

**Placer County Water Agency
Middle Fork American River Project
(FERC No. 2079)**

FINAL

**AQ 11 – CONTINGENCY WATER QUALITY
TECHNICAL STUDY REPORT: METHYLMERCURY
FISH TISSUE SAMPLING (2007–2009)**



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1.0 INTRODUCTION

This report describes the methylmercury sampling study results from the 2007 AQ 11 – Water Quality Technical Study Plan (TSP) and the 2008 AQ 11 – Water Quality Contingency Study (Contingency TSP) conducted by the Placer County Water Agency (PCWA) in 2007–2009 in accordance with the AQ 11 – TSP (PCWA 2007) and AQ 11 – Contingency TSP (PCWA 2008). The AQ 11 – TSP was included in the Supporting Document (SD) H of the Pre-Application Document (PAD) for the Middle Fork American River Project (MFP or Project) (PCWA 2007).

The AQ 11 – TSP included a screening level assessment of methylmercury concentrations in sport fish muscle tissue at the four Project reservoirs and in the Middle Fork American River downstream of Ralston Afterbay near Otter Creek. The results of the 2007 study were provided to the Aquatic Technical Working Group (TWG) in the AQ 11 – Water Quality Technical Study Report (TSR) (PCWA 2008) on February 1, 2008 for a 60 day comment period. The comment period ended on April 4, 2008. Comments were addressed in the final 2007 report which was distributed in June 30, 2008 (PCWA 2008).

Numerous fish tissue samples analyzed in 2007 exceeded California's Office of Environmental Health Hazard Assessment (OEHHA) screening guidelines for methylmercury of 0.08 ppm (PCWA 2008). The AQ 11 – TSP specified a contingency study process that would be implemented if methylmercury concentrations exceeded the screening guidelines. The process was as follows:

- *If methylmercury in fish tissue exceeds the OEHHA guidelines of 0.08 ppm (Cal EPA 2005; Klasing and Brodberg 2006) during the initial sampling, the Aquatic TWG will be consulted concerning the need for additional sampling. If additional sampling is deemed appropriate, a sampling protocol will be developed.*

The results of the 2007 AQ 11 – TSR were discussed during the March 10, 2008, May 5, 2008, and June 2, 2008 Aquatic TWG meetings. The Aquatic TWG determined that additional sport fish tissue methylmercury sampling was warranted. PCWA developed a draft AQ 11 – Contingency TSP. The scope of work incorporated recommendations provided by Russ Kanz, State Water Board, based on his discussions with OEHHA. The final draft AQ 11 – Contingency TSP was distributed for a 10 day comment period to the stakeholders on September 16, 2008 with a stipulation that if no comments were received, the scope of work would be considered final. No comments were received and fish sampling for the AQ 11 – Contingency TSP was conducted in late fall 2008. The stakeholder-approved AQ 11 – Contingency TSP was included in the 2008 Study Implementation Progress Report for the MFP (FERC Project No. 2079) and filed with the Federal Energy Regulatory Commission (FERC or Commission) on January 21, 2009 (PCWA 2009a). The targeted numbers of fish specified in the AQ 11 – Contingency TSP were not captured during the fall 2008 sampling for certain species/locations. The results of the sampling were discussed with the Aquatic TWG on February 3, 2009. The Aquatic TWG approved a modification to the AQ 11 –

Contingency TSP to reduce the number of fish targeted for collection and extend the sampling period through 2009 (Section 3.3. Proposed Modifications to the Technical Study Plan). The initial 2008 fall contingency sampling results were compiled in a report and provided to the Aquatic TWG (PCWA 2009b).

This report presents the results from the extended 2009 fish collection/analysis combined with the results previously reported for the contingency sampling (PCWA 2009b) and the 2007 AQ 11 – TSR (PCWA 2008). This report includes a description of the study objectives, study implementation, extent of study area, study approach, and study results.

2.0 STUDY OBJECTIVE

The objective of the original AQ 11 – TSP was to do a screening level analysis of methylmercury concentration in sport fish tissue and the objective of the follow-up AQ 11 – Contingency TSP was to sample a target number of each sport fish species that could be used to develop safe eating guidelines (if necessary). The overall water quality study objective described in the AQ 11 – TSP and the related 2007 fish tissue analysis study task was to:

- Characterize physical, chemical, and bacterial water quality conditions in the bypass reaches and the peaking reach, comparison reaches, and Project reservoirs, Ralston Afterbay, and Middle Fork Interbay and compare to the Central Valley Regional Water Quality Control Board (CVRWQCB) Basin Plan objectives and water quality standards (Fourth Edition revised February 2007).
 - Fish Tissue Analysis Task: Collect a total of 10 native (non-hatchery) sport fish of edible size, if present, from each of the following locations: French Meadows Reservoir, Hell Hole Reservoir, Middle Fork Interbay, Ralston Afterbay, and one location in the Middle Fork American River below Ralston Afterbay.

The study objective of the AQ 11 – Contingency TSP and the related study task was to:

- Collect and sample additional methylmercury concentrations in sport fish muscle tissue following OEHHA guidelines (Cal EPA 2005) that could be used to develop safe eating guidelines for the locations in the study area.
 - Fish Tissue Analysis Task: Collect a total of 9–12 edible size sport fish of each target species present in the following locations: French Meadows Reservoir, Hell Hole Reservoir, Middle Fork Interbay, Ralston Afterbay, and the Middle Fork American River at Otter Creek. The total number of fish includes fish already sampled during the 2007 field season.

Figure AQ 11-1 shows the AQ 11 – TSP and AQ 11 – Contingency TSP objectives and study elements and activities that relate to the completion of the studies. Figure AQ 11-1 also shows how the information developed during the studies was documented and provided to stakeholders.

3.0 STUDY IMPLEMENTATION

Study elements described in the AQ 11 – TSP (PCWA 2007) were initiated in 2007 and completed in 2008. The study elements described in the AQ 11 – Contingency TSP were initiated in 2008 and completed in 2010. The AQ 11 – Contingency TSP study elements that have been completed, deviations from the technical study plan, proposed modifications to the technical study plan, and outstanding study elements are discussed below.

3.1. STUDY ELEMENTS COMPLETED

The following methylmercury fish tissue sampling study elements from the AQ 11 – TSP were completed in 2007 and early 2008:

- Collected 42 fish samples for methylmercury screening at Project reservoirs (Hell Hole, French Meadows, Ralston Afterbay, and Middle Fork Interbay) and at one river site (Middle Fork American River downstream of Ralston Afterbay near Otter Creek).
- Provided fish tissue samples to a State-certified laboratory approved by the State Water Board for chemical analyses (Brooks Rand Laboratory, Seattle, Washington).
- Compared fish tissue results to the OEHHA guidelines.

The following study elements from the AQ 11 – Contingency TSP were completed in 2008 and early 2009:

- Collected 81 additional edible sized sport fish from French Meadows Reservoir, Hell Hole Reservoir, Ralston Afterbay, Middle Fork Interbay, and the Middle Fork American River near Otter Creek.
- Collected crayfish from French Meadows and Hell Hole reservoirs.
- Submitted fish and crayfish to the same laboratory used for the 2007 analyses (Brooks Rand Laboratory Seattle, Washington) for individual fish and crayfish muscle tissue methylmercury analyses.
- Consulted with the Aquatic TWG on how to proceed for the locations where the target numbers of individuals were not collected during the 2008 field season.

The following study elements from the AQ 11 – Contingency TSP were completed in 2009 and early 2010:

- Collected 18 additional edible sized sport fish from French Meadows Reservoir (six rainbow trout), Hell Hole Reservoir (three lake trout), and the Middle Fork American River near Otter Creek (nine brown trout).
- Submitted fish to the same laboratory used for the 2007 and 2008 analyses (Brooks Rand Laboratory Seattle, Washington) for individual fish muscle tissue

methylmercury analyses.

3.2. DEVIATIONS FROM THE TECHNICAL STUDY PLAN

The target numbers of sport fish and crayfish identified in the AQ 11 – Contingency TSP were caught and analyzed at all locations except the following:

- Hell Hole Reservoir: only six of nine lake trout and one of nine rainbow trout targeted for collection were captured and analyzed; and
- Ralston Afterbay: only seven of the nine rainbow trout targeted for collection were captured.

Targeted fish that were not collected were in low abundance and could not be captured in spite of substantial sampling effort.

3.3. PROPOSED MODIFICATIONS TO THE TECHNICAL STUDY PLAN

First Modification to the AQ 11 – Contingency TSP:

The 2008 fall sampling results were presented to the Aquatic TWG on February 3, 2009 and the locations where target numbers of certain species were not achieved was discussed. Based on the difficulty of obtaining target fish samples at these locations, the following modification to the AQ 11 – Contingency TSP was approved by the Aquatic TWG: (1) reduce the number of target fish required at some locations; and (2) continue fish sampling in 2009 to collect the remaining target fish.

