Appendix H. Calculation of the Human Health Objectives

This appendix provides the equations used to derive the water quality objectives to protect human health. This includes different options for the water quality objective that were considered in the issues analysis (Chapter 6 of the Staff Report) for recreational fishing and subsistence fishing. More specifically, in this appendix, calculations are shown for the 1) Sport Fish Water Quality Objective, 2) the Subsistence Fishing Water Quality Objective, and 3) Native American Tribal Subsistence Fishing Water Quality Objective. Also information on the calendar year averaging period is at the end of this appendix (Section H.4).

H.1 Calculation of the Methylmercury Water Quality Objective to Protect Human Health

The water quality objective for human health was calculated using United States Environmental Protection Agency's (U.S. EPA) equation for calculating the fish tissue criterion (U.S. EPA 2001):

$$FTC = \frac{BW*(RfD-RSC)}{FI} \qquad (1)$$

where,

FTC = fish tissue concentration in milligrams (mg) methylmercury (MeHg) per kilogram (kg) fish. **The FTC value is the methylmercury water quality objective.**

BW = human body weight, default value of 70 kg

RfD = reference dose of 0.0001 mg MeHg/kg body weight-day. The value was derived from a study of mothers and their children in the Faroe Islands, where fish and whale is a large part of the diet. The blood mercury concentration in the umbilical cord was correlated to cognitive effects in the children.

RSC = relative source contribution, estimated at 2.7×10^{-5} mg MeHg/kg body weight-day. This value is subtracted from the reference dose to account for other sources (e.g., store bought marine fish).

FI = fish intake (kg fish/day), which is the consumption rate of locally caught fish (see Section H.2).

H.2 Fish Consumption Rate

The U.S. EPA provided values for all parameters in equation 1 including a fish intake rate of 17.5 grams per day (g/day) based on national data to derive the methylmercury criterion of 0.3 mg/kg. However, the U.S. EPA encourages modification of the fish intake rate to protect the population of concern (U.S. EPA 2001). Also, the U.S. EPA "strongly believes that States and authorized Tribes should … develop criteria, on a site-specific basis, that provide additional protection appropriate for highly exposed populations" (U.S. EPA 2000). Therefore, alternative fish consumption rates for the water quality objectives for California were considered. To protect the majority of the population U.S. EPA recommends using the 90 and 95th percentiles from fish consumption surveys, as opposed to average rates (e.g. arithmetic mean, median, geometric mean).

At least two dozen fish consumption studies have been carried out in California. For a complete list of California fish consumption studies, see Appendix G. Table H-1 shows fish consumption rates used as options for the statewide mercury objectives and other consumption rates used by U.S. EPA and other state are shown for comparison (discussed in the Staff Report, Sections 6.2 and 6.5).

U.S. EPA derived the recommended methylmercury water quality criterion using a default fish intake rate for the general population of 17.5 g/day (U.S. EPA 2001). The data was originally from surveys, titled, *Continuing Survey of Food Intakes by Individuals* (CSFII), which are conducted annually by the United States Department of Agriculture. U.S. EPA summarized the methods and results of the 1994-1996 and 1998 CSFII surveys in a report titled, *Estimated per capita fish consumption in the United States* (U.S. EPA 2002). The rate of 17.5 g/day represents general U.S. consumption (90th percentile) for people who do and do not eat fish. From that same data set U.S. EPA derived a default fish subsistence consumption rate of 142 g/day (Table H-1).

Table H-1 also includes California's most often used fish consumption rate from the San Francisco Bay Seafood Consumption Survey (San Francisco Estuary Institute 2001). This study recognized as one of the best and largest surveys to date in California, and is the basis of the one meal a week fish consumption rate that has been used in the past by Water Boards and other agencies. This study was used to derive Fish Contaminant Goals by the Office of Environmental Health Hazard Assessment (described in Appendix E). The one fish meal a week rate has also been used to establish a site-specific water quality objective for San Francisco Bay and the Sacramento-San Joaquin Delta. The San Francisco Bay study did not specifically target recreational fishers or subsistence fishers, but surveyed anyone fishing at the time of the survey.

Also included in Table H-1 is the recently established fish consumption rate for Oregon and rates proposed for Washington and Maine, which are much higher rates (five to nine meals per week) than has been used in the past. Another study listed in Table H-1 is the Santa Monica Bay study, which was considered the best study to date in California (Office of Environmental Health Hazard Assessment 2001) until the San Francisco Bay study was published. The Santa Monica Bay study includes more ocean fish, while the geographic scope of this project does not include ocean waters.

