping was undertaken. Data points were for total mercury with a proportion having no assay LOD/LOQ values recorded.

Table 17: Summary of occurrence data on total mercury in mg/kg in phycid hake 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
Forkbeard (greater)	*Phycis blennoides*	Total	Yes	G07 (60)	59	0	0.12	0.04	0.20	0.25
Forkbeard (unspecified)	*Phycis sp.*	Total	No	G10 (1)	1	0	0.22	0	0.22	0.22
White hake	*Urophycis tenuis*	Total	No	G10 (1)	1	0	0.30	0	0.30	0.30
Phycid hake	*Phycidae*	Total	Yes	G10 (2)	2	0	0.26	0.04	0.30	0.30
Phycid hake	*Phycidae*	Total	Yes	G07 (60) G10 (2)	61	0	0.13	0.05	0.21	0.30

99. The average annual capture production did not exceed 9000 tonnes for any of the identified phycid hake species over the 2010-2016 period. Catch of greater forkbeard was limited to two FAO fishing regions with the majority caught by countries in the WHO GEM G07 and G08 cluster diet regions.

100. A single result was available for white hake of 0.3 mg/kg which meets the selection criteria level, although with a single result no conclusion can be made on the need for an ML.

101. For the forkbeard species and the broader phycid hake family all mean values for total mercury fell below 0.3 mg/kg. It can be concluded that no MLs are necessary. Further data collection to supplement methylmercury concentrations for white hake would be beneficial.

Pike (*Esox sp.*)

102. Data for pike were extracted from GEMS/Food (Table 18). The pike family(*Escoidae*; taxonomic code: 1,24(03)) is monotypic so no further grouping was possible. All data points were for total mercury, a proportion had no LOD/LOQ values reported.

Table 18: 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	No	G07 (1), G10 (216)	217	1	0.30	0.18	0.64	1.00
Pike	*Esox sp.*	Total	Yes	G07 (11) G10 (216)	227	1	0.29	0.18	0.63	1.40

103. The average annual capture production of Northern pike exceeded 9000 tonnes over the 2010-2016 period. The catch was distributed across five FAO fishing regions, although the majority of the catch was by countries in the WHO GEMS G07 and G10 cluster diet regions. As a freshwater species with a broad range, further data collection could be beneficial for pike as there may be potential for wider inherent variation in the methylmercury levels.

104. The mean value for total mercury in pike was at the selection criteria level of 0.3 mg/kg when only data points with LOD/LOQ values entered are considered, however for the full dataset the average value drops below the selection criteria. No data on methylmercury was available to confirm the ratios of methylmercury to total mercury.

105. As the average total mercury concentration is approaching the selection criteria further data collection would be beneficial for pike to establish the ratio of methylmercury to total mercury and confirm the occurrence dataset is geographically representative.

Sturgeon (*Acipenseridae*)

106. Data for sturgeon (Atlantic, shortnose, and unspecified) were extracted from GEMS/Food (Table 19). An all sturgeon family (*Acipenseridae*; taxonomic code: 1,17(01)) grouping was undertaken to achieve the minimum of 10 data points. Data points were for total mercury and methylmercury with a proportion having no LOD/LOQ values reported.

107. The average annual capture production for the identified sturgeon species and unspecified sturgeon species did not exceed 9000 tonnes over the 2010-2016 period. The catch occurred over six FAO fishing regions, contributed to by countries in the WHO GEMS G08 and G10. However aquaculture production of unspecified sturgeon species was significant with a country in the G09 cluster diet region a majority producer. With the limited number of results and as sturgeon is a species with a broad range, further data collection could be beneficial as there may be potential for wider inherent variation in the methylmercury levels.

108. The mean values for total mercury for individual sturgeon and the family grouping fell below the selection criteria of 0.3 mg/kg. It can be concluded that no ML is necessary.

Table 19: 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
Stugeon (shortnose)	*Acipenser brevirostrum*	Total	No	G10 (3)	3	0	0.11	0.01	0.13	0.13
Sturgeon (unspecified)	*Acipenseridae sp.*	Total	No	G07 (1) G08 (1) G10 (2)	4	2	0.05	0.05	0.10	0.11
Sturgeon (unspecified)	*Acipenseridae sp.*	Total	Yes	G07 (1) G08 (3) G10 (2)	6	2	0.06	0.04	0.10	0.11
All sturgeon	*Acipenseridae sp.*	Total	No	G07 (1) G08 (1) G10 (6)	8	2	0.08	0.05	0.12	0.13
All sturgeon	*Acipenseridae sp*	Total	Yes	G07 (1) G08 (3) G10 (6)	10	2	0.08	0.04	0.12	0.13

Yellowfin grouper (*Mycteroperca venenosa*) and all grouper (*Epinephelus sp.)*

109. Data for grouper (yellowfin and unspecified) was extracted from GEMS/Food (Table 20). These species are within the grouper genus (*Epinephelus;* taxonomic code: 1,70(02)42) so grouping to this level was possible. The broader *Serranidae* family contains a wide range of species, including soap fish, dallies and species termed sea bass, however, as there were no samples for other species in the family a broader grouping was not considered. New Zealand groper/Hapuku (*Polyprion oxygeneios*) is unrelated and was considered separately above. All data points were for total mercury and had the assay LOD/LOQ values recorded.

Table 20: Summary of occurrence data on total mercury and methylmercury in mg/kg in grouper 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
Grouper (yellowfin)	*Mycteroperca venenosa*	Total	No	G10 (2)	2	0	0.22	0.24	0.37	0.39
Grouper (unspecified)	*Epinephelinae sp.*	Total	No	G10 (32)	32	0	0.28	0.24	0.83	0.99
All grouper	*Epinephelinae sp.*	Total	No	G10 (34)	34	0	0.27	0.24	0.81	0.99

110. The average production of yellowfin grouper did not exceed 9000 tonnes over the 2010-2016 period. However both average annual capture production and aquaculture production of unspecified grouper species was in excess of 9000 tonnes. The catch was widely distributed across FAO fishing regions and by countries in various WHO GEMS cluster diet regions, as a result the occurrence data is unlikely to be geographically representative for this species in trade. Greasy grouper and orange-spotted grouper are other species in this genus with appreciable capture production values.

111. The averages for total mercury in yellowfin grouper and unspecified grouper, as well as for the subfamily grouping, are below the selection criteria of 0.3 mg/kg. Although progression to setting an ML at this stage is not deemed necessary, with a sample size of less than 50 samples and the proximity of the mean concentration to the selection criteria, further data collection may lead to a future need to reconsider grouper against the selection criteria.

Species below selection criteria for which MLs are not required

Anchovy (*Engraulidae sp.*)

112. Data for anchovy were extracted from GEMS/Food (Table 21). No individual species within anchovy family (*Engraulidae*; taxonomic code: 1,21(06)) were identified, as a result the data is presented only at a family level. Data points were for both total mercury and methylmercury, with a proportion having no assay LOD/LOQ values recorded.

113. A number of anchovy species, including: anchoveta, Argentine anchovy, Californian anchovy; European anchovy, Japanese anchovy, longnose anchovy, Pacific anchovy, Southern African anchovy and unspecified species of anchovy had average annual production quantities in excess of 9000 tonnes over 2010-2016. The catch was widely distributed across FAO fishing regions and by countries in various WHO GEMS cluster diets.

114. All mean values for total mercury and methylmercury fall below 0.3 mg/kg, as a result no ML is necessary for anchovy species.

Table 21: Summary of occurrence data on total mercury and methylmercury in mg/kg in anchovy 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
Anchovy	*Engraulidae sp.*	Total	No	G08 (31), G10 (16)	47	36	0.01	0.02	0.05	0.05
Anchovy	*Engraulidae sp.*	Total	Yes	G07 (22), G08 (68), G10 (28), G11 (1), G15 (24)	143	36	0.07	0.14	0.20	1.25
Anchovy	*Engraulidae sp.*	Methyl	No	ER (11), G08(5)	15	4	0.05	0.05	0.12	0.12
Anchovy	*Engraulidae sp.*	Methyl	Yes	ER (11), G08(4)	16	4	0.05	0.05	0.12	0.12

Footnote. ER: WHO European Region

Bluenose warehou/Antarctic butterfish (*Hyperoglyphe antarctica), common warehou (seriollela brama)* and all medusafish

115. Data for bluenose warehou and common warehou were extracted from GEMS/Food (Table 22). Both are species in the medusafish family (*Centrolophidae*; taxonomic code: 1,76(08)) and a grouping was also undertaken. All data points were for total mercury and had the assay LOD/LOQ values recorded.