The Aquatic TWG approved modification to AQ 11 – Contingency TSP is provided in the Table AQ 11-1. The approved modification corresponds to the following changes in the AQ 11 – Contingency TSP:

- The target number of rainbow trout to be sampled from Hell Hole Reservoir in 2008 changed from eight fish to zero fish.
- The target number of rainbow trout to be sampled from Ralston Afterbay in 2008 changed from eight fish to six fish.

All other fish targeted for sampling in 2008, but that were not successfully captured (total 20 fish), were to be collected in 2009 (Table AQ 11-1). These included the following:

- Six additional rainbow trout from French Meadows Reservoir;
- Six additional lake trout from Hell Hole Reservoir; and
- Eight additional brown trout from the Middle Fork American River (near Otter Creek).

Second Modification to the AQ 11 – Contingency TSP:

Because three of the six lake trout targeted for collection in 2009 (following the first modification to the AQ 11 – Contingency TSP) could not be captured, it is recommended that the study be completed without these fish (Table AQ 11-1). This recommendation will be presented to the Aquatic TWG for approval during the draft review period of this report. (It should be noted that two lake trout smaller than the target size of 350 mm TL were collected during the sampling and analyzed and we have included the results for these fish the report).

3.4. OUTSTANDING STUDY ELEMENTS

There are no outstanding study elements to be completed.

4.0 EXTENT OF STUDY AREA

The study area included French Meadows Reservoir, Hell Hole Reservoir, Middle Fork Interbay, Ralston Afterbay, and the Middle Fork American River at Otter Creek (Map AQ 11-1).

5.0 STUDY APPROACH

In 2007 as part of the AQ 11 – TSP, a screening level study of methylmercury concentrations in sport fish muscle tissue was conducted at selected locations in the study area. As identified in the AQ 11 – TSP, at least 10 non-hatchery sport fish of edible size were targeted for collection from each of the following locations: Hell Hole Reservoir, French Meadows Reservoir, Middle Fork Interbay, Ralston Afterbay, and the Middle Fork American River near the Otter Creek confluence. Larger fish and species with greater potential for bioaccumulation were targeted for collection and analysis. The initial goal of the study was to collect five fish of two different species from each location based on the following priority ranking. The two species present with the highest priority ranking would be targeted for collection (1 = highest priority) as follows:

- 1) bass;
- 2) pikeminnow;
- 3) lake trout;
- 4) brown trout; and
- 5) rainbow trout.

If five fish of two different species were not caught, then fish from a third species was included in the analysis.

As part of the 2008 AQ 11 – Contingency TSP, the overall fish tissue sampling goal was increased to collect and analyze methylmercury from a total of 9–12 edible size sport fish of each target species present in French Meadows Reservoir, Hell Hole Reservoir, Middle Fork Interbay, Ralston Afterbay, and the Middle Fork American River at Otter Creek. Crayfish were also collected and analyzed from French Meadows and Hell Hole reservoirs in 2008.

The minimum size (edible) of each species that was collected for analysis in 2008 and 2009 is provided in Table AQ 11-2. Some fish that were collected and analyzed in 2007 were smaller than the minimum size of the fish in the AQ 11 – Contingency TSP. These smaller fish were not counted toward the target number of fish analyzed in this report, but the results are included in Table AQ 11-3.

A total of 9–12 fish of each species was targeted for collection and individual fish tissue analysis (combined 2007–2009 samplings). The total number of each target fish species analyzed in 2007–2009 is summarized in Table AQ 11-1. Two composite samples (comprised of five brown trout each) were also analyzed in 2007. Locations where composite fish analyses were conducted or where fish smaller than the 2008 and 2009 minimum size limit are summarized in Tables AQ 11-1 and AQ 11-3.

Fish and crayfish were captured using a combination of methods. At the four reservoirs, fish and crayfish (only in French Meadows and Hell Hole reservoirs) were captured in clean nylon gill nets. In 2008 and 2009, fish were also caught with hook-and-line. In the Middle Fork American River near Otter Creek, fish were captured by electrofishing, gill netting, and hook-and-line sampling. For each fish collected, the species, fork length, total length, and weight were recorded. For crayfish, the total length, carapace length, and weight were recorded.

The field handling procedures used in 2007–2009 were consistent with those outlined in the California Environmental Protection Agency (Cal EPA 2005) and those used at the Department of Fish and Game Marine Pollution Studies Laboratory at Moss Landing (Method # MPSSL-102a). All fish and crayfish were handled with polyethylene gloves. Each sample was placed into a labeled zipper-closure bag (double bagged and double labeled) and placed immediately on ice in a cooler (Mark Stephenson and Amy Byington, Pers. Comm. 2008). The fish and crayfish were then stored in a freezer prior to shipment to the analytical laboratory. All fish and crayfish were shipped in an ice chest packed with ice and delivered by an overnight courier to Brooks Rand Laboratory (Seattle, Washington). Each cooler was shipped with a chain of custody form showing the sample identification number and collection date and time of each sample.

Muscle tissue from individual fish (fillet with skin off and homogenized) and crayfish (tail only) was analyzed for concentrations of methylmercury in accordance with the General Protocol for Sport Fish Sampling and Analysis developed by the Cal EPA (2005) and with methods comparable to those used at the Department of Fish and Game Marine Pollution Studies Laboratory at Moss Landing. The results of the fish fillet analyses were reported in ng/g. These were converted to mg/kg (ppm) to be consistent with the OEHHA guidelines.

6.0 RESULTS

The following section provides the results of the 2007–2009 fish tissue analysis from the study area. The 2007 results were also reported in the 2007 AQ 11 – TSR (PCWA 2008) and the combined 2007–2008 results were previously reported in the 2008 AQ 11 – TSR (PCWA 2009b). The summary data presented (e.g., averages) include only fish

that met the minimum size requirements (Table AQ 11-2)¹.

A total of 154 (including the 10 fish analyzed as a composite and three fish analyzed in 2007 that were smaller than the minimum size)¹ sport fish and crayfish from the five sampling locations were caught and analyzed in 2007–2009. Methylmercury concentrations in at least one fish and crayfish from each location exceeded the OEHHA screening value of 0.08 mg/kg.

Sixty-six of the 120 individual fish analyzed exceeded the screening value (including the three fish sampled that were less than the minimum size requirements). The highest concentrations (up to 2.31 mg/kg) were measured in fish from Hell Hole Reservoir, where the largest fish were caught. The lowest concentrations were found in rainbow trout from Ralston Afterbay. A summary of the fish that were caught and analyzed, including the species, fork and total lengths, and weight, is provided in Table AQ 11-3. The relationship between methylmercury concentration and the weight of the fish for each of the sampling locations is shown in Figures AQ 11-2a through AQ 11-2f.

Fifteen of the 24 crayfish analyzed from Hell Hole and French Meadows reservoirs exceeded the screening value of 0.08 mg/kg. The highest concentrations were from Hell Hole Reservoir (up to 0.264 mg/kg). The results of the crayfish analyses are summarized in Table AQ 11-4. Figure AQ 11-3 shows that there was no observable relationship between crayfish weight and methylmercury concentration.

The average and maximum methylmercury concentrations by location and species are summarized below in order of locations with the highest to the lowest concentrations (Tables AQ 11-3, AQ 11-4, and AQ 11-5).

- Hell Hole Reservoir

Fish

- The average methylmercury concentration for all fish samples was 0.576 mg/kg, with the highest concentrations found in brown trout (1.032 mg/kg on average).
- Methylmercury concentrations in 27 of the 31 individual fish analyzed (brown trout, lake trout, kokanee, and rainbow trout, as well as the composite sample of brown trout (analyzed in 2007)), exceeded the OEHHA screening value.
- All the brown trout, lake trout, and kokanee except for one fish of each species exceeded the screening level. The highest concentration was in a 3.5 lbs brown trout (2.310 mg/kg).
- The methylmercury concentration in the one rainbow trout analyzed was lower than the OEHHA screening value.

¹ A few fish reported in the 2007 results were smaller than the minimum size specified in the 2008 AQ 11 – Contingency TSP. The locations where these fish were analyzed are identified in Table AQ 11-2.

Crayfish

- Average methylmercury concentration for crayfish was 0.223 mg/kg. The highest individual concentration was 0.264 mg/kg. All of the crayfish captured exceeded the screening value.

