SWAMP
Surface Water Ambient Monitoring Program

Final Technical Report	2008

Screening Study of Bioaccumulation in California Lakes and Reservoirs Quality Assurance Program Plan

January 2008

California Water Boards

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QUALITY ASSURANCE PROJECT PLAN

SCREENING STUDY OF BIOACCUMULATION IN CALIFORNIA LAKES AND RESERVOIRS

The Bioaccumulation Oversight Group (BOG)

Surface Water Ambient Monitoring Program

Revision 1.3
January 2008

Section A1. Title and Approval Sheets, QAPP Preface

Program Title

SWAMP Bioaccumulation Oversight Group Lake and Reservoir Study

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Effective Date

This Quality Assurance Project Plan (QAPP) is effective from May 2007 to June 2009 unless otherwise revised, approved and distributed accordingly at an earlier date.

Citation for QAPP

Bonnema, A. 2007. Quality Assurance Project Plan Screening Study of Bioaccumulation in California Lakes and Reservoirs. Moss Landing Marine Labs. Prepared for SWAMP BOG, 49 pages plus appendices and attachments.

QAPP Preface

This Quality Assurance Project Plan (QAPP) document defines procedures and criteria that will be used for this project conducted by SWAMP Bioaccumulation Oversight Group (BOG) in association with the California Department of Fish and Game Marine Pollution Studies Laboratory (MPSL-DFG), California Dept. of Fish and Game Fish and Wildlife Pollution Control Laboratory (DFG-WPCL), and the San Francisco Estuary Institute (SFEI). Included are criteria for data quality acceptability, procedures for sampling, testing (including deviations) and calibration, as well as preventative and corrective measures. The responsibilities of SFEI, MPSL-DFG, and DFG-WPCL also

are contained within. The BOG selects the sampling sites, the types and size of fish, and the number of analyses to be conducted.

This work is funded through the Surface Water Ambient Monitoring Program (SWAMP) fiscal year 06/07 Bioaccumulation funding.

Approvals

Mark Stephenson
Project Manager/MPSL-DFG Laboratory Director

_____ Date_____

Jay Davis
Lead Scientist

_____ Date_____

Beverly van Buuren
SWAMP Quality Assurance Officer

_____ Date_____

Autumn Bonnema
Project Coordinator/ MPSL-DFG Quality Assurance Officer

_____ Date_____

David Crane
DFG-WPCL Laboratory Director

_____ Date_____

Loc Nguyen
DFG-WPCL Quality Assurance Officer

_____ Date_____

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Section A3. Distribution List and Contact Information

A copy of this Quality Assurance Project Plan (QAPP), in hardcopy or electronic format, is to be received and retained by at least one person from each participating entity. At least one person from each participating entity (names shown with asterisk*) shall be responsible for receiving, retaining and distributing the QAPP to their respective staff within their own organization. Contact information for the primary contact person (listed first) for each participating organization also is provided below in Table 1.

Table 1. Contact Information

Name	Agency, Company or Organization
SAN FRANCISCO ESTUARY INSTITUTE	
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CALIFORNIA DEPARTMENT OF FISH AND GAME **FISH AND WILDLIFE WATER POLLUTION CONTROL LABORATORY**	
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MOSS LANDING MARINE LABORATORIES **QUALITY ASSURANCE RESEARCH GROUP**	
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Section A4. Project Organization

The lines of communication between the participating entities, project organization and responsibilities are outlined in Table 2 and Figure 1.

Table 2. Positions and duties

Position	Person	Responsibilities
Contract Manager	Rusty Fairey MPSL-MLML	Approve reports and invoices for payment.
Project Manager	Mark Stephenson MPSL-DFG	Project management and oversight.
Lead Scientist	Jay Davis SFEI	Advisory Roll; Data reporting
Project Coordinator	Autumn Bonnema, MPSL-DFG	Generation of a QAPP, Project coordination; ensures all laboratory activities are completed within proper timeframes.
Program QA Officer	Beverly van Buuren QA Research Group, MLML	Approve QAPP and oversee SWAMP projects' QA/QC
Laboratory QA Officer	Loc Nguyen DFG-WPCL Autumn Bonnema, MPSL-DFG	Ensures that the laboratory quality assurance plan and quality assurance project plan criteria are met through routine monitoring and auditing of the systems. Ensure that data meets project's objective through verification of results.
Sample Collection	Gary Ichikawa MPSL-DFG	Sampling coordination, operations, and implementing field-sampling procedures.
Laboratory Director	David Crane DFG-WPCL Mark Stephenson MPSL-DFG	Organizing, coordinating, planning and designing research projects and supervising laboratory staff; Data validation, management and reporting
Sample Custodian	Kyle Skaff MPSL-DFG Laurie Smith DFG-WPCL additional staff	Sample storage. Not responsible for any deliverables.
Technicians	Technical staff MPSL-DFG DFG-WPCL	Conduct fish tissue dissection, digestion, and chemical analyses. Not responsible for any deliverables.

4.1. Involved parties and roles

Rusty Fairey of Marine Pollution Studies Lab - Moss Landing Marine Laboratories (MPSL-MLML) will be the Contract Manager (CM) for this project. The CM will approve reports and invoices for payment.

Mark Stephenson of MPSL-DFG will serve as the Project Manager (PM) for the project. The PM will 1) review and approve the QAPP, 2) review, evaluate and document project reports, and 3) verify the completeness of all tasks.

Jay Davis of San Francisco Estuary Institute (SFEI) is the Lead Scientist (LS) and primary contact of this project. The LS will 1) generate the Sampling Plan, 2) approve the QAPP, and 3) provide the BOG with a final report on completion of this project.

Autumn Bonnema of MPSL-DFG is the Project Coordinator (PC). The PC will 1) prepare the QAPP, 2) ensure that laboratory technicians have processing instructions and 3) ensure all laboratory activities are completed within the proper timelines. In addition, the PC may assist field crew in preparation and logistics.

Gary Ichikawa of MPSL-DFG is in charge of directing fish collection for this project. He will 1) oversee preparation for sampling, including vehicle maintenance and 2) oversee sample and field data collection.

Kyle Skaff is responsible for sample storage and custody at MPSL. His duties will be to oversee compositing of tissue samples. Laurie Smith will do the same for samples processed at DFG-WPCL.

David Crane will serve as the Laboratory Director (LD) for the DFG-WPCL component of this project. His specific duties will be to 1) review and approve the QAPP, 2) provide oversight for all organic chemical analyses to be done for this project, and 3) ensure that all DFG-WPCL activities are completed within the proper timelines.

Mark Stephenson will also serve as the Laboratory Director (LD) for the MPSL-DFG component of this project. His specific duties will be to 1) review and approve the QAPP, 2) provide oversight for all trace metal analyses to be done for this project, and 3) ensure that all MPSL-DFG activities are completed within the proper timelines.

The following serve in an advisory role and are not responsible for any deliverables: Terry Fleming (EPA), Del Rasmussen (State Water Resources Control Board (SWRCB)), Bob Brodberg (Office of Environmental Health Hazard Assessment (OEHHA)), Mary Adams (RWQCB3), Michael Lyons (RWQCB4), Robert Holmes (RWQCB5), Chris Foe (RWQCB5), Tom Kimball (SWRCB), Don Stevens (Oregon State University), Cassandra Lamerdin (MPSL-MLML), Marco Sigala (MPSL-MLML), Billy Jakl (MPSL), Glenn Sibbald (DFG-WPCL), and Max Puckett (DFG).

4.2. Quality Assurance Officer (QAO) Role

The Laboratory Quality Assurance Officers fulfill the functions and authority of a project quality assurance officer (QAO). Autumn Bonnema is the MPSL-DFG QAO and Loc Nguyen is the DFG-WPCL QAO. The role of the Laboratory QAO is to ensure that quality control for sample processing and data analysis procedures described in this QAPP are maintained throughout the project. The Program QAO (Beverly van Buuren, SWAMP) acts in a consulting role to the Laboratory QAOs and ensures the project meets all SWAMP QA/QC criteria (Puckett, 2002).

The Laboratory QAOs will review and assess all procedures during the life of this project against QAPP requirements, and assess whether the procedures are performed according to protocol. The Laboratory QAOs will report all findings (including qualified data) to the Program QAO and the PM, including all requests for corrective action. The Laboratory and Program QAOs have the authority to stop all actions if there are significant deviations from required procedures or evidence of a systematic failure.

A conflict of interest does not exist between the Laboratory QAOs and the work outlined in this QAPP as neither Laboratory QAO participates in any of the chemical analyses of the project. There is not a conflict of interest with one person fulfilling the roles of Laboratory QAO and Project Coordinator (PC), as laboratory decisions are not made by the PC and no other duties overlap. The role of the PC is detailed above.

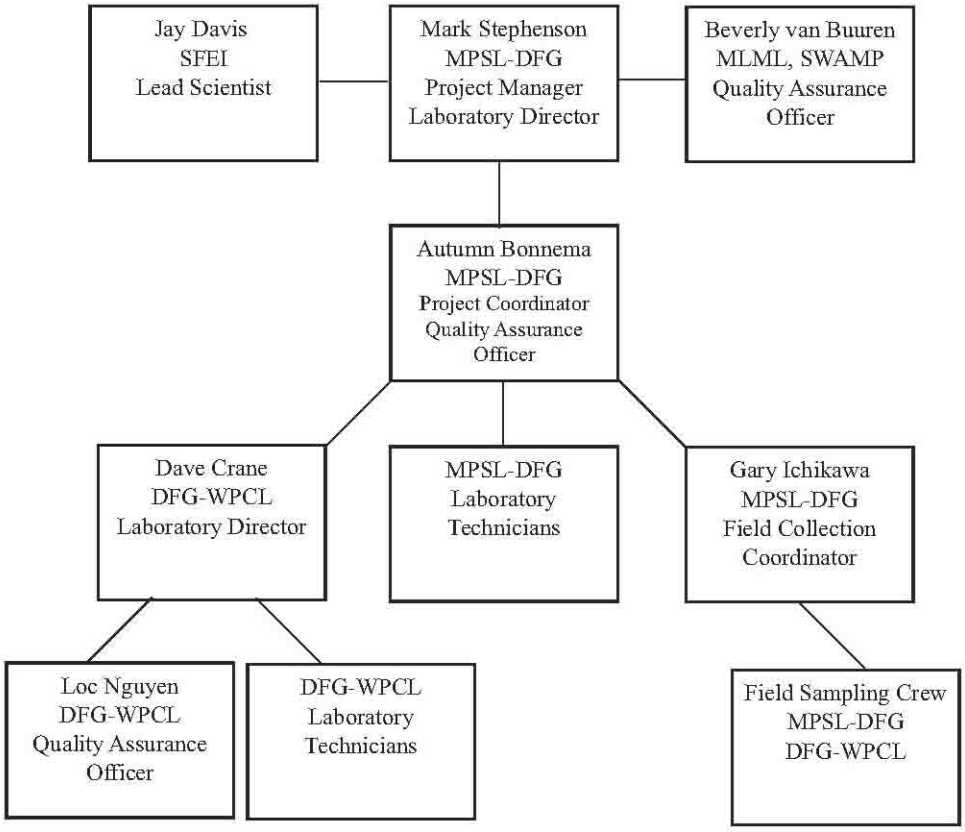
4.3. Persons responsible for QAPP update and maintenance

Revisions and updates to this QAPP will be carried out by Autumn Bonnema (PC), with technical input of the PM and the Laboratory and Program QAOs. All changes will be considered draft until reviewed and approved by the PM and the SWAMP QAO. Finalized revisions will be submitted for approval to the SWAMP QAO, if necessary.

Copies of this QAPP will be distributed to all parties involved in the project. Any future amended QAPPs will be held and distributed in the same fashion. All originals of these first and subsequent amended QAPPs will be held on site at SFEI, DFG-WPCL and MPSL.

4.4. Organizational chart and responsibilities

Figure 1. Organizational Chart



Section A5. Problem Definition/Background

5.1. Problem statement

5.1.1. Addressing Multiple Beneficial Uses

Bioaccumulation in California water bodies has an adverse impact on both the fishing and aquatic life beneficial uses (Davis et al. 2007). The fishing beneficial use is affected by human exposure to bioaccumulative contaminants through consumption of sport fish. The aquatic life beneficial use is affected by exposure of wildlife to bioaccumulative contaminants, primarily piscivorous species exposed through consumption of small fish. Different indicators are used to monitor these different types of exposure. Monitoring of status and trends in human exposure is accomplished through sampling and analyzing sport fish. On the other hand, monitoring of status and trends in wildlife exposure can accomplished through sampling and analysis of wildlife prey (small fish, other prey species) or tissues of the species of concern (e.g., bird eggs or other tissues of juvenile or adults of the species at risk).

Over the long-term, a SWAMP bioaccumulation monitoring is envisioned that assesses progress in reducing impacts on both the fishing and aquatic life beneficial uses for all water bodies in California. In the near-term, however, funds are limited, and there is a need to demonstrate the value of a comprehensive statewide bioaccumulation monitoring program through successful execution of specific components of a comprehensive program. Consequently, with funds available for sampling in 2007 ($797,000) and additional funds of a similar magnitude anticipated for 2008, the BOG has decided to focus on sampling that addresses the issue of bioaccumulation in sport fish and impacts on the fishing beneficial use. This approach is intended to provide the information that the Legislature and the public would consider to be of highest priority. Monitoring focused on evaluating the aquatic life beneficial use will be included in the Project when expanded funding allows a broader scope.

5.1.2. Addressing Multiple Monitoring Objectives and Assessment Questions for the Fishing Beneficial Use

The BOG has developed a set of monitoring objectives and assessment questions for a statewide program evaluating the impacts of bioaccumulation on the fishing beneficial use (Table 3). This assessment framework is consistent with frameworks developed for other components of SWAMP, and is intended to guide the bioaccumulation monitoring program over the long-term. The four objectives can be summarized as 1) status; 2) trends; 3) sources and pathways; and 4) effectiveness of management actions.

Over the long-term, the primary emphasis of the statewide bioaccumulation monitoring program will be on evaluating status and trends. Bioaccumulation monitoring is a very effective and essential tool for evaluating status, and is often the most cost-effective tool for evaluating trends. Monitoring status and trends in bioaccumulation will provide some information on sources and pathways and effectiveness of management actions at a broader geographic scale. However, other types of monitoring (i.e., water and sediment monitoring) and other programs (regional TMDL programs) are more appropriate for addressing sources and pathways and effectiveness of management actions.

In the near-term, the primary emphasis of the statewide bioaccumulation monitoring program will be on evaluating Objective 1 (status). The reasons for this are:

1. a systematic statewide assessment of status has not been performed to date and is urgently needed;
2. we are starting a new program and establishing a foundation for future assessments of trends;
3. past monitoring of sport fish established very few time series that are useful in trend analysis.

5.1.3. Addressing Multiple Habitat Types

SWAMP has defined the following categories of water bodies:

- lakes and reservoirs;
- bays and estuaries;
- coastal waters;
- large rivers;
- wadeable streams; and
- wetlands.

Due to their vast number, high fishing pressure, and a relative lack of information on bioaccumulation, lakes and reservoirs were identified as the highest priority for monitoring. With over 9000 lakes in California, performing a statewide assessment of just this one water body type would be a challenge with the limited amount of funding available for bioaccumulation monitoring. The BOG therefore decided that sampling in 2007 (with funds already allocated – approximately $800,000) and 2008 (with additional funds anticipated – approximately $700,000) should focus on a thorough assessment of lakes and reservoirs. The long-term plan for bioaccumulation monitoring will include a strategy for monitoring bioaccumulation in the other water body types (for both the fishing and aquatic life beneficial uses).

In summary, focusing on one habitat type (lakes), one objective (status), and one beneficial use (fishing) will allow us to provide reasonable coverage and a thorough assessment of bioaccumulation in California's lakes and reservoirs.

Table 3. Bioaccumulation monitoring assessment framework for the fishing beneficial use.

D.1. Determine the status of the fishing beneficial use throughout the State with respect to bioaccumulation of toxic pollutants

D.1.1 What are the extent and location of water bodies with sufficient evidence to indicate that the fishing beneficial use is at risk due to pollutant bioaccumulation?

D.1.2 What are the extent and location of water bodies with some evidence indicating the fishing beneficial use is at risk due to pollutant bioaccumulation?

D.1.3 What are the extent and location of water bodies with no evidence indicating the fishing beneficial use is at risk due to pollutant bioaccumulation?

D.1.4 What are the proportions of water bodies in the State and each region falling within the three categories defined in questions D.1.1, D.1.2, and D.1.3?

D.2. Assess trends in the impact of bioaccumulation on the fishing beneficial use throughout the State

D.2.1 Are water bodies improving or deteriorating with respect to the impact of bioaccumulation on the fishing beneficial use?

D.2.1.1 Have water bodies fully supporting the fishing beneficial use become impaired?

D.2.1.2 Has full support of the fishing beneficial use been restored for previously impaired water bodies?

D.2.2 What are the trends in proportions of water bodies falling within the three categories defined in questions D.1.1, D.1.2, and D.1.3 regionally and statewide?

D.3. Evaluate sources and pathways of bioaccumulative pollutants impacting the fishing beneficial use

D.3.1 What are the magnitude and relative importance of pollutants that bioaccumulate and indirect causes of bioaccumulation throughout each Region and the state as a whole?

D.3.2 How is the relative importance of different sources and pathways of bioaccumulative pollutants that impact the fishing beneficial use changing over time on a regional and statewide basis?

D.4. Provide the monitoring information needed to evaluate the effectiveness of management actions in reducing the impact of bioaccumulation on the fishing beneficial use

D.4.1 What are the management actions that are being employed to reduce the impact of bioaccumulation on the fishing beneficial use regionally and statewide?

D.4.2 How has the impact of bioaccumulation on the fishing beneficial use been affected by management actions regionally and statewide?

5.2. Decisions or outcomes

Three management questions have been articulated to guide the 2007-2008 survey of the status bioaccumulation in sport fish of California lakes and reservoirs. These management questions are specific to this initial monitoring effort; different sets of management questions will be established to guide later efforts.

5.2.1. Management Question 1 (MQ1): Should a specific lake be considered impaired and placed on the 303(d) list due to bioaccumulation of contaminants in sport fish?

Answering this question is critical to determining the need for cleanup actions to reduce contaminant exposure in specific water bodies. TMDLs are required for water bodies placed on the 303(d) list. This is the principal regulatory mechanism being used by the State Water Board, the Regional Water Boards, and USEPA to establish priorities for management actions.

The State Water Board has established a policy for placing water bodies on the 303(d) list. The information needed to make a listing determination includes results from two independent samples that exceed the relevant threshold of concern.

5.2.2. Management Question 2 (MQ2): What is the condition of California lakes with respect to bioaccumulation in sport fish?

Answering this question is the goal of the biennial 305(b) reports that the State Water Resources Control Board submits to the U.S. Environmental Protection Agency pursuant to Section 305(b) of the federal Clean Water Act (e.g., SWRCB 2003). The 305(b) report provides water quality information to the general public and serves as the basis for U.S. EPA 's National Water Quality Inventory Report to Congress. The report provides a statewide, comprehensive assessment of the status of California water bodies with respect to support of designated beneficial uses. Answering this question also provides the state legislature and the public with information that helps establish the magnitude and priority of the bioaccumulation problem relative to other environmental and societal problems.