Table 22: Summary of occurrence data on total mercury in mg/kg in medusafish 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
Bluenose warehou	*Hyperoglyphe antarctica*	Total	No	G10 (47)	47	0	0.14	0.13	0.42	0.62
Common warehou	*Seriolella brama*	Total	No	G10 (20)	20	0	0.06	0.04	0.12	0.14
All medusafish	*Centrolophidae sp.*	Total	No	G10 (67)	67	0	0.11	0.12	0.37	0.62

116. The average production of common warehouse or bluenose warehou did not exceed 9000 tonnes over the 2010-2016 period. The majority of the catch was from a single FAO fishing region by a country in the WHO GEMS G10 cluster diet region, as a result the occurrence data is considered geographically representative for this species in trade. Silver warehou was a further species in the medusafish family with an average annual catch of above 9000 tonnes.

117. All mean values for total mercury fell below 0.3 mg/kg, as a result no ML is necessary for either individually bluenose warehou or common warehou, or a broader medusafish grouping.

Butterfish/greenbone (*Odax pullus*)

118. Data for butterfish was extracted from GEMS/Food (Table 23). No other species in the weed whiting family (*Odacidae*; taxonomic code: 1,70(64)) were identified, as a result no grouping was possible. All data points were for total mercury and had the assay LOD/LOQ values recorded.

Table 23: Summary of occurrence data on total mercury in mg/kg in butterfish 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
Butterfish	*Odax pullus*	Total	No	G10 (60)	60	0	0.02	0.01	0.03	0.04

119. No production statistics were available for butterfish.

120. The mean values for total mercury for butterfish fell below 0.3 mg/kg, as a result no ML is necessary.

Capelin (*Mallotus villosus*), lake smelt/rainbow smelt (*Osmerus mordax*), smelt unspecified (*Osemrus sp.*) and all typical smelt (*Osmeridae*)

121. Data for capelin and smelt (lake and unspecified) were extracted from GEMS/Food (Table 24). These species are within the smelt/typical smelt family (*Osmeridae*; taxonomic code: 1,23(04)) as a result a grouping was undertaken. A single data point for Atlantic smelt was assumed to be for *Argentina silus* and excluded as falling within a different family (taxonomic code: 1,23(05)). Data points were for both total mercury and methylmercury, with a proportion having no assay LOD/LOQ values recorded.

122. The average production of capelin and unspecified smelt exceeded 9000 tonnes over the 2010-2016 period. The catch was widely distributed across FAO fishing regions. The majority of smelt was caught by countries in the WHO GEMS G10 cluster diet region, while for capelin the majority was from countries in the G07 cluster diet region. Further data for capelin could be of value to confirm the analysis above is geographically representative.

Table 24: Summary of occurrence data on total mercury and methylmercury in mg/kg in typical smelt 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**
Capelin	*Mallotus villosus*	Total	No	G10 (33)	33	6	0.04	0.02	0.05	0.05
Lake smelt	*Osmerus mordax*	Total	No	G10 (11)	11	0	0.05	0.01	0.06	0.06
Smelt unspecified	*Osemrus sp.*	Total	Yes	G10 (2)	2	0	0.33	0.04	0.37	0.37
Smelt unspecified	*Osemrus sp.*	Methyl	Yes	G08 (1)	1	0	0.07	0	0.07	0.07
All typical smelts	*Osmeridae sp.*	Total	No	G10 (44)	44	6	0.04	0.02	0.05	0.07
All typical smelts	*Osmeridae sp.*	Total	Yes	G10 (46)	46	6	0.06	0.06	0.07	0.37
All typical smelts	*Osmeridae sp.*	Methyl	Yes	G08 (1)	1	0	0.07	0	0.07	0.07

123. With the exception of the two unspecified smelt samples all of the mean values for total mercury, including for the all typical smelt grouping, fell below the selection criteria. The average of the two samples above slightly exceeded the selection criteria, although with only two data points there would be uncertainty in concluding on this. In addition, a single methylmercury result for smelt unspecified fell below the selection criteria.

124. As mean values for total mercury in capelin and lake smelt, and for the grouping of all typical smelt, fell below the selection criteria no ML is necessary.

Barbel (*Barbus barbus*), Bream (*Abramis brama*), Carp (*Cypriniuss sp.*), Mrigal carp (*Cirrhinus cirrhosus*), Roach (*Rutilius sp.*) and all cyprinids/carp family (*Cyprinidae sp.*)

125. Data for barbel, bream, carp, mrigal carp and roach were extracted from GEMS/Food (Table 25). Bream is a common name that may apply to many species, however given the associated coding in the metadata the dataset was interpreted as being for freshwater bream. As all of the extracted species are within the carp/ cyprinid family (*Cyprinidae;* taxonomic code: 1,40(02)) a grouping was also possible. Data points were for both total mercury and methylmercury, with a proportion having no assay LOD/LOQ values recorded.

126. The average production of freshwater bream, common carp, crucian carp, grass carp, silver carp, roach and unspecified cyprinids exceeded 9000 tonnes over the 2010-2016 period. The catch was widely distributed across FAO fishing regions. A number of carp species, including common and mrigal also had significant aquaculture production in a range of countries.

127. All mean values for total mercury and methylmercury fell below 0.3 mg/kg for all of the individual species and for the grouping. It can be concluded that no MLs are necessary.

Table 25: Summary of occurrence data on total mercury and methylmercury in mg/kg in cyprinid 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**
Barbel	*Barbus barbus*	Total	Yes	G08 (5) G15 (5)	10	0	0.22	0.12	0.41	0.43
Bream	*Abramis brama*	Total	No	G07 (4) G08 (20) G10 (5)	29	29	0	0	0	0
Bream	*Abramis brama*	Total	Yes	G06 (1) G07 (20) G08 (96) G10 (94) G15 (44)	255	29	0.22	0.31	0.84	2.91
Bream	*Abramis brama*	Methyl	No	G08 (2)	2	2	0	0	0	0
Bream	*Abramis brama*	Methyl	Yes	G08 (4) ER (14)	18	2	0.06	0.05	0.14	0.14
Carp	*Cyprinius sp.*	Total	No	G07(10) G08 (3) G10 (13) G15 (13)	39	26	0.05	0.10	0.27	0.27
Carp	*Cyprinius sp.*	Total	Yes	G07(37) G08 (28) G10(13) G15 (290)	368	26	0.06	0.09	0.23	0.99
Carp	*Cyprinius sp.*	Methyl	No	G15 (7) ER (93)	100	21	0.02	0.03	0.05	0.17
Carp	*Cyprinius sp.*	Methyl	Yes	G15(33) ER (97)	130	21	0.03	0.09	0.08	0.72
Mrigal carp	*Cirrhinus cirrhosus*	Total	No	G10 (1)	1	0	0.05	0	0.05	0.05
Roach	*Rutilius sp.*	Total	Yes	G07 (4) G08 (6) G15 (7)	17	0	0.12	0.07	0.23	0.24
All cyprinids	*Cyprinidae sp.*	Total	No	G07 (14) G08 (23) G10 (19) G15 (13)	69	55	0.03	0.08	0.24	0.35
All cyprinids	*Cyprinidae sp.*	Total	Yes	G06 (1) G07 (61) G08 (135) G10 (108) G15 (346)	651	55	0.13	0.22	0.47	2.91
All cyprinids	*Cyprinidae sp.*	Methyl	No	G08(2) G15(7) ER (93)	102	23	0.02	0.02	0.05	0.17
All cyprinids	*Cyprinidae sp.*	Methyl	Yes	G08 (4) G15(33) ER (97)	134	23	0.03	0.09	0.11	0.72

Footnote. ER: WHO European Region

Alaskan pollock/Walleye pollock (*Gadus chalcogrammus),* Cod (*Gadus sp.*), Haddock (*Melanogrammus aeglefinus)*, Pollock (*Pollachius pollachius)*, Saithe (*Pollachius virens*), Southern blue whiting (*Micromesistius australis*), Whiting (*Merlangius merlangus*) and all codfishes (*Gadidae sp.*)

128. Data for Alaskan pollock, cod, haddock, pollock, saithe, southern blue whiting and whiting were extracted from GEMS/Food (Table 26). A proportion of the datasets were combined cod and whiting values. Red cod (*Pseudophycis bachus*) and lingcod (assumed *Ophiodon elongates)* were excluded from the cod dataset as being unrelated species. All of the extracted species are within the codfish subfamily (*Gadinae*) of the broader codfish family (*Gadidae*; taxonomic code 1,48(04)) so grouping was possible. Data points were for both total mercury and methylmercury, with a proportion having no assay LOD/LOQ values recorded.