- French Meadows Reservoir

Fish

- The average methylmercury concentration for all fish samples was 0.139 mg/kg, with the highest concentrations found in brown trout (0.211 mg/kg on average).
- Methylmercury concentrations in all the brown trout and one of the nine rainbow trout exceeded the screening value.
- The composite sample of five brown trout also exceeded the screening value.
- The highest fish methylmercury concentration measured was 0.357 mg/kg (large 8.6 lbs brown trout).

Crayfish

- The average methylmercury concentration for crayfish was 0.072 mg/kg (three of the 12 crayfish exceeded the screening value). The highest concentration in an individual was 0.119 mg/kg.

- Ralston Afterbay

- The average methylmercury concentration for all fish samples was 0.097 mg/kg, with the highest concentrations found in Sacramento pikeminnow (0.247 mg/kg on average).
- Methylmercury concentrations in all the Sacramento pikeminnows and in six of the 12 brown trout exceeded the screening value. The highest brown trout concentration was (0.150 mg/kg) and the overall highest concentration was in a Sacramento pikeminnow (0.348 mg/kg).
- None of the rainbow trout analyzed had methylmercury concentrations that exceeded the screening value.

- Middle Fork Interbay

- The average methylmercury concentration for all fish samples was 0.070 mg/kg, with the highest concentrations found in brown trout (0.079 mg/kg on average).
- Methylmercury concentrations in only one of the 12 brown (0.061 mg/kg) and two of the nine rainbow trout analyzed exceeded the screening value (0.135 and 0.203 mg/kg).

- Middle Fork American River near Otter Creek

- The average methylmercury concentration for all fish samples was 0.085 mg/kg.

- Methylmercury concentrations in eight of the 10 brown trout and two of the 11 rainbow trout caught exceeded 0.08 mg/kg.
- The highest concentration measured in fish from the Middle Fork American River was 0.210 mg/kg (in the largest brown trout caught, 3.6 lbs.).

7.0 LITERATURE CITED

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PCWA. 2009b. Final AQ 11 – Contingency Water Quality Technical Study Report: Methylmercury Fish Tissue Sampling (2007 and 2008). July 2009.

Personal Communication

Mark Stephenson. Personal communication with Director of the Marine Pollution Studies Laboratories - Department of Fish and Game. Moss Landing California. August 11, 2008.

Amy Byington. Personal communication with Research Technician at Marine Pollution Studies Laboratories - Department of Fish and Game. Moss Landing California. August 11, 2008.

TABLES

Table AQ 11-1. Total Number of Each Fish Species Analyzed and Targeted for Methylmercury Sampling by Location.

Sampling Location	Species	Total Analyzed 2007–2009 ¹	Initial AQ 11 Contingency TSP Sampling Target	First Modification to AQ 11 Contingency TSP Sampling Target	Second Modification to AQ 11 Contingency TSP Sampling Target
French Meadows Reservoir	Brown Trout	12 (5) ²	9	9	9
	Rainbow Trout	9	9	9	9
	Crayfish	12	9	9	9
Hell Hole Reservoir	Brown Trout	12 (5) ²	9	9	9
	Lake Trout	6 (2) ^{3,4}	9	9	3
	Kokanee	12	9	9	9
	Rainbow Trout	1 ⁴	9	1	1
	Crayfish	12	9	9	9
Middle Fork Interbay	Brown Trout	12	9	9	9
	Rainbow Trout	9	9	9	9
Ralston Afterbay	Brown Trout	12	9	9	9
	Rainbow Trout	7 ⁴	9	7	7
	Sacramento Pikeminnow	4 (1) ³	0 ⁵	0 ⁵	0 ⁵
Middle Fork American River (Otter Creek)	Brown Trout	10	9	9	9
	Rainbow Trout	11	9	9	9

¹Total number of fish analyzed as part of the of 2007 AQ – 11 TSR and the AQ – 11 Contingency TSP (2008 and 2009 sampling).

²Fish that were analyzed as one composite sample in 2007.

³Fish that were analyzed in 2007, but were smaller than the 2008 edible size limit (Table AQ 11-2).

⁴Low abundance of this species at the sampling location made it difficult to collect the target number of individuals; a good-faith effort was made to collect the target number of individuals.

⁵No Sacramento pikeminnow were targeted for analysis in the AQ 11 – Contingency TSP.

Table AQ 11-2. 2008–2009 Legal and/or Edible Size Limits for Target Species.

Legal/edible Size Limits	Minimum Size (mm)
Brown Trout	200
Rainbow Trout	200
Lake Trout	350
Kokanee	200
Crayfish	30

Table AQ 11-3. Summary Methylmercury Results for Fish Specimens.

A bold number indicates that the screening level criteria of 0.08 mg/kg were exceeded (based on Cal EPA 2005 and Klasing and Brodberg 2006).

Species	Fish Sample ID ²	Date Collected	Time Collected	Total Length (mm)	Fork Length (mm)	Weight (g)	Weight (lbs)	Methyl-mercury Concentration (mg/kg)
Individual Fish Analysis								
Hell Hole Reservoir								
Brown Trout	HH-1-DS-1-BNT-2	10/11/2007	1330	398	393	650	1.430	0.662
	HH-1-US2-BNT-2	10/11/2007	930	422	415	925	2.035	0.596
	HH-1-US2-BNT-3	10/11/2007	930	477	470	1075	2.365	1.030
	HH-1-MID3-BNT-3	10/11/2007	1030	495	490	1175	2.585	0.921
	HH-1-MID1-BNT-1	10/11/2007	1150	485	480	1200	2.640	1.080
	HH-3B-BT-1	9/11/2007	1420	571 ⁽¹⁾	561	2150	4.730	1.140
	HH-1B-BNT-1	9/18/2008	820	310	310	348	0.766	0.010
	HH-1B-BNT-2	9/18/2008	820	505	505	1661	3.654	1.900
	HH-2-BNT-1	9/17/2008	950	420	420	898	1.976	0.463
	HH-2-BNT-2	9/17/2008	950	510 ⁽⁴⁾	≈ 505 ⁽⁵⁾	1567	3.447	2.310
	HH-3-BNT-1	9/17/2008	1640	500	500	1640	3.608	1.920
	HH-6B-BNT-3	9/18/2008	1030	402	402	738	1.624	0.356
Lake Trout	HH-1-MIDL-LT-1	10/11/2007	1150	360	330	450	0.990	0.004
	HH-1-MID3-LT-1	10/11/2007	1030	265	235	160 ⁽³⁾	0.352	0.243
	HH-1-US1-LT-1	10/11/2007	830	270	245	125 ⁽³⁾	0.275	0.213
	HH-2-LT-1	9/17/2008	950	350	330	421	0.926	0.217
	HH-LT-2	10/18/2008	1550	420	380	576	1.267	0.845
	HH-LT-1	5/24/2009	1130	559	≈ 516 ⁽⁵⁾	1357	2.992	0.680
	HH-LT-2	5/29/2009	1100	610	≈ 564 ⁽⁵⁾	2098	4.625	0.942
	HH-LT-3	9/12/2009	950	381	≈ 349 ⁽⁵⁾	506	1.116	0.729
Rainbow Trout	HH-1-US2-RBT-1	10/11/2007	930	230	220	125	0.275	0.049
Kokanee	HH-1-KOK-1	9/17/2008	939	374	350	470	1.034	0.050
	HH-5b-KOK-2	9/17/2008	1720	405	385	619	1.362	0.110
	HH-1-KOK-shock	10/24/2008	1045	415	402	628	1.382	0.131
	HH-2-KOK-shock	10/24/2008	1045	365	355	442	0.972	0.207
	HH-3-KOK-shock	10/24/2008	1045	385	375	555	1.221	0.177
	HH-4-KOK-shock	10/24/2008	1045	380	368	476	1.047	0.194
	HH-5-KOK-shock	10/24/2008	1045	386	373	386	0.849	0.184
	HH-6-KOK-shock	10/24/2008	1045	395	380	562	1.236	0.158
HH-7-KOK-shock	10/24/2008	1045	385	375	625	1.375	0.206	

Table AQ 11-3. Summary Methylmercury Results for Fish Specimens (continued).

A bold number indicates that the screening level criteria of 0.08 mg/kg were exceeded (based on Cal EPA 2005 and Klasing and Brodberg 2006).