The information needed to answer this question is the representative, average concentration of bioaccumulative contaminants in each lake for an adequately large sampling of lakes.

5.2.3. Management Question 3 (MQ3): Should additional sampling of bioaccumulation in sport fish at a lake be conducted for the purpose of developing consumption guidelines?

Answering this question is essential as a first step in determining the need for more thorough sampling in support of developing consumption guidelines. Consumption guidelines provide a mechanism for reducing human exposure in the short-term. The information requirements for consumption guidelines are more extensive than for 303(d)

listing. The California Office of Environmental Health Hazard Assessment (OEHHA), the agency responsible for issuing consumption guidelines, needs samples representing 9 or more fish from a variety of species abundant in a water body in order to issue guidance. It is valuable to have information not only on the species with high concentrations, but also the species with low concentrations so anglers can be encouraged to target the low species.

5.2.4. Overall Approach

The overall approach to be taken to answer these three questions is to perform a statewide screening study of bioaccumulation in sport fish. The highest priority for SWAMP in the short-term is to answer MQ1 and MQ2. Answering these questions will provide a basis for decision-makers to understand the scope of the bioaccumulation problem and will provide regulators with information needed to meet their needs and establish priorities for cleanup actions. In the longer-term, developing consumption guidelines that inform the public on ways to reduce their exposure is also a high priority, and this effort would cost-effectively establish a foundation for this by identifying lakes where guidelines appear to be needed and more sampling is required.

It is anticipated that the screening study will lead to more detailed follow-up investigations of many water bodies that become placed on the 303(d) list or where consumption guidelines are needed. Funding for these follow-up studies will come from other local or regional programs rather than the statewide monitoring budget.

5.3. Fish tissue contamination criteria

Threshold levels for determining impairment of a body of water based on pollutants in fish tissue are listed in Table 4. Thresholds are from Klasing and Brodberg (2006), and correspond to a concentration at which OEHHA would begin to consider advising limited consumption (i.e., fewer than 8 meals per month). Exceeding these thresholds will be considered an indication of impairment.

In addition, the thresholds for triggering analysis of archived samples from a location are in Table 5. These triggers are 75% of the threshold for concern.

Thresholds for Total PCBs, DDTs, and Chlordanes are based on the summation of concentrations from the compounds listed in Table 6.

Table 4. Thresholds for concern for pollutants included in the survey.

Pollutant	Threshold for concern (ng/g wet wt)
Methylmercury[1]	120
Total PCBs[2]	30
Total DDTs[3]	830
Dieldrin[4]	24
Total Chlordanes[5]	300
Selenium[6]	2,920
PBDEs	Not available

[1] Estimated by total mercury measurements in fish. Threshold for sensitive populations (i.e., women of childbearing age and children 17 and under), based on non-cancer risk and a reference dose of $1X10^{-4}$ mg/kg-day.
[2] Threshold based on non-cancer risk and a reference dose of $2X10^{-5}$ mg/kg-day.
[3] Threshold based on non-cancer risk and a reference dose of $5X10^{-4}$ mg/kg-day.
[4] Threshold based on cancer risk and a slope factor of 16 $(mg/kg/day)^{-1}$.
[5] Threshold based on cancer risk and a slope factor of 1.3 $(mg/kg/day)^{-1}$.
[6] Threshold for sensitive populations (consumers who take selenium supplements in excess of the RDA), based on non-cancer risk and a reference dose of $5X10^{-3}$ mg/kg-day.

Table 5. Thresholds for triggering follow-up analysis of archived composite samples.

Pollutant	Threshold for follow-up analysis (ng/g wet wt)
Methylmercury[1]	90
Total PCBs	22
Total DDTs	622
Dieldrin	18
Total Chlordanes	225
Selenium	2,190
PBDEs	Not available

[1] Estimated by total mercury measurements in fish.

Table 6. Compounds summed for comparison with threshold levels.

Pollutant	Components	Reference
Total PCBs	Sum of all congeners analyzed	
Total PCB Aroclors	PCB AROCLOR 1248 PCB AROCLOR 1254 PCB AROCLOR 1260	SWRCB 2000
Total Chlordanes	Chlordane, cis- Chlordane, trans- Nonachlor, cis- Nonachlor, trans- Oxychlordane	USEPA 2000
Total DDTs	DDD(o,p') DDD(p,p') DDE(o,p') DDE(p,p') DDT(o,p') DDT(p,p')	USEPA 2000
Total PBDEs	Sum of all congeners analyzed	

Section A6. Project Description

6.1. Work statement and produced products

Sampling will be conducted from June 2007 through November 2007. Seasonal variation in body condition (Cidziel et al. 2003) and reproductive physiology are recognized as factors that could affect contaminant concentrations. However, sampling as many lakes as possible is essential to a statewide assessment, and it will take many months to sample the 130 lakes targeted for 2007.

A technical report on the 2007 sampling will be drafted by June 2008 and will include a complete assessment of condition of lakes based on a randomized sampling of 50 lakes across California for use in a 305(b) report, supplemented by a thorough sampling of 80 popular lakes that will provide a sound basis for determining whether 130 lakes should be included on the 303(d) list. The report will be distributed for peer review in June 2008. The final report, incorporating revisions in response to reviewer comments, will be completed in September 2008.

It is anticipated that funding for an additional round of sampling will be available in 2008. This work would follow the same approach described in this document, but focus on remaining popular lakes. This sampling would begin May 2008.

6.2. Constituents to be analyzed and measurement techniques.

A detailed Sampling and Analysis Plan is in Appendix II. Chemistry analytical methods are summarized in Section B13. Constituents to be analyzed are summarized in Tables 7-9a,b,c. All chemistry data will be reported on a wet weight basis.

Table 7. Constituents to be Analyzed – Fish Attributes

Fish Attributes
Total Length (mm)
Fork Length (mm)
Weight (g)
Moisture (%)
Lipid Content (%)
Sex
Age[1]

[1]Age will be determined by otolith analysis on black bass species. Age of bottom feeder species will also be determined by otolith analysis from lakes identified as Trend Lakes.

Table 8. Constituents to be Analyzed – Metals and Metalloids

Analyte	Analytical Method
Total Mercury	EPA 7374
Total Selenium	EPA 200.8

Table 9a. Constituents to be Analyzed – Organochlorine (OC) Pesticides

Organochlorine Pesticides (by EPA 8081AM using GC-ECD)	
Group	**Parameter**
Chlordanes	Chlordane, cis-
	Chlordane, trans-
	Heptachlor
	Heptachlor epoxide
	Nonachlor, cis-
	Nonachlor, trans-
	Oxychlordane
DDTs	DDD(o,p')
	DDD(p,p')
	DDE(o,p')
	DDE(p,p')
	DDMU(p,p')
	DDT(o,p')
	DDT(p,p')
Cyclodienes	Aldrin
	Dieldrin
	Endrin
HCHs	HCH, alpha
	HCH, beta
	HCH, gamma
Others	Dacthal
	Endosulfan I
	Hexachlorobenzene
	Methoxychlor
	Mirex
	Oxadiazon
	Tedion

Table 9b. Constituents to be Analyzed – Polychlorinated Biphenyls (PCB)

Polychlorinated Biphenyl (PCB) Congeners and Arochlor Compounds (by EPA Method 8082M)	
PCB 008	PCB 141
PCB 018	PCB 146
PCB 027	PCB 149
PCB 028	PCB 151
PCB 029	PCB 153
PCB 031	PCB 156
PCB 033	PCB 157
PCB 044	PCB 158
PCB 049	PCB 169
PCB 052	PCB 170
PCB 056	PCB 174
PCB 060	PCB 177
PCB 064	PCB 180
PCB 066	PCB 183
PCB 070	PCB 187
PCB 074	PCB 189
PCB 077	PCB 194
PCB 087	PCB 195
PCB 095	PCB 198/199
PCB 097	PCB 200
PCB 099	PCB 201
PCB 101	PCB 203
PCB 105	PCB 206
PCB 110	PCB 209
PCB 114	
PCB 118	**Calculated values from Lab**
PCB 126	PCB AROCLOR 1248
PCB 128	PCB AROCLOR 1254
PCB 137	PCB AROCLOR 1260
PCB 138	

Table 9c. Constituents to be Analyzed – Polybrominated Diphenyl Ethers (PBDE)

Polybrominated Diphenyl Ethers (PBDEs) (by EPA Method 8082M)
PBDE 017
PBDE 028
PBDE 047
PBDE 066
PBDE 100
PBDE 099
PBDE 085

6.3. Project schedule and number of samples to be analyzed.

Key tasks in the project and their expected due dates are outlined in Table 10.

Table 10. Project Schedule Timeline

Item		Activity and/or Deliverable	Deliverable Due Date
1		**Contracts**	
		Subcontract Development	April 2007
2		**Quality Assurance Project Plan & Monitoring Plan**	
	2.1	Draft Monitoring Plan	May 2007
	2.2	Final Monitoring Plan	June 2007
	2.3	Draft Quality Assurance Project Plan	May 2007
	2.4	Final Quality Assurance Project Plan	June 2007
3		**Sample Collection**	June-November 2007
4		**Sample Selection and Chemical Analysis**	
	4.1	Selection of Tissue for Analysis	June-November 2007
	4.2	Creation of Sample Composites	June 2007-December 2007
	4.3	Chemical Analysis	June 2007-March 2008
5		**Interpretive Report**	
	5.1	Draft Report	June 2008
	5.2	Final Report	September 2008

6.4. Geographical setting and sample sites

California has over 9,000 lakes. Collecting and analyzing fish from all of these lakes would be prohibitively expensive, so a representative subset was selected to answer the management questions established for the survey.

Sampling of Popular Lakes

The primary emphasis of the sampling effort will be to address MQ1 for as many lakes as possible. The focus of this aspect of the survey will be on lakes that are of greatest interest to managers and the public – the lakes that are most popular for fishing. This approach is considered the most prudent use of the limited funds available. Eighty percent of the funds anticipated to be available in 2007 and 2008 are being allocated to sampling these popular lakes.

Details on “popular lake” site selection can be found in the SAP (Appendix II).

Sampling of Other Lakes

The second major emphasis of the sampling effort will be to provide a statewide assessment that addresses MQ2. The most cost-effective approach to obtaining a statewide assessment is through sampling of a random, unbiased selection of lakes from the entire population of lakes in the state. Twenty percent of the funds anticipated to be available in 2007 and 2008 are being allocated to this statewide assessment of "other" lakes (i.e., lakes not include in the list of popular lakes.

Details on “other lake” site selection can be found in the SAP (Appendix II).

6.5. Constraints

All sampling must be completed by the end of the current year’s sampling season in order to meet analysis and reporting deadlines set forth in Table 10.

In addition, lakes that have been selected for sampling but yield no fish after one day’s fishing effort may be replaced by the next randomly identified lake. Ultimately, additional sites may be sampled pending time remaining in the sampling season and available funding within the project once cost savings from analysis has been determined.

Section A7. Quality Indicators and Acceptability Criteria for Measurement Data

Data quality indicators for the analysis of fish tissue concentrations of analytes will include accuracy (bias), precision, recovery, completeness and sensitivity. Measurement Quality Objectives for analytical measurements of organics and metals in tissue are in Table 11.

Previously collected data will not be utilized in this study, therefore specific acceptance criteria are not applicable.

Table 11. Measurement quality objectives for laboratory measurements.

Parameter	Accuracy	Precision	Recovery	Completeness	Sensitivity
Synthetic Organics (including PCBs, pesticides, and PBDEs)	Certified Reference Materials (CRM, PT) within 95% CI stated by provider of material. If not available then within 50% to 150% of true value	Duplicate RPD ± 25%	Matrix spike 50% - 150% or control limits at ± 3 standard deviations based on actual lab data	90%	See Tables 16a,b,c
Trace metals (including mercury)	CRM 75% to 125%	Duplicate RPD ± 25%	Matrix Spike 75% - 125%	90%	See Table 14

7.1. Accuracy

Evaluation of the accuracy of laboratory procedures is achieved through the preparation and analysis of reference materials with each analytical batch. Ideally, the reference materials selected are similar in matrix and concentration range to the samples being prepared and analyzed. The accuracy of the results is assessed through the calculation of a percent recovery.

$$\% \text{ recovery} = \frac{V_{analyzed}}{V_{certified}} x100$$

Where:

$v_{analyzed}$: the analyzed concentration of the reference material
$v_{certified}$: the certified concentration of the reference material

The acceptance criteria for reference materials are listed in Tables 13a, b.

While reference materials are not available for all analytes, a way of assessing the accuracy of an analytical method is still required. Laboratory control samples (LCSs) provide an alternate method of assessing accuracy. An LCS is a specimen of known composition prepared using contaminant-free reagent water or an inert solid spiked with the target analyte at the midpoint of the calibration curve or at the level of concern. The LCS must be analyzed using the same preparation, reagents, and analytical methods employed for regular samples. If an LCS needs to be substituted for a reference material, the acceptance criteria are the same as those for the analysis of reference materials. These are detailed in Tables 12a, b.

7.2. Precision

In order to evaluate the precision of an analytical process, a field sample is selected and digested or extracted in duplicate. Following analysis, the results from the duplicate samples are evaluated by calculating the RPD.

$$RPD = \left| \frac{(V_{sample} - V_{duplicate})}{mean} \right| x100$$

Where:

V_{sample}: the concentration of the original sample digest
$V_{duplicate}$: the concentration of the duplicate sample digest mean: the mean concentration of both sample digests

Specific requirements pertaining to the analysis of laboratory duplicates vary depending on the type of analysis. The acceptance criteria for laboratory duplicates are specified in Tables 13a, b.

Upper and lower control chart limits (e.g., warning limits and control limits) will be continually updated at DFG-WPCL; control limits are based on 99% confidence intervals around the mean.

A minimum of one duplicate per analytical batch will be analyzed. If the analytical precision is unacceptable, calculations and instruments will be checked. A repeat analysis may be required to confirm the results.

Duplicate precision is considered acceptable if the resulting RPD is $\leq$ 25% for analyte concentrations that are greater than the Minimum Level (ML). The U.S. Environmental Protection Agency (EPA) defines the ML as the lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. It is equivalent to the concentration of the lowest calibration standard, assuming that all standard operating procedure (SOP) or method-specified sample weights, volumes, and cleanup procedures have been employed.

7.2.1. Replicate Analysis

Replicate analyses are distinguished from duplicate analyses based simply on the number of involved analyses. Duplicate analyses refer to two sample digests, while replicate analyses refer to three or more. Analysis of replicate samples is not explicitly required; however it is important to establish a consistent method of evaluating these analyses. The method of evaluating replicate analysis is by calculation of the relative standard deviation (RSD). Expressed as a percentage, the RSD is calculated as follows:

$$RSD = \frac{Stdev(v_1, v_2, ...v_n)}{mean} x100$$

Where:

Stdev(v_1,v_2,…,v_n): the standard deviation of the values (concentrations) of the replicate analyses.

mean: the mean of the values (concentrations) of the replicate analyses.

7.3. Bias

Bias is the systematic or persistent distortion of a measurement process that skews data in one direction. Certified Reference Materials (CRM) and Matrix Spike (MS) samples are used to determine the analyte-specific bias associated with each analytical laboratory. CRMs are used to determine analytical bias, and MS are used to determine the bias associated with the tissue matrix.

A matrix spike (MS) is prepared by adding a known concentration of the target analyte to a field sample, which is then subjected to the entire analytical procedure. If the ambient concentration of the field sample is known, the amount of spike added is within a specified range of that concentration. Matrix spikes are analyzed in order to assess the magnitude of matrix interference and bias present. Because matrix spikes are analyzed in pairs, the second spike is called the matrix spike duplicate (MSD). The MSD provides information regarding the precision of the matrix effects. Both the MS and MSD are split from the same original field sample.

The success or failure of the matrix spikes is evaluated by calculating the percent recovery.

$$\% \text{ recovery} = \frac{\left(V_{MS} - V_{ambient}\right)}{V_{spike}} x100$$

Where:

V_{MS}: the concentration of the spiked sample

$V_{ambient}$: the concentration of the original (unspiked) sample

V_{spike}: the concentration of the spike added

In order to properly assess the degree of matrix interference and potential bias, the spiking level should be approximately 2-5 times the ambient concentration of the spiked sample. If the MS or MSD is spiked too high or too low relative to the ambient concentration, the calculated recoveries are no longer an acceptable assessment of analytical bias. In order to establish spiking levels prior to analysis of samples, the laboratories should review any relevant historical data. In many instances, the laboratory will be spiking the samples blind and will not meet a spiking level of 2-5X the ambient concentration. However, the results of affected samples will not be automatically rejected.

In addition to the recoveries, the relative percent difference (RPD) between the MS and MSD is calculated to evaluate how matrix affects precision.

$$RPD = \left| \frac{(V_{MS} - V_{MSD})}{mean} \right| x100$$

There are two different ways to calculate this RPD, depending on how the samples are spiked.

1) The samples are spiked with the same amount of analyte. In this case,
   V_{MS}: the concentration for the matrix spike
   V_{MSD}: the concentration of the matrix spike duplicate mean: the mean of the two concentrations (MS + MSD)
2) The samples are spiked with different amounts of analyte. In this case,
   V_{MS}: the recovery associated with the matrix spike
   v_{MSD}: the recovery associated with matrix spike duplicate mean: the mean of the two recoveries ($recovery_{MS}$ + $recovery_{MSD}$)

The MQO for the RPD between the MS and MSD is the same regardless of the method of calculation. These are detailed in Tables 13a, b.

7.4. Contamination assessment – Method blanks

Laboratory method blanks (also called extraction blanks, procedural blanks, or preparation blanks) are used to assess laboratory contamination during all stages of sample preparation and analysis. At least one laboratory method blank will be run in every sample batch of 20 or fewer field samples. The method blanks will be processed through the entire analytical procedure in a manner identical to the samples. The QC criterion for method blank analysis states that the blanks must be less than the Reporting Limit (<RL) for target analytes. If blank values exceed the RL, the sources of the contamination are determined and corrected, and in the case of method blanks, the previous samples associated with the blank are re-analyzed. All blank analysis results will be reported. If is not possible to eliminate the contamination source, all impacted analytes in the analytical batch will be flagged. In addition, a detailed description of the contamination sources and the steps taken to eliminate/minimize the contaminants will be included in interim and final reports. Subtracting method blank results from sample results is not permitted, unless specified in the analytical method.

7.5. Routine monitoring of method performance for organic analysis – surrogates

Surrogates are compounds chosen to simulate the analytes of interest in organic analyses. Surrogates are used to estimate analyte losses during the extraction and clean-up process, and must be added to each sample, including QC samples, prior to extraction. The reported concentration of each analyte is adjusted to correct for the recovery of the surrogate compound. The surrogate recovery data will be carefully monitored. If possible, isotopically-labeled analogs of the analytes will be used as surrogates. Surrogate recoveries for each sample are reported with the target analyte data. Surrogate is considered acceptable if the percent recovery is within 50-150%.