Table H-1. Selected Fish Consumption Rates

Type/Source	Fish consumption rate in grams per day (g/day)	Equivalent 8 oz. meals/week of locally caught fish	Resulting Water Quality Objective (mg MeHg/kg fish)
General U.S. population (U.S. EPA 2000)	17.5	0.5**	0.3*
San Francisco Bay anglers (San Francisco Estuary Institute 2001),	32*	1**	0.2*
1991-92 Santa Monica Bay (Allen et al. 1996)	107	3**	0.05*
Subsistence, U.S. population (U.S. EPA 2000)	142*	4.4	0.05
California Tribes - contemporary (Shilling et al. 2014)	142*	4.4**	0.04*
California Tribes: two generation ago (Shilling et al. 2014)	223	7	0.03
Oregon, including Columbia River Tribes (Oregon Department of Environmental Quality 2011)	175	5-6	0.04
Proposed by U.S. EPA for Washington State (80 FR 55063, September 14, 2015)	175	5-6**	0.03*
Proposed by U.S. EPA for Maine (81 FR 23239, April 20, 2016)	286	9	0.02***

*Included in the options analysis in Sections 6.2 and 6.5 of the Staff Report.

**Indicates an additional small portion of store bought fish is included in the relative source contribution (equation 1), which is not included in the estimate of "Equivalent 8 oz. meals/week of locally caught fish".

***For Maine, the U.S. EPA proposed to use trophic-specific fish consumption rates of 103 g/day (trophic level 2), 114 g/day (trophic level 3), and 68.6 g/day (trophic level 4).

Table H-2A. Variables Used for Calculation of the Mercury Objective and the Possible Resulting Objectives

FI (kg/day)	Rfd (mgMeHg/ kg bw *day)	RSC (mgMeHg/ kg bw *day)	BW (kg)	Resulting Water Quality Objective (mg MeHg/kg fish)	Aprox. Meals Per Week Protected
0.0175	0.0001	0.000027	70	0.29	0.5*
0.032	0.0001	0.000027	70	0.16[1]	1*
0.142	0.0001	0	70	0.049[2]	4.4
0.142	0.0001	0.000027	70	0.036[3]	4.4*
0.182	0.0001	0	70	0.038	5.6
0.223	0.0001	0	70	0.031	7
0.175	0.0001	0	70	0.040	5
0.107	0.0001	0.000027	70	0.048	3*

*also includes an additional moderate amount of store-bought fish that is not included in the "Aprox. Meals Per Week Protected".

[1] The Sport Fish Water Quality Objective in the Provisions

[2] The Subsistence Fishing Water Quality Objective in the Provisions

[3] The Native American Tribal Subsistence Fishing Water Quality Objective in the Provisions

Table H-2B. The Effect of a Greater Body Weight Value on the Possible Resulting Objectives

FI (kg/day)	Rfd (mgMeHg/ kg bw *day)	RSC (mgMeHg/ kg bw *day)	BW (kg)	Resulting Water Quality Objective (mg MeHg/kg fish)	Aprox. Meals Per Week Protected
0.0175	0.0001	0.000027	80	0.33	0.5*
0.032	0.0001	0.000027	80	0.18	1*
0.142	0.0001	0	80	**0.056**	4.4
0.142	0.0001	0.000027	80	0.041	4.4*
0.182	0.0001	0	80	0.044	5.6
0.223	0.0001	0	80	**0.036**	7
0.175	0.0001	0	80	**0.046**	5
0.107	0.0001	0.000027	70	0.0546	3*

Table H-2A shows all values used to derive possible water quality objectives based on the various consumption rates from Table H-1. The resulting values used for the water quality objectives in the Provisions are indicated by footnotes. For some of the calculations the relative source contribution (see equation 1) was set at zero because it was assumed that the population was not consuming store bought fish, such as for some subsistence fishing values. If the reference suggested that the population also bought a smaller portion of fish, then the standard value used by U.S. EPA for the relative source contribution was included in the calculation of the possible resulting water quality objective and is shown in Table H-2A.