Table 26: Summary of occurrence data on total mercury and methylmercury in mg/kg in codfish 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**
Alaskan Pollock	*Gadus chalcogrammus*	Total	No	G10 (2)	2	0	0.05	0	0.05	0.05
Alaskan Pollock	*Gadus chalcogrammus*	Methyl	No	G10 (240)	240	0	0.05	0.05	0.13	0.32
Cod (Atlantic)	*Gadus morhua*	Total	No	G07 (2) G10 (14)	16	3	0.08	0.06	0.20	0.21
Cod (Atlantic)	*Gadus morhua*	Total	Yes	G07 (2405) G10 (14)	2419	3	0.08	0.07	0.21	0.71
Cod (Pacific)	*Gadus macrocephalus*	Total	No	G10 (29)	29	3	0.11	0.17	0.17	0.97
Cod (unspecified)	Gadus sp.	Total	No	G05(1) G07 (1) G10 (44)	46	6	0.21	0.23	0.62	1
Cod (unspecified)	Gadus sp.	Total	Yes	G07 (8) G10 (44)	53	6	0.20	0.21	0.60	1
Cod (unspecified)	Gadus sp.	Methyl	No	G10 (10)	10	0	0.08	0.05	0.16	0.17
Combined Cod and Whiting	*Gadus and merlangius sp.*	Total	No	G07 (206) G08 (22), G10 (1) G15(5)	234	234	0	0	0	0
Combined Cod and Whiting	*Gadus and merlangius sp.*	Total	Yes	G07 (1152) G08 (67) G10 (8), G11 (1) G15(80)	1308	234	0.09	0.12	0.34	1
Combined Cod and Whiting	*Gadus and merlangius sp.*	Methyl	No	G08 (8) ER (23)	31	14	0.06	0.08	0.13	0.40
Combined Cod and Whiting	*Gadus and merlangius sp.*	Methyl	Yes	G08 (183) ER (41)	224	14	0.04	0.11	0.10	0.92
Haddock	*Melanogrammus aeglefinus*	Total	No	G10 (15)	15	3	0.05	0.04	0.11	0.15

Common name	*Species*	Total or methyl mercury	Includes data points without LOQs	Region	Total records	Non-detects	Mean	SD	P95	Max
Haddock	*Melanogrammus aeglefinus*	Total	Yes	G07 (241) G10 (15)	256	3	0.07	0.06	0.19	0.41
Pollock	*Pollachius pollachius*	Total	No	G07 (6)	6	6	0	0	0	0
Pollock	*Pollachius pollachius*	Total	Yes	G07 (116)	116	6	0.12	0.08	0.32	0.49
Saithe	*Pollachius virens*	Total	Yes	G07 (664)	664	0	0.07	0.04	0.13	0.35
Southern blue whiting	*Micromesistius australis*	Total	No	G10 (60)	60	0	0.24	0.09	0.39	0.48
Whiting	*Merlangius merlangus*	Total	No	G07 (1)	1	1	0	0	0	0
Whiting	*Merlangius merlangus*	Total	Yes	G07 (40)	40	1	0.10	0.06	0.20	0.23
All codfish	*Gadidae sp.*	Total	No	G05(1) G07 (216) G08 (22) G10 (165) G15 (5)	408	250	0.07	0.14	0.33	1
All codfish	*Gadidae sp.*	Total	Yes	G07 (4626) G08 (67) G10 (172) G11 (1) G15 (80)	4946	250	0.09	0.10	0.26	1
All codfish	*Gadidae sp.*	Methyl	No	G05 (1) G8 (8) G10 (250) ER (23)	281	14	0.05	0.05	0.14	0.40
All codfish	*Gadidae sp.*	Methyl	Yes	G8 (183), G10 (10) ER (41)	474	14	0.05	0.08	0.13	0.92

Footnote. ER: WHO European Region

129. Species in the codfish subfamily have very large catch volumes, Alaskan Pollock had the largest capture production of any seafood species in 2016. Additionally Atlantic cod, Pacific cod, saithe, southern blue whiting, blue whiting, whiting and haddock all had average catch volumes that exceeded 9000 tonnes over the 2010-2016 period. Atlantic cod, haddock, saithe, pollock, blue whiting and whiting catches all occurred in the North Atlantic FAO fishing regions, largely by countries in the WHO GEMS G07 and G08 cluster diets. Pacific cod and Alaskan Pollock catch occurred in the two northernmost Pacific Ocean FAO fishing regions by countries in the WHO GEMS G10 cluster diet region. The dataset for the codfish family can be considered geographically representative.

130. All mean values for total mercury and methylmercury fell below 0.3 mg/kg for all of the individual species and for the grouping. It can be concluded that no MLs are necessary.

Arrowtooth flounder (*Atheresthes stomas),* Dab (*Limanda limanda),* Flounder (*Pleuronectoidei sp.),* Halibut (*Hippoglossus sp.),* Plaice and sole (*Pleuronectoidei sp. / Soleidae sp.*), Rex sole (*Glyptocephalus zachirus)* and all right eye flatfish (*Pleuronectidae sp.*) and sole

131. Data for arrowtooth flounder, dab, flounder, halibut (both Atlantic and Alaskan), plaice (Canadian and European), rex sole and sole were extracted from GEMS/Food (Table 27). Flounder was assumed to be common flounder unless otherwise specified. All of the extracted species, except sole, are within the right eyed flatfish family (*Pleuronectidae;* taxonomic code: 1,83(02)) so grouping was possible. Sole as a common name term could encompass species within the right eyed flatfish family (such as lemon sole and rock sole) and common sole which is in the true sole family (*Soleidae;* taxonomic code: 1,83(03)), as such it was grouped together with the right-eyed flatfish. Data points were for both total mercury and methylmercury, with a proportion having no assay LOD/LOQ values recorded.

Table 27: Summary of occurrence data on total mercury and methylmercury in mg/kg in right eyed flatfish and sole 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
Arrowtooth flounder	*Atheresthes stomas*	Total	No	G10 (3)	3	0	0.09	0.04	0.13	0.13
Dab	*Limanda limanda*	Total	Yes	G07 (7)	7	0	0.06	0.02	0.09	0.1
Flounder	*Pleuronectidae sp.*	Total	No	G07 (1) G08 (3) G10 (11)	15	4	0.08	0.13	0.27	0.5
Flounder	*Pleuronectidae sp.*	Total	Yes	G07 (3) G08 (12) G10 (11) G11 (8)	34	4	0.09	0.13	0.30	0.58
Flounder	*Pleuronectidae sp.*	Methyl	No	G10 (10)	10	0	0.11	0.14	0.33	0.48
Flounder	*Pleuronectidae sp.*	Methyl	Yes	G8 (45), G10 (10)	55	0	0.07	0.07	0.18	0.48
Halibut (Atlantic)	*Hippoglossus hippoglossus*	Total	No	G10 (44)	44	2	0.44	0.38	1.29	1.74
Halibut (Atlantic)	*Hippoglossus hippoglossus*	Total	Yes	G07 (391) G10 (44)	435	2	0.23	0.31	0.68	2.4
Halibut (Alaskan)	*Hippoglossus stenolepis*	Total	No	G10 (240)	239	6	0.3	0.28	0.78	2.25
Halibut (unspecified)	*Hippoglossus sp.*	Total	No	G10 (153)	153	0	0.29	0.23	0.8	1.07
Halibut (unspecified)	*Hippoglossus sp.*	Total	Yes	G07 (1609) G08 (73) G10 (154) G15 (30)	1866	0	0.22	0.19	0.64	2.28
Halibut (unspecified)	*Hippoglossus sp.*	Methyl	Yes	G08 (61)	61	0	0.13	0.18	0.40	1.21
Halibut (All)	*Hippoglossus sp.*	Total	Yes	G07 (2000) G08 (73) G10 (436) G15 (30)	2210	8	0.23	0.22	0.66	2.40

Common name	*Species*	Total or methyl mercury	Includes data points without LOQs	Region	Total records	Non-detects	Mean	SD	P95	Max
Plaice (Canadian)	*Hippoglossoides platessoides*	Total	No	G10(1)	1	0	0.11	0	0.11	0.11
Plaice (European)	*Pleuronectes platessa*	Total	Yes	G07 (53)	53	0	0.04	0.01	0.07	0.08
Plaice (European)	*Pleuronectes platessa*	Methyl	No	ER (1)	1	1	0	0	0	0
Plaice (European)	*Pleuronectes platessa*	Methyl	Yes	ER (3)	3	1	0.03	0.02	0.04	0.04
Plaice (unspecified)	*Pleuronectidae sp.*	Total	No	G07 (3) G08 (1)	4	4	0	0	0	0
Rex sole	*Glyptocephalus zachirus*	Total	No	G10 (2)	2	0	0.09	0.03	0.11	0.11
Sole	*Pleuronectidae sp./ Soleidae sp.*	Total	No	G07 (1) G08 (12) G10 (9) G11 (1)	21	12	0.05	0.07	0.16	0.22
Sole	*Pleuronectidae sp./ Soleidae sp.*	Total	Yes	G07 (25) G08 (16) G10 (14) G11 (14)	69	12	0.08	0.09	0.23	0.50
All right eyed flatfish and sole	*Pleuronectidae sp./ Soleidae sp*	Total	No	G07 (5) G08 (14) G10 (462) G11 (1)	482	28	0.29	0.28	0.87	2.25
All right eyed flatfish and sole	*Pleuronectidae sp./ Soleidae sp*	Total	Yes	G07 (2298) G08 (111) G10 (478) G11 (41) G15 (33)	2910	28	0.21	0.22	0.63	2.40
All right eyed flatfish	*Pleuronectidae sp.*	Methyl	No	G08 (4) G10 (10) ER (7)	21	6	0.15	0.29	0.69	1.20
All right eyed flatfish	*Pleuronectidae sp.*	Methyl	Yes	G08 (120) G10 (10) ER (13)	133	6	0.11	0.17	0.31	1.21