Species	Fish Sample ID ²	Date Collected	Time Collected	Total Length (mm)	Fork Length (mm)	Weight (g)	Weight (lbs)	Methyl-mercury Concentration (mg/kg)
Hell Hole Reservoir (continued)								
Kokanee (continued)	HH-8-KOK-shock	10/24/2008	1045	390	370	574	1.263	0.153
	HH-10-KOK-shock	10/24/2008	1045	425	405	593	1.305	0.210
	HH-11-KOK-shock	10/24/2008	1045	372	364	478	1.052	0.221
French Meadows Reservoir								
Brown Trout	FM-2B-BT-3	9/12/2007	1550	615 ⁽¹⁾	605	2000	4.400	0.210
	FM-2C-BT-1	9/13/2007	1020	740	730	3900	8.580	0.357
	FM-4-BNT-1	9/19/2008	830	490	485	1266	2.785	0.324
	FM-7-BNT-3	9/19/2008	920	443	440	950	2.090	0.170
	FM-5-BNT-2	9/19/2008	845	375	365	444	0.977	0.171
	FM-BNT-1	11/23/2008	650	420	430	748	1.646	0.276
	FM-BNT-2	11/23/2008	705	395	415	525	1.155	0.125
	FM-BNT-3	11/23/2008	715	380	400	611	1.344	0.216
	FM-BNT-4	11/23/2008	730	425	440	817	1.797	0.151
	FM-BNT-5	11/23/2008	743	460	480	995	2.189	0.153
	FM-BNT-6	11/23/2008	800	475	490	1092	2.402	0.301
FM-BNT-7	11/23/2008	810	415	430	759	1.670	0.084	
Rainbow Trout	FM-1E-RT-1	9/13/2007	1700	240	230	100	0.220	0.053
	FM-2F-RT-1	9/13/2007	1530	290	280	180	0.396	0.071
	FM-3D-RT-2	9/13/2007	1124	335	325	270	0.594	0.176
	FM-RBT-1	8/8/2009	928	≈ 245 ⁽⁵⁾	235	175	0.386	0.013
	FM-RBT-2	8/8/2009	940	≈ 245 ⁽⁵⁾	235	179	0.395	0.013
	FM-RBT-3	8/8/2009	949	≈ 239 ⁽⁵⁾	229	151	0.333	0.014
	FM-RBT-4	8/8/2009	1005	≈ 239 ⁽⁵⁾	229	154	0.340	0.012
	FM-RBT-5	8/8/2009	1029	≈ 245 ⁽⁵⁾	235	159	0.351	0.015
FM-RBT-6	8/8/2009	1028	≈ 251 ⁽⁵⁾	241	150	0.331	0.015	
Middle Fork Interbay								
Brown Trout	I-U2-BNT-1	9/20/2007	1456	323	315	390	0.858	0.050
	I-US-1-BNT-3	9/21/2007	1030	320	310	420	0.924	0.029
	I-US2-BNT-3	9/21/2007	1115	330	320	430	0.946	0.013
	I-US-1-BNT-1	9/20/2007	1446	345	338	450	0.990	0.024
	I-US-2-BNT-2	9/21/2007	1115	355	350	570	1.254	0.027
	I-US1-BNT-2	9/21/2007	1030	370	360	625	1.375	0.032

Table AQ 11-3. Summary Methylmercury Results for Fish Specimens (continued).

A bold number indicates that the screening level criteria of 0.08 mg/kg were exceeded (based on Cal EPA 2005 and Klasing and Brodberg 2006).

Species	Fish Sample ID ²	Date Collected	Time Collected	Total Length (mm)	Fork Length (mm)	Weight (g)	Weight (lbs)	Methyl-mercury Concentration (mg/kg)
Middle Fork Interbay (continued)								
Brown Trout (continued)	I-2-BNT-1	9/23/2008	1005	230	219	113	0.249	0.019
	I-2-BNT-3	9/23/2008	1005	419	419	629	1.384	0.039
	I-1-BNT-2	9/23/2008	950	367	358	446	0.981	0.045
	I-2-BNT-2	9/23/2008	1005	375	375	491	1.080	0.046
	I-1-BNT-1	9/23/2008	950	585	580	2267	4.987	0.609
	I-3-BNT-2	9/23/2008	1020	338	326	262	0.576	0.009
Rainbow Trout	I-US1-RBT-1	9/21/2007	1030	285	270	200	0.440	0.018
	I-US2-RBT-5	9/21/2007	1115	263	253	210	0.462	0.026
	I-L1-RBT-1	9/21/2007	1115	255	245	225	0.495	0.028
	I-US2-RBT-1	9/21/2007	1115	315	307	410	0.902	0.135
	I-1-RBT-1	9/23/2008	950	221	212	119	0.262	0.203
	I-3-RBT-1	9/23/2008	1020	347	345	143	0.315	0.037
	I-4-RBT-2	9/23/2008	1045	270	260	181	0.398	0.032
	I-4-RBT-1	9/23/2008	1045	235	230	131	0.288	0.023
	I-5-RBT-1	9/23/2008	1058	250	240	135	0.297	0.027
Ralston Afterbay								
Brown Trout	RA-2A-BT-14	9/14/2007	1305	476	465	925	2.035	0.085
	RA-2A-BT-7	9/14/2007	1240	470	464	1050	2.310	0.104
	RA-3B-BT-7	9/14/2007	1450	462	460	1100	2.420	0.063
	RA-2B-BT-6	9/14/2007	1330	477	474	1250	2.750	0.107
	R-BNT-1	6/27/2008	1315	444	426	902	1.984	0.049
	R-BNT-2	6/27/2008	1130	435	432	784	1.725	0.067
	R-BNT-3	9/4/2008	1130	480	≈ 472 ⁽⁵⁾	1353	2.977	0.090
	R-BNT-4	6/27/2008	1129	555	545	1670	3.674	0.150
	R-BNT-5	9/5/2008	1050	453	435	903	1.987	0.097
	R-BNT-6	9/4/2008	not recorded	450	≈ 441 ⁽⁵⁾	826	1.817	0.058
	R-BNT-7	6/27/2008	not recorded	515	510	1010	2.222	0.057
	R-BNT-8	6/27/2008	not recorded	515	510	911	2.004	0.067
Rainbow Trout	RA-3B-RT-19	9/14/2007	1510	375	365	550	1.210	0.042
	R-RBT-1	9/5/2008	1215	381	355	466	1.025	0.026
	R-RBT-2	9/5/2008	1100	365	345	426	0.937	0.044
	R-RBT-3	9/5/2008	1100	335	320	342	0.752	0.028

Table AQ 11-3. Summary Methylmercury Results for Fish Specimens (continued).

A bold number indicates that the screening level criteria of 0.08 mg/kg were exceeded (based on Cal EPA 2005 and Klasing and Brodberg 2006).

Species	Fish Sample ID ²	Date Collected	Time Collected	Total Length (mm)	Fork Length (mm)	Weight (g)	Weight (lbs)	Methyl-mercury Concentration (mg/kg)
Ralston Afterbay (continued)								
Rainbow Trout (continued)	R-RBT-4	9/5/2008	1215	355	334	365	0.803	0.046
	R-RBT-5	9/5/2008	1050	355	345	445	0.979	0.040
	R-RBT-6	9/4/2008	not recorded	260	252	188	0.414	0.031
Sacramento Pikeminnow	RA-3A-SPM-21	9/14/2007	1430	260	245	50	0.110	0.117
	RA-1D-SPM-4	9/14/2007	1619	405 ⁽¹⁾	385	510	1.122	0.314
	RA-2B-SPM-8	9/14/2007	1335	405	384	640	1.408	0.209
	RA-2B-SPM-7	9/14/2007	1331	470	445	840	1.848	0.348
	RA-3A-SPM-20	9/14/2007	1425	239	225	100 ⁽³⁾	0.220	0.114
Middle Fork American River near Otter Creek								
Brown Trout	OC-1-BNT-1	10/9/2007	940	390 ⁽¹⁾	385	634	1.395	0.085
	OC-1-BNT-5	11/10/2009	2000	500	490	1650	3.637	0.210
	OC-1-BNT-6	11/10/2009	2000	495	475	1815	4.001	0.185
	OC-1-BNT-7	11/10/2009	2000	325	320	356	0.785	0.045
	OC-1-BNT-8	11/11/2009	1130	525	520	2003	4.416	0.093
	OC-1-BNT-9	11/11/2009	1200	480	485	1450	3.197	0.167
	OC-1-BNT-10	11/11/2009	1200	530	530	2015	4.442	0.113
	OC-1-BNT-11	11/11/2009	1200	505	505	1520	3.351	0.209
	OC-1-BNT-12	11/11/2009	1200	445	445	1293	2.851	0.044
	OC-1-BNT-13	11/11/2009	1200	275	275	245	0.540	0.106
Rainbow Trout	OC-1-RBT-2	10/2/2007	1130	202	193	65	0.143	0.012
	OC-1-RBT-3	10/2/2007	1130	202	200	66	0.145	0.017
	OC-1-RBT-4	10/2/2007	1130	249	238	139	0.306	0.021
	OC-1-RBT-5	10/2/2007	1130	303	311	236	0.519	0.041
	OC-1-RBT-1	10/2/2007	1130	308	300	282	0.620	0.029
	OC-1-RBT-7	10/9/2007	1030	310 ⁽¹⁾	300	282	0.620	0.032
	OC-RBT-1	10/16/2007	morning	365	344	380	0.836	0.081
	OC-1-RBT-6	10/2/2007	1130	374	363	463	1.019	0.078
	OC-1-RBT-8	10/9/2007	1330	415 ⁽¹⁾	395	468	1.030	0.130
	OC-1-RBT	11/17/2008	1445	392	375	392	0.862	0.051
OC-2-RBT	11/17/2008	1445	376	356	441	0.970	0.046	

Table AQ 11-3. Summary Methylmercury Results for Fish Specimens (continued).