U.S. EPA has recently revised some of the standard parameters used for calculating human health water quality criteria. They have increased the body weight from 70 to 80 kg to reflect the increasing weight of the U.S. population. U.S. EPA has not yet updated the national recommended mercury criterion with the change in body weight. To test how this change would affect the resulting possible objective, the 80 kg body weight was used to re-calculate the possible water quality objectives in Table H-2B. Overall, the resulting possible objectives did not change much when using the 80 kg body weight vs. 70 kg. Only the results for three of the eight possible values for the objective slightly increased (shown in bold in H2-B). The comparison was made considering that the final objective will be expressed with only one significant digit as is the U.S. EPA criterion. For more information on the increase of the average weight of a person to 80 kg. see http://water.epa.gov/scitech/swguidance/standards/criteria/health/.

Of the options listed in Table H-2A, the issues analysis (Section 6 of the Staff Report) only considers the first four options. For the objective for tribal subsistence fishing, the contemporary rate for tribes was used, which is the same as the U.S. EPA nationally recommended subsistence rate. With store bought fish included, the objective calculated from the contemporary rate (0.04 mg/kg) was close to the objective calculated from the traditional rate (0.03 mg/kg). The last four values, including those from Oregon and an older California study (Allen et al. 1996) are provided for comparison.

H.3 Application of the Objective to Mixed Consumption Patterns

H.3.1 Trophic Level Averaging During Data Assessment

The way that the water quality objective is applied to trophic level 3 and trophic level 4 fish affects how stringent the objective will be. This is because trophic level 4 fish species, such as bass and catfish, accumulate more mercury than trophic level 3 species, such as trout, anadromous salmon, and carp (Figures H-1 and Figure H-2), since these species are highest on the food chain (see Section 4.2 of the Staff Report). Applying the objective to only trophic level 4 fish is more stringent than applying the objective to only trophic level 3 fish, because trophic level 4 fish have higher concentrations of mercury in the tissue than trophic level 3 fish. Applying the objective to a mixture of trophic level 3 and trophic level 4 fish is a middle level of stringency. Using a mixed consumption (a mixture of trophic level 3 and trophic level 4 fish) may better represent the population being protected and could save valuable resources by making the objective easier to achieve (making the objective less stringent).

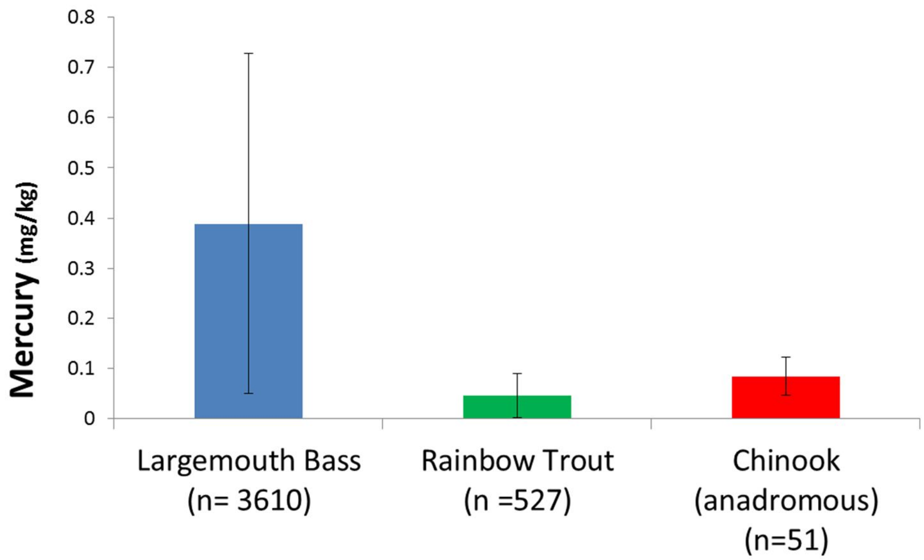

Figure H-1. Mercury concentrations in largemouth bass, rainbow trout, anadromous chinook salmon in California. Largemouth bass and trout were 150-500 mm. Chinook were 500-1000 mm. Data from ceden.org.