Footnote. ER: WHO European Region

132. Alaskan halibut, European plaice, Greenland halibut, arrowtooth flounder, flathead sole, yellowfin sole, common dab, common sole, rock sole, lemon sole, European flounder and unspecified sole species all had average catch volumes that exceeded 9000 tonnes over the 2010-2016 period. Atlantic halibut, European plaice, common dab, lemon sole and common sole catches all occurred in the North Atlantic FAO fishing regions, largely by countries in the WHO GEMS G07, G08, G11 and G15 cluster diets. Alaskan halibut and arrowtooth flounder catch occurred in the two northernmost Pacific Ocean FAO fishing regions by countries in the WHO GEMS G10 cluster diet region. Unspecified right-eyed flounder were also a significant aquaculture species, with a large production volume by a country in the G09 cluster diet region. The dataset for the right-eyed flatfish family and sole can be considered geographically representative.

133. The averages for total mercury in Atlantic and Alaskan halibut were at, or above, the selection criteria level when only data with recorded LOD/LOQs was analysed. However, as the majority of the halibut data is not specific to species there is difficulty in interpreting these species datasets individually.

134. For all other individual species, and for the grouping of all right eyed flatfish and sole, the average total mercury and methylmercury results were below the selection criteria, as a result no MLs are required.

Turbot (Psetta maxima)

135. Data for turbot were extracted from GEMS/Food (Table 28). Turbot are in the Scophthalmidae family (taxonomic code: 1,83(05)) separate from right-eyed flatfish and sole. As no other turbot species were reported no grouping was undertaken. All data points were for total mercury, a proportion had no assay LOD/LOQ values recorded.

Table 28: Summary of occurrence data on total mercury in mg/kg in turbot 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
Turbot	*Psetta maxima*	Total	No	G10 (53)	53	4	0.07	0.07	0.15	0.46
Turbot	*Psetta maxima*	Total	Yes	G07 (45) G10 (53)	98	4	0.08	0.06	0.19	0.46

136. The average capture production of turbot did not exceed 9000 tonnes over the 2010-2016 period. The majority of the catch was from one FAO fishing region by countries in the WHO GEMS G07, G08 and G11 cluster diet regions. In contrast, turbot was a significant aquaculture species, with a country in the G09 cluster diet region producing the majority. As there is a broad production of turbot the current dataset is unlikely to be geographical representative for this species.

137. The mean values for total mercury for turbot fell below 0.3 mg/kg, as a result no ML is necessary.

Mahi-Mahi / Dolphinfish/ Dorado (*Coryphaena hippurus)*

138. Data for mahi-mahi was extracted from GEMS/Food (Table 29). The dolphinfish family (*Coryphaenidae*; taxonomic code: 1,70(28)) only has one genus, containing two species: Mahi-mahi and Pompano dolphinfish (*Coryphaena equiselis)*, no data was available for the latter species therefore no further grouping is possible. All data points were for total mercury, a proportion had no assay LOD/LOQ values recorded.

Table 29: Summary of occurrence data on total mercury in mg/kg in mahi-mahi 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
Mahi-mahi	*Coryphaena hippurus*	Total	No	G10 (82)	82	2	0.26	0.17	0.52	1.02
Mahi-mahi	*Coryphaena hippurus*	Total	Yes	G07 (18) G10 (82)	100	2	0.23	0.17	0.51	1.02

139. The average production of mahi-mahi exceeded 9000 tonnes over the 2010-2016 period. The catch was widely distributed across FAO fishing regions and by countries in various WHO GEMS cluster diet regions. As a result, the occurrence data from only two cluster diet regions is unlikely to be geographically representative.

140. The mean values for total mercury for mahi-mahi fell below 0.3 mg/kg, as a result no ML is necessary.

Hake (Merluccius sp.), Hoki/Blue grenadier/Blue hake (*Macruronus novaezelandiae*) and all Merluccid Hake (*Merlucciidae*)

141. Data for hake (European, Pacific, southern, silver and unspecified) and hoki was extracted from GEMS/Food (Table 10). As these species are within the merluccid hake family (*Merlucciidae*; taxonomic code 1,48(05)) a grouping was possible. White hake (*Urophycis tenuis)* was considered separately within the phycid hake grouping. Data points were for both total mercury and methylmercury, with a proportion having no assay LOD/LOQ values recorded.

Table 30: Summary of occurrence data on total mercury and methylmercury in mg/kg in merluccid hake 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**
Hake (European)	*Merluccius merluccius*	Total	Yes	G07 (64)	64	0	0.19	0.09	0.30	0.65
Hake (Pacific)	*Merluccius productus*	Total	No	G10 (6)	6	1	0.08	0.05	0.12	0.12
Hake (silver)	*Merluccius bilinearis*	Total	No	G10 (1)	1	0	0.06	0	0.06	0.06
Hake (southern)	*Merluccius australis*	Total	No	G10 (62)	62	0	0.13	0.06	0.24	0.40
Hake (unspecified)	*Merluccius sp.*	Total	No	G07 (1) G08 (19) G15 (1)	21	21	0	0	0	0
Hake (unspecified)	*Merluccius sp.*	Total	Yes	G07 (22) G08 (81) G10 (17) G15 (27)	147	21	0.13	0.13	0.41	0.66
Hake (unspecified)	*Merluccius sp.*	Methyl	No	G08 (7) ER (34)	41	12	0.21	0.28	0.90	0.92
Hake (unspecified)	*Merluccius sp.*	Methyl	Yes	G08 (11) ER (34)	45	12	0.20	0.27	0.90	0.92
Hoki	*Macruronus novaezelandiae*	Total	No	G10 (35)	35	0	0.08	0.03	0.14	0.18
All merluccid hake	*Merlucciidae sp.*	Total	No	G07 (1) G08 (19), G10 (104) G15 (1)	125	22	0.09	0.07	0.18	0.40
All merluccid hake	*Merlucciidae sp.*	Total	Yes	G07 (22), G08 (145) G10 (121) G15 (27)	315	22	0.13	0.11	0.34	0.66
All merluccid hake	*Merlucciidae sp.*	Methyl	No	G08 (7) ER (34)	41	12	0.21	0.28	0.90	0.92
All merluccid hake	*Merlucciidae sp.*	Methyl	Yes	G08 (11) ER (34)	45	12	0.20	0.27	0.90	0.92

Footnote. ER: WHO European Region

142. The average annual capture production of European hake, southern hake, silver hake, South Pacific hake, Argentine hake, North Pacific hake, Cape hake and hoki all exceeded 9000 tonnes over the 2010-2016 period. The majority of the catch for European hake occurred in one FAO fishing region by countries in the WHO GEMS G07 and G08 cluster diet regions. Similarly the majority of hoki was from one South Pacific fishing regions and taken by a country in the G10 cluster diet region. As the dataset reports results from a number of GEMS cluster diet regions it is likely to be geographically representative for the identified merluccid hake species.

143. For all individual species and the grouping of merluccid hake all averages for total mercury and methylmercury were below 0.3 mg/kg, as a result it can be concluded no ML is required.

European pickerel/ Xander/ Zander (*Sander lucioperca),* Perch (*Perca sp.*), Sauger (*Sander Canadensis*), Yellow walleye/ Yellow pickerel (*Sander vitreus)* and all perch family *(Percidae)*

144. Data for perch (European and yellow), European pickerel, sauger and yellow walleye were extracted from GEMS/Food (Table 31). As all of the extracted species are within the perch family (*Percidae*; taxonomic code: 1,70(14)) a grouping was also possible. White perch (*Morone chrysops)* were classed within bass, nile perch (*Lates niloticus)* and climbing perch (*Anabas testudineus*) were excluded as unrelated. Data points were for total mercury with a proportion having no assay LOD/LOQ values recorded.