A bold number indicates that the screening level criteria of 0.08 mg/kg were exceeded (based on Cal EPA 2005 and Klasing and Brodberg 2006).

Species	Fish Sample ID ²	Date Collected	Time Collected	Total Length (mm)	Fork Length (mm)	Weight (g)	Weight (lbs)	Methyl-mercury Concentration (mg/kg)
Composited Fish Analysis								
Hell Hole Reservoir								
Brown Trout	Composite-HH-BT-1							1.070
	HH-1A-BT-34	9/11/2007	1000	449 ⁽¹⁾	432	940	2.068	
	HH-1B-BT-15	9/11/2007	1100	483 ⁽¹⁾	473	1040	2.288	
	HH-2A-BT-6	9/11/2007	1215	419 ⁽¹⁾	411	760	1.672	
	HH-3A-BT-3	9/11/2007	1345	485 ⁽¹⁾	475	1260	2.772	
	HH-2C-BT-1	9/11/2007	945	360	350	310	0.682	
French Meadows Reservoir								
Brown Trout	Composite-FM-BT-1							0.183
	FM-2B-BT-4	9/12/2007	1550	360 ⁽¹⁾	353	420	0.924	
	FM-2A-BT-2	9/12/2007	1620	355	348	430	0.946	
	FM-1A-BT-1	9/12/2007	1830	410	400	470	1.034	
	FM-1D-BT-1	9/13/2007	950	408	392	590	1.298	
	FM-3D-BT-3	9/13/2007	1130	400	393	600	1.32	

¹Total length was not measured in the field, but estimated based on fish size, species, and fork length.

²BNT: brown trout; RBT: rainbow trout; LT: lake trout; KOK: kokanee; SPM: Sacramento pikeminnow.

³The fish were analyzed in 2007, but were smaller than the minimum size collected in 2008. The fish was not included in the results presented in this report.

⁴Fish total length was recorded as 610 mm. Regression analyses suggest that the length should be approximately 510 mm.

⁵Length was not measured in the field, and was calculated from a regression analysis.

Table AQ 11-4. Summary Methylmercury Results for Crayfish Specimens.

A bold number indicates that the screening level criteria of 0.08 mg/kg were exceeded (based on Cal EPA 2005 and Klasing and Brodberg 2006).

Species	Fish Sample ID	Date Collected	Time Collected	Carapace Length (to tip of rostrum) (mm)	Carapace Length (to back of eye) (mm)	Weight (g)	Weight (lbs)	Methylmercury (mg/kg)
Individual Crayfish Analysis								
Hell Hole Reservoir								
Crayfish	HH-1B-CF-1	9/17/2008	950	62	47	50	0.110	0.262
	HH-2-CF-1	9/17/2008	950	60	47	61	0.134	0.730
	HH-2-CF-2	9/17/2008	950	45	32	18	0.040	0.111
	HH-2-CF-4	9/17/2008	950	48	37	28	0.062	0.172
	HH-2-CF-5	9/17/2008	950	40	30	15	0.033	0.206
	HH-5B-CF-2	9/17/2008	1720	57	41	59	0.130	0.136
	HH-5B-CF-3	9/17/2008	1720	55	40	44	0.097	0.143
	HH-5B-CF-4	9/17/2008	1720	50	32	24	0.053	0.150
	HH-5B-CF-5	9/17/2008	1720	51	40	29	0.064	0.194
	HH-5B-CF-6	9/17/2008	1720	55	37	31	0.068	0.140
	HH-6-CF-6	9/17/2008	1720	52	42	39	0.086	0.172
HH-5B-CF-7	9/17/2008	1720	46	36	23	0.051	0.264	
French Meadows Reservoir								
Crayfish	FM-1-CF-1	9/18/2008	1410	52	38	33	0.073	0.066
	FM-1-CF-2	9/18/2008	1410	59	45	52	0.114	0.073
	FM-1-CF-3	9/18/2008	1410	65	41	61	0.134	0.077
	FM-1-CF-4	9/18/2008	1410	50	39	31	0.068	0.038
	FM-1-CF-5	9/18/2008	1410	50	38	37	0.081	0.062
	FM-1-CF-6	9/18/2008	1410	51	39	38	0.084	0.064
	FM-1-CF-7	9/18/2008	1410	53	43	49	0.108	0.119
	FM-1-CF-8	9/18/2008	1410	57	40	40	0.088	0.060
	FM-1-CF-9	9/18/2008	1410	47	36	32	0.070	0.113
	FM-1-CF-10	9/18/2008	1410	49	36	27	0.059	0.060
	FM-1-CF-11	9/18/2008	1410	47.5	35	25	0.055	0.050
	FM-1-CF-12	9/18/2008	1410	47	39	30	0.066	0.086

Table AQ 11-5. Average Methylmercury Concentrations (mg/kg Sampling Location and Species¹.

A bold number indicates that the screening level criteria of 0.08 mg/kg were exceeded (based on Cal EPA 2005 and Klasing and Brodberg 2006).

Species	French Meadows Reservoir	Hell Hole Reservoir	Middle Fork American River near Otter Creek	Middle Fork Interbay	Ralston Afterbay	Species Average
Fish Species						
Brown Trout (No.)	0.211 (12)	1.032 (12)	0.126 (10)	0.079 (12)	0.083 (12)	0.312 (58)
Lake Trout (No.)	-	0.570 (6)	-	-	-	0.570 (6)
Rainbow Trout (No.)	0.042 (9)	0.049 (1)	0.049 (11)	0.059 (9)	0.037 (7)	0.047 (37)
Kokanee (No.)	-	0.167 (12)	-	-	-	0.167 (12)
Sacramento Pikeminnow (No.)	-	-	-	-	0.247 (4)	0.247 (4)
Fish Average	0.139 (21)	0.576 (31)	0.085 (21)	0.070 (21)	0.097 (23)	0.225 (117)
Crayfish						
Crayfish (No.)	0.072 (12)	0.223 (12)	-	-	-	0.148 (24)

¹Only includes fish that were larger than the minimum size limits (see Table AQ 11-2).

FIGURES

Figure AQ 11-1. 2007- 2009 Methylmercury Fish Sampling Objectives and Related Study Elements and Reports.

Study Objectives

2007 AQ 11 – TSP:
 Characterize physical, chemical, and bacterial water quality conditions in the bypass reaches and the peaking reach, comparison reaches, and Project reservoirs and diversion pools and compare to the CVRWQCB Basin Plan objectives and water quality standards.
 • Fish Tissue Analysis Task: Collect sport fish for screening level methylmercury analysis

2008 AQ 11 – Quality Contingency Study:
 Collect and quantify additional methylmercury concentrations in sport fish muscle tissue following OEHHA guidelines (Cal EPA 2005) that could be used to develop safe eating guidelines for the locations in the study area.