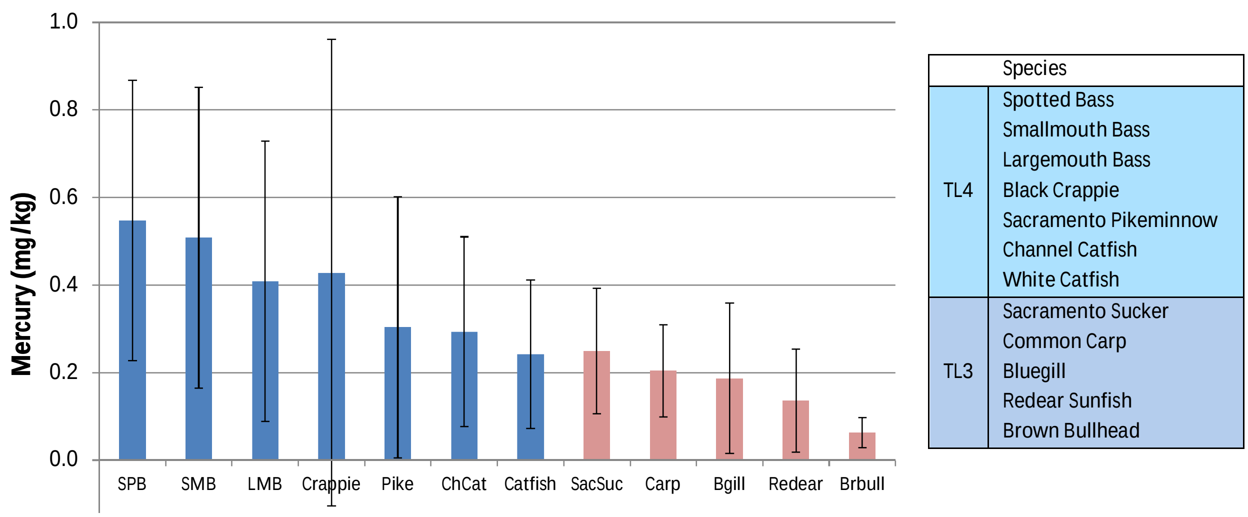

Figure H-2. Average mercury concentrations in California warm water fish. Trophic level 4 species (blue) generally have mercury concentrations that are twice as high as trophic level 3 species (pink). Data are from ceden.org and described in (Appendix L). Error bars represent standard deviation.

U.S. EPA advises "If target populations consume fish from different trophic levels, the state or authorized tribe should consider factoring the consumption by trophic level when computing the average methylmercury concentration in fish tissue. To take this approach, the state or authorized tribe would need some knowledge of the fish species consumed by the general population so that the state or authorized tribe could perform the calculation using only data for fish species that people commonly eat" (U.S. EPA 2010). This U.S. EPA advice specifically describes how to treat a data set for measuring compliance with the objective. The average fish tissue concentration (FTC_{ave}) of mercury in trophic level 3 and trophic level 4 fish would be calculated and compared to the objective using the equations:

$$([HgTL4] \times \%TL4) + ([HgTL3] \times \%TL3) \quad = \quad FTC_{ave} \qquad (2)$$

where,

%TL3 = percent of trophic level 3 fish in diet from an angler survey
%TL4 = percent of trophic level 4 fish in diet from an angler survey
[Hg TL3] = average measured mercury concentration in trophic level 3 fish
[Hg TL4] = average measured mercury concentration in trophic level 4 fish
FTC_{ave} = the resulting average fish tissue concentration

Ultimately this approach is not recommended for statewide application of the objective to protect recreational fishing (the Sport Fish Water Quality Objective). This is because some people eat mostly trophic level 4 fish and it will be difficult to ensure protection of wildlife (see Staff Report, Section 6.3 and Section H.3.2 through Section H.3.6).

For a subsistence fishing-type water quality objective, this approach (incorporating a mixed consumption pattern during data assessment) is the recommended way to incorporate a mixed consumption pattern. Another approach is described in the Sections H.3.2 through – Section H.3.5, in which two objectives are derived. Section H.3.6 describes how the approach described in this section is preferable since it includes less assumptions and uncertainty vs. the approach described in Section H.3.2 through – Section H.3.5.

H.3.2 Separate Objectives for Different Trophic Levels

Evidence that people eat fish from different trophic levels can also be used with equation 2 to separate the water quality objective into two water quality objectives: one for trophic level 3 species and another for trophic level 4 species. For example, the objective for the Sacramento San Joaquin Delta was applied to a 50:50 mixture of trophic level 3 and trophic level 4 fish and different objectives were derived for the two types of fish: 0.24 mg/kg in trophic level 4 fish and 0.08 mg/kg in trophic level 3 fish.