145. The average annual capture production of European perch and European pickerel both exceeded 9000 tonnes over the 2010-2016 period. For yellow walleye and yellow perch all of the catch was from one FAO fishing region solely by countries in the WHO GEMS G10 cluster diet region. European pickerel and European perch were caught over four FAO fishing regions by countries in a number of WHO GEMS cluster diets, including G07, G08, G10 and G15. As there is broad coverage of most of the catch regions in the dataset for the perch family it can be considered geographically representative.

Table 31: Summary of occurrence data on total mercury in mg/kg in perch family 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
European pickerel	*Sander lucioperca*	Total	No	G10 (16)	16	3	0.06	0.03	0.11	0.11
Perch (European)	*Perca fluviatilis*	Total	No	G08 (1) G10 (1) G15 (1)	3	2	0.02	0.04	0.06	0.07
Perch (European)	*Perca fluviatilis*	Total	Yes	G07 (354) G08 (44) G10 (1) G11 (4), G15 (26)	429	2	0.16	0.12	0.37	0.78
Perch (yellow)	*Perca flavescens*	Total	No	G10 (85)	85	8	0.09	0.07	0.20	0.43
Sauger	*Sander canadensis*	Total	No	G10 (12)	12	0	0.28	0.09	0.45	0.52
Yellow walleye	*Sander vitreus*	Total	No	G10 (326)	329	1	0.28	0.15	0.54	0.93
All perch family	Percidae sp.	Total	No	G08 (1) G10 (431) G15 (1)	433	17	0.23	0.16	0.50	0.93
All perch family	Percidae sp.	Total	Yes	G07 (354) G08 (44) G10 (431, G11 (4), G15 (26)	871	17	0.20	0.14	0.49	0.93

146. All mean values for total mercury fell below 0.3 mg/kg for all of the individual species and for the perch family grouping. It can be concluded that no MLs are necessary.

Wolffish/ Sea catfish (*Anarhichas sp*)

147. Data for wolffish (Atlantic, northern, spotted and unspecified) were extracted from GEMS/Food (Table 32). The wolffish family *(anarhichadidae*; taxonomic code: 1,71(02)) contains two genera *Anarhichas* and *Anarrhichthys*. Wolf eel (*Anarrhichthys ocellatus*) is monotypic for the latter genus, but was not represented in the extracted data, therefore grouping to a family level was not performed, with grouping only to the *Anarhichas* genus (taxonomic code: 1,71(02)001). Data points were for both total mercury and methylmercury, with a proportion having no assay LOD/LOQ values recorded.

148. The average annual capture production of Atlantic wolfish, northern wolfish and spotted wolfish all exceeded 9000 tonnes over the 2010-2016 period. Catch for all three species was limited to two North Atlantic FAO fishing regions, with the majority caught by countries in the WHO GEMS G07 and G10 cluster diet regions. As a result, the dataset for wolffish is considered geographically representative in trade.

149. All mean values for total mercury and methylmercury fell below 0.3 mg/kg for all of the individual species and for the grouping. It can be concluded that no MLs are necessary.

Table 32: Summary of occurrence data on total mercury and methylmercury in mg/kg in wolffish 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
Wolffish (Atlantic)	*Anarhichas lupus*	Total	Yes	G07 (47)	47	0	0.12	0.11	0.09	0.29
Wolffish (northern)	*Anarhichas denticulatus*	Total	Yes	G07 (12)	12	0	0.03	0.02	0.02	0.07
Wolffish (spotted)	*Anarhichas minor*	Total	Yes	G07 (26)	26	0	0.06	0.04	0.06	0.14
Wolffish (unspecified)	*Anarhichas sp.*	Total	No	G08 (24) G10 (7) G15 (5)	36	36	0	0	0	0
Wolffish (unspecified)	*Anarhichas sp.*	Total	Yes	G08 (27) G10 (7) G11 (2) G15 (30)	67	36	0.10	0.24	0.04	0.75
Wolffish (unspecified)	*Anarhichas sp.*	Methyl	Yes	G08 (1)	1	0	0.12	0	0.12	0.12
All wolffish	*Anarhichas sp.*	Total	No	G08 (24) G10 (7) G15 (5)	36	36	0	0	0	0
All wolffish	*Anarhichas sp.*	Total	Yes	G07 (86) G08 (27) G10 (7) G11 (2) G15 (30)	152	36	0.10	0.17	0.04	0.51
All wolffish	*Anarhichas sp.*	Methyl	Yes	G08 (1)	1	0	0.12	0	0.12	0.12

Pacific Ocean Perch/ Pacific rockfish (*sebastes alutus*), Redfish (*Sebastes fasciatus* and *Sebastes mentella)*, Rosefish/golden red fish (*Sebastes marnius*) and all rockfish (*Sebastes sp*.)

150. Data for Pacific ocean perch, redfish (Arcadia and beaked), rosefish and rockfish were extracted from GEMS/Food (Table 33). Only species within the *Sebastes* genus (taxonomic code: 1,78(01)001) were identified, although samples within the unspecified rockfish entries may have been from other species in the broader rockfish (*Scorpaenidae*) family. The validity of grouping the dataset as a family is therefore unknown and grouping was only undertaken to a genus level. Data points were for total mercury with a proportion having no assay LOD/LOQ values recorded.

Table 33: Summary of occurrence data on total mercury in mg/kg in rockfish 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**
Pacific ocean perch	*Sebastes alutus*	Total	No	G10 (5)	5	0	0.08	0.03	0.12	0.13
Redfish (Arcadia)	*Sebastes fasciatus*	Total	No	G10 (2)	2	0	0.12	0.02	0.13	0.13
Redfish (beaked/unspecified)	*Sebastes mentella*	Total	No	G10 (51)	51	15	0.08	0.08	0.22	0.36
Redfish (beaked unspecified)	*Sebastes mentella*	Total	Yes	G07 (7) G10 (51)	58	15	0.09	0.08	0.25	0.36
Rosefish	*Sebastes norvegicus*	Total	Yes	G07 (18) G10 (1)	19	0	0.14	0.07	0.25	0.27
Rockfish (unspecified)	*Sebastes sp. (unspecified)*	Total	No	G10 (92)	92	1	0.27	0.22	0.70	1.26
All rockfish	*Sebastes sp.*	Total	No	G10 (151)	151	16	0.20	0.20	0.60	1.26
All rockfish	*Sebastes sp.*	Total	Yes	G07 (25) G10 (151)	176	16	0.19	0.19	0.59	1.26

151. The average annual capture production of Pacific ocean perch, golden redfish, beaked redfish and unspecified Atlantic redfish species all exceeded 9000 tonnes over the 2010-2016 period. Catch for rosefish, beaked redfish and unspecified redfish was largely limited to two North Atlantic FAO fishing regions, with the majority caught by countries in the WHO GEMS G07 and G10 cluster diet regions. As a result the dataset for rockfish is considered geographically representative.

152. All mean values for total mercury fell below 0.3 mg/kg for all of the individual species and for the grouping. It can be concluded that no MLs are necessary.

Australasian snapper / silver sea bream (*Pagrus auratus*), Axillary seabream (*Pagrus acarne*), Bogue (*Boops boops*), Seabream (*Sparidae sp)* and all Porgies/seabream (*Sparidae sp)*

153. Data for Australasian snapper, bogue and sea bream (axillary and unspecified) were extracted from GEMS/Food (Table 34). As these species are within the porgy/ seabream (*Sparidae*; taxonomic code: 1,70(39)) family a grouping was undertaken. Seabream are distinct from freshwater bream which are considered above within the carp family. Data points were for both total mercury and methylmercury, with all LOD/LOQ values recorded.

Table 34: Summary of occurrence data on total mercury in mg/kg in porgy 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
Australasian snapper	*Pagrus auratus*	Total	No	G10 (64)	64	0	0.12	0.17	0.25	1.21
Bouge	*Boops boops*	Total	No	G10 (1)	1	0	0.09	0	0.09	0.09
Seabream (Axillary)	*Pagellus acarne*	Total	No	G10 (4)	4	1	0.07	0.06	0.15	0.17
Seabream (unspecified)	*Sparidae sp.*	Total	No	G10 (10)	10	0	0.20	0.10	0.36	0.43
Seabream (unspecified)	*Sparidae sp.*	Methyl	No	G10 (10)	10	0	0.17	0.09	0.33	0.37
All porgies	*Sparidae sp.*	Total	No	G10 (79)	79	1	0.13	0.16	0.28	1.21
All porgies	*Sparidae sp.*	Methyl	No	G10 (10)	10	0	0.17	0.09	0.33	0.37

154. The average annual capture production of Australasian snapper, black seabream, bogue and unspecified seabream all exceeded 9000 tonnes over the 2010-2016 period. For Australasian seabream the majority of the catch was from two FAO fishing regions by countries in the WHO GEMS G10 cluster diet region. Additionally for this species there was a significant aquaculture production by a country in the G10 cluster diet region. As a result the occurrence dataset is likely geographically representative for this species in trade. However, for other porgy species the catch was widely distributed across FAO fishing regions and by countries in various WHO GEMS cluster diets, the limitation of the occurrence data to only one GEMS cluster diet region means it is unlikely to be geographically representative for these species in trade.