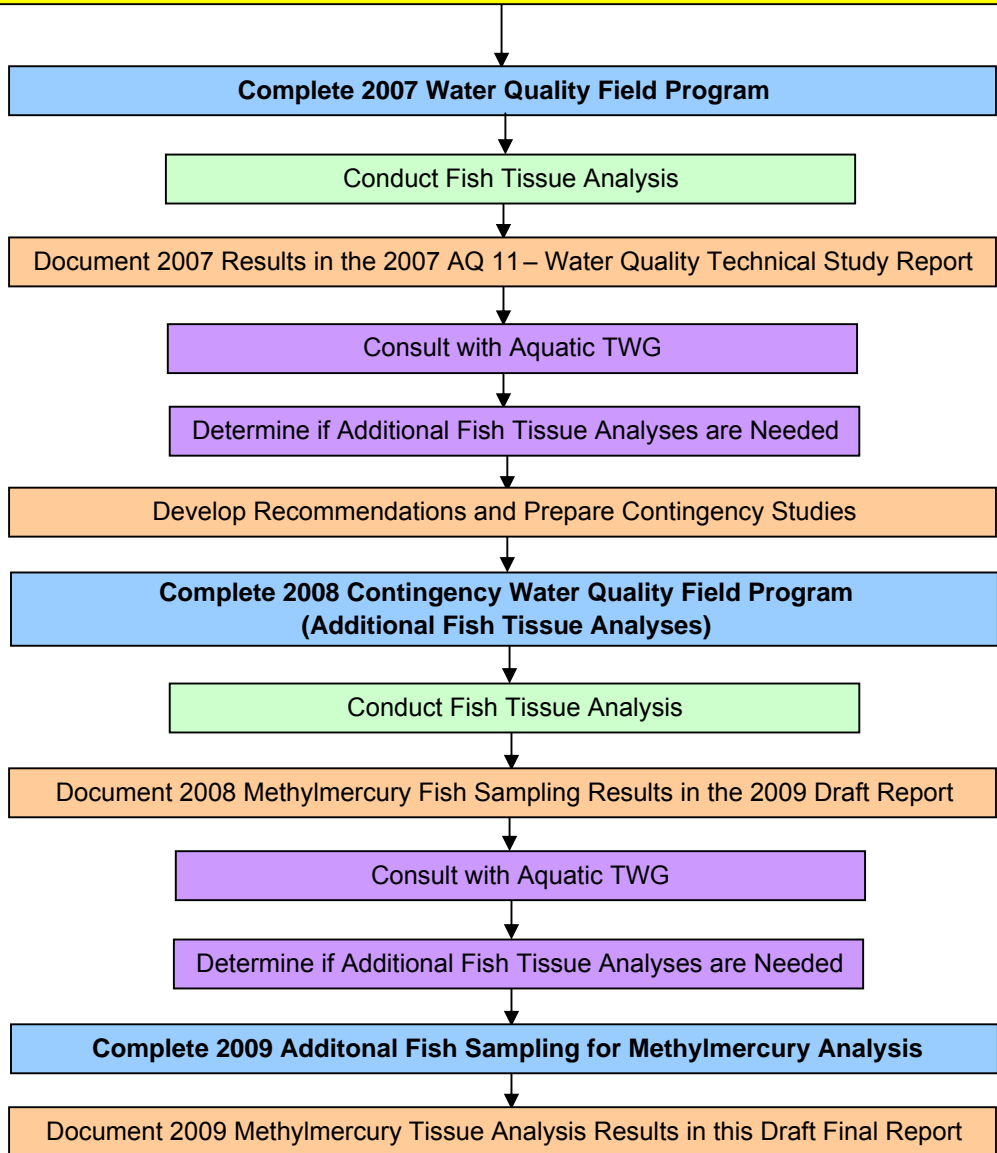


Figure AQ 11-2a. Methylmercury Fish Tissue Analysis Results at All Sampling Locations by Species.

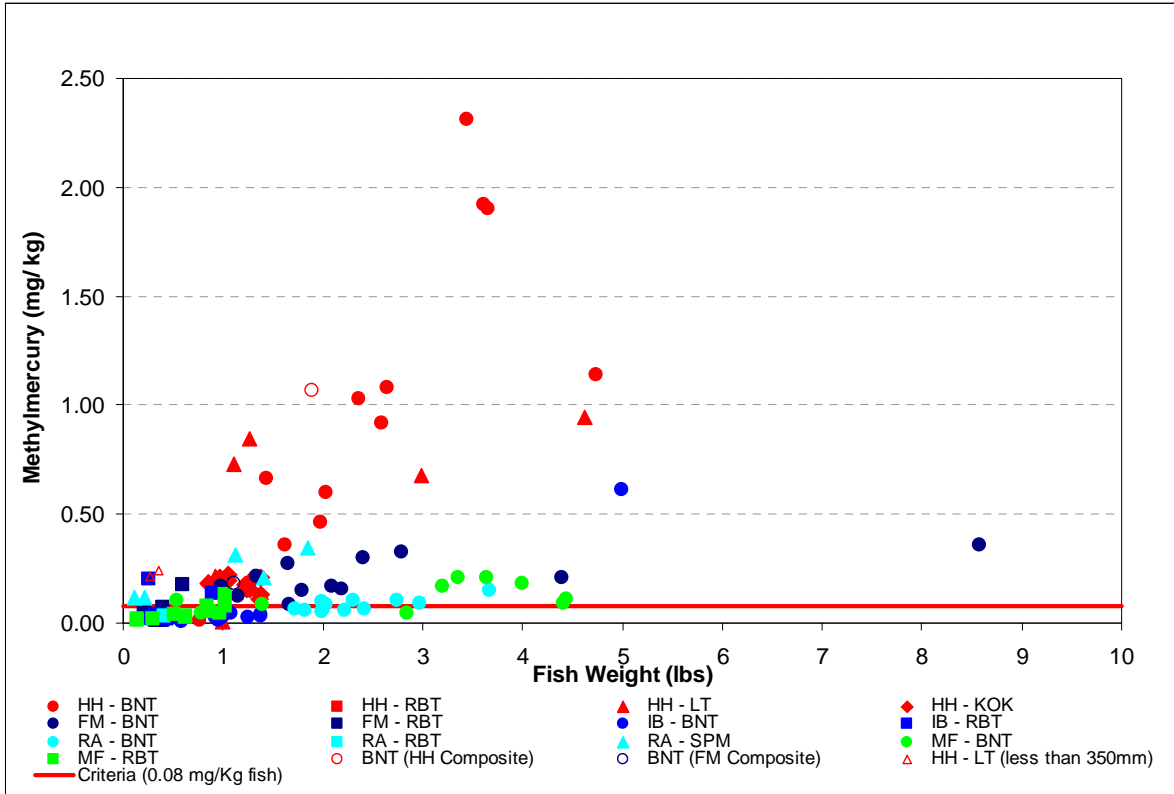
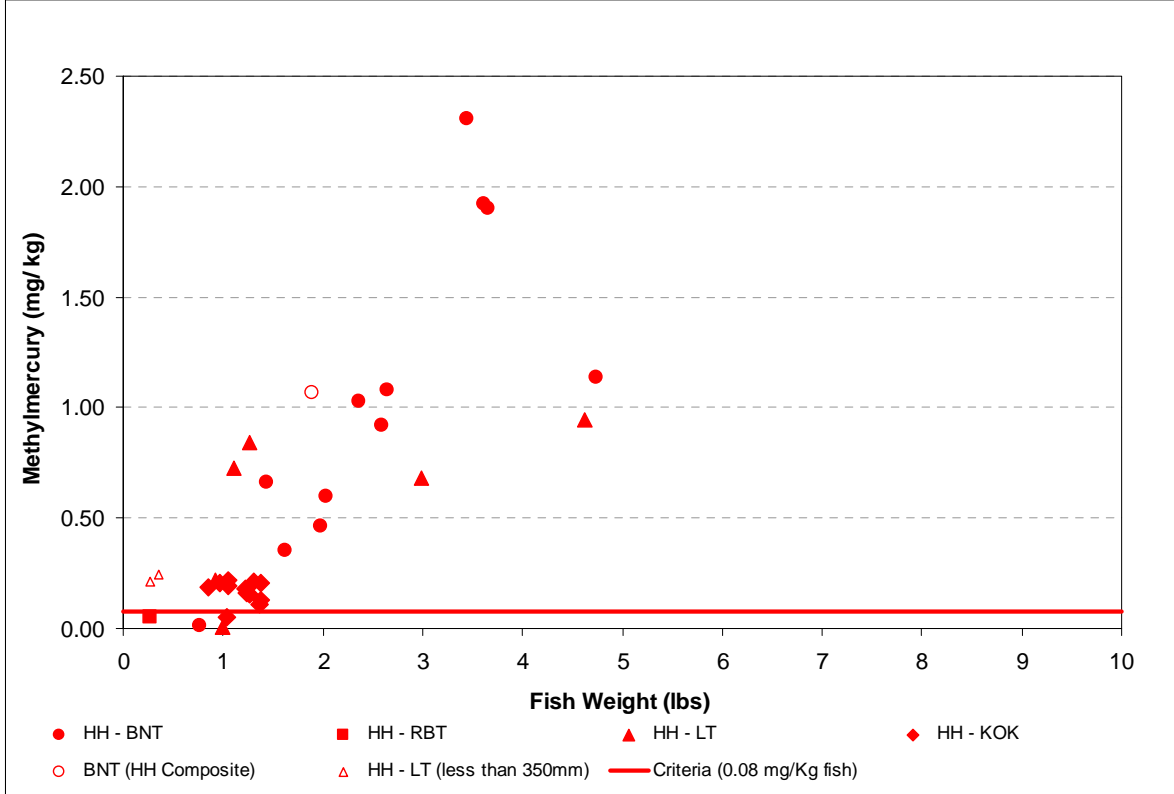


Figure AQ 11-2b. Methylmercury Fish Tissue Analysis Results at Hell Hole Reservoir by Species.