To do this calculation, a ratio is required of the mercury concentrations trophic level 3 and trophic level 4 fish. For the Delta, the mercury concentration in trophic level 4 fish was 3 times higher than the trophic level 3 fish, so the ratio was 3 (Central Valley Water Board 2010). Objectives can be derived for specific trophic levels with the following equations, (equation 3 is similar to equation 2):

$$FTC_{ave} = ([HgTL4] \times \%TL4) + ([HgTL3] \times \%TL3) \qquad (3)$$

substituting [HgTL4] = (R4/3) × [HgTL3]

$$FTC_{ave} = ([HgTL3] \times (R4/3) \times \%TL4) + ([HgTL3] \times \%TL3) \qquad (4)$$

solving for [HgTL3]

$$[HgTL3] = FTC_{ave} / [(\%TL4) \times (R4/3) + ((\%TL3)] \qquad (5)$$

where,

%TL3 = percent of trophic level 3 fish in diet from an angler survey
%TL4 = percent of trophic level 4 fish in diet from an angler survey
[Hg TL3] = allowable mercury concentration in trophic level 3 fish
[Hg TL4] = allowable mercury concentration in trophic level 4 fish
FTC_{ave} = Average fish tissue concentration, from equation 1, based on a given consumption rate.
R4/3 = the ratio of the average measured mercury concentration in trophic level 4 fish to the average measured mercury concentration in trophic level 3 fish.

U.S. EPA estimates trophic level 3 fish have four times less mercury than trophic level 4 fish (U.S. EPA 2001, Appendix A: Draft national methylmercury bioaccumulation factors). An analysis of California fish mercury data (using all data available for the whole state) found that trophic level 4 fish have mercury concentrations two times higher than the mercury concentration in the trophic level 3 fish in the same waters (Appendix L)[20]. However, this California ratio was based on a limited data set. Most of the data were from the Central Valley, which are warm water fisheries most suitable for species of bass, catfish, perch, crappie, and sunfish. This ratio is not very applicable to waters with trout. The proportion of waters that have trout only or a mixture of trout and bass can be estimated from existing monitoring data. Of currently monitored waters, 5% of waters have both trout and bass, while 36% have only trout. The remaining 59% of the waters sampled did not have trout, but had bass (www.ceden.org, see also Figure K-3 in Appendix K).

[20] All TL4 species data were used to calculate the ratios, which happened to be mostly bass (68% bass, 14% channel catfish, 9% pikeminnow, 8% black crappie). Generally monitoring programs have primarily caught bass if bass are available. If only data in bass are available for assessment, then the assessment will be a bit over protective compared to the way these ratios were calculated.

H.3.3 Separate Objectives for Different Trophic Levels – Recreational Fishing

Two example trophic level specific objectives were derived that would protect consumption of one fish meal per week (0.016 mg/kg in fish tissue on average, from Table H-2A) with 50% consumption from trophic level 3 and 50% consumption form trophic level 4, with the following calculations:

$$[HgTL3] = FTC_{ave} / [(\%TL4) \times (R4/3) + ((\%TL3)]$$
$$[HgTL3] = 0.16 / [(0.5) \times (2) + (0.5)]$$
$$[HgTL3] = 0.106$$
$$[Hg\ TL4] = 0.213$$

In this example, the objective for trophic level 4 fish would be 0.2 mg/kg and for trophic level 3 fish the objective would be 0.1 mg/kg. This is essentially equivalent to applying the water quality objective to trophic level 4 fish only, since the objective in trophic level 4 fish is the same value (0.2 mg/kg, when rounded to one significant figure as done in the U.S. EPA criterion). Therefore, the mixture provides no advantage in terms of achievability.

Alternatively, if we use U.S. EPA's ratio of 4, based on national data (U.S. EPA 2001, Appendix A: Draft national methylmercury bioaccumulation factors), which might better represent waters with mixture of trout and bass, the two objectives would be calculated as:

$$[HgTL3] = FTC_{ave} / [(\%TL4) \times (R4/3) + ((\%TL3)]$$
$$[HgTL3] = 0.16 / [(0.5) \times (\mathbf{4}) + (0.5)]$$
$$[HgTL3] = 0.064$$
$$[Hg\ TL4] = 0.25$$

In this example, the objective for trophic level 4 fish would be 0.3 mg/kg and the objective for trophic level 3 fish would be 0.06 mg/kg. In this scenario there is an advantage because the objective for trophic level 4 is more achievable. However, it is likely *more* difficult to achieve the trophic level 3 objective of 0.06 mg/kg. This may be difficult to achieve in warm waters, where a statewide data analysis suggests that if bass have a mercury concentration of 0.3 mg/kg, then trophic level 3 fish probably have a concentration of 0.15 mg/kg in (a factor of 2 difference, Appendix L). Overall, since the ecosystems in California vary so widely, one set ratio will not accurately represent conditions in many waters. Therefore, it may be too difficult and impractical to use this mixed consumption pattern approach to derive two sport fish objectives for trophic level 3 and trophic level 4 fish on a statewide basis.