155. All mean values for total mercury and methylmercury fell below 0.3 mg/kg for all of the individual species and for the grouping. It can be concluded that no MLs are necessary.

Grey/common mullet (*Mugil cephalus*) and all Mullet (*Mulidae sp.)*

156. Data for mullet (grey/common and unspecified) were extracted from GEMS/Food (Table 35). As these species are within the mullet (*Mulidae*; taxonomic code: 1,65(01)) family a grouping was undertaken. Data points were for total mercury and methylmercury with a proportion having no assay LOD/LOQ values recorded.

157. The average annual capture production of grey mullet and unspecified mullet species exceeded 9000 tonnes over the 2010-2016 period. The catch was widely distributed across FAO fishing regions, with the majority of grey mullet catch being reported by a country in the WHO GEMS G09 cluster diet region. Additionally grey mullet and unspecified mullet species were a significant aquaculture species, with a large volume of the latter produced by a country in a G06 cluster diet regions. As the occurrence dataset was uploaded by countries in other cluster diet regions it is unknown how geographically representative it is for the species in trade.

158. All mean values for total mercury and methylmercury fell below 0.3 mg/kg for all of the individual species and for the grouping. It can be concluded that no MLs are necessary

Table 35: Summary of occurrence data on total mercury and methylmercury in mg/kg in mullet 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
Grey mullet	*Mugil cephalus*	Total	No	G08 (10) G10 (10)	20	17	0.03	0.05	0.09	0.18
Grey mullet	*Mugil cephalus*	Total	Yes	G07 (2) G08 (12) G10 (43) G15 (3)	60	17	0.14	0.19	0.54	1.00
Grey mullet	*Mugil cephalus*	Methyl	No	G08 (7)	7	7	0	0	0	0
Grey mullet	*Mugil cephalus*	Methyl	Yes	G08 (8)	8	7	0.02	0.05	0.09	0.14
Mullet (unspecified)	*Muglidae sp.*	Total	Yes	G07 (3)	3	0	0.07	0.20	0.10	0.10
All mullet	*Muglidae sp.*	Total	No	G08 (10) G10 (10)	20	17	0.03	0.05	0.09	0.18
All mullet	*Muglidae sp.*	Total	Yes	G07 (5) G08 (12) G10 (43) G15 (3)	63	17	0.14	0.19	0.53	1.00
All mullet	*Muglidae sp.*	Methyl	No	G08 (7)	7	7	0	0	0	0
All mullet	*Muglidae sp.*	Methyl	Yes	G08 (8)	8	7	0.02	0.05	0.09	0.14

Pacific red gurnard/ Bluefin gurnard (*Chelidonichthys kumu)*

159. Data for Pacific red gurnard were extracted from GEMS/Food (Table 36). No other species in the gurnard/sea robin family (*Triglidae*; taxonomic code: 1,78(02)) were identified, as a result no grouping was possible. All data points were for total mercury and had the assay LOD/LOQ values recorded.

160. The average annual capture production for pacific red gurnard did not exceed 9000 tonnes over the 2010-2016 period. Catch occurred in three FAO fishing regions with the majority caught by countries in the WHO GEMS G10 cluster diet region. As a result the occurrence dataset can be considered geographically representative.

Table 36: Summary of occurrence data on total mercury in mg/kg in Pacific red gurnard 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
Pacific red gurnard	*Chelidonichthys kumu*	Total	No	G10 (28)	28	0	0.11	0.12	0.40	0.47

161. The mean values for total mercury for pacific red gurnard fell below the selection criteria of 0.3 mg/kg. It can be concluded that no ML is necessary.

Atlantic herring (*Clupea harengus*), Pacific herring (*Clupea pallasii*), Sardines and Pilchard (various *Clupeidae sp.*) Shad (*Alosa sp.*), Sprat (*Sprattus sp.)* and all Herring/clupeids (*Clupeidae*)

162. Data for herring (Atlantic, Pacific and unspecified), sardines and pilchards, shad and sprat were extracted from GEMS/Food (Table 37). All are species within the herring/clupinid family (*Clupeidae*; taxonomic code: 1,21(05)) so a grouping was undertaken. Data points were for total mercury and methylmercury with a proportion having no assay LOD/LOQ values recorded.

Table 37: Summary of occurrence data on total mercury and methylmercury in mg/kg in herring 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
Herring (Atlantic)	*Clupea harengus*	Total	No	G10 (21)	21	6	0.06	0.05	0.14	0.15
Herring (Pacific)	*Clupea pallasii*	Total	No	G10 (4)	4	0	0.06	0.01	0.08	0.08
Herring (unspecified)	*Clupea sp.*	Total	No	G07 (3)	3	3	0	0	0	0
Herring (unspecified)	*Clupea sp.*	Total	Yes	G07 (1058) G08 (73) G15 (143)	1274	3	0.04	0.03	0.08	0.4
Herring (unspecified)	*Clupea sp.*	Methyl	No	ER (2)	2	1	0.05	0.07	0.10	0.10
Herring (unspecified)	*Clupea sp.*	Methyl	Yes	G08 (39), ER (8)	47	1	0.03	0.02	0.06	0.10
Sardines and pilchard	*various species*	Total	No	G07 (3), G08 (64), G10 (17), G15 (3), NC (18)	105	89	0.01	0.01	0.03	0.06
Sardines and pilchard	*various species*	Total	Yes	G07 (12), G08 (200), G10 (38), G11 (1), G15 (150) NC (18)	464	72	0.04	0.10	0.12	2.00
Sardines and pilchard	*various species*	Methyl	No	G08 (14), G10 (10), ER (46)	70	34	0.06	0.19	0.12	0.95
Sardines and pilchard	*various species*	Methyl	Yes	G08 (16), G10 (10), ER (46)	72	34	0.06	0.19	0.12	0.95
Shad	*Alosia sp.*	Total	Yes	G10 (1)	1	0	0.17	0	0.17	0.17
Sprat	*Sprattus sp.*	Total	No	G07 (1)	1	1	0	0	0	0

Common name	*Species*	Total or methyl mercury	Includes data points without LOQs	Region	Total records	Non-detects	Mean	SD	P95	Max
Sprat	*Sprattus sp.*	Total	Yes	G07 (47), G08 (7), G10 (30), G11 (1), G15 (22)	107	1	0.02	0.02	0.05	0.12
Sprat	*Sprattus sp.*	Methyl	No	ER (1)	1	1	0	0	0	0
Sprat	*Sprattus sp.*	Methyl	Yes	G08 (25), ER (1)	26	1	0.01	<0.01	0.02	0.02
All herring	*Clupeidae sp.*	Total	No	G07 (7), G08 (64), G10 (42), G15 (3), NC (18)	134	99	0.01	0.03	0.07	0.15
All herring	*Clupeidae sp.*	Total	Yes	G07 (1117) G08 (280) G10 (94), G11 (2), G15 (315) NC (18)	1871	99	0.04	0.05	0.09	2.00
All herring	*Clupeidae sp.*	Methyl	No	G08 (14), G10 (10), ER (49)	73	36	0.06	0.19	0.12	0.95
All herring	*Clupeidae sp.*	Methyl	Yes	G08 (80), G10 (10), ER (55)	145	36	0.04	0.13	0.11	0.95

Footnote. ER: WHO European Region; NC: Country not classified within GEMS cluster diets.

163. The average annual capture production of Atlantic herring, Pacific herring, Japanese pilchard, California pilchard, South African pilchard, Sardine, European sprat and Falkland sprat exceeded 9000 tonnes over the 2010-2016 period.

164. All mean values for total mercury and methylmercury fell below 0.3 mg/kg for all of the individual species and for the grouping. It can be concluded that no MLs are necessary.

Kahawai/ Australian Salmon (*Arripis trutta*)

165. Data for Kahawai were extracted from GEMS/Food (Table 38). No other species in the same family (*Arripidae*; taxonomic code: 1,70(29)) were identified, as a result no grouping was possible. All data points were for total mercury and had the assay LOD/LOQ values recorded.