7.6. Internal standards

For Gas Chromatography Mass Spectrometry (GC-MS) analysis, internal standards (i.e., injection internal standards) are added to each sample extract just prior to injection to enable optimal quantification, particularly of complex extracts subject to retention time shifts relative to the analysis of standards. Internal standards are essential if the actual recovery of the surrogates added prior to extraction is to be calculated. The internal standards can also be used to detect and correct for problems in the GC injection port or other parts of the instrument. The compounds used as internal standards will be different from those already used as surrogates. The analyst(s) will monitor internal standard retention times and recoveries to determine if instrument maintenance or repair, or changes in analytical procedures, are indicated. Corrective action will be initiated based on the judgment of the analyst(s). Instrument problems that may have affected the data or resulted in the reanalysis of the sample will be documented properly in logbooks and internal data reports and used by the laboratory personnel to take appropriate corrective action.

7.7. Dual-column confirmation

Dual-column chromatography is required for analyses using GC-ECD due to the high probability of false positives arising from single-column analyses.

7.8. Representativeness

The representativeness of the data is mainly dependent on the sampling locations and the sampling procedures adequately representing the true condition of the sample site. Requirements for selecting sample sites are discussed in more detail in the SAP (Appendix II). Sample site selection, sampling of relevant media (water, sediment and biota), and use of only approved/documented analytical methods will determine that the measurement data does represent the conditions at the investigation site, to the extent possible. The goal for meeting total representation of the site will be tempered by the types and number of potential sampling points (Puckett, 2002).

7.9. Completeness

Completeness is defined as “a measure of the amount of data collected from a measurement process compared to the amount that was expected to be obtained under the conditions of measurement” (Stanley and Verner, 1985).

Field personnel will always strive to achieve or exceed the SWAMP completeness goals of 85% for fish samples (Puckett, 2002) when target species (SAP Table XXX, Appendix II) are present. Due to the variability and uncertainty of species availability in each lake, it is not appropriate to assign an overall completeness level to field collection.

Laboratories will strive for analytical completeness of 90% (Table 11).

Table 12a. Measurement Quality Objectives – Inorganic Analytes in Tissues

SWAMP Measurement Quality Objectives* - General		
Laboratory Quality Control	**Frequency of Analysis**	**Measurement Quality Objective**
Calibration Standard	Per analytical method or manufacturer's specifications	Per analytical method or manufacturer's specifications
Continuing Calibration Verification	Per 10 analytical runs	80-120% recovery
Laboratory Blank	Per 20 samples or per batch, whichever is more frequent	Blanks <ML for target analyte
Reference Material	Per 20 samples or per batch, whichever is more frequent	75-125% recovery
Matrix Spike	Per 20 samples or per batch, whichever is more frequent	75-125% recovery
Matrix Spike Duplicate	Per 20 samples or per batch, whichever is more frequent	75-125% recovery, RPD ≤25%
Laboratory Duplicate	Per 20 samples or per batch, whichever is more frequent	RPD ≤25%; n/a if concentration of either sample <ML
Internal Standard	Accompanying every analytical run when method appropriate	75-125% recovery

*Unless method specifies more stringent requirements.
ML = minimum level (Puckett, 2002)
n/a = not applicable

Table 12b. Measurement Quality Objectives – Synthetic Organic Compounds in Tissues

SWAMP Measurement Quality Objectives* - General		
Laboratory Quality Control	**Frequency of Analysis**	**Measurement Quality Objective**
Calibration Standard	Per analytical method or manufacturer's specifications	Per analytical method or manufacturer's specifications
Continuing Calibration Verification	Per 10 analytical runs	75-125% recovery
Laboratory Blank	Per 20 samples or per batch, whichever is more frequent	Blanks <ML for target analytes
Reference Material	Method validation: as many as required to assess accuracy and precision of method before routine analysis of samples; routine accuracy assessment: per 20 samples or per batch (preferably blind)	70-130% recovery if certified; otherwise, 50-150% recovery
Matrix Spike	Per 20 samples or per batch, whichever is more frequent	50-150% recovery or control limits based on 3x the standard deviation of laboratory's actual method recoveries
Matrix Spike Duplicate	Per 20 samples or per batch, whichever is more frequent	50-150% recovery, RPD ≤25%
Laboratory Duplicate	Per 20 samples or per batch, whichever is more frequent	RPD ≤25%; n/a if concentration of either sample <ML
Surrogate or Internal Standard	As specified in method	50-150% recovery

*Unless method specifies more stringent requirements.
MDL = method detection limit (to be determined according to the SWAMP QA Management Plan)
n/a = not applicable

Section A8. Special Training Requirements/Safety

8.1. Specialized training and safety requirements

Analysts are trained to conduct a wide variety of activities using standard protocols to ensure samples are analyzed in a consistent manner. Training of each analyst includes the use of analytical equipment and conducting analytical protocols, and other general laboratory processes including glassware cleaning, sampling preparation and processing, hazardous materials handling, storage, disposal. All laboratory staff must demonstrate proficiency in all the aforementioned and required laboratory activities that are conducted, as certified by the Laboratory QAO. All personnel involved in

performing chemical analyses must meet the proficiency requirements set forth by SWAMP (Puckett 2002).

8.2. Training, safety and certification documentation

Staff and safety training is documented at DFG-WPCL and MPSL-DFG. Documentation consists of a record of the training date, instructor and signatures of completion. The Laboratory QAO will certify the proficiency of staff at chemical analyses. Certification and records are maintained and updated by the Laboratory QAO, or their designee, for all laboratory staff.

8.3. Training personnel

The DFG-WPCL or MPSL-DFG Lab Director (LD) trains or appoints senior staff to train personnel. The Laboratory QAO ensures that training is given according to standard laboratory methods, maintains documentation and performs performance audits to ensure that personnel have been trained properly.

8.3.1. Laboratory Safety

New laboratory employees receive training in laboratory safety and chemical hygiene prior to performing any tasks in the laboratory. Employees are required to review the laboratory's safety program and chemical hygiene plan and acknowledge that they have read and understood the training. An experienced laboratory employee or the laboratory safety officer is assigned to the new employee to provide additional information and answer any questions related to safety that the new employee may have.

On-going safety training is provided by quarterly safety meetings conducted by the laboratory's safety officer or an annual laboratory safety class conducted by the DFG-OSPR Industrial Hygiene Officers or MLML Chemical Safety Officer.

8.3.2. Technical Training

New employees and employees required to learn new test methods are instructed to thoroughly review the appropriate standard operating procedure(s) and are teamed up with a staff member who is experienced and qualified to teach those test methods and observe and evaluate performance. Employees learning new test methods work with experienced staff until they have demonstrated proficiency for the method both by observation and by obtaining acceptable results for QC samples. This demonstration of proficiency is documented and certified by the section leader, Laboratory QAO and the laboratory director prior to the person independently performing the test method. Training records are retained on file for each employee by their supervisor or QAO. On-going performance is monitored by reviewing QC sample results.

Section A9. Documentation and Records

The following documents, records, and electronic files will be produced:

- Quality Assurance Project Plan (submitted to contract manager in paper and electronic formats)
- Monitoring Plan (submitted to contract manager in paper and electronic formats)
- Archived Sample Sheets (internal documentation available on request)
- Chain-of-Custody Forms (exchanged for signatures with chemistry lab, and kept on file)
- Lab Sample Disposition Logs (internal documentation available on request)
- Calibration Logs for measurements of water quality standards (internal documentation available on request)
- Refrigerator and Freezer Logs (internal documentation available on request)
- Quarterly Progress Reports (oral format to contract manager)
- Data Tables (submitted to contract manager in electronic formats)
- Draft Manuscript (produced in electronic format)
- Final Manuscript (in electronic format)
- Data Appendix (submitted to contract manager in paper and electronic spreadsheet formats)

Copies of this QAPP will be distributed by the project manager to all parties directly involved in this project. Any future amended QAPPs will be distributed in the same fashion. All originals of the first and subsequent amended QAPPs will be held at MPSL-DFG. Copies of versions, other than the most current, will be discarded to avoid confusion.

The final report will consist of summary data tables and an appendix that contains all project data in electronic SWAMP compatible spreadsheet format. All laboratory logs and data sheets will be maintained at the generating laboratory by the Laboratory Manager for five years following project completion, and are available for review by the Contract Manager or designee during that time. Copies of reports will be maintained at SFEI for five years after project completion then discarded, except for the database, which will be maintained without discarding. Laboratories will provide electronic copies of tabulated analytical data (including associated QA/QC information outlined below) in the SWAMP database format or a format agreed upon by the Contract Manager. All electronic data are stored on computer hard drives and electronic back-up files are created every two weeks or more frequently.

Laboratories will generate records for sample receipt and storage, analyses and reporting.

Laboratories maintain paper copies of all analytical data, field data forms and field notebooks, raw and condensed data for analysis performed on-site, and field instrument calibration notebooks.

The PC will be responsible for sending out the most current electronic copies of the approved QAPP to all appropriate persons listed in Table 1.

Section B10. Data Generation and Acquisition

10.1. Sample Design

The project design is described in the Sampling and Analysis Plan (SAP), Section III, pp. 6-14 (Appendix II). Eighty "Popular Lakes" and 50 "Other Lakes" will be sampled for 2 fish species each, when possible. Specific details on site selection is found in Section III B, pp. 7-9, and target species in Section III C, pp. 9-10 of the SAP.

If a lake chosen for sampling is not accessible, another lake will be chosen to replace it.

All measurements and analyses to be performed are critical to address the objectives laid out in Section III of the SAP (Appendix II), with the exception of fish weight, moisture, lipid content, sex and age. These parameters may be used to support other data gathered.

10.2. Variability

Due to potential variability of contaminant loads in individual tissue samples, samples will be analyzed in composites as outlined in the SAP (Appendix II) and MPSL-DFG SOPs (Appendix III).

10.3. Bias

Bias can be introduced by using fish of one particular species and/or total length for chemistry regressions and statistical analyses. The SAP (Appendix II) was reviewed by a Scientific Review Panel which approved of the inclusion of length ranges and multiple target species to reduce the associated bias.

Another way bias could be introduced to sampling is by proceeding from one end of the state to the other without regard to ambient temperature, rain, etc. This bias will be minimized by scheduling sampling events throughout the state without concentrating on one region for longer than a few weeks at a time. This will also be accomplished by using multiple, arbitrarily distributed, sampling crews when possible.

Section B11. Sampling Methods

Fish will be collected in accordance with MPSL-102a, Section 7.4 (Appendix III) except where noted here. Whenever possible, an electro-fishing boat will be used, however it may be necessary to employ another method described.

Details on targeted fish species, number of individuals and size ranges can be found in the SAP (Appendix II, Tables 5 and 7).

The following adaptation to MPSL-102a, Section 7.4.5 (Appendix III) has been made: Collected fish will be partially dissected in the field. At the dock, the fish is placed on a measuring board covered with a clean plastic bag; fork and total length are recorded. Weight is recorded. The fish is then placed on the cutting board covered with a clean plastic bag where the head, tail, and guts are removed using a clean cleaver (scrubbed with Micro™, rinsed with tap and deionized water). The fish cross section is tagged with a unique numbered ID, individually wrapped in aluminum foil, and placed in a clean labeled bag. When possible, sex, parasites, and body anomalies are noted. The cleaver and cutting board are re-cleaned between fish species, per site if multiple stations are sampled.

Further details on sample collection and processing can be found in the SAP, Section III, D (Appendix II).

11.1. Corrective Action

Table 13 describes action to take in the event of a collection failure.

Table 13. Field collection corrective actions

Collection Failure	Corrective Action
No Bottom Feeder Present	Collect one species of predator and analyze for all constituents; document the occurrence
No Predator Present	Collect one species of bottom feeder and analyze for all constituents; document the occurrence
No fish present (uninhabitable lake)	Inform PC, and move on to another lake; document the occurrence

Section B12. Sample Handling and Custody

The field coordinator will be responsible for ensuring that each field sampling team adheres to proper custody and documentation procedures. A master sample logbook of field data sheets shall be maintained for all samples collected during each

sampling event. A chain-of-custody (COC, Attachment 1) form must be completed after sample collection, archive storage, and prior to sample release.

Fish samples will be wrapped in aluminum foil and frozen on dry ice for transportation to the laboratory, where they will be stored at -20°C until dissection and homogenization. Homogenates will also be frozen until analysis is performed. Frozen tissue samples have a 12 month hold time from the date of collection. If a hold-time violation has occurred, data will be flagged appropriately in the final results.

Section B13. Analytical Methods

Methods and equipment for laboratory analyses are listed in Table 14. EPA methods can be downloaded from www.epa.gov/epahome/index/nameindx.htm. EPA method numbers followed by "M" indicate modifications have been made. Modifications and non-EPA SOPs are listed in Appendix III and IV. Method validation data for modifications and SOPs can be obtained by contacting the analytical laboratory (Table 1.)

An AWS brand AMW-DISC digital pocket scale, or similar, is used to measure fish weights in the field and is calibrated monthly in the lab with standard weights. Length measurements are conducted on a fish measuring board that does not require calibration. No other field measurements are being measured.

Table 14. Methods for laboratory analyses

Parameter	Method	Instrument
Mercury (Individuals)	EPA 7473	Milestone DMA 80
Mercury (Composites)	EPA 3052M MPSL-103	CEM MARS5 Digester Perkin Elmer FIMS with Autosampler
Selenium	EPA 3052M EPA 200.8	CEM MARS5 Digester Perkin-Elmer Elan 6000 ICP-MS
Organochlorine Pesticides	EPA 8081AM	Agilent 6890 GC-ECD Varian 3800 GC with Varian 1200 Triple-Quad MS
Polychlorinated Biphenyls	EPA 8082M	Varian 3800 GC with Varian 1200 Triple-Quad MS
Polybrominated Diphenyl Ethers	EPA 8082M	Agilent 6890 GC-ECD

Mercury in individuals will be analyzed according to EPA 7473, "Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry" (USEPA, 1998) using a Direct Mercury Analyzer (DMA 80). Mercury in composite samples will be digested according to EPA 3052M, "Microwave Assisted Acid Digestion of Siliceous and Organically Based Matrices" (USEPA, 1996), modified (Appendix III), and analyzed according to MPSL-103, "Analysis of Mercury in Sediments and Tissue by Flow Injection Mercury System (FIMS)" (Appendix III). Samples, blanks, and standards will be prepared using clean techniques. ASTM Type II water and analytical grade chemicals will be used for all standard preparations. A continuing calibration verification (CCV) will be performed after every 10 samples. Initial and continuing calibration verification values must be within ±20% of the true value, or the previous 10 samples must be reanalyzed. Three blanks, a certified reference material (DORM-2), as well as a method duplicate and a matrix spike pair will be run with each analytical batch of samples. Reporting Limits (RL) can be found in Table 15 and Measurement Quality Objectives (MQO) in Section 7, Table 12a.

Selenium will be digested according to EPA 3052M, "Microwave Assisted Acid Digestion of Siliceous and Organically Based Matrices" (USEPA, 1996), modified (Appendix III), and analyzed according to EPA 200.8, "Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry" (USEPA, 1994). Samples, blanks, and standards will be prepared using clean techniques. ASTM Type II water and analytical grade chemicals will be used for all standard preparations. A continuing calibration verification (CCV) will be performed after every 10 samples. Initial and continuing calibration verification values must be within ±20% of the true

value, or the previous 10 samples must be reanalyzed. Two blanks, a certified reference material (2976 or DORM-2), as well as a method duplicate and a matrix spike pair will be run with each set of samples. Reporting Limits (RL) can be found in Table 15 and Measurement Quality Objectives (MQO) in Section 7, Table 12a.

Organochlorine pesticides will be analyzed according to EPA 8081AM, "Organochlorine Pesticides by Gas Chromatography", modified (Appendix IV). PCBs and PBDEs will be analyzed according to EPA 8082M, "Polychlorinated Biphenyls (PCBs) by Gas Chromatography", modified (Appendix XXX). Samples, blanks, and standards will be prepared using clean techniques. ASTM Type II water and analytical grade chemicals will be used for all standard preparations. A continuing calibration verification (CCV) will be performed after every 10 samples. Initial and continuing calibration verification values must be within ±25% of the true value, or the previous 10 samples must be reanalyzed. One blank, a laboratory control spike (LCS), as well as a method duplicate and a matrix spike pair will be run with each set of samples. Reporting Limits (RL) can be found in Table 16a,b,c and Measurement Quality Objectives (MQO) in Section 7, Table 12b.

Table 15. Trace metal analytical parameters, reporting units, and reporting limits (RL) for tissue samples.

Parameter	Method	RL (µg/g wet wt)
Mercury	EPA 7473	0.02
Selenium	EPA 3052M, EPA 200.8	0.30

Table 16a. Trace organic analytical parameters, reporting units, and reporting limits (RL) for tissue samples. Organochlorine Pesticides by EPA 8081AM using GC-ECD.

Organochlorine Pesticides (by EPA 8081AM using GC-ECD)		
Group	**Parameter**	**RL (ng/g wet wt)**
Chlordanes	Chlordane, cis-	1
	Chlordane, trans-	1
	Heptachlor	1
	Heptachlor epoxide	1
	Nonachlor, cis-	1
	Nonachlor, trans-	1
	Oxychlordane	1
DDTs	DDD(o,p')	1
	DDD(p,p')	1
	DDE(o,p')	2
	DDE(p,p')	2
	DDMU(p,p')	3
	DDT(o,p')	3
	DDT(p,p')	5
Cyclodienes	Aldrin	1
	Dieldrin	0.5
	Endrin	2
HCHs	HCH, alpha	0.5
	HCH, beta	1
	HCH, gamma	0.5
Others	Dacthal	1
	Endosulfan I	2
	Hexachlorobenzene	0.692
	Methoxychlor	3
	Mirex	1.5
	Oxadiazon	1
	Tedion	2

Table 16b. Trace organic analytical parameters, reporting units, and reporting limits (RL) for tissue samples. PCBs by EPA Method 8082M.

Polychlorinated Biphenyl congeners and arochlors (by EPA Method 8082M)			
PCB	**RL ppb (ng/g wet wt)**	**PCB**	**RL ppb (ng/g wet wt)**
PCB 008	0.226	PCB 141	0.200
PCB 018	0.200	PCB 146	0.200
PCB 027	0.200	PCB 149	0.200
PCB 028	0.296	PCB 151	0.200
PCB 029	0.200	PCB 153	0.352
PCB 031	0.238	PCB 156	0.200
PCB 033	0.238	PCB 157	0.200
PCB 044	0.245	PCB 158	0.200
PCB 049	0.200	PCB 169	0.200
PCB 052	0.326	PCB 170	0.200
PCB 056	0.200	PCB 174	0.200
PCB 060	0.200	PCB 177	0.200
PCB 064	0.200	PCB 180	0.200
PCB 066	0.200	PCB 183	0.200
PCB 070	0.260	PCB 187	0.200
PCB 074	0.200	PCB 189	0.200
PCB 077	0.200	PCB 194	0.200
PCB 087	0.200	PCB 195	0.200
PCB 095	0.220	PCB 198/199	0.200
PCB 097	0.200	PCB 200	0.200
PCB 099	0.200	PCB 201	0.200
PCB 101	0.249	PCB 203	0.200
PCB 105	0.267	PCB 206	0.200
PCB 110	0.340	PCB 209	0.200
PCB 114	0.200		
PCB 118	0.423	**Calculated values from Lab**	
PCB 126	0.200	PCB AROCLOR 1248	25.00
PCB 128	0.200	PCB AROCLOR 1254	10.00
PCB 137	0.200	PCB AROCLOR 1260	10.00
PCB 138	0.368		

Table 16c. Trace organic analytical parameters, reporting units, and reporting limits (RL) for tissue samples. PBDEs by EPA Method 8082M.