Locations: HH = Hell Hole Reservoir, FM = French Meadows Reservoir, IB = Middle Fork Interbay, RA = Ralston Afterbay, MF = Middle Fork American River
 Species: BNT = Brown Trout, LT= Lake Trout, RBT = Rainbow Trout, KOK = Kokanee, SPM = Sacramento Pikeminnow

Figure AQ 11-2c. Methylmercury Fish Tissue Analysis Results at French Meadows Reservoir by Species.

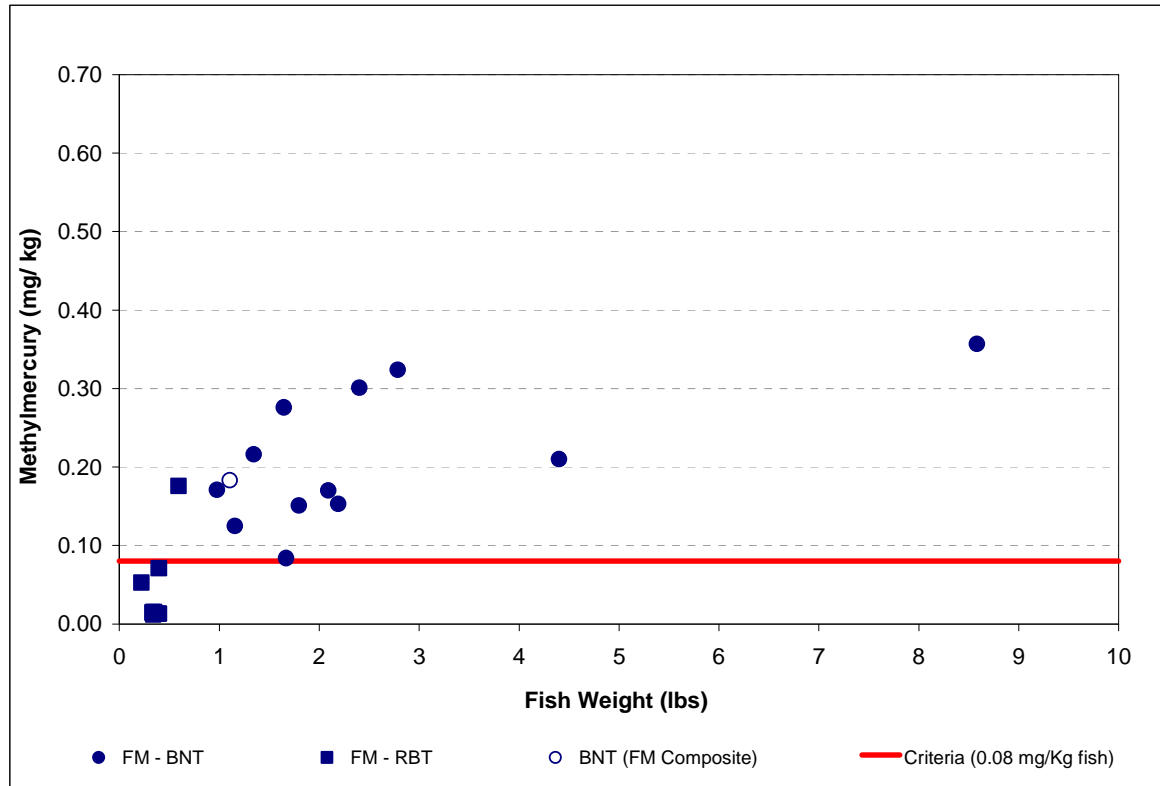
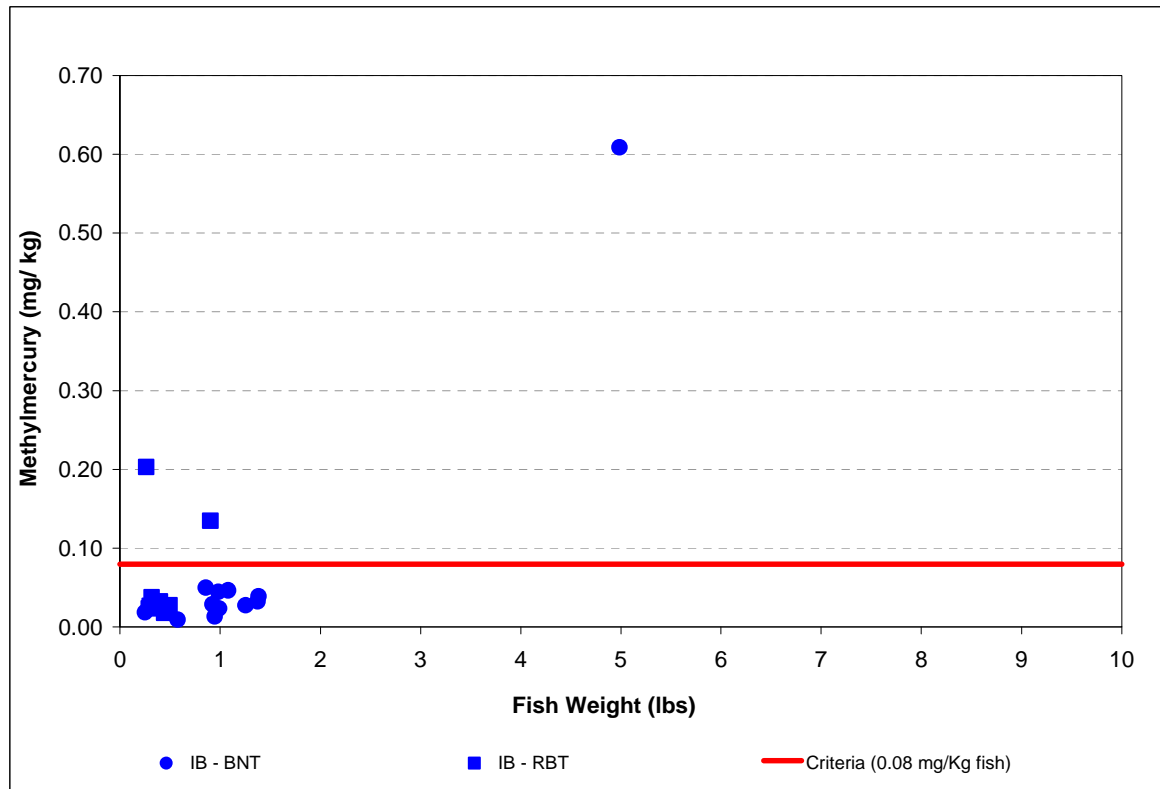


Figure AQ 11-2d. Methylmercury Fish Tissue Analysis Results at Middle Fork Interbay by Species.



Locations: FM = French Meadows Reservoir, IB = Middle Fork Interbay
 Species: BNT = Brown Trout, RBT = Rainbow Trout

Figure AQ 11-2e. Methylmercury Fish Tissue Analysis Results at Ralston Afterbay by Species.