Table 38: Summary of occurrence data on total mercury in mg/kg in kahawai 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
Kahawai	*Arripis trutta*	Total	No	G10 (60)	60	0	0.24	0.10	0.38	0.65

166. The average annual capture production for kahawai did not exceed 9000 tonnes over the 2010-2016 period. The catch was limited to two fishing regions, with a greater than 50% share reported by a country in the WHO GEMS G10 cluster diet region. As a result, the dataset can be considered geographically representative for the species in trade.

167. The mean values for total mercury for kahawai fell below the selection criteria of 0.3 mg/kg. It can be concluded that no MLs are necessary.

Blue moki (*Latridopsis ciliaris)*

168. Data for blue moki were extracted from GEMS/Food (Table 39). No other species in the trumpeter family (*Latridae*; taxonomic code: 1,70(71))) were identified, as a result no grouping was possible. All data points were for total mercury and had the assay LOD/LOQ values recorded.

Table 39: Summary of occurrence data on total mercury in mg/kg in blue moki 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
Blue moki	*Latridopsis ciliaris*	Total	No	G10 (35)	35	0	0.12	0.10	0.17	0.64

169. No production statistics were available for blue moki.

170. The mean values for total mercury for blue moki fell below the selection criteria of 0.3 mg/kg. It can be concluded that no ML is necessary.

Rays and Skates (*Rajiformes*)

171. Data for rays and skates were extracted from GEMS/Food (Table 40). No individual species of ray or skate were identified in the dataset so the data is grouped at an order level (*Rajiformes*; taxonomic code 1,10). All data points were for total mercury, the majority had no LOD/LOQ values reported.

172. No individual identified species of ray or skate exceed an annual capture production quantity of 9000 tonnes over the 2010-2016 period, however the total for all unspecified rays and skates was far in excess of 9000 tonnes. The catch was widely distributed across FAO fishing regions and by countries in various WHO GEMS cluster diets, as a result the occurrence data is unlikely to be geographically representative.

173. The mean values for total mercury for rays and skate combined fell below the selection criteria of 0.3 mg/kg. It can be concluded that no ML is necessary.

Table 40: Summary of occurrence data on total mercury in mg/kg in ray 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
Rays	*Rajiformes sp.*	Total	No	G07 (1)	1	1	0	0	0	0
Rays	*Rajiformes sp.*	Total	Yes	G07 (33) G08 (1) G10 (13) G15 (8)	55	1	0.20	0.32	1.00	1.60
Skate	*Rajiformes sp.*	Total	No	G10 (17)	17	2	0.13	0.11	0.29	0.49
All rays and skate	*Rajiformes sp.*	Total	No	G07 (1) G10 (17)	18	3	0.12	0.11	0.26	0.49
All rays and skate	*Rajiformes sp.*	Total	Yes	G07 (33) G08 (1) G10 (30) G15 (8)	72	3	0.18	0.28	0.69	1.60

Rays bream/Atlantic pomfret (*Brama brama) and* Reineta/ Southern Rays bream (*Brama australis*)

174. Data for rays bream and reineta was extracted from GEMS/Food (Table 41). No other species in the pomfret family (*Bramidae*; taxonomic code: 1,70(27)) were identified, as a result grouping was only undertaken to a genus level (*Brama*: taxonomic code: 1,70(27)003). All data points were for total mercury and had the assay LOD/LOQ values recorded.

Table 41: Summary of occurrence data on total mercury in mg/kg in ray and skate 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
Rays bream	*Brama brama*	Total	No	G10 (30)	30	0	0.08	0.05	0.16	0.29
Reineta	*Brama australis*	Total	No	G05 (1)	1	1	0	0	0	0
Pomfrets (Brama)	*Brama sp.*	Total	No	G05 (1) G10 (30)	31	1	0.07	0.05	0.15	0.29

175. The average annual capture production of rays bream and reineta exceeded 9000 tonnes over the 2010-2016 period. The catch of reineta was limited to one FAO fishing region, predominantly by a country in the WHO GEMS G05 cluster diet region. Rays bream was caught from number of FAO fishing regions by countries in various WHO GEMS cluster diets. The dataset for pomfrets is unlikely to be geographically representative.

176. All mean values for total mercury fell below 0.3 mg/kg for all of the individual species and for the grouping. It can be concluded that no MLs are necessary.

Red cod/ Red codling (*Pseudophycis bachus)*

177. Data for red cod were extracted from GEMS/Food (Table 42). Red cod is in the morid cod (*Moridae*; taxonomic code: 1,48(02)) family, separate from other cod so the data was analysed separately. No other species in the morid cod family were identified, as a result no grouping was possible. All data points were for total mercury and had the assay LOD/LOQ values recorded.

178. The average annual capture production for red cod did not exceed 9000 tonnes over the 2010-2016 period. The catch was limited to one fishing region, all by a country in the WHO GEMS G10 cluster diet region. As a result, the dataset can be considered geographically representative for this species in trade.

Table 42: Summary of occurrence data on total mercury in mg/kg in red cod 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
Red cod	*Pseudophycis bachus*	Total	No	G10 (23)	23	0	0.06	0.04	0.14	0.14

179. The mean value for total mercury for red cod fell below the selection criteria of 0.3 mg/kg. It can be concluded that no ML is necessary.

Redbait/ Cape bonnetmouth (*Emmelichthys nitidus)*

180. Data for redbait were extracted from GEMS/Food (Table 43). No other species in the rover family (*Emmelichthyidae*; taxonomic code: 1,70(30)) were identified, as a result no grouping was possible. All data points were for total mercury and had the assay LOD/LOQ values recorded.

Table 43: Summary of occurrence data on total mercury in mg/kg in redbait 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
Redbait	*Emmelichthys nitidus*	Total	No	G10 (33)	33	0	0.15	0.07	0.28	0.30

181. The average annual capture production for redbait did not exceed 9000 tonnes over the 2010-2016 period. The catch was limited to two fishing regions with the majority of the catch reported by a country in the WHO GEMS G10 cluster diet region. As a result, the dataset can be considered geographically representative for this species in trade.

182. The mean values for total mercury for redbait fell below the selection criteria of 0.3 mg/kg. It can be concluded that no ML is necessary.

Char (*Salvelinus sp.*), Cisco and whitefish (*Coregonus sp.*), Inconnu (*Stenodus nelba*), Salmon and Trout (*Salmo and Oncorhyncus sp.*); and all salmonids (*Salmonidae)*

183. Data for char (Arctic and unspecified), ciscso, inconnu, salmon (Atlantic, chinook, chum, coho, pink, sockeye and Pacific unspecified), trout (lake, rainbow/ steelhead salmon, unspecified), combined trout and salmon, and whitefish were extracted from GEMS/Food (Table 44). All are species within the salmonid family (*Salmonidae*; taxonomic code: 1,23(01)) so a grouping was undertaken. Whitefish was interpreted as *Coregonus sp.* based on the metadata, although it is noted this could also be a common name term for fish meat to contrast against oily fish. Lake trout could be either *Salmo trutta* or *Salvelinus namaycush*, however both are within the salmonid family. Data points were for total mercury and methylmercury with a proportion having no assay LOD/LOQ values recorded.

184. The average annual capture production over 2010-2016 exceeded 9000 tonnes for chum salmon, sockeye salmon, chinook salmon, coho salmon and unspecified salmonid species. Catch was distributed primarily across four FAO fishing regions, with the large majority by countries in the WHO GEMS G10 cluster diets. Three species were significant in aquaculture, Atlantic salmon being produced predominantly by a country in the G07 cluster diet region, Chinook salmon by a country in the G10 cluster diet region and Rainbow trout with a large volume of aquaculture production across a range of countries. As there is a broad representation of countries in the salmonid dataset the data can be considered geographically representative.

185. All mean values for total mercury and methyl mercury fell below 0.3 mg/kg for all of the individual species and for the salmonid grouping. The ratio of methylmercury to total mercury across the salmonid grouping was approximately 75%. It can be concluded that no MLs are necessary.