Polybrominated Diphenyl Ethers (by EPA Method 8082M)	
PBDE	**RL ppb (ng/g wet wt)**
PBDE 017	1.2
PBDE 028	1.2
PBDE 047	1.6
PBDE 066	1.2
PBDE 100	1.2
PBDE 099	1.6
PBDE 085	1.6

13.2.1. Corrective Action

It is the responsibility of each analyst to take corrective action upon instrument failure. Corrective action will be conducted according to manufacturer or method specifications. Additional information on corrective actions can be found in Section 20.2.

13.2.2. Turn around time

All tissue analyses must be completed within the 1 year hold time. In addition, results need to be reported according to the timeline outlined in Table 10.

13.3. Sample Disposal

The laboratories are responsible for complying with all Federal, State and local regulations governing waste management, particularly hazardous waste identification rules and land disposal restrictions. Chemicals must be appropriately neutralized prior to disposal or must be handled as hazardous waste.

Section B14. Quality Control

MPSL-DFG and DFG-WPCL conduct quality control through several activities and methods. These methods of quality control are performed to identify possible contamination problem(s), matrix interference and the ability to duplicate/repeat results. When control limits are exceeded the Laboratory QAO will review with appropriate laboratory staff to ascertain the possible cause of the exceedance. A review of SOPs will be conducted and any deficiencies will be identified, documented, and corrected. A written report of the corrective action(s) will be provided to the PI and PM via email.

The PM will contact the SWAMP QAO as needed. A written report containing all corrective actions will be submitted to the SWAMP QAO on a quarterly basis.

Each aspect of laboratory quality control is listed in Tables 13a and b for frequency as well as Measurement Quality Objectives (MQO) for each.

Section B15. Instrument/Equipment Testing, Inspection and Maintenance

Laboratory instruments are inspected and maintained in accordance with lab SOPs, which include those specified by the manufacturer and those specified by the method (Table 17). These SOPs have been reviewed by each respective Laboratory QAO and found to be in compliance with SWAMP criteria. DFG-WPCL and MPSL-DFG analysts are responsible for equipment testing, inspection, and maintenance. Appendices III and IV list the referenced SOPs. DFG-WPCL SOPs are available upon request from the Laboratory Director by email: dcrane@ospr.dfg.ca.gov. Likewise, MPSL-DFG SOPS are available upon request from the Laboratory QAO by email: bonnema@mlml.calstate.edu.

Electronic laboratory equipment usually has recommended maintenance prescribed by the manufacturer. These instructions will be followed as a minimum requirement. Due to the cost of some laboratory equipment, back up capability may not be possible. But all commonly replaced parts will have spares available for rapid maintenance of failed equipment. Such parts include but are not limited to: batteries; tubes; light bulbs; tubing of all kinds; replacement specific ion electrodes; electrical conduits; glassware; pumps; etc. In some cases, the cost of instruments (i.e., GC-MS, EFD, etc) prohibits the procurement of additional spare parts. However, those instruments are typically maintained and repaired by the manufacturer.

The lead chemist, or designee, is responsible for the testing, inspection, and maintenance of equipment. Each instrument has its own logbook where the results of tests, inspections, maintenance and repairs are documented. When an instrument's test results fail to meet accuracy and/or precision criteria after the lead chemist has performed maintenance, the manufacturer will be contacted.

Table 17. Equipment maintenance and calibration frequency.

Instrument	Inspection/Maintenance Frequency	Calibration Frequency
Agilent 6890 Gas Chromatograph equipped with micro-ECD detectors and autosamplers using Enviroquant Software (Agilent)	As needed	At least once prior to each batch
Varian 3800 Gas Chromatograph with Varian 1200 Triple Quadrupole Mass Spectrometer equipped with Combi-Pal autosampler	As needed	At least once prior to each batch
Perkin-Elmer Elan 6000 Inductively Coupled Plasma - Mass Spectrometer	As needed	At least once prior to each batch
Milestone DMA-80 Direct Mercury Analyzer	As needed	At least every 2 weeks

Section B16. Instrument/Equipment Calibration and Frequency

Laboratory instruments (listed in Table 17) are calibrated, standardized and maintained according to procedures detailed in laboratory SOPs (Appendices III and IV). Instrument manuals identify step-by-step calibration and maintenance procedures. Instruments and types of calibration required are listed in Table 16. If analytical instrumentation fails to meet performance requirements, the instrument(s) will be checked according to their respective SOP(s) and recalibrated. If the instrument(s) does again does not meet specifications, it will be repaired and retested until performance criteria are achieved. The maintenance will be entered in the instrument log. If sample analytical information is in question due to instrument performance, the PM will be contacted regarding the proper course of action including reanalyzing the sample(s).

At a minimum all calibration procedures will meet the requirements specified in the US EPA approved methods of analysis. The means and frequency of calibration recommended by the manufacturer of the equipment or devices as well as any instruction given in an analytical method will be followed. When such information is not specified by the method, instrument calibration will be performed at least once daily and continuing calibration will be performed on a 10% basis thereafter except for analysis by GC/MS. It is also required that records of calibration be kept by the person performing the calibration and be accessible for verification during either a laboratory or field audit.

16.1. Analytical Instrumentation

16.1.1. Instrument calibration

Upon initiation of an analytical run, after each major equipment disruption, and whenever on-going calibration checks do not meet recommended MQOs, the system will be calibrated with a full range of analytical standards. Immediately after this procedure, the initial calibration must be verified through the analysis of a standard obtained from a different source than the standards used to calibrate the instrumentation, prepared in an independent manner, and ideally having certified concentrations of target analytes of a CRM or certified solution. Frequently, calibration standards are included as part of an analytical run, interspersed with actual samples. However, this practice does not document the stability of the calibration and is incapable of detecting degradation of individual components, particularly pesticides, in standard solutions used to calibrate the instrument. The calibration curve is acceptable if it has an R^2 of 0.990 or greater for all analytes present in the calibration mixtures. If not, the calibration standards, as well as all the samples in the batch are re-analyzed. All calibration standards will be traceable to a recognized organization for the preparation and certification of QC materials (e.g., National Institute of Standards and Technology, National Research Council Canada, US EPA, etc.).

Calibration curves will be established for each analyte and batch analysis from a calibration blank and a minimum of three analytical standards of increasing concentration, covering the range of expected sample concentrations. Only data which result from quantification within the demonstrated working calibration range may be reported (i.e., quantification based on extrapolation is not acceptable). Alternatively, if the instrumentation is linear over the concentration ranges to be measured in the samples, the use of a calibration blank and one single standard that is higher in concentration than the samples may be appropriate. Samples outside the calibration range will be diluted or concentrated, as appropriate, and reanalyzed.

16.1.2. Continuing calibration verification (CCV)

Calibration verification solutions traceable to a recognized organization are inserted as part of the sample stream. The sources of the calibration verification solutions are independent from the standards used for the calibration. Calibration verification solutions used for the CCV will contain all the analytes of interest. The frequency of these verifications is dependent on the type of instrumentation used and, therefore, requires considerable professional judgment. The required frequency for this project is listed in Table 6. All analyses are bracketed by an acceptable calibration verification; all samples not bracketed by an in control CCV should be reanalyzed. If the control limits for analysis of the calibration verification solution are not met, the initial calibration will have to be repeated. All samples analyzed before the calibration verification solution that failed the MQOs will be reanalyzed following the recalibration. Only the re-analysis results will be reported. If it is not possible or feasible to perform reanalysis of samples, all earlier data (i.e., since the last successful calibration control verification) are suspect.

In this case, DFG-WPCL will contact the PM to determine proceedings, and will flag the data and note the issue in interim and final reports.

Section B17. Inspection/Acceptance of Supplies and Consumables

All supplies will be examined for damage as they are received. Laboratory ordering personnel will review all supplies as they arrive to ensure the shipment is complete and intact. All chemicals are logged in to the appropriate logbook and dated upon receipt. All supplies are stored appropriately and are discarded upon expiration date. The following items are considered for accuracy, precision, and contamination: meters, sample bottles, balances, chemicals, standards, titrants, and reagents. If these items are not found to be in compliance with the above considerations, they will be returned to the manufacturer.

Section B18. Non-Direct Measures

Data will not be used from non-direct measures in this study.

Section B19. Data Management

Field data will be entered into the SWAMP database upon return to the lab. Original field sheets will be retained in a log book, and copies of the COCs will be kept by each receiving laboratory. SWAMP Authorization forms will also accompany samples sent to each laboratory (Attachment 4).

All data generated by DFG-WPCL will be maintained as described in DFG-WPCL SOPs (Appendix IV) and the DFG-WPCL Quality Assurance Manual (Appendix I). The DFG-WPCL QAO will be responsible for oversight of the collection of all organic chemical analysis data and entering QA-checked data into the SWAMP database.

Likewise, all MPSL-DFG data will be generated and maintained according to the Marine Pollution Studies Laboratory Quality Assurance Plan (Appendix I). The MPSL-DFG QAO will be responsible for oversight of the collection of all dissection and metals analysis data and entering QA-checked data into the SWAMP database.

All data collected will be entered into electronic spreadsheets that are SWAMP compatible. Each data element is checked at a minimum by the technician that entered the data and verified by the technician's signature on the data sheet. Tissue data will be provided to the PC in Microsoft Excel spreadsheets. Data will be reviewed to ensure they are consistent with the format of the database and other data records.

All raw and statistical analysis data are subject to a 100% check for accuracy by the PM and Laboratory QAOs. Data are analyzed and proofread for accuracy, and then

QA checked against the QAPP and SWAMP criteria before being entered into the SWAMP database. Original hard copies of the data are filed in a secure cabinet until requested by the PM and/or inclusion into the Final Report. Electronic copies are stored and backed up by each analyst and respective laboratory internal project manager.

Hardware and software will be updated as recommended by the manufacturer or as needed. Testing of each component is not required on a regular basis aside from day to day functionality. Each entity is responsible for the necessary updates or upgrades, whether provided regularly through an Information Technology department or otherwise.

Data management checklists are not required. Analytical completeness will be tracked through the SWAMP Tissue Database version 2.5.

Section C20. Assessments and Oversight

20.1. Audits

The PM or designee (e.g., a QAO) may conduct inspections of the physical facilities, operational systems and operating procedures at either laboratory. The inspections can be conducted while chemical analyses are being performed; the facility requests a 24-hour notice prior to the inspections.

If an audit discovers discrepancies or protocol deviations, the PM will discuss the observed discrepancy with the appropriate person(s) responsible for the activity (see organization chart). The appropriate parties will discuss the accuracy of the information collected, the cause(s) of deviation(s), and possible impact on data quality and possible corrective actions.

Informal audits of the systems, procedures, and technician performance will be conducted throughout the duration of the project. These audits will be performed by the QAO of each respective laboratory. The Laboratory QAO will report findings to the PM, including all requests for corrective action. The Laboratory QAO has the authority to stop all actions if there are significant deviations from required procedures or evidence of a systematic failure.

All laboratories involved with SWAMP projects may be audited by the SWAMP QAO as part of the program's QA protocols. The PM will receive copies of any audits conducted on project laboratories within the project's scheduled scope.

20.2. Deviations and corrective actions

Analyses are conducted according to procedures and conditions recommended by the US EPA and described in laboratory SOPs, with the exception of those reported herein. Beyond those identified, deviations from these recommended conditions are

reported to the Laboratory QAO. The PM will be notified within 24 hours of these deviations.

In the event of a SOP/QAPP deviation or corrective action, a deviation/corrective action form will be prepared, completed, signed and the PM notified. Best professional judgment will be used in interpretation of results obtained when deviations in the test conditions have occurred. All deviations and associated interpretations will be reported in interim and final reports. Protocol amendments will be submitted to the Laboratory QAO and PM. Upon approval, protocol amendments will be employed.

This study strives for 90% analytical data completeness. If this goal cannot be achieved, various corrective actions can be undertaken as described in Section D24.

Section C21. Reports to Management

The following products are to be delivered to PM according to the schedule shown in Table 18:

- Each LD shall regularly brief the PC, LS and PM on the progress of all on-going chemical analyses in monthly emails or conference calls. When deemed necessary for decision making, other BOG participants will also be notified of progress.
- The LS will provide a draft final report and a final report to the PM in accordance with the dates listed in Table 10.

Table 18. Report due dates

Report	Due By
Draft Final Report	June 2008
Final Report	September 2008

Section D22. Data Validation and Usability

Data generated by project activities will be reviewed against the measurement quality objectives (MQOs) in Tables 13a and 13b, Section 7.

Section D23. Verification and Validation Methods

All data reported for this project will be subject to a 100% check for errors in transcription, calculation and computer input by the laboratory internal project manager and/or laboratory QAO. Additionally, the Laboratory QAO will review sample logs and data forms to ensure that requirements for sample preservation, sample integrity, data

quality assessments and equipment calibration have been met. At the discretion of the LD, data that do not meet these requirements will either not be reported, or will be reported with qualifiers which serve as an explanation of any necessary considerations.

Reconciliation and correction will be decided upon by the Laboratory QAO and LD. The Laboratory QAO will be responsible for informing data users of the problematic issues that were discussed, along with the associated reconciliations and corrections. DFG-WPCL checklists and forms are in Attachment 4. MPSL-DFG does not have specific forms; comments are made on original data sheets and reports.

Data will be reported to the Project Coordinator, then to the SWAMP Database Management Team (DMT) for inclusion in the SWAMP Tissue Database 2.5. The DMT will follow SWAMP verification methods (Appendix V).

Validated data will be made available to users via the SWAMP Tissue Database 2.5 provided by the DMT.

Section D24. Reconciliation with User Requirements

Data will be reported in the SWAMP Tissue Database 2.5. Data that do not meet with the Measurement Quality Objectives in Tables 12a and b will be flagged accordingly as discussed in Section D23. Rejected data will not be included in data analyses while data flagged as estimated will be evaluated for inclusion on a case-by-case basis in conjunction with the associated QA data and program objectives.

The project needs sufficient data, as represented by the completeness objective (Table 11, Section 7), to address the management questions laid out in Section 5; specifically MQ1 and MQ2. A failure to achieve the number of data points cited could mean an inability to answer these questions.

To address MQ1, the concentrations from lakewide composites, as well as any location composites analyzed, will be compared with the BOG adopted thresholds presented in Table 4. Mercury will be calculated as laid out on p.11 of the SAP (Appendix II).

Those lakes with analyte results greater than the thresholds in Table 4 will be called to the attention of the California Regional Water Quality Control Boards in the technical report. It will be up to each Region to compare the measured chemistry results of this study with the appropriate regional 303(d) list requirements

In order to answer MQ2 the analytical results will be compared to the BOG adopted thresholds as described in the previous paragraph. For each analyte the percent of lakes that have fish that exceeded the threshold will be calculated. Since the sampling design of the BOG study is probabilistic in nature the results of this sampling can be extrapolated to all lakes in California (SAP, section B; Appendix II)).

Since this study is a screening study with primarily the two management questions as objectives, complex statistical analysis is not anticipated except as mentioned above. The data collected by this study is not intended to be used with traditional statistics.

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APPENDIX I: List of Associated QAPPs

CDFG MPSL MLML Laboratory QAP, Revision 5. February, 2006

CDFG WPCL Laboratory QAPP, Revision 9. August, 2006

APPENDIX II

SAMPLING AND ANALYSIS PLAN FOR A SCREENING STUDY OF BIOACCUMULATION IN CALIFORNIA LAKES AND RESERVOIRS

The Bioaccumulation Oversight Group (BOG)

Surface Water Ambient Monitoring Program

September 25, 2007

THE BIOACCUMULATION OVERSIGHT GROUP

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I. INTRODUCTION

This document presents a plan for sampling and analysis of sport fish in the first year of a two-year screening survey of bioaccumulation in California lakes and reservoirs. This work will be performed as part of the State Water Resources Control Board's Surface Water Ambient Monitoring Program (SWAMP). This effort will mark the beginning of a new long-term Bioaccumulation Monitoring Project that will provide comprehensive monitoring of bioaccumulation in California water bodies.

Oversight for this Project is being provided by the SWAMP Roundtable. The Roundtable is composed of State and Regional Board staff and representatives from other agencies and organizations including USEPA, the Department of Fish and Game, the Office of Environmental Health Hazard Assessment, and the University of California. Interested parties, including members of other agencies, consultants, or other stakeholders are also welcome to participate.

The Roundtable has formed a subcommittee, the Bioaccumulation Oversight Group (BOG) that focuses on the Bioaccumulation Monitoring Project. The BOG is composed of State and Regional Board staff and representatives from other agencies and organizations including USEPA, the Department of Fish and Game, the Office of Environmental Health Hazard Assessment, and the San Francisco Estuary Institute. The members of the BOG individually and collectively possess extensive experience with bioaccumulation monitoring.

The BOG has also convened a Bioaccumulation Peer Review Panel that is providing programmatic evaluation and review of specific deliverables emanating from the Project, including this Sampling Plan. The members of the Panel are internationally-recognized authorities on bioaccumulation monitoring.

The BOG was formed and began developing a strategy for designing and implementing a statewide bioaccumulation monitoring program in September 2006. To date the efforts of the BOG have been focused on developing a short-term plan for obtaining the most critical information needed through a sampling effort that will begin in May 2007. After this short-term plan is completed, the BOG will develop a long-term Business Plan that will be a more comprehensive document that describes a strategy for establishing and implementing bioaccumulation monitoring over the next five years. The Long-term Business Plan will include a thorough presentation of both the planned activities and their rationale. Some of the elements to be included in the Long-term Plan are:

- Long-term (five-year) strategies for addressing the mission, goals, objectives, and assessment questions related to both the fishing and aquatic life beneficial uses in all water body types;
- An inventory of programs with common assessment questions;
- Plans for coordination with other programs;
- Evaluation of potential for models to forecast future trends and contribute to answering the assessment questions;
- Strategies for sustaining the program over the long-term; and
- Framework for integrating other monitoring efforts into statewide program.

A draft Project Plan for the Bioaccumulation Monitoring Project has also been prepared that provides a more complete description of how this Project fits into the broader objectives of SWAMP.

II. OBJECTIVES AND ASSESSMENT QUESTIONS AND PLANS FOR ADDRESSING THEM

A. Addressing Multiple Beneficial Uses

Bioaccumulation in California water bodies has an adverse impact on both the fishing and aquatic life beneficial uses (Davis et al. 2007). The fishing beneficial use is affected by human exposure to bioaccumulative contaminants through consumption of sport fish. The aquatic life beneficial use is affected by exposure of wildlife to bioaccumulative contaminants, primarily piscivorous species exposed through consumption of small fish. Different indicators are used to monitor these different types of exposure. Monitoring of status and trends in human exposure is accomplished through sampling and analyzing sport fish. On the other hand, monitoring of status and trends in wildlife exposure can accomplished through sampling and analysis of wildlife prey (small fish, other prey species) or tissues of the species of concern (e.g., bird eggs or other tissues of juvenile or adults of the species at risk).