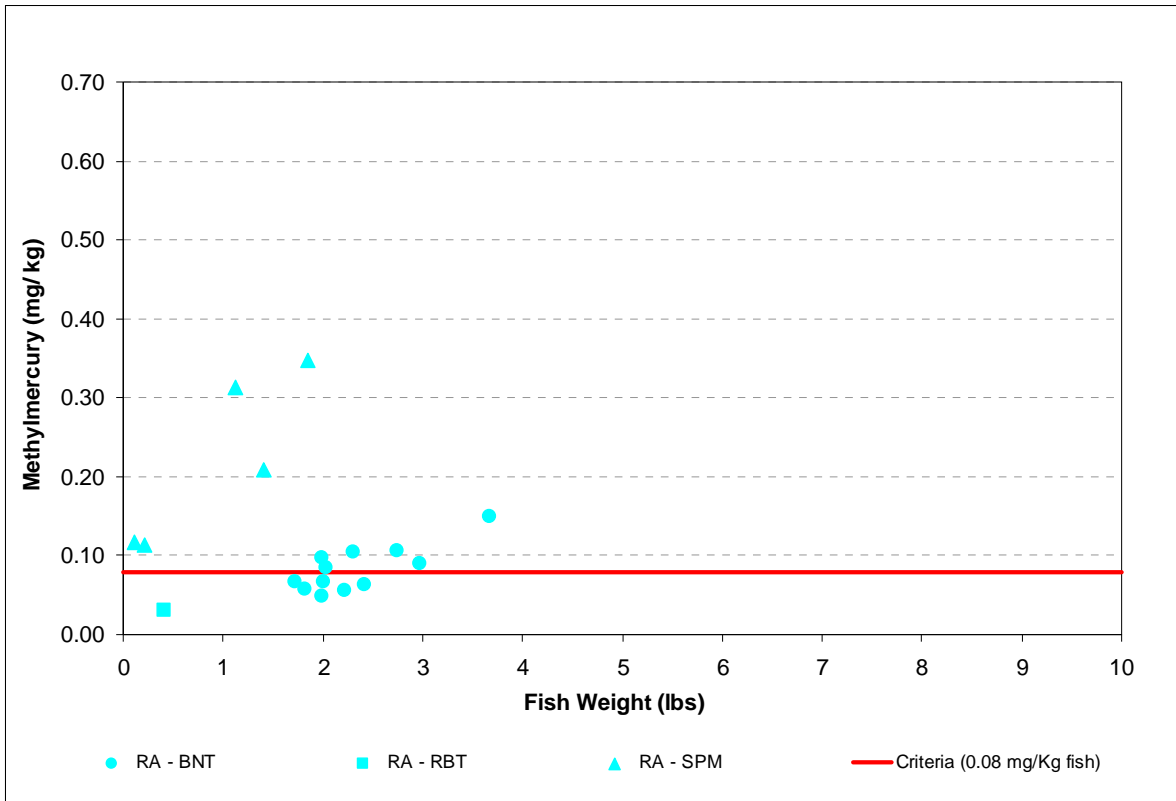


Figure AQ 11-2f. Methylmercury Fish Tissue Analysis Results at the Middle Fork American River by Species.

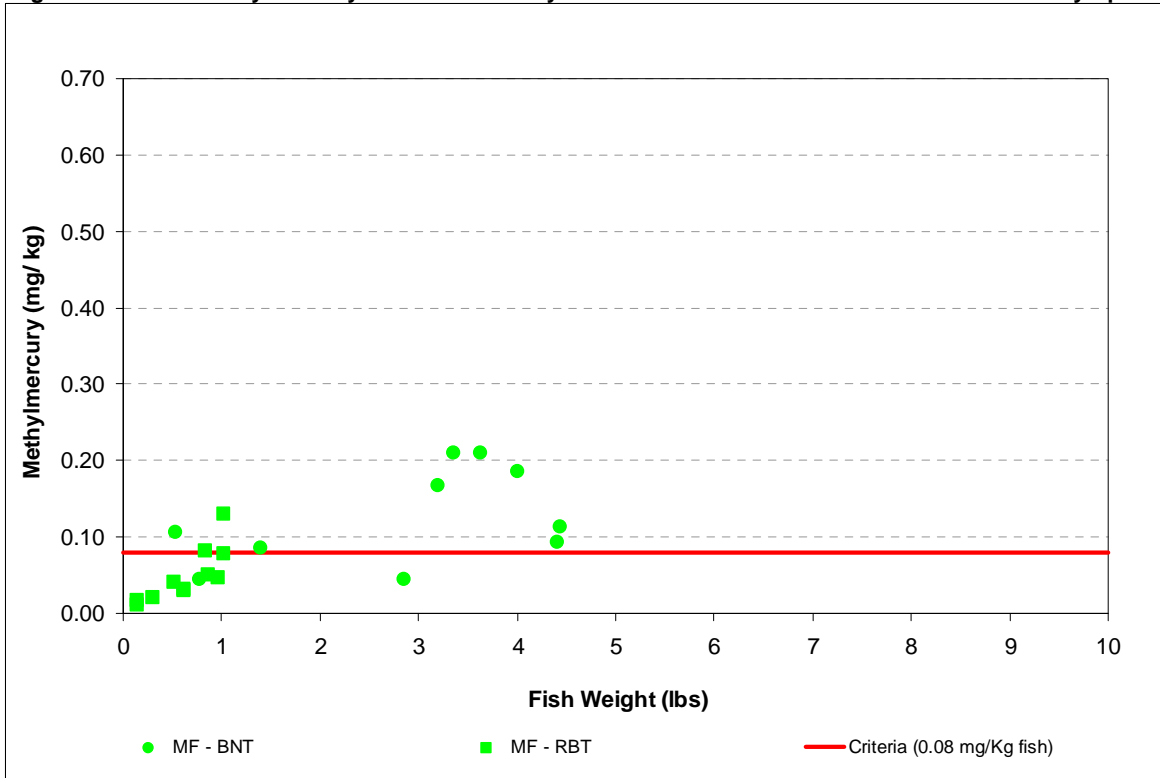
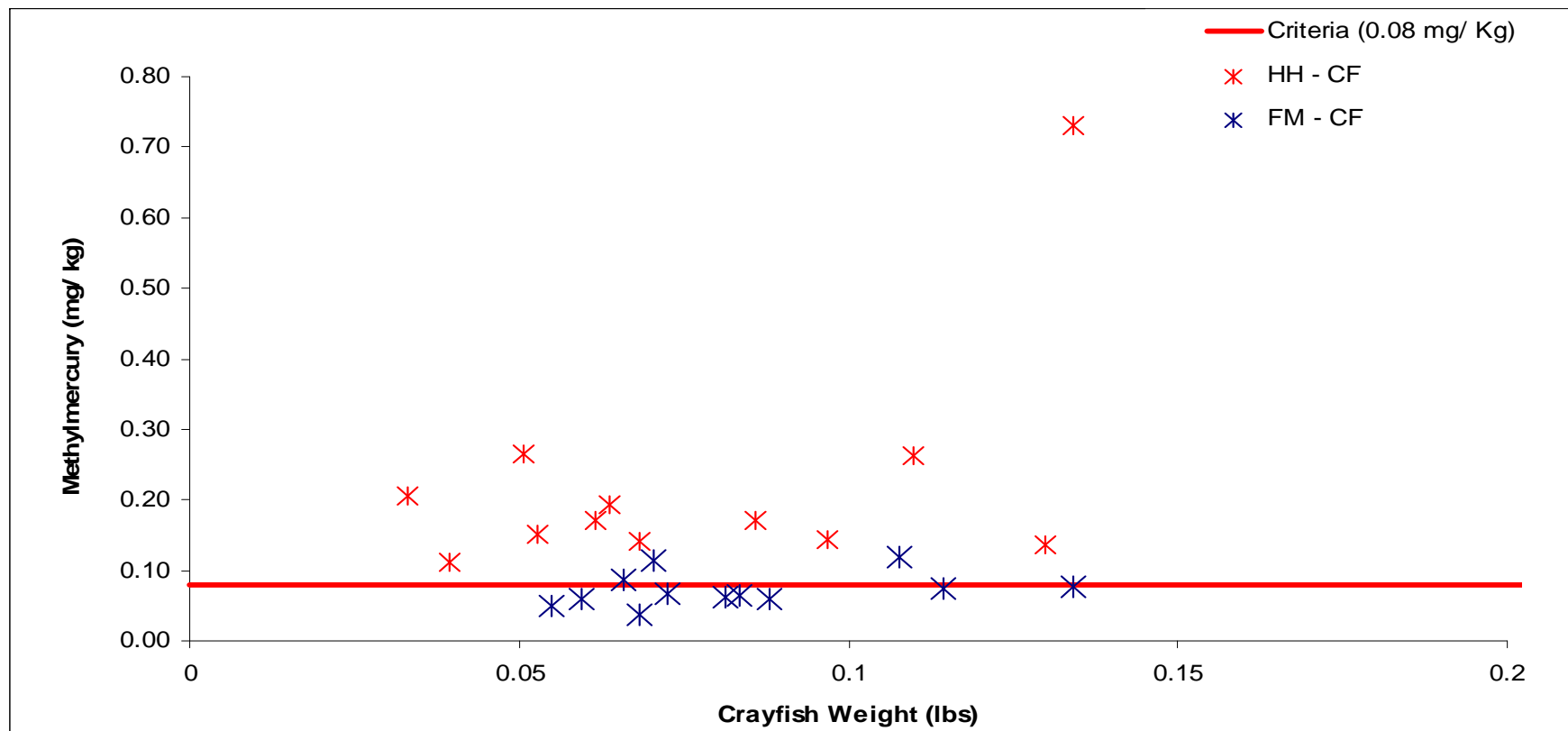


Figure AQ 11-3. Methylmercury Crayfish Tissue Analysis Results by Sampling Location.



MAP