Table 44: Summary of occurrence data on total mercury and methylmercury in mg/kg in salmonid 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
Char (Arctic)	*Salvelinus alpinus*	Total	No	G10 (12)	12	3	0.03	0.03	0.07	0.08
Char (unspecified)	*Salvelinus sp.*	Total	Yes	G07 (8)	8	0	0.03	0.01	0.04	0.04
Char (unspecified)	*Salvelinus sp.*	Methyl	No	ER (8)	8	0	0.02	0.01	0.03	0.03
Cisco	*Coregonus sp.*	Total	No	G10 (3)	3	1	0.06	0.04	0.10	0.10
Inconnu	*Stenodus nelba*	Total	No	G10 (3)	3	0	0.13	0.02	0.14	0.14
Salmon (Atlantic)	*Salmo sabar*	Total	No	G07 (1) G10 (70) NC (2)	73	31	0.03	0.05	0.05	0.07
Salmon (Atlantic)	*Salmo sabar*	Total	Yes	G07 (3) G10 (70) NC (2)	75	31	0.03	0.03	0.05	0.08
Salmon (chinook)	*Oncorhynchus tshawytscha*	Total	No	G10 (8)	8	0	0.07	0.02	0.09	0.10
Salmon (chum)	*Oncorhynchus keta*	Total	No	G10 (5)	5	3	0.02	0.02	0.05	0.05
Salmon (coho)	*Oncorhynchus kisutch*	Total	No	G10 (6)	6	3	0.02	0.02	0.05	0.05
Salmon (pink)	*Oncorhynchus gorbuscha*	Total	No	G10 (5)	5	3	0.01	0.01	0.02	0.02
Salmon (sockeye)	*Oncorhynchus nerka*	Total	No	G10 (10)	10	5	0.03	0.03	0.06	0.06
Salmon (Pacific unspecified)	*Oncorhyncus sp.*	Total	No	G05 (2) G10 (12) NC (1)	15	7	0.03	0.03	0.08	0.14
Salmon (Pacific unspecified)	*Oncorhyncus sp.*	Methyl	No	C10 (10)	10	0	0.04	0.03	0.09	0.13
Trout (lake)	*Salmo trutta*	Total	No	G10 (44)	44	0	0.21	0.10	0.39	0.58
Trout (rainbow)	*Oncorhynchus mykiss*	Total	No	G07 (48) G10 (36)	84	61	0.01	0.02	0.05	0.10
Trout (rainbow)	*Oncorhynchus mykiss*	Total	Yes	G07 (457) G10 (36)	493	61	0.05	0.06	0.10	0.86
Trout (rainbow)	*Oncorhynchus mykiss*	Methyl	No	G10 (10)	10	0	0.01	0	0.02	0.02
Trout (unspecified)	*Salmo and oncorhyncus sp.*	Total	No	G07 (1) G10 (4)	5	1	0.04	0.02	0.05	0.05
Trout (unspecified)	*Salmo and oncorhyncus sp.*	Total	Yes	G07 (4) G10 (4)	8	1	0.04	0.02	0.05	0.06
Combined salmon and trout	*Salmo and oncorhyncus sp.*	Total	No	G07 (56) G08 (91) G10 (5) G15 (1)	153	153	0	0	0	0

Common name	*Species*	Total or methyl mercury	Includes data points without LOQs	Region	Total records	Non-detects	Mean	SD	P95	Max
Combined salmon and trout	*Salmo and oncorhyncus sp.*	Total	Yes	G07 (1138) G08 (380) G10 (12) G11 (2), G15 (209)	1741	153	0.03	0.03	0.06	0.95
Combined salmon and trout	*Salmo and oncorhyncus sp.*	Methyl	No	G08 (14) ER (45)	69	28	0.03	0.04	0.11	0.11
Combined salmon and trout	*Salmo and oncorhyncus sp.*	Methyl	Yes	G08 (15) G15 (13) ER (45)	83	28	0.03	0.04	0.11	0.11
Whitefish	*Coregonus sp.*	Total	No	G08 (6) G10 (89)	95	17	0.07	0.15	0.13	1.43
Whitefish	*Coregonus sp.*	Total	Yes	G07 (11) G08 (26) G10 (89)	126	17	0.08	0.13	0.16	1.43
All salmonids	*Salmonidae sp.*	Total	No	G05 (2) G07 (106) G08 (97) G10 (312) G15 (1) NC (3)	521	288	0.04	0.09	0.18	1.43
All salmonids	*Salmonidae sp.*	Total	Yes	G05 (2) G07 (1621), G08 (406) G10 (319) G11 (2) G15 (209) NC (3)	2562	288	0.04	0.05	0.10	1.43
All salmonids	*Salmonidae sp.*	Methyl	No	G08 (14) G10 (10) ER (53)	97	28	0.03	0.04	0.11	0.13
All salmonids	*Salmonidae sp.*	Methyl	Yes	G08 (15) G10 (1) G15 (13) ER (53)	111	28	0.03	0.04	0.11	0.13

Footnote. ER: WHO European Region; NC: Country not classified in GEMS cluster diets

Conger eel (*Conger sp.*), Pike conger eel (*Muraenesox sp.),* Diadromous Eels (*Anguilla sp.)* and all Eels (*Anguilliformes sp.)*

186. Data for conger eel, pike conger eel, eels (American, longfin, *anguilla* unspecified and unspecified) were extracted from GEMS/Food (Table 45). All eel species are members of the order *Anguilliformes* (taxonomic code: 1,43), as a result all the data points were grouped to an order level. Results for swamp eel (*Synbranchidae sp.*) and cusk-eel were excluded as unrelated, the latter was considered above within the cusk-eel family. A sample for spiny/spotted eel was interpreted as *Mastacembelus armatus* and also excluded as unrelated. A single result of 110 mg/kg for eel (unspecified) was omitted as an extreme outlier. Data points were for total mercury and methylmercury with a proportion having no LOD/LOQ values reported.

Table 45: Summary of occurrence data on total mercury and methylmercury in mg/kg in 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**
Conger eel	*Conger sp.*	Total	No	G07 (2) G10 (8)	6	2	0.13	0.13	0.30	0.34
Conger eel	*Conger sp.*	Total	Yes	G07 (9) G10 (8)	13	2	0.18	0.11	0.33	0.34
Conger pike eel	*Muraenesox sp.*	Total	No	G10 (4)	4	0	0.11	0.11	0.24	0.27
Eel (American)	*Anguilla rostrata*	Total	No	G10 (57)	57	6	0.35	0.34	0.89	1.95
Eel (anguilla unspecified)	*Anguilla sp.*	Total	No	G10 (8)	8	0	0.12	0.05	0.18	0.19
Eel (long-finned)	*Anguilla dieffenbachii*	Total	No	G10 (1)	1	0	0.23	0	0.23	0.23
Eel (unspecified)	*Anguilla sp.*	Total	No	G07 (1) G08 (10) G10 (37)	48	12	0.15	0.16	0.40	0.72
Eel (unspecified)	*Anguilla sp.*	Total	Yes	G07 (34) G08 (211) G10 (65) G11 (217) G15 (2)	528	12	0.18	0.19	0.46	1.90
Eel (unspecified)	*Anguilla sp.*	Methyl	Yes	G08 (8), ER (4)	12	0	0.18	0.14	0.44	0.46
All eels	*All anguilliformes sp.*	Total	No	G07 (3), G08 (10) G10 (111)	124	20	0.24	0.27	0.71	1.95
All eels	*All anguilliformes sp.*	Total	Yes	G07 (43) G08 (211) G10 (140) G11 (217) G15 (2)	611	20	0.19	0.21	0.56	1.95
All eels	*All anguilliformes sp.*	Methyl	Yes	G08 (8) ER (4)	12	0	0.18	0.14	0.44	0.46

Footnote. ER: WHO European Region

187. The average annual capture production for conger eel, daggertooth pike conger and unspecified pike conger exceeded 9000 tonnes over the 2010-2016 period. The majority of conger eel catch was reported in one FAO fishing region by countries in the WHO GEMS G08 cluster diet region. For pike conger eels the majority of the capture production was from one FAO fishing region by a country in the G09 cluster diet region. Capture production of diadromous eels did not exceed 9000 tonnes, however aquaculture production of Japanese eel exceeded 9000 tonnes. The majority of the production was by a country in the G09 cluster diet region. As there is a large proportion of unspecified eel species data it is unknown as to how globally representative the dataset is.

188. Of the eel species only American eel had an average total mercury concentration that exceeded the screening concentration of 0.3 mg/kg. A difficulty in interpreting this species individually, however, is the large proportion of eel data that is unspecified as to a species, of which the results may also represent American eel. Additionally, the degree to which eel may be distinguished by species in trade is unknown.

189. All mean values for total mercury and methylmercury fell below 0.3 mg/kg for the remaining individual eel species and for the *Anguilliformes* grouping. It can be concluded that no MLs are necessary.

APPENDIX IV

COUNTRIES WITH TOTAL MERCURY AND METHYLMERCURY DATA CONSIDERED IN THE ANALYSIS OF FISH, GROUPED BY GEMS/FOOD CLUSTER DIETS[11] (FOR INFORMATION TO CCCF)

G05	G06	G07	G08	G10	G11	G15
Chile	Greece	Finland France Norway United Kingdom	Austria Germany Spain	Canada Cyprus Italy Japan Latvia Malta New Zealand	Netherlands	Czech Republic Denmark Portugal Romania Slovakia Slovenia

[11] GEMS/Food cluster diets 2012 (accessed online at https://www.who.int/foodsafety/chem/cluster_diets_2012.pdf)

APPENDIX V

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