Over the long-term, a SWAMP bioaccumulation monitoring is envisioned that assesses progress in reducing impacts on both the fishing and aquatic life beneficial uses for all water bodies in California. In the near-term, however, funds are limited, and there is a need to demonstrate the value of a comprehensive statewide bioaccumulation monitoring program through successful execution of specific components of a comprehensive program. Consequently, with funds available for sampling in 2007 ($797,000) and additional funds of a similar magnitude anticipated for 2008, the BOG has decided to focus on sampling that addresses the issue of bioaccumulation in sport fish and impacts on the fishing beneficial use. This approach is intended to provide the information that the Legislature and the public would consider to be of highest priority. Monitoring focused on evaluating the aquatic life beneficial use will be included in the Project when expanded funding allows a broader scope.

B. Addressing Multiple Monitoring Objectives and Assessment Questions for the Fishing Beneficial Use

The BOG has developed a set of monitoring objectives and assessment questions for a statewide program evaluating the impacts of bioaccumulation on the fishing beneficial use (Table 1). This assessment framework is consistent with frameworks developed for other components of SWAMP, and is intended to guide the bioaccumulation monitoring program over the long-term. The four objectives can be summarized as 1) status; 2) trends; 3) sources and pathways; and 4) effectiveness of management actions.

Over the long-term, the primary emphasis of the statewide bioaccumulation monitoring program will be on evaluating status and trends. Bioaccumulation monitoring is a very effective and essential tool for evaluating status, and is often the most cost-effective tool for evaluating trends. Monitoring status and trends in bioaccumulation will provide some information on

sources and pathways and effectiveness of management actions at a broader geographic scale. However, other types of monitoring (i.e., water and sediment monitoring) and other programs (regional TMDL programs) are more appropriate for addressing sources and pathways and effectiveness of management actions.

In the near-term, the primary emphasis of the statewide bioaccumulation monitoring program will be on evaluating Objective 1 (status). The reasons for this are:

1. a systematic statewide assessment of status has never been performed and is urgently needed;
2. we are starting a new program and establishing a foundation for future assessments of trends;
3. past monitoring of sport fish established very few time series that are useful in trend analysis that this program could have built upon.

C. Addressing Multiple Habitat Types

SWAMP has defined the following categories of water bodies:

- lakes and reservoirs;
- bays and estuaries;
- coastal waters;
- large rivers;
- wadeable streams; and
- wetlands.

Due to their vast number, high fishing pressure, and a relative lack of information on bioaccumulation (Davis et al. 2007), lakes and reservoirs were identified as the highest priority for monitoring. With over 9000 lakes in California, performing a statewide assessment of just this one water body type would be a challenge with the limited amount of funding available for bioaccumulation monitoring. The BOG therefore decided that sampling in 2007 (with funds already allocated – approximately $800,000) and 2008 (with additional funds anticipated – approximately $700,000) should focus on a thorough assessment of lakes and reservoirs. The long-term plan for bioaccumulation monitoring will include a strategy for monitoring bioaccumulation in the other water body types (for both the fishing and aquatic life beneficial uses).

In summary, focusing on one habitat type (lakes), one objective (status), and one beneficial use (fishing) will allow us to provide reasonable coverage and a thorough assessment of bioaccumulation in California’s lakes and reservoirs.

III. DESIGN OF THE LAKES SURVEY

A. Management Questions for this Survey

Three management questions have been articulated to guide the 2007-2008 survey of the status bioaccumulation in sport fish of California lakes and reservoirs. These management questions are specific to this initial monitoring effort; different sets of management questions will be established to guide later efforts.

Management Question 1 (MQ1)

Should a specific lake be considered impaired and placed on the 303(d) list due to bioaccumulation of contaminants in sport fish?

Answering this question is critical to determining the need for cleanup actions to reduce contaminant exposure in specific water bodies. TMDLs are required for water bodies placed on the 303(d) list. This is the principal regulatory mechanism being used by the State Water Board, the Regional Water Boards, and USEPA to establish priorities for management actions.

The State Water Board has established a policy for placing water bodies on the 303(d) list. The information needed to make a listing determination is concentrations from two independent samples from the water body that exceed the relevant threshold of concern. The more representative the samples are of the water body, the better.

Management Question 2 (MQ2)

What is the condition of California lakes with respect to bioaccumulation in sport fish?

Answering this question is the goal of the biennial 305(b) reports that the State Water Resources Control Board submits to the U.S. Environmental Protection Agency pursuant to Section 305(b) of the federal Clean Water Act (e.g., SWRCB 2003). The 305(b) report provides water quality information to the general public and serves as the basis for U.S. EPA 's National Water Quality Inventory Report to Congress. The report provides a statewide, comprehensive assessment of the status of California water bodies with respect to support of designated beneficial uses. Answering this question also provides the state legislature and the public with information that helps establish the magnitude and priority of the bioaccumulation problem relative to other environmental and societal problems.

The information needed to answer this question is the representative, average concentration of bioaccumulative contaminants in each lake for an adequately large sampling of lakes.

Management Question 3 (MQ3)
Should additional sampling of bioaccumulation in sport fish at a lake be conducted for the purpose of developing consumption guidelines?

Answering this question is essential as a first step in determining the need for more thorough sampling in support of developing consumption guidelines. Consumption guidelines provide a mechanism for reducing human exposure in the short-term. The information requirements for consumption guidelines are more extensive than for 303(d) listing. The California Office of Environmental Health Hazard Assessment (OEHHA), the agency responsible for issuing consumption guidelines, needs samples representing 9 or more fish from a variety of species abundant in a water body in order to issue guidance. It is valuable to have information not only on the species with high concentrations, but also the species with low concentrations so anglers can be encouraged to target the low species.

Overall Approach

The overall approach to be taken to answer these three questions is to perform a statewide screening study of bioaccumulation in sport fish. The highest priority for SWAMP in the short-term is to answer MQ1 and MQ2. Answering these questions will provide a basis for decision-makers to understand the scope of the bioaccumulation problem and will provide regulators with information needed to meet their needs and establish priorities for cleanup actions. In the longer-term, developing consumption guidelines that inform the public on ways to reduce their exposure is also a high priority, and this effort would cost-effectively establish a foundation for this by identifying lakes where guidelines appear to be needed and more sampling is required.

It is anticipated that the screening study will lead to more detailed follow-up investigations of many water bodies that become placed on the 303(d) list or where consumption guidelines are needed. Funding for these follow-up studies will come from other local or regional programs rather than the statewide monitoring budget.

B. Selecting Lakes to Sample

California has over 9,000 lakes. Collecting and analyzing fish from all of these lakes would be prohibitively expensive, so a representative subset was selected to answer the management questions established for the survey.

Sampling of Popular Lakes

The primary emphasis of the sampling effort will be to address MQ1 for as many lakes as possible. The focus of this aspect of the survey will be on lakes that are of greatest interest to managers and the public – the lakes that are most popular for fishing. This approach is considered the most prudent use of the limited funds available. Eighty percent of the funds anticipated to be available in 2007 and 2008 are being allocated to sampling these popular lakes.

The 216 most popular fishing lakes and reservoirs in California (Table 2, Figure 1) were identified through review of published fishing guides (Stienstra 2004), websites, and consultation

with Regional Board staff from each of the nine regions. The goal of the study is to sample as many of these popular lakes as possible. It is anticipated that, if funding for year two is obtained as expected, approximately 200 of these popular lakes will be sampled (approximately 80 in 2007 and 120 in 2008).

Given the uncertainty regarding how many popular lakes will be sampled, and the likelihood that the entire set will not be sampled, a probabilistic approach is being taken to sample this set of lakes. The lakes will be sampled in a random order indicated by the "Sampling Sequence" column in Table 2. The sequence was determined using the generalized random tessellation-stratified (GRTS) approach developed for USEPA's Environmental Monitoring and Assessment Program (Stevens and Olsen 2004). The GRTS approach achieves a random point distribution that is spatially balanced – in other words, it avoids the spatial clustering that often occurs in a conventional random sample. This balance is achieved even if only a subset of the population of interest is sampled as long as the samples are collected in the order specified. In the random selection of these lakes, each lake was assigned an equal probability of inclusion. Another advantage of this approach is that if the entire population of 216 lakes is not sampled, then inferences can still be drawn about the population as a whole, including the unsampled lakes. In addition, after the first year of sampling is completed, it will be possible to make a preliminary assessment based on inference about the status of all the popular lakes. For the popular lakes, no minimum size limit will be applied.

Though long-term trend analysis (Objective 2) is not being performed in this study, lakes for potential future trend analysis were identified by each Regional Board (Table 3). These lakes are scheduled for inclusion in the first year of sampling regardless of the sampling sequence.

The second major emphasis of the sampling effort will be to provide a statewide assessment that addresses MQ2. The most cost-effective approach to obtaining a statewide assessment is through sampling of a random, unbiased selection of lakes from the entire population of lakes in the state. Twenty percent of the funds anticipated to be available in 2007 and 2008 are being allocated to this statewide assessment of "other" lakes (i.e., lakes not included in the list of popular lakes) (Table 4).

The minimum sample size needed for a reasonably precise statewide characterization of degrees of impairment due to bioaccumulation is 50 (Don Stevens, personal communication). As with the popular lakes, the other lakes were selected using the GRTS approach, and will be sampled in a random order indicated by the "Sampling Sequence" column in Table 4. Of the more than 9000 lakes in California, a vast majority are very small and not subject to much fishing pressure. Given the general focus of the survey on evaluating the impact of bioaccumulation on the fishing beneficial use, higher inclusion probabilities were assigned to larger lakes following the relationship illustrated in Figure 2. This weighting scheme skews the sampling as much toward larger lakes as possible without compromising the validity of the sample as a representation of the entire population of "other" lakes. Many of the lakes and reservoirs in California are inaccessible or unfishable. To avoid wasting sampling resources on these lakes, the population of "other" lakes was restricted to lakes greater than 4 ha in size, and that could be accessed and sampled within a one day period. These restrictions resulted in the

exclusion of many lakes from the population to be sampled. Evaluating access to these lakes is a time-consuming task that is still being performed (as indicated in the "Sampleable" column).

The 50 "other" lakes will all be sampled in 2007 in order to provide an answer as quickly as possible to MQ2. After completion of collection and analysis of the 2007 samples, it will therefore be possible to prepare a report that provides a sound preliminary answer to MQ1 and a full answer to MQ2.

MQ3 will also be addressed through the sampling of both the popular and other lakes, but most effectively through sampling of the popular lakes.

C. Sampling Design Within Each Lake

1. Species Targeted

Given the focus of the screening study on the fishing beneficial use, the species to be sampled will be those that are commonly caught and consumed by anglers. Other factors considered include abundance, geographic distribution, and value as indicators for the contaminants of concern. The abundance and geographic distribution of species are factors that facilitate sample collection and assessment of spatial patterns in contamination. For example, largemouth bass is very common and widely distributed, and these factors contribute to making this an appropriate indicator species even though it is less popular for consumption than some other species.

The goal of this screening study is to determine whether or not California lakes have unacceptably high concentrations of contaminants. Given this goal, the study is focusing on indicator species that tend to accumulate the highest concentrations of the contaminants of concern. Different contaminants tend to reach their highest concentrations in different species. Mercury biomagnifies primarily through its accumulation in muscle tissue, so top predators such as largemouth bass tend to have the highest mercury concentrations. In contrast, the organic contaminants of concern biomagnify, but primarily through accumulation in lipid. Concentrations of organics are therefore are also influenced by the lipid content of the species, with species that are higher in lipid having higher concentrations. Bottom-feeding species such as catfish and carp tend to have the highest lipid concentrations in their muscle tissue, and therefore usually have the highest concentrations of organics. Selenium also biomagnifies primarily through accumulation in muscle, but past monitoring in the San Joaquin Valley suggests that bottom-feeders accumulate slightly higher concentrations, perhaps an indication of a stronger association with the benthic food web.

Consequently, this study will target two indicator species in each lake – a top predator (e.g., black bass or Sacramento pikeminnow) as a mercury indicator and a high lipid, bottom-feeding species (e.g., catfish, carp) as an organics and selenium indicator. Another advantage of this approach is that it provides a characterization of both the pelagic and benthic food chains. These considerations led USEPA (2000) to recommend this two species approach in their guidance document for monitoring in support of development of consumption advisories.

Some lakes, particularly high elevation lakes, may only have one abundant high trophic level species (i.e., trout). In these cases, the one species will be sampled as an indicator of all the target analytes.

Fish species are distributed unevenly across the State, with different assemblages in different regions (e.g., high Sierra Nevada, Sierra Nevada foothills, and Central Valley) and a variable distribution within each region. To cope with this, the sampling crew will have a prioritized menu of several potential target species (Table 5). Primary target species will be given the highest priority. If primary targets are not available in sufficient numbers, secondary targets have been identified. Other species will also be observed in the process of electroshocking. This "bycatch" will not be collected, but the sampling crew will record estimates of the numbers of each species observed. This information may be useful if follow-up studies are needed at any of the sampled lakes.

2. Locations

Lakes and reservoirs in California vary tremendously in size, from hundreds of small ponds less than 10 ha to Lake Tahoe at 50,000 ha. The distribution of lake sizes of different categories is shown in Table 6. As lakes increase in size it becomes necessary to sample more than one location to obtain a representative characterization of the water body.

In sport fish sampling using an electroshocking boat, it is frequently necessary to sample over a linear course of 0.5 – 1 miles to obtain an adequate number of fish. A sampling location in this study can therefore be thought of as a circle with a diameter of 1 mile. For small lakes less than 500 ha in size, one sampling location covers a significant fraction of the surface area of the lake. An example (Lake Piru, 484 ha) is shown in Figure 3. Therefore, for lakes less than 500 ha, one location will be sampled. Since the goal of the study is to characterize human exposure, the locations will be established near centers of fishing activity.

Decisions regarding the number and placement of locations in each lake will be made in consultation with Regional Board staff with local knowledge of the lakes, especially for lakes in the large and very large categories. Criteria to be considered in determining the placement of sampling locations will include the existence of discrete centers of fishing activity, known patterns of spatial variation in contamination or other factors influencing bioaccumulation, road or boat ramp access, and possibly other factors.

As lakes increase in size, sampling of additional locations will be considered. For lakes of medium size (500 – 1000 ha), two locations will generally be sampled. Many lakes are in this size category – including 35 of the 216 (16%) popular lakes. An example of a lake in this category (Pardee Reservoir, 884 ha) is shown in Figure 4. Two locations would provide coverage of a significant portion of the surface area of a lake of this size. In some cases, upon consultation with Regional Board staff, it may even be decided that one location is adequate for a lake in this size category.

For lakes in the large category (1000 – 5000 ha), two to four locations will be sampled. A smaller percentage of lakes are in this category (22 of the 216 popular lakes, or 10%). An

example of a lake in this category (Black Butte Lake, 1824 ha) is shown in Figure 5. Three locations would provide coverage of a significant portion of the surface area of a lake of this size. In some cases, upon consultation with Regional Board staff, it may even be decided that two locations are adequate for a lake in this size category. In other cases where lakes are known to have significant spatial variation in factors affecting human exposure, four locations might be sampled in a lake in this size range.

For lakes in the very large category (>5000 ha), two to four locations will be sampled. A small percentage of lakes are in this category (11 of 216 popular lakes, or 5%). An example of a lake in this category (Lake Berryessa, 6800 ha) is shown in Figure 6. Three locations would provide coverage of a significant portion of the surface area of a lake of this size. In some cases, upon consultation with Regional Board staff, it may even be decided that two locations are adequate for a lake in this size category. In other cases where lakes are known to have significant spatial variation in factors affecting human exposure, four locations might be sampled in a lake in this size range. The largest lakes, Lake Tahoe and the Salton Sea, are special cases where consultation with Regional Board staff will be particularly important.

3. Size Ranges and Compositing for Each Species

Size Ranges and Compositing

Chemical analysis of trace organics is relatively expensive ($470 per sample for PCB congeners and $504 per sample for organochlorine pesticides), and the management questions established for this survey can be addressed with good information on average concentrations, so a compositing strategy will be employed for these chemicals. These data will be used to answer the management questions listed on page 6.

Chemical analysis of mercury is much less expensive ($60 per sample), and SWAMP partners would like to answer management questions in addition to the ones listed on page 6. The additional questions relate to statistical evaluation of differences among lakes and of trends over time. The partners include the State Water Resources Control Board and some of the Regional Boards, and these partners are bringing additional funds to the table to contribute to obtaining the information needed to address the additional questions. Consequently, the sampling design for the mercury indicator species includes analysis of mercury in individual fish. For the mercury indicator species, an analysis of covariance approach will be employed, in which the size:mercury relationship will be established for each location and an ANCOVA will be performed that will allow the evaluation of differences in slope among the locations and the comparison of mean concentrations and confidence intervals at a standard length, following the approach of Tremblay (1998). Experience applying this approach in the Central Valley indicates that to provide robust regressions 10 fish spanning a broad range in size are needed (Davis et al. 2003, Melwani et al. 2007).

Specific size ranges to be targeted for each species are listed in Table 7. Black bass (including largemouth, smallmouth, and spotted bass) and Sacramento pikeminnow (included in Group 1) are the key mercury indicators. These species have a high trophic position and a strong size:mercury relationship. These species will be analyzed for mercury only, and will be analyzed

individually. The numbers and sizes indicated for these species will provide the size range needed to support ANCOVA. In addition, the size range for black bass takes the legal limit for these species (305 mm, or 12 inches) into account. The goal for black bass is to have a size distribution that encompasses the standard length (350 mm) to be used in statistical comparisons. This length is near the center of the distribution of legal-sized fish encountered in past studies (Davis et al. 2003, Melwani et al. 2007).

In many high elevation lakes only trout species will be available. Past sampling of rainbow trout in the Bay-Delta watershed has found low concentrations and a weak size:mercury relationship. Therefore, for these species the ANCOVA approach will not be used. Mercury will be analyzed in composites of 5 individuals. These trout will also be analyzed as composites for organics. The size ranges established for trout are based on a combination of sizes prevalent in past sampling (Melwani et al. 2007) and the 75% rule recommended by USEPA (2000) for composite samples.

Catfish and carp are the primary targets for high lipid bottom-feeders. These species will be analyzed for organics, selenium, and mercury. Organics are expected to be highest in these species based on past monitoring in the Toxic Substances Monitoring Program and other studies (Davis et al. 2007). Selenium is expected to be highest in these species, although the difference is not as distinct as for the organics, based on data from the Grassland Bypass Project. Mercury is expected to be highest in the pelagic predators, but concentrations are also expected to be above thresholds for concern in the bottom-feeders, so mercury will be analyzed in these samples as well. Samples for these species will be analyzed as composites. The size ranges established for bottom-feeders are based on a combination of sizes prevalent in past sampling (Melwani et al. 2007) and the 75% rule recommended by USEPA (2000) for composite samples.