Although the 50:50 mixture does not provide an advantage as described above, this approach was tested further using other mixture scenarios. Table H-3 shows the results of various mixtures, other than the 50:50 mixture. These are evaluated further in regards to protecting wildlife in the next section.

Table H-3. Potential Mercury Objectives Using Mixed Consumption Scenarios, Protecting One Meal per Week of Fish Consumption

Mixture		Potential water quality objectives, calculated from the trophic level ratio of 2 (California, Appendix L)		Potential water quality objectives, calculated from the trophic level ratio of 4 (Nationwide, U.S. EPA 2001)	
%TL4	**%TL3**	**TL3 Mercury (mg/kg)**	**TL4 Mercury (mg/kg)**	**TL3 Mercury (mg/kg)**	**TL4 Mercury (mg/kg)**
0	100	0.16	0.32	0.16	0.64
10	90	0.15	0.29	0.12	0.49
20	80	0.13	0.27	0.10	0.40
30	70	0.12	0.25	0.08	0.34
40	60	0.11	0.23	0.07	0.29
50	**50**	**0.11**	**0.21**	**0.06**	**0.26**
60	40	0.10	0.20	0.06	0.23
70	30	0.09	0.19	0.05	0.21
80	20	0.09	0.18	0.05	0.19
90	10	0.08	0.17	0.04	0.17
100	0	0.08	0.16	0.04	0.16

Note: values shaded grey will not protect wildlife (see text).

H.3.4 Separate Objectives for Different Trophic Levels – Wildlife

The water quality objective that will protect recreational fishing (Sport Fish Water Quality Objective, based on one meal per week) is also intended to protect most wildlife (see Staff Report Section 6.2 and Section 6.8). If the mixture scenarios cannot ensure that wildlife are protected they will not be very useful. The analysis for the wildlife targets (in Appendix K) found that 0.08 mg/kg is needed in trophic level 3 fish 150-350 mm (roughly 0.1 in trophic level 3 fish 150-500 mm) to protect merganser and grebe, which are widely distributed through the state. Also this target in trophic level 3 150-300 mm is consistent for maintaining protection for light-footed clapper rail and Yuma clapper rail that eat small fish or fish lower on the food chain. Therefore, if two objectives are used to protect mixed consumption by sport fishers, the trophic level 3 objectives should be no higher than 0.08 mg/kg in fish 150-300 mm (or an equivalent that provides the same protection for wildlife). This equates to 0.1 in trophic level 3 fish of larger size: 150-500 mm (Appendix K).

Table H-3 shows the resulting mercury concentration in the top two trophic levels of various mixture scenarios based on an objective to protect a meal a week of fish. Values shaded grey in the table are above the protective wildlife targets of 0.1 mg/kg in trophic level 3 fish 150 – 500 mm, or they are 0.4 or higher in trophic level 4 fish which is not protective of osprey and eagles (Appendix K). Table H-3 shows that when the concentration in trophic level 3 fish is 0.1 the equivalent concentration in trophic level 4 is 0.2 mg/kg, which is equivalent to applying the objective to trophic level 4 fish only. All scenarios that protect wildlife equate to 0.2 in trophic level 4 fish. Again, this approach does not improve achievability or provide much advantage over simply setting the objective as 0.2 mg/kg in trophic level 4 fish (as shown in Table H-2A).

However, if *site-specific* mercury concentrations in fish are used (versus the one statewide ratio calculated in Appendix L), this mixture approach may be useful. The results of using the ratio of 4 from U.S. EPA is shown as an example in Table H-3.

H.3.5 Separate Objectives for Different Trophic Levels –Subsistence Fishing

Below are examples of mixed consumption patterns that could be used with higher fish consumption rates to protect subsistence fishers or tribes. The calculation can also be modified to include trophic level 2, which includes shellfish. For the ratio of trophic level 2 to trophic level 3, the ratio of 5.7 from U.S. EPA national default values was used (U.S. EPA 2001). For the ratio of trophic level 3 to trophic level 4, the ratio of 2 from Appendix L was used.