Secondary targets have been identified that will be collected if the primary targets are not available. These species would be processed for potential analysis of mercury, selenium, and organics. The samples would be analyzed as composites. The size ranges established for secondary target species are based on a combination of sizes prevalent in past sampling (Melwani et al. 2007) and the 75% rule recommended by USEPA (2000) for composite samples.

The BOG has decided that when no primary or secondary predator target species are found in a given lake, only one bottom-feeder species will be collected and analyzed. Likewise if no bottom-feeder species are present, one predator species will be collected and analyzed for all constituents including organics.

The sampling crew will report their catch back to the BOG on a weekly basis to make sure that the appropriate samples are collected and to address any unanticipated complications.

4. Compositing and Archiving Strategies

Strategies for compositing and archiving will vary somewhat for lakes of different size. The overall strategy will be described first for small lakes, followed by a discussion of the differences for larger lakes.

Small Lakes

Figure 7 illustrates the approach to be taken for the predator and bottom-feeding species. As described above, the predator species will be analyzed for mercury only and as individual fish. All samples of the predator species will be analyzed. Small lakes will be treated as one sampling location, so fish from anywhere in the lake will be counted toward meeting the targets for each size range listed in Table 7. For ANCOVA, one common regression line will be developed to describe the size:mercury relationship for the lake as a whole. Each individual will be archived for 1 year in case of any problems or other circumstances calling for reanalysis at a later time. Additionally, unhomogenized aliquots from 5 fish following the 75% rule will be retained indefinitely for use in composite analysis of organics or other analytes of interest.

The bottom-feeding species will be analyzed as composites for organics, selenium, and mercury (Figure 7). It is anticipated, based on review of past data (Davis et al. 2007) that the majority of lakes will not exceed thresholds of concern for organics or selenium. Therefore, to address the management questions guiding this study in a cost-effective manner, these composite samples will be analyzed in a stepwise fashion. To answer MQ2 (305(b) assessment), a representative indication of the average concentration in the lake is needed. For a statewide screening survey, one sample per lake is adequate for this purpose. Therefore, one representative composite sample will be analyzed immediately for organics and selenium. To answer MQ1 (303(d) listing), the State Water Board's listing policy requires a minimum of two samples to support a determination that a water body should be on the 303(d) list. Therefore, another composite sample will also be collected. Both composites will be analyzed immediately for mercury, given the low cost of analysis. However, this second composite sample will only be analyzed for organics and/or selenium if the first composite sample exceeds a threshold (Tables 8 and 9). The threshold for this follow-up analysis (Table 9) has been designated as 75% of the threshold for concern (Table 8). The thresholds for concern (Table 8) are derived from an assessment by OEHHA (Klasing and Brodberg 2006). At concentrations below these thresholds, OEHHA strongly encourages consumption of up to 8 meals per month. At concentrations above these thresholds, OEHHA would begin to consider advising limited consumption (i.e., fewer than 8 meals per month). Considering PCBs as an example, if the first composite has a concentration of 22 ppb or higher, then the second archived composite would also be analyzed. If the concentration in the first composite is below 22 ppb, then the second composite would not be analyzed. This approach will avoid expenditure of funds on organics analysis where it is not helping to answer the management questions of interest. Aliquots from all composites will also be archived whether they are analyzed or not in case of any problems or other circumstances calling for analysis or reanalysis at a later time.

The follow-up analysis will be performed as quickly as possible so that the management questions can be answered as well as possible in a report to be prepared within one year of sampling. The following steps will be taken to expedite the analysis of these samples.

1. Lakes that are likely, based on existing information, to exceed thresholds for organics and selenium will be identified and sampled early in the sampling season.
2. When the lab obtains results indicating concentrations above the follow-up threshold, the remaining composites from that lake will be immediately put to the front of the queue for analysis.

Larger Lakes

For lakes in the medium, large, and very large categories the basic approach will be similar, with a couple of modifications. Figures 8-10 illustrate the approach. The first difference from the small lake approach is that sampling locations will be treated discretely. For the predator species, this means that 11 fish spanning a wide range of sizes will be targeted for each location to support the development of a size:mercury regression and an estimated mean concentration at standard length for each location. From these location means a lakewide mean will be calculated to answer MQ2. The location means will be used to answer MQ1.

For the bottom-feeder species, discrete composites will be prepared for each location. These composites will be homogenized and analyzed immediately for mercury, but archived for organics and selenium. Aliquots of homogenate from each location composite will be pooled to form a lakewide composite. The lakewide composite will be analyzed immediately for organics and selenium. If the lakewide composite concentration of any of the organics or selenium exceeds a threshold for follow-up analyis (Table 9), then all of the discrete location composites will be analyzed. Aliquots from all composites will also be archived whether they are analyzed or not in case of any problems or other circumstances calling for analysis or reanalysis at a later time.

D. Sample Processing and Analysis

Fish will be collected in accordance with MPSL-102a, Section 7.4 (Appendix II). Whenever possible an electro-fishing boat will be used, however it may be necessary to employ another method also described in Section 7.4.

The following adaptation to MPSL-102a, Section 7.4.5 (Appendix II) has been made for this study: At the dock, all fish collected will be placed on a measuring board covered with a clean plastic bag; fork and total length will be recorded. Weight will be recorded with a digital spring scale. Small fish will be returned to the lab whole for processing. Large fish will be partially dissected in the field using the following protocol: fish will be placed on a cutting board covered with a clean plastic bag where the head, tail, and guts are removed using a clean (laboratory detergent, DI) cleaver. The cleaver and cutting board are re-cleaned between fish species, per site if multiple stations are sampled.

When possible, field personnel will note sex, parasites and body anomalies on the larger fish. Fin erosion will be noted particularly on trout to distinguish hatchery fish from native fish; effort will be made to collect as many native fish as possible. The lab personnel will do the same for small fish received whole. Each whole fish or cross section will be tagged with a unique numbered ID, individually wrapped in aluminum foil, and placed in a clean labeled zipper-style bag.

All samples will be kept cold on ice until frozen in a freezer or on dry ice within 24 hours of collection. Samples will be stored at -20°C at the laboratory until dissection and homogenization. Homogenates will also be frozen until analysis is performed. Frozen tissue

samples have a 12 month hold time from the date of collection (USEPA 2000); however, the scientific advisory board has stated that samples kept frozen, with minimal thaw-freeze cycles, for several years have no appreciable degradation of organic contaminants.

All fish will be dissected "skin off" according to MPSL-105, Section 7.1 (Appendix II); Section 7.2.4 describes homogenization. This is inconsistent with the guidance of USEPA (2000) that recommends that fish with scales have the scales removed and be processed with skin on, and skin is only removed from scaleless fish (e.g. catfish). The BOG is aware of this difference, but favors skin removal. Skin removal has been repeatedly used in past California monitoring. All fish (with limited exceptions) in Toxic Substances Monitoring Program, the Coastal Fish Contamination Program, and the Fish Mercury Project have also been analyzed skin-off. Processing fish with the skin on is very tedious and results in lower precision because the skin is virtually impossible to homogenize thoroughly and achieving a homogenous sample is difficult. Also, skin-on preparation actually dilutes the measured concentration of mercury because there is less mercury in skin than in muscle tissue. The most ubiquitous contaminant in fish in California that leads to most of our advisories is mercury. By doing all preparation skin-off we will be getting more homogeneous samples, better precision for all chemicals, and definitely a better measure of mercury concentrations, which are our largest concern.

Fish are filleted to expose the flesh. It is important to maintain the cleanliness of the tissue for analysis, therefore any flesh that has been in direct contact with the skin, with instruments in contact with skin, or with any potential contaminant surface such as foil or a plastic bag must be eliminated from the analyzed sample. The exposed edges of the fillet should be trimmed by 1/4 inch with a clean scalpel or fillet knife to remove this contaminated tissue.

How a sample is dissected is greatly dependent on the types of analyses being conducted. Tissue from individual fish for mercury analysis only will be dissected from the fillet above the lateral line and analyzed immediately; no homogenization is required. When composites must be created, equal tissue weights are taken from 5 individual fish following the 75% size rule recommended by USEPA (2000) and homogenized with a Büchi B-400 mixer (MPSL-105, Section 7.2.4; Appendix III) into a Location Composite with a target weight of 200g or greater. Tissue for composites will be taken from the fillet of each fish above the lateral line and from the belly to include areas of higher lipid content. A subsequent lakewide composite will be created from equal portions of each contributing Location Composite within each lake. Figure 11 diagrams compositing strategies and target weights for predator and bottom species. Post-homogenization aliquots will be taken from the lakewide composite for mercury, selenium and organics analyses. Aliquots for mercury and selenium will be transferred to pre-cleaned 30ml polypropylene jars (MPSL-101, Section 7.1.5; Appendix II). Organics aliquots will be transferred to 60ml borosilicate environmentally cleaned jars (example I-Chem class 200).

Mercury will be analyzed according to EPA 7473, "Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry" using a Direct Mercury Analyzer. Samples, blanks, and standards will be prepared using clean techniques. ASTM Type II water and analytical grade chemicals will be used for all standard preparations. A continuing calibration verification (CCV) will be performed after every 10 samples. Initial and continuing calibration verification values must be within ±20% of the true

value, or the previous 10 samples must be reanalyzed. Three blanks, a standard reference material (DORM-2), as well as a method duplicate and a matrix spike pair will be run with each set of samples.

Selenium will be digested according to EPA 3052M, "Microwave Assisted Acid Digestion of Siliceous and Organically Based Matrices", modified, and analyzed according to EPA 200.8, "Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry". Samples, blanks, and standards will be prepared using clean techniques. ASTM Type II water and analytical grade chemicals will be used for all standard preparations. A continuing calibration verification (CCV) will be performed after every 10 samples. Initial and continuing calibration verification values must be within ±20% of the true value, or the previous 10 samples must be reanalyzed. Two blanks, a standard reference material (2976 or DORM-2), as well as a method duplicate and a matrix spike pair will be run with each set of samples.

Organochlorine pesticides and PBDEs will be analyzed according to EPA 8081AM, "Organochlorine Pesticides by Gas Chromatography" and PCBs will be analyzed according to EPA 8082M, "Polychlorinated Biphenyls (PCBs) by Gas Chromatography". Samples, blanks, and standards will be prepared using clean techniques. ASTM Type II water and analytical grade chemicals will be used for all standard preparations. A continuing calibration verification (CCV) will be performed after every 10 samples. Initial and continuing calibration verification values must be within ±25% of the true value, or the previous 10 samples must be reanalyzed. One blank, a laboratory control spike (LCS), as well as a method duplicate and a matrix spike pair will be run with each set of samples.

E. Analytes

Table 10 provides a summary of the contaminants included on the list of analytes for the study. Since the study is focused on assessing the impacts of bioaccumulation on the fishing beneficial use, the list is driven by concerns over human exposure. Contaminants were included if they were considered likely to provide information that is needed to answer the three management questions for the study (see page 6). Addressing the first two management questions (relating to information needs of the Water Boards) is the immediate priority, but providing information that builds toward addressing MQ3 (relating to information needs of OEHHA) is a longer-term priority.

Additional discussion of the analytes is provided below. A detailed evaluation by OEHHA of which congeners and metabolites to include in the analyses is provided in Appendix 1.

Ancillary Parameters

Ancillary parameters to be measured in the lab include moisture, lipid, sex and age (Table 11). Age will be determined through analysis of otoliths on predator species at all lakes, as well as on the bottom species of those lakes identified for trend analysis. Studies have indicated there is a weak relationship between otolith rings and fish age in trout, therefore otolith analysis will

not be conducted on these species. When a fish is too large to bring back whole, the head, labeled with the same tag number as the rest of the body, will be transported for otolith extraction at the lab. Both otoliths will be extracted and cleaned in isopropyl alcohol. The alcohol will be evaporated and the dry otolith stored until analysis. Otoliths will not be extracted from trout as the relationship between age and otolith growth rings is weak.

Mercury

Mercury is the contaminant of greatest concern with respect to bioaccumulation on a statewide basis. Based on past studies (Davis et al. 2007), mercury is expected to exceed the threshold of concern in many lakes and reservoirs. Mercury will be measured as total mercury. Nearly all of the mercury present in edible fish muscle is methylmercury, and analysis of fish tissue for total mercury provides a valid, cost-effective estimate of methylmercury concentration. Mercury will be analyzed in all samples of both the pelagic predator and bottom-feeder species because a substantial proportion of samples of each are expected to exceed the threshold of concern.

PCBs

PCBs are the contaminant of second greatest concern with respect to bioaccumulation on a statewide basis. Based on past studies (Davis et al. 2007), PCBs are expected to exceed the threshold of concern in approximately 20 – 30% of California lakes and reservoirs. PCBs will be analyzed using a congener specific method. Considerations regarding the list to be analyzed are discussed in Appendix 1. A total of 55 congeners will be analyzed. The congener data will be used to estimate concentrations on an Aroclor basis, since the thresholds for concern are expressed on an Aroclor basis (Klasing and Brodberg 2006). USEPA (2000) also recommends the use of Aroclor data for development of fish advisories. The concentrations of Aroclors 1248, 1254, and 1260 will be estimated using the method of Newman et al. (1998). PCBs will be analyzed in only the primary target bottom-feeder species or the secondary target species if the primary targets are not available.

Legacy pesticides

Based on past studies (Davis et al. 2007), legacy pesticides are expected to exceed thresholds of concern in a very small percentage of California lakes and reservoirs. Considerations regarding the list of pesticides to be analyzed are discussed in Appendix 1. Pesticides will be analyzed in only the primary target bottom-feeder species or the secondary target species if the primary targets are not available.

Selenium

Selenium was not included in the review of Davis et al. (2007), but based on TSMP monitoring selenium is expected to exceed the threshold of concern in a very small percentage of California lakes and reservoirs. Selenium will be measured as total selenium. Selenium will be analyzed in only the primary target bottom-feeder species or the secondary target species if the

primary targets are not available. As discussed above, data from the Grassland Bypass Project indicate that bottom-feeders accumulate slightly higher concentrations than pelagic predators. Selenium is not expected to exceed thresholds in many water bodies on a statewide basis. The 2007 sampling will be performed to confirm this hypothesis. Whether additional sampling is needed in 2008 will be decided based on the results of the 2007 sampling.

PBDEs

Few data are currently available on PBDEs in California sport fish, and a threshold of concern has not yet been established. However, a rapid increase in concentrations in the 1990s observed in San Francisco Bay and other parts of the country raised concern about these chemicals, and led to a ban on the production and sale of the penta and octa mixtures in 2006 (Oros et al. 2005). The deca mixture is still produced commercially. A threshold of concern is anticipated to be established soon by USEPA. The most important PBDE congeners with respect to bioaccumulation are PBDEs 47, 99, and 100. These congeners, and a few others, can be measured along with the PCBs at no additional cost as they can be separated using the same column and GC program as the PCBs. Estimated concentrations will be determined for PBDEs 17, 28, 47, 66, 99, and 100. These will only be estimates as the analysis will not include measurement of matrix spikes and other QA samples needed to report more accurate data. PBDEs accumulate in lipid, and will therefore be analyzed in only the primary target bottom-feeder species or the secondary target species if the primary targets are not available. If results from this screening indicate concentrations of concern in some water bodies, then follow-up sampling with a quantitative method will be considered.

Dioxins and Dibenzofurans

Few data are available on dioxins and dibenzofurans in California sport fish. Perhaps the best dataset exists for San Francisco Bay, where sampling in 1994, 1997, and 2000 indicated that concentrations in high lipid species exceeded a published screening value of 0.3 TEQs (for dioxins and furans only) by five fold (Greenfield et al. 2003). However, there are no known major point sources of dioxins in the Bay Area and the concentrations measured in the Bay are comparable to those in rural areas of the U.S. OEHHA did not include dioxins in their recent evaluation of guidance tissue levels for priority contaminants due to the lack of data for dioxins in fish throughout the state (Klasing and Brodberg 2006). Given the relatively high cost of dioxin analysis and these other considerations, OEHHA recommended that dioxins not be included in this screening study (Table 10). The priority of dioxins with respect to 303(d) listing is also unclear, with inconsistencies between USEPA and the Regional Boards. However, water bodies in the San Francisco Bay-Delta do appear on the 303(d) list due to dioxin contamination, and currently Region 2 is considering developing a TMDL for dioxins. From a 303(d) perspective, therefore, dioxin analysis is considered a priority, albeit a low one (as indicated on the 303(d) list). Given the ambiguity regarding the priority of obtaining dioxin data and the high expense of the analyses, dioxins are not included on the analyte list for the statewide survey.

Organophophates, PAHs, and TBT

Past monitoring (TSMP, San Francisco Bay work – SFBRWQCB 1995) indicates that concentrations of these chemicals in sport fish are far below thresholds of concern for human exposure. Therefore, they will not be included in the present study.

Other Emerging Contaminants

Other emerging contaminants are likely to be present in California sport fish. Examples include perfluorinated chemicals, other brominated flame retardants in addition to PBDEs, and others. Thresholds do not exist for these chemicals, so advisories or 303(d) listing are not likely in the near future. However, early detection of increasing concentrations of emerging contaminants can be very valuable for managers, as evidenced by the PBDE example. Measuring emerging contaminants would not directly address the management questions guiding this study, so analysis of these chemicals is not included in the design.

F. Archiving

As described above, aliquots of homogenates of all samples analyzed will be archived on a short-term basis to provide for reanalysis in case of any mishaps or confirmation. In addition, aliquots of the lakewide homogenates prepared for the bottom-feeder species will be made and archived on a long-term basis. This will provide a integrative, representative sample for each lake that can be reanalyzed in later years to confirm earlier analyses, look for new chemicals of concern, provide material for application of new analytical methods, provide material for other ecological research, and other purposes. Long-term archiving of the lakewide homogenates is the most cost-effective approach to addressing this need.

Figure 11 diagrams the archive that will be retained from each species collected at each location in 60ml borosilicate environmentally cleaned or polyethylene jars. Five individuals within the 75% size rule from the black bass species will be archived in glass, un-homogenized. Two archives of each location composite of the bottom species and Trout will be retained so that analysis of location composites may be performed in the event that lakewide composite results are greater than the trigger thresholds (Table 9). One of these archives will be retained in polyethylene to eliminate Teflon contamination in the event that perfluoroalkoxy polymer resin (PFA) analysis is conducted in the future. In addition, up to five aliquots from the lakewide composite of the bottom species and Trout will be archived. At least one of the five archive jars will be polyethylene. Each jar will be filled as completely as possible to reduce freezer burn by ensuring the tissue comes in contact with as little air as possible.

Lakes identified by the Regional Boards as sites for potential future trend analysis (Trend Lakes, Table 3) will have individual archives retained for all species and all locations (Figure 12). The location composite will be archived if there is sufficient tissue available from the fish collected. If necessary for re-analysis, this composite can be re-created from individual archives retained.

G. Timing

Sampling will be conducted from May 2007 through November 2007. Seasonal variation in body condition (Cidziel et al. 2003) and reproductive physiology are recognized as factors that could affect contaminant concentrations. However, sampling as many lakes as possible is essential to a statewide assessment, and it will take this many months to sample the 130 lakes targeted for 2007.

H. Products and Timeline

A technical report on the 2007 sampling will be drafted by June 2008 and will include a complete assessment of condition of lakes based on a randomized sampling of 50 lakes across California for use in a 305(b) report, supplemented by a thorough sampling of 80 popular lakes that will provide a sound basis for determining whether 130 lakes should be included on the 303(d) list. The report will be distributed for peer review in June 2008. The final report, incorporating revisions in response to reviewer comments, will be completed in September 2008.

It is anticipated that funding for an additional round of sampling will be available in 2008. This work would follow the same approach described in this document, but focusing on the remaining popular lakes. This sampling would begin May 2008. Preliminary results from the 2007 sampling will be evaluated to determine whether any adjustments to the design are needed.

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Table 1. Bioaccumulation monitoring assessment framework for the fishing beneficial use.

D.1. Determine the status of the fishing beneficial use throughout the State with respect to bioaccumulation of toxic pollutants

D.1.1 What are the extent and location of water bodies with sufficient evidence to indicate that the fishing beneficial use is at risk due to pollutant bioaccumulation?

D.1.2 What are the extent and location of water bodies with some evidence indicating the fishing beneficial use is at risk due to pollutant bioaccumulation?

D.1.3 What are the extent and location of water bodies with no evidence indicating the fishing beneficial use is at risk due to pollutant bioaccumulation?

D.1.4 What are the proportions of water bodies in the State and each region falling within the three categories defined in questions D.1.1, D.1.2, and D.1.3?

D.2. Assess trends in the impact of bioaccumulation on the fishing beneficial use throughout the State

D.2.1 Are water bodies improving or deteriorating with respect to the impact of bioaccumulation on the fishing beneficial use?

D.2.1.1 Have water bodies fully supporting the fishing beneficial use become impaired?

D.2.1.2 Has full support of the fishing beneficial use been restored for previously impaired water bodies?

D.2.2 What are the trends in proportions of water bodies falling within the three categories defined in questions D.1.1, D.1.2, and D.1.3 regionally and statewide?

D.3. Evaluate sources and pathways of bioaccumulative pollutants impacting the fishing beneficial use

D.3.1 What are the magnitude and relative importance of pollutants that bioaccumulate and indirect causes of bioaccumulation throughout each Region and the state as a whole?

D.3.2 How is the relative importance of different sources and pathways of bioaccumulative pollutants that impact the fishing beneficial use changing over time on a regional and statewide basis?

D.4. Provide the monitoring information needed to evaluate the effectiveness of management actions in reducing the impact of bioaccumulation on the fishing beneficial use

D.4.1 What are the management actions that are being employed to reduce the impact of bioaccumulation on the fishing beneficial use regionally and statewide?

D.4.2 How has the impact of bioaccumulation on the fishing beneficial use been affected by management actions regionally and statewide?

Table 2. List of popular lakes. Lakes with sampling sequence number 80 or less will be targeted for sampling in 2007.

Sampling Sequence	Name	Region	County	Area (ha)	Elevation (ft)
23	Alondra Park Lake	4	LOS ANGELES	3	55
16	Anderson Lake	2	SANTA CLARA	410	623
175	Antelope Lake	5	PLUMAS	373	5004
79	Apollo Lake	6	LOS ANGELES	2	2326
166	Barrett Lake	9	SAN DIEGO	51	1593
98	Bass Lake	5	MADERA	417	3368
8	Bear River Reservoir	5	AMADOR	67	5878
132	Beardsley	5	TUOLUMNE	282	3408
202	Benbow Lake	1	HUMBOLDT	25	367
131	Big Bear Lake	8	SAN BERNARDINO	1102	6760
66	Big Lagoon	1	HUMBOLDT	553	9
34	Big Lake	5	SHASTA	12	5850
153	Big Reservoir	5	PLACER	24	4048
125	Black Butte Lake	5	TEHAMA	1824	475
97	Blue Lakes	5	LAKE	37	1361
140	Boca Reservoir	6	NEVADA	386	5607
189	Bon Tempe Lake	2	MARIN	49	718
108	Bowman Lake	5	NEVADA	328	5560
199	Bridgeport Reservoir	6	MONO	1058	6456
122	Brite Valley Lake	5	KERN	1	5256
61	Bucks Lake	5	PLUMAS	672	5160
109	Butt Valley Reservoir	5	PLUMAS	613	4144
114	Butte Lake	5	LASSEN	80	6051
128	Calero Reservoir	2	SANTA CLARA	135	505
145	Camanche Reservoir	5	AMADOR	2994	218
37	Camp Far West Reservoir	5	YUBA	787	284
24	Caples Lake	5	ALPINE	246	7800
95	Castaic Lake	4	LOS ANGELES	923	1518
146	Castle Lake	5	SISKIYOU	20	5439
207	Cave Lake	5	MODOC	2	6640
47	Cherry Lake	5	TUOLUMNE	726	4754
32	Chesbro Reservoir	3	SANTA CLARA	80	549
173	Clear Lake	5	LAKE	16216	1328
118	Cleone Lake	1	MENDOCINO	6	26
5	Collins Lake	5	YUBA	411	1186
17	Contra Loma Reservoir	5	CONTRA COSTA	25	192
163	Convict Lake	6	MONO	70	7579
181	Copco Lake	1	SISKIYOU	314	2608
178	Courtright Reservoir	5	FRESNO	685	8185
212	Coyote Lake	2	SANTA CLARA	172	773
6	Dead Lake	1	DEL NORTE	11	36
30	Dixon Lake	9	SAN DIEGO	26	1032
107	Dodge Reservoir	6	LASSEN	204	5734
167	Don Pedro Reservoir	5	TUOLUMNE	4484	803
103	Donnells Lake	5	TUOLUMNE	174	4924
28	Donner Lake	6	NEVADA	332	5936
85	Duncan Reservoir	5	MODOC	65	4953
213	Eagle Lake	6	LASSEN	8118	5110
25	East Park Reservoir	5	COLUSA	687	1198
194	Eastman Lake	5	MADERA	712	NA
136	Echo Lake	6	EL DORADO	132	7416
62	El Capitan Lake	9	SAN DIEGO	589	773
143	Ellery Lake	6	MONO	23	9481

Table 2. List of popular lakes (continued).

Sampling Sequence	Name	Region	County	Area (ha)	Elevation (ft)
58	Elsinore, Lake	8	RIVERSIDE	984	1242
155	Evans, Lake	8	RIVERSIDE	11	783
180	Fallen Leaf Lake	6	EL DORADO	560	6379
208	Faucherie Lake	5	NEVADA	55	6134
38	Florence Lake	5	FRESNO	369	7333
177	Folsom Lake	5	PLACER	4478	468
12	French Meadows Reservoir	5	PLACER	575	5223
11	Frenchman Lake	5	PLUMAS	619	5590
43	George, Lake	6	MONO	17	9025
56	Gold Lake	5	SIERRA	198	6409
71	Grant Lake	6	MONO	421	7134
147	Gregory, Lake	6	SAN BERNARDINO	33	4551
211	Gull Lake	6	MONO	26	7618
50	Gumboot Lake	5	SISKIYOU	3	6101
65	Harry L Englebright Lake	5	YUBA	305	524
52	Hell Hole Reservoir	5	PLACER	555	4584
82	Hensley Lake	5	MADERA	600	NA
112	Hernandez Reservoir	3	SAN BENITO	254	2400
7	Hesperia Lake	6	SAN BERNARDINO	1	4675
99	Horseshoe Lake	6	MONO	20	8960
69	Howard Lake	1	MENDOCINO	9	3856
78	Hume Lake	5	FRESNO	35	5203
134	Huntington Lake	5	FRESNO	574	6951
204	Ice House Reservoir	5	EL DORADO	252	5436
44	Indian Creek Reservoir	6	ALPINE	66	5604
81	Indian Valley Reservoir	5	LAKE	1404	1479
45	Iron Canyon Reservoir	5	SHASTA	131	2666
154	Iron Gate Reservoir	1	SISKIYOU	435	2329
26	Isabella Lake	5	KERN	3120	2584
160	Jackson Meadow Reservoir	5	SIERRA	421	6038
96	Jenkinson Lake	5	EL DORADO	194	3473
127	June Lake	6	MONO	119	7620
90	Kangaroo Lake	1	SISKIYOU	8	6022
119	Ken Hahn State Recreational Ar	4	LOS ANGELES	1	NA
1	Lafayette Reservoir	2	CONTRA COSTA	46	458
165	Lake Almanor	5	PLUMAS	10044	4502
20	Lake Alpine	5	ALPINE	70	7305
129	Lake Amador	5	AMADOR	121	482
91	Lake Arrowhead	6	SAN BERNARDINO	302	5117
77	Lake Berryessa	5	NAPA	6800	NA
101	Lake Britton	5	SHASTA	411	2735
191	Lake Cachuma	3	SANTA BARBARA	1255	754
115	Lake Cahuilla	7	RIVERSIDE	48	22
55	Lake Casitas	4	VENTURA	700	519
157	Lake Chabot	2	SOLANO	19	83
27	Lake Crowley	6	MONO	1967	6768
123	Lake Davis	5	PLUMAS	1494	5777
169	Lake del Valle	2	ALAMEDA	413	747
216	Lake Havasu	7	MOHAVE	7986	451
3	Lake Hemet	8	RIVERSIDE	126	4339
214	Lake Henshaw	9	SAN DIEGO	731	2688
70	Lake Hodges	9	SAN DIEGO	166	277
102	Lake Jennings	9	SAN DIEGO	52	697

Table 2. List of popular lakes (continued).

Sampling Sequence	Name	Region	County	Area (ha)	Elevation (ft)
54	Lake Kaweah	5	TULARE	687	698
53	Lake Lagunitas	2	MARIN	9	785
215	Lake McClure	5	MARIPOSA	2267	839
116	Lake McSwain	5	MARIPOSA	123	399
149	Lake Mendocino	1	MENDOCINO	690	741
142	Lake Miramar	9	SAN DIEGO	56	716
60	Lake Nacimiento	3	SAN LUIS OBISPO	2331	806
133	Lake Natoma	5	SACRAMENTO	196	129
21	Lake Oroville	5	BUTTE	6272	901
137	Lake Pillsbury	1	LAKE	799	1820
179	Lake Piru	4	VENTURA	494	1078
86	Lake Poway	9	SAN DIEGO	25	958
164	Lake San Antonio	3	MONTEREY	2194	780
121	Lake Sonoma	1	SONOMA	962	452
124	Lake Spaulding	5	NEVADA	281	5013
198	Lake Sutherland	9	SAN DIEGO	227	2055
10	Lake Webb	5	KERN	338	294
126	Lake Wohlford	9	SAN DIEGO	90	1482
162	Lee Lake/Corona Lake	8	RIVERSIDE	27	1127
161	Lewiston Lake	1	TRINITY	290	1914
144	Lexington Reservoir	2	SANTA CLARA	129	648
159	Lily Lake	5	MODOC	3	6709
197	Little Grass Valley Reservoir	5	PLUMAS	561	5036
158	Little Oso Flaco Lake	3	SAN LUIS OBISPO	9	21
135	Littlerock Reseroir	6	LOS ANGELES	41	3260
184	Loch Lomond Reservoir	3	SANTA CRUZ	71	573
80	Loon Lake	5	EL DORADO	399	6381
106	Lopez Lake	3	SAN LUIS OBISPO	374	478
64	Los Banos Reservoir	5	MERCED	276	333
68	Lower Bear River Reservoir	5	AMADOR	294	5819
100	Lower Blue Lake	5	ALPINE	65	8057
182	Lower Otay Reservoir	9	SAN DIEGO	425	494
87	Lundy Lake	6	MONO	41	7805
151	Mamie, Lake	6	MONO	7	8894
188	Mammoth Pool Reservoir	5	MADERA	486	3333
59	Mary, Lake	6	MONO	35	8963
74	McCumber Reservoir	5	SHASTA	23	4061
141	Medicine Lake	5	SISKIYOU	173	6679
138	Millerton Lake	5	MADERA	1512	563
63	Modesto Reservoir	5	STANISLAUS	795	212
110	Morena Reservoir	9	SAN DIEGO	42	2955
117	New Bullards Bar Reservoir	5	YUBA	1613	1908
89	New Hogan Lake	5	CALAVERAS	1287	681
92	New Melones Lake	5	CALAVERAS	726	1091
105	Nicasio Lake	2	MARIN	335	168
130	North Battle Creek Reservoir	5	SHASTA	31	5581
104	O'Neill Forebay	5	MERCED	912	229
192	Packer Lake	5	SIERRA	5	6227
170	Paradise Lake	5	BUTTE	61	2546
73	Pardee Reservoir	5	AMADOR	884	575
168	Parker Dam	7	SAN BERNARDINO	0	472
203	Perris Reservoir	8	RIVERSIDE	770	1567
42	Pine Flat Lake	5	FRESNO	2100	954
36	Pinecrest	5	TUOLUMNE	120	5619
88	Pinto Lake	3	SANTA CRUZ	47	114

Table 2. List of popular lakes (continued).

Sampling Sequence	Name	Region	County	Area (ha)	Elevation (ft)
13	Plaskett Lake	1	GLENN	2	5951
83	Pleasant Valley Reservoir	6	INYO	40	4393
187	Prado Park Lake	8	RIVERSIDE	9	487
84	Prosser Creek Reservoir	6	NEVADA	262	5745
51	Puddingstone Reservoir	4	LOS ANGELES	98	941
39	Pyramid Lake	4	LOS ANGELES	590	2581
75	Ramer Lake	7	IMPERIAL	63	-174
29	Reservoir C	5	MODOC	8	4943
139	Rock Creek Lake	6	INYO	22	9698
201	Rollins Reservoir	5	NEVADA	313	2172
193	Ruth Lake	1	TRINITY	431	2656
94	Sabrina, Lake	6	INYO	78	9131
183	Saddlebag Lake	6	MONO	113	10068
76	Salt Springs Reservoir	5	AMADOR	362	3954
171	Salton Sea	7	RIVERSIDE	94403	-231
200	San Luis Reservoir	5	MERCED	5208	555
205	San Pablo Reservoir	2	CONTRA COSTA	317	318
14	San Vicente Reservoir	9	SAN DIEGO	428	652
67	Santa Fe Reservoir	4	LOS ANGELES	424	NA
210	Santiago Reservoir/Irvine Lake	8	ORANGE	235	794
206	Santo Margarita Lake	3	SAN LUIS OBISPO	301	1305
49	Scotts Flat Reservoir	5	NEVADA	267	3071
113	Shadow Cliffs Reservoir	2	ALAMEDA	27	352
18	Shasta Lake	5	SHASTA	11037	1077
150	Shaver Lake	5	FRESNO	905	5372
120	Silver Lake	5	AMADOR	212	7264
15	Silver Lake	6	MONO	44	7230
2	Silver Lake	5	SHASTA	10	6580
35	Silverwood Lake	6	SAN BERNARDINO	364	3375
186	Siskiyou Lake	5	SISKIYOU	172	3185
93	Soulejoule Lake	2	MARIN	20	258
190	South Lake	6	INYO	68	9771
172	Spicer Meadow Reservoir	5	ALPINE	67	6433
9	Spring Lake	1	SONOMA	29	293
176	Stampede Reservoir	6	SIERRA	1370	5952
48	Stevens Creek Reservoir	2	SANTA CLARA	37	NA
41	Stony Gorge Reservoir	5	GLENN	571	842
174	Success Lake	5	TULARE	1006	656
46	Sweetwater Reservoir	9	SAN DIEGO	372	242
40	Tahoe, Lake	6	WASHOE	49692	6231
148	Tioga Lake	6	MONO	27	9643
196	Topaz Lake	6	DOUGLAS	775	5009
209	Trinity Lake	1	TRINITY	6497	2374
111	Tulloch Reservoir	5	CALAVERAS	401	511
4	Turlock Lake	5	STANISLAUS	1286	242
195	Twin Lakes	6	MONO	5	8559
156	Union Valley Reservoir	5	EL DORADO	976	4844
152	Upper Blue Lake	5	ALPINE	118	8138
72	Uvas Reservoir	3	SANTA CLARA	81	463
31	Virginia Lakes	6	MONO	10	9810
57	Whiskeytown Lake	5	SHASTA	1258	1213
19	Wiest Lake	7	IMPERIAL	17	-162
22	Wishon Reservoir	5	FRESNO	400	6583
185	Woodward Reservoir	5	STANISLAUS	718	212
33	Yosemite Lake	5	SAN JOAQUIN	2	11

Table 3. List of lakes identified for Trend Analysis

Sampling Sequence	NAME	Region	County	Area (ha)	Elevation (ft)
166	Barrett	9	SAN DIEGO	50.7	1593
131	Big Bear Lake	8	SAN BERNARDINO	1102.4	6760
199	Bridgeport Reservoir	6	MONO	1058.1	6456
95	Castaic Lake	4	LOS ANGELES	923.4	1518
28	Donner Lake	6	NEVADA	331.5	5936
213	Eagle Lake	6	LASSEN	8118	5110
58	Elsinore, Lake	8	RIVERSIDE	983.6	1242
Other	Ferguson Lake	7	IMPERIAL	197.2	191
115	Lake Cahuilla	7	RIVERSIDE	48.1	22
55	Lake Casitas	4	VENTURA	699.6	519
217	Lake Chabot (San Leandro)	2	ALAMEDA	126	522
27	Lake Crowley	6	MONO	1966.9	6768
216	Lake Havasu	7	MOHAVE	7985.7	451
70	Lake Hodges	9	SAN DIEGO	165.6	277
149	Lake Mendocino	1	MENDOCINO	689.5	741
60	Lake Nacimiento	3	SAN LUIS OBISPO	2330.8	806
133	Lake Natoma	5	SACRAMENTO	196.3	129
137	Lake Pillsbury	1	LAKE	798.7	1820
179	Lake Piru	4	VENTURA	493.9	1078
164	Lake San Antonio	3	MONTEREY	2194.1	780
Other	Lake Shastina	1	SISKIYOU	363	2808
121	Lake Sonoma	1	SONOMA	962.1	452
209	Lake Trinity	1	TRINITY	6497	2374
80	Loon Lake	5	EL DORADO	399.2	6381
182	Lower Otay	9	SAN DIEGO	425.1	494
158	Oso Flaco Lake	3	SAN LUIS OBISPO	9.4	21
88	Pinto Lake	3	SANTA CRUZ	46.7	114
187	Prado Park Lake	8	RIVERSIDE	8.8	487
51	Puddingstone Reservoir	4	LOS ANGELES	98.4	941
75	Ramer Lake	7	IMPERIAL	62.8	-174
171	Salton Sea	7	RIVERSIDE	94403.1	-231
200	San Luis Reservoir	5	MERCED	5208.2	555
205	San Pablo Reservoir	2	CONTRA COSTA	317.3	318
210	Santiago Reservoir/Irvine Lake	8	ORANGE	234.6	794
18	Shasta Lake	5	SHASTA	11036.9	1077
35	Silverwood Lake	6	SAN BERNARDINO	364.4	3375
93	Soulejule	2	MARIN	19.7	258
48	Stevens Creek Reservoir	2	SANTA CLARA	36.8	NA
46	Sweetwater Reservoir	9	SAN DIEGO	372.4	242
40	Tahoe, Lake	6	PLACER	49692.2	6231
19	Wiest Lake	7	IMPERIAL	16.8	-162

Table 4. List of other lakes.