Shilling et al.'s survey of California Tribes found that two generations ago tribes ate non-native, trophic level 4 species, such as catfish, bass, brown trout, but the majority of the diet is trophic level 3 species, and that the pattern of fish use is similar today (Shilling et al. 2014). Many non-native fishes were introduced to California waters in the 1870s and 1890s, including small mouth bass, largemouth bass, striped bass, channel catfish, white catfish, yellow perch, common carp, and others (Moyle 2002, Table 10). Since then, some of these non-native species have become part of the fishing habits of many tribes. Fish consumption two generations ago included 31% trophic level 4 species, on average for all tribes statewide. Shilling organized the data by Water Board regions and the North Coast Region had the lowest potion of trophic level 4 species, at 21%, and the Lahontan Region had the highest portion of trophic level 4 species, at 36% (Shilling et al. 2014, Table 4). Table H-4 shows the resulting objectives for different trophic levels, based on a variety of species compositions.

Table H-4. Potential Subsistence Objectives Using Mixed Consumption Scenarios

FTC_{ave}	%TL2	%TL3	%TL4	TL2 Objective (mg/kg)	TL3 Objective (mg/kg)	TL4 Objective (mg/kg)
0.049	0	1	0	0.0086	0.049	0.098
0.049	0	0.9	0.1	0.0078	0.045	0.089
0.049	0	0.8	0.2	0.0072	0.041	0.082
0.049	0	0.7	0.3	0.0066	0.038	0.075
0.049	0	0.6	0.4	0.0061	0.035	0.070
0.049	0.2	0.6	0.2	0.0083	0.047	0.095
0.036	0	1	0	0.0063	0.036	0.072
0.036	0	0.9	0.1	0.0057	0.033	0.065
0.036	0	0.8	0.2	0.0053	0.030	0.060
0.036	0	0.7	0.3	0.0049	0.028	0.055
0.036	0	0.6	0.4	0.0045	0.026	0.051
0.036	0.2	0.6	0.2	0.0061	0.035	0.070

The calculations in Table H-4 were done using 1) a fish consumption rate of 142 g/day and 2) the rate of 142 g/day plus the U.S. EPA relative source contribution to represent consumption of a small amount of store bought fish. These rates yielded objectives of 0.05 and 0.04 mg/kg, respectively (after the value is rounded). For example, if the diet is assumed to be 30% trophic level 4 fish, the raw value for an objective of 0.036 mg/kg could be separated into two objectives of: 0.06 mg/kg in trophic level 4 fish (bass, catfish, crappie) and 0.03 in lower trophic level 3 fish (salmon, trout, suckers, blue gill, carp). This equates to an overall diet with 0.04 mg/kg mercury.

Again, the advantage of the application of the objective to a mixed consumption pattern is that the objective is a more realistic representation of the species consumed and the objective is easier to achieve. However, in this case the two separate objectives may not improve achievability. The 0.03 value may not be currently attainable in salmon since the current average concentration in anadromous chinook is 0.08 mg/kg (Figure H-1). For anadromous salmon like chinook, the mercury is not from the water body the fish are caught in. These fish feed mostly in the ocean and mercury in ocean fish cannot be controlled though California dischargers. The mercury concentration of 0.03 mg/kg is not currently attainable in most other species. On the other hand, 0.05 or 0.04 mg/kg is attainable in waters with only rainbow trout (and other trout species, except brown trout) since 0.05 is the average concentration in trout presently (Figure H-1). Since the approach of using a mixed consumption pattern by deriving separate objectives for the different trophic levels provides no advantage in these scenarios, it is not recommended for the mercury water quality objectives.

H.3.6 Recommendations for Options to Consider for the Issues Analysis

There are two ways to apply the water quality objective to a mixed consumption pattern (a mixture of trophic level 3 and trophic level 4 fish), but only one seems worthwhile on a practical basis. The more practical approach is to calculate the average mercury concentration in the two fish types during data assessment (Section H.3.1), vs. deriving an objective for trophic level 3 species and another objective for trophic level 4 species (Sections H.3.2 through Section H.3.5). The two objectives approach did not provide the advantage of making the objectives easier to attain, and the objective became more complicated. Also, the recommended approach of averaging data during assessment will also be more accurate because the exact ratio of mercury in trophic level 3 fish to mercury in trophic level 4 fish is likely ecosystem specific. It is best to avoid unnecessary additional assumptions that would be part of calculating a ratio of mercury in trophic level 3 fish to mercury in trophic level 4 fish that would be applied statewide.