NAME	Region	Sampling Sequence	Area (ha)	Elevation (	Sampleabl
Rubicon Reservoir	5	2	34	6548	N
NA	3	4	28	534	?
Lower Klamath Lake	1	5	33	4081	?
Reservoir F	1	7	162	4963	?
NA	5	9	8	154	?
Merritt, Lake	2	10	58	0	?
Little Egg Lake	5	11	23	4258	?
NA	6	13	16	9856	N
Marysville Lake	5	14	13	162	?
Warren Lake	6	16	44	3956	N
NA	5	17	5	697	N
Long Lake	5	19	27	5338	N
NA	3	20	7	432	N
NA	1	21	25	2529	?
NA	1	23	6	4559	N
NA	5	25	48	8661	N
NA	5	26	17	27	N
NA	5	28	5	11188	N
NA	5	30	5	52	?
Pine Flat Lake	5	32	222	954	Y
Kunkle Reservoir	5	33	7	1443	?
Las Virgenes Reservoir	4	36	50	1028	?
Marsh in Fresno Slough	5	40	6	160	Y
Lobdell Lake	6	41	13	9252	Y
Guest Lake	5	44	7	10193	N
Lake of the Pines	5	45	87	1511	Y
Buena Vista Lagoon	9	47	29	12	Y
Lower Klamath Lake	1	49	276	4081	?
West Valley Reservoir	5	51	377	4763	Y
NA	5	53	10	3874	Y
NA	6	55	5	5565	N
NA	5	56	5	11223	N
Dog Lake	5	57	11	9173	N
Discovery Bay	5	58	35	0	Y
NA	5	60	8	10857	N
Milton Reservoir	5	61	16	5726	?
Loveland Reservoir	9	63	170	1357	Y
Fontanillis Lake	6	66	11	8287	N
NA	6	67	6	4445	?
NA	3	68	6	54	N
Whitehorse Flat Reservoir	5	69	825	4387	?
Sage Lake	1	71	28	4577	?
NA	5	73	48	138	?
Graven Reservoir	5	75	68	5202	?
Virginia, Lake	5	77	29	10342	N
San Gabriel Reservoir	4	79	215	1455	?
NA	5	80	5	11390	N
NA	5	81	44	351	Y
NA	6	83	52	5696	N

Table 4. List of other lakes (continued).

NAME	Region	Sampling Sequence	Area (ha)	Elevation (	Sampleabl
NA	5	85	16	161	N
Hog Lake	5	87	23	4924	?
NA	5	89	6	9156	N
NA	5	90	7	-3	?
Ferguson Lake	7	91	197	191	Y
NA	5	92	11	11240	N
NA	6	93	38	6464	N
NA	5	94	6	56	N
Horseshoe Lake	5	97	41	6540	N
Brenda Reservoir	5	100	59	273	Y
NA	5	101	21	7531	N
Baseball Reservoir	1	103	63	5256	?
Sphinx Lakes	5	104	11	10517	N
NA	5	105	5	9816	N
NA	5	106	21	14	?
Evolution Lake	5	108	24	10860	N
Stump Meadow Lake	5	109	120	4264	?
Vail Lake	9	111	101	1400	Y
NA	1	113	60	4081	?
Lower Crystal Springs Reservoir	2	114	231	287	?
Mendiboure Reservoir	6	115	21	5981	?
Tamarack Lake	5	120	8	9219	N
Emeric Lake	5	121	12	9340	N
Calaveras Reservoir	2	122	608	768	?
NA	5	124	11	9533	N
Fuller Lake	5	125	26	5345	?
Lake Henne	2	126	6	1812	?
Mirror Lake	1	129	6	6609	N
Susie Lake	6	130	16	7767	N
NA	2	132	10	313	?
Crum Reservoir	5	133	11	3585	?
NA	1	135	4	4671	N
Upper Twin Lakes at Bridgeport	6	137	116	7096	Y
Upper San Leandro Reservoir	2	138	310	463	?
Graves Reservoir	5	139	22	4419	?
NA	5	140	7	9603	N
Mott Lake	5	141	7	10072	N
Ponderosa Reservoir	5	142	39	961	?
NA	5	144	11	11525	N
Hamilton Dam	5	145	6	803	?
NA	4	148	188	1518	Y
NA	1	151	56	4754	?
Hetch Hetchy Reservoir	5	153	745	3799	Y
Gene Wash Reservoir	7	155	82	737	?
Upper Indian Lake	5	156	5	10472	N
NA	5	157	4	7100	N
Soda Lake	3	160	1063	1912	?
Buckhorn Lake	5	161	8	4781	N
NA	5	164	24	258	?

Table 4. List of other lakes (continued).

NAME	Region	Sampling Sequence	Area (ha)	Elevation (	Sampleabl
Griener Reservoir	5	167	19	4819	N
NA	5	168	11	11545	N
Waugh Lake	6	169	67	9446	N
NA	5	172	19	10236	N
NA	5	173	10	1570	Y
NA	5	176	6	278	N
NA	1	177	4	4470	N
Moon Lake	5	179	1069	5518	?
NA	5	180	8	865	?
NA	5	181	6	1154	?
Juniper Lake	5	183	37	5605	N
Erin Lake	5	184	10	11647	N
Tenaya Lake	5	185	69	8152	?
Lower Blue Lake	5	186	14	1365	?
Haiwee Reservoir	6	187	443	3749	?
NA	5	188	12	12050	N
Star Lake	6	189	9	9098	N
Abbotts Lagoon	2	190	86	33	N
Cliff Lake	1	193	23	6111	N
Lake Madigan	2	194	35	1370	N
Crater Lake	5	195	10	6871	N
NA	3	196	5	295	N
Toad Lake	5	197	10	6938	?
Dry Lake	1	199	96	4143	N
NA	5	200	33	75	N
NA	5	201	60	8897	N
NA	5	202	6	59	?
Three Finger Lake	7	203	29	219	?
NA	5	204	20	11150	N
NA	6	205	5	9408	N
NA	5	206	18	62	?
Green Island Lake	5	209	5	6102	N
NA	6	211	153	5594	?
NA	4	212	7	887	?
NA	5	213	5	285	?
Whitney Reservoir	1	215	107	4687	?
NA	5	217	13	9822	N
NA	5	218	33	1	?
Vee Lake	5	220	22	11165	N
Independence Lake	6	221	276	6946	?
Upper Letts Lake	5	222	14	4484	?
NA	6	227	22	5839	N
NA	5	228	7	98	?
Lake Eleanor	5	229	417	4661	?
Goose Lake	5	231	37626	4704	Y
NA	6	232	6	12184	N
Beck Lakes	5	233	11	9806	N
NA	5	234	9	21	N
Davis Lake	5	236	45	11074	N

Table 4. List of other lakes (continued).

NAME	Region	Sampling Sequence	Area (ha)	Elevation (	Sampleabl
Horseshoe Lake	5	238	8	28	?
Glaser Lakes	1	241	13	4090	?
NA	5	244	26	105	?
Preston Reservoir	5	245	7	359	?
Holbrook Reservoir	5	247	46	5370	?
NA	5	248	5	4654	?
Iron Lakes	5	249	6	8230	N
NA	1	250	14	14	N
Salt Lake	6	251	329	1056	?
Rae Lakes	5	252	25	10541	N
Scotts Lake	6	253	10	8021	N
Lower Bucks Lake	5	254	51	5029	?
NA	5	256	171	221	?
Dead Horse Reservoir	5	259	196	5020	?
NA	5	260	18	85	?
Cecil Lake	5	261	9	10880	N
NA	5	262	13	130	?
Walnut Canyon Reservoir	8	263	16	816	Y
North Lake	6	264	5	9263	?
NA	5	265	6	522	?
Lake Hennessey	2	266	297	318	Y
NA	3	268	7	162	?
Freeway Lake	1	269	16	2709	N
Lone Pine Lake	1	271	33	4553	?
NA	5	272	53	550	N
NA	5	273	18	8808	N
NA	7	275	33	156	?
Upper Lamarck Lake	6	276	15	10922	N
NA	6	279	92	2817	Y
Wilson Lake	5	281	40	5274	?
Shugru Reservoir	6	283	11	4186	?
Malibu Lake	4	284	16	721	Y
Lake Ramona	5	285	7	45	?
South Mountain Reservoir	1	287	94	5091	?
NA	5	288	7	165	?
NA	6	289	5	6989	N
NA	5	292	5	12024	N
Lake Combie	5	293	147	1614	Y
Washington, Lake	5	294	10	11	?
NA	9	295	46	107	?
NA	1	297	362	4081	?
Briones Reservoir	2	298	232	503	?
Patterson Lake	6	299	9	9017	N
NA	5	301	17	302	?
NA	6	303	44	5291	N
NA	5	304	18	10728	N
NA	5	305	5	11519	N
Cherry Flat Reservoir	2	306	10	1701	?
High Lake	6	307	5	11485	N

Table 4. List of other lakes (continued).

NAME	Region	Sampling Sequence	Area (ha)	Elevation (	Sampleabl
Jackson Lake	5	309	21	6587	?
Amel Lake	5	310	29	1029	?
Big Laguna Lake	9	311	7	5427	N
Essex Pond	1	313	9	59	?
Half Moon Lake	6	314	9	8142	N
NA	6	315	13	4002	?
Schwan Lagoon	3	316	10	13	?
NA	5	317	16	3318	?
NA	2	318	11	43	?
Harvey Lake	1	319	7	4738	?
NA	5	320	9	80	?
NA	5	321	11	208	N
White Reservoir	5	323	11	4804	?
John's River	5	324	7	413	?
Pika Lake	5	325	8	10535	N
Thermalito Afterbay	5	326	1564	139	Y
NA	5	328	6	11268	N
Spring Creek Reservoir	5	329	38	797	?
NA	1	330	5	373	N
McCoy Flat Reservoir	6	331	576	5548	?
Fairmont Reservoir	6	332	58	3034	N
NA	5	333	10	75	?
NA	1	335	15	4660	N
NA	5	337	21	7352	N
NA	2	338	25	0	?
Payne Lake	5	340	13	11225	N
NA	6	341	9	6579	N
NA	5	342	8	54	?
NA	3	344	4	1082	?
Summit Lake	5	345	5	6678	?
Hartson Lake	6	347	197	3992	?
NA	5	349	25	7708	N
NA	5	352	7	10439	N
Sadler Lake	5	353	6	9367	N
NA	6	355	70	1892	?
NA	5	356	9	11811	N
NA	5	357	5	247	?
NA	5	358	12	12	?
NA	9	359	17	1336	N
Tule Lake	1	361	1319	4035	?
Pilarcitos Lake	2	362	39	700	?
NA	6	363	6	6016	?

Table 5. Target species and their characteristics.

	Foraging Type		Trophic Level	Distribution			
Species	Water column	Bottom feeder		Low Eleva-tion	Foothi lls	High Elevati on	Priority for Collection
Largemouth bass	X		4	**X**	**X**		**A**
Smallmouth bass	X		4	x	**X**		**A**
Spotted bass	X		4	x	**X**		**A**
Sacramento pikeminnow	X		4	x	x		B
White catfish		X	4	x	x		**A**
Brown bullhead		X	3	x			B
Channel catfish		X	4	**X**	**X**		**A**
Carp		X	3	**X**	**X**		**A**
Sacramento sucker		X	3	x	x		B
Tilapia		X	3				B
Bluegill	X		3	**X**	**X**		B
Green sunfish	X		3	**X**	**X**		B
Crappie	X		3/4	x	x		B
Redear sunfish	X		3	**X**	**X**		B
Rainbow trout	X		3/4	x	x	**X**	**A**
Brown trout	X		3		x	x	**A**
Brook trout	X		3			x	**A**
Kokanee	X		3	?	x	x	B

Trophic levels are the hierarchical strata of a food web characterized by organisms that are the same number of steps removed from the primary producers. The USEPA's 1997 Mercury Study Report to Congress used the following criteria to designate trophic levels based on an organism's feeding habits:

Trophic level 1: Phytoplankton.
Trophic level 2: Zooplankton and benthic invertebrates.
Trophic level 3: Organisms that consume zooplankton, benthic invertebrates, and TL2 organisms.
Trophic level 4: Organisms that consume trophic level 3 organisms.

X widely abundant X less widely abundant "A" primary target for collection "B" secondary target for collection

Table 6. Frequency distribution of lake sizes.

Area (ha)	Percentage
1-2	21.34
2-3	17.89
3-5	19.07
5-7	9.45
7-10	8.02
10-50	17.74
50-100	2.57
>100	3.92

Table 7. Target species, size ranges, and processing instructions.

	Process as Individuals and/or Composites	Process for Organics	Numbers and Size Ranges (mm)
Primary Targets: stay on location until one of these targets from both Group 1 and 2 is obtained			
Group 1) Predator			
Black bass	I		2X(200-249), 2X(250-304), 5X(305-407), 2X(>407)
Rainbow trout	C	X	5X(300-400)
Brown trout	C	X	5X(300-400)
Brook trout	C	X	5X(300-400)
Group 2) Bottom feeder			
White catfish	C	X	5X(229-305)
Channel catfish	C	X	5X(375-500)
Common carp	C	X	5X(450-600)
Secondary Targets: collect these if primary targets are not available			
Sacramento pikeminnow	I		3X(200-300), 3X(300-400), 3X(400-500)
Bluegill	C	X	5X(142-190)
Redear sunfish	C	X	5X(165-220)
Brown bullhead	C	X	5X(262-350)
Sacramento sucker	C	X	5X(375-500)
Black crappie	C	X	5X(187-250)
Tilapia	C	X	??
Green sunfish	C		??
Kokanee			??

Table 8. Thresholds for concern for pollutants included in the survey. Thresholds are from Klasing and Brodberg (2006), and correspond to a concentration at which OEHHA would begin to consider advising limited consumption (i.e., fewer than 8 meals per month). Exceeding these thresholds will be considered an indication of impairment.

Pollutant	**Threshold for concern (ppb)**
Methylmercury[1]	120
PCBs[2]	30
DDTs[3]	830
Dieldrin[4]	24
Chlordanes[5]	300
Selenium[6]	3,930
PBDEs	Not available

[1] Estimated by total mercury measurements in fish. Threshold for sensitive populations (i.e., women of childbearing age and children 17 and under), based on non-cancer risk and a reference dose of $1X10^{-4}$ mg/kg-day.
[2] Threshold based on non-cancer risk and a reference dose of $2X10^{-5}$ mg/kg-day.
[3] Threshold based on non-cancer risk and a reference dose of $5X10^{-4}$ mg/kg-day.
[4] Threshold based on cancer risk and a slope factor of 16 $(mg/kg/day)^{-1}$.
[5] Threshold based on cancer risk and a slope factor of 1.3 $(mg/kg/day)^{-1}$.
[6] Threshold for consumers who do not take selenium supplements in excess of the RDA, based on non-cancer risk and a reference dose of $5X10^{-3}$ mg/kg-day.

Table 9. Thresholds for triggering follow-up analysis of archived composite samples. Triggers are 75% of the threshold for concern.

Pollutant	**Threshold for follow-up analysis (ppb)**
Methylmercury[1]	90
PCBs	22
DDTs	622
Dieldrin	18
Chlordanes	225
Selenium	2,947
PBDEs	Not available

[1] Estimated by total mercury measurements in fish.

Table 10. Summary of analytes included in the study. +/- indicates whether an analyte is a priority for a given management question.

Analyte	**303(d) and 305(b) (MQs 1 and 2) (Water Boards)**	**Fish Advisories (MQ 3) (OEHHA)**	**Included in Screening Study?**
Methylmercury[1]	+	+	All samples
PCBs	+	+	Bottom-feeder only
DDTs	+	+	Bottom-feeder only
Dieldrin	+	+	Bottom-feeder only
Aldrin	+	+	Bottom-feeder only
Chlordanes	+	+	Bottom-feeder only
Selenium	+	+	Bottom-feeder only
PBDEs	+	+	Bottom-feeder only
Dioxins	+	-	Not included – low priority for OEHHA and expensive
Organophosphates	-	-	Not included – low concern in sport fish
PAHs	-	-	Not included – low concern in sport fish
TBT	-	-	Not included – low concern in sport fish

[1] Measured as total mercury.

Table 11. Parameters to be measured.

Fish Attributes
Total Length (mm)
Fork Length (mm)
Weight (g)
Moisture (%)
Lipid Content (%)
Sex
Age[1]

METALS AND METALLOIDS

Analyte	Analytical Method
Total Mercury	EPA 7374
Total Selenium	EPA 200.8

Table 11. Parameters to be measured (continued).

Organochlorine Pesticides (by EPA 8081AM using GC-ECD)	
Group	**Parameter**
Chlordanes	Chlordane, cis-
	Chlordane, trans-
	Heptachlor
	Heptachlor epoxide
	Nonachlor, cis-
	Nonachlor, trans-
	Oxychlordane
DDTs	DDD(o,p')
	DDD(p,p')
	DDE(o,p')
	DDE(p,p')
	DDMU(p,p')
	DDT(o,p')
	DDT(p,p')
Cyclodienes	Aldrin
	Dieldrin
	Endrin
HCHs	HCH, alpha
	HCH, beta
	HCH, gamma
Others	Dacthal
	Endosulfan I
	Hexachlorobenzene
	Methoxychlor
	Mirex
	Oxadiazon
	Tedion

Table 11. Parameters to be measured (continued).

Polychlorinated Biphenyl (PCB) Congeners and Arochlor Compounds (by EPA Method 8082M)	
PCB 008	PCB 141
PCB 018	PCB 146
PCB 027	PCB 149
PCB 028	PCB 151
PCB 029	PCB 153
PCB 031	PCB 156
PCB 033	PCB 157
PCB 044	PCB 158
PCB 049	PCB 169
PCB 052	PCB 170
PCB 056	PCB 174
PCB 060	PCB 177
PCB 064	PCB 180
PCB 066	PCB 183
PCB 070	PCB 187
PCB 074	PCB 189
PCB 087	PCB 194
PCB 095	PCB 195
PCB 097	PCB 198
PCB 099	PCB 199
PCB 101	PCB 200
PCB 105	PCB 201
PCB 110	PCB 203
PCB 114	PCB 206
PCB 118	PCB 209
PCB 126	**Calculated values from Lab**
PCB 128	PCB AROCLOR 1248
PCB 132	PCB AROCLOR 1254
PCB 137	PCB AROCLOR 1260
PCB 138	

Table 11. Parameters to be measured (continued).

PBDEs (these would be estimated values obtained along with PCB congeners at no additional cost without matrix spikes and lab control solutions)

Polybrominated Diphenyl Ethers (PBDEs) (by EPA Method 8082M)
PBDE 017
PBDE 028
PBDE 047
PBDE 066
PBDE 100
PBDE 099

Figure 1. Locations of the 216 popular lakes. Water Board regional boundaries also shown.