For an objective based on one meal per week (0.2 mg/kg) to protect recreational fishing (the Sport Fish Water Quality Objective), it is recommended that the objective should not be applied to a mixed consumption pattern. Conversely, it is recommended that the objective is applied to highest trophic level fish. This is because some people eat mostly trophic level 4 fish (see Staff Report, Section 6.3 or Section G.5 of Appendix G). Also, if data are averaged during assessment it will be difficult to ensure that wildlife are protected, using the water quality objective for recreational fishing. To save monitoring resources, it is preferable to establish one objective that protects both recreational fishing and wildlife, if possible (see Staff Report, Section 6.8).

If a mixed consumption approach is used to protect recreational fishing (contrary to the recommendation above), then to ensure statewide protection of wildlife, a trophic level 3 objective should be established as 0.08 mg/kg in fish 150-300 mm (or no higher), or an equivalent. This concentration of 0.08 mg/kg in trophic level 3 fish protects mergansers and grebes and ensures protection for other species such as otters (Appendix K). An equivalent objective could be 0.05 mg/kg in fish 50-150 mm, since it provides similar protection (it just applies to a different size of fish, Appendix K).

For a subsistence level fishing objective, it will be easier to attain such objective in trophic level 3 species because trophic level 3 species have lower mercury levels than trophic 4 species in the same waters. However, some subsistence fishers (e.g. tribes, communities in the delta) also consume trophic level 4 fish. For the subsistence objective to be applied to relevant species, the objective should be stated in a manner that can be adapted to the species present in a particular water body. If multiple trophic levels are present and consumed, the objective should be applied to a mixed consumption pattern. The mercury concentrations in multiple species should be averaged during the assessment procedures (as shown in Section H.3.1), because specific ratios and relationships vary across the state. The recommended default composition is 30% trophic level 4 and 70% trophic level 3 (from Shilling et al. 2014). This composition should be modified based on site-specific evidence. Site-specific information may be available for some tribes in the fish use survey (Shilling et al. 2014) or by contacting the author.

Few waters will support subsistence level of fishing, perhaps 20% of all lakes and 30% of all rivers and streams (Davis et al. 2010, Fig.3, Davis et al. 2013, Fig. 7) and these are generally waters with no trophic level 4 species. Very few coastal locations (~ 1%) would support a subsistence objective if it included trophic level 4 fish (Davis et al. 2012). However, the only way to ensure these few waters will maintain water quality that supports a subsistence level of fishing would be for Regional Water Boards (Regional Water Quality Control Boards) to designate those waters with a subsistence fishing type of beneficial use and apply a corresponding water quality objective. Regional Water Boards would need to consider other contaminants that bioaccumulate in fish tissue as well for designation of the subsistence fishing use.

H.4 Averaging Period for the Water Quality Objectives

For the mercury objectives, the averaging period is one calendar year. Averaging periods are used in evaluating whether the water quality objective is achieved. The State Water Board's assessment policy allows for the use of different averaging periods as specified by particular water quality objectives (State Water Board 2004). All fish mercury samples collected within the same averaging period (a calendar year) will be combined into a single resultant value (see section 6.1.5.6 of State Water Board 2004). Data collected during another averaging period (a different calendar year) would be combined into separate additional values. The values are then evaluated to determine if the water quality objective is being exceeded according to State Water Board's assessment policy (State Water Board 2004).

An averaging period describes the period of time during which risk due to exposure is assessed. For methylmercury, the harmful effects being addressed by the water quality objectives are caused by chronic exposure. The averaging period, therefore, is long, as is common for other bioaccumulative toxicants.

The methylmercury reference doses do not identify particular averaging periods (U.S. EPA 2001). When reporting concentrations of mercury in fish for comparison with screening values, the US Food and Drug Administration and the California Office of Environmental Health Hazard Assessment report data by year and often, by multiple years grouped to increase the sample size (U.S. Food and Drug Administration & U.S. EPA 2014; Office of Environmental Health Hazard Assessment 2014).

The frequency of sample collection may be one or more times during the averaging period, but typically the Water Board's monitoring program collects fish only once every five to ten years and typically all fish are collected on one day. Methylmercury concentrations in sport fish result from methylmercury intake over time. Although aqueous methylmercury concentrations may vary by season, slow depuration rates (i.e., removal of impurities) are expected to dampen strong fluctuations in methylmercury concentrations in fish (U.S. EPA 2010, pg. 57). Thus, allowing a sample of sport fish to be comprised of fish collected on one date is reasonable.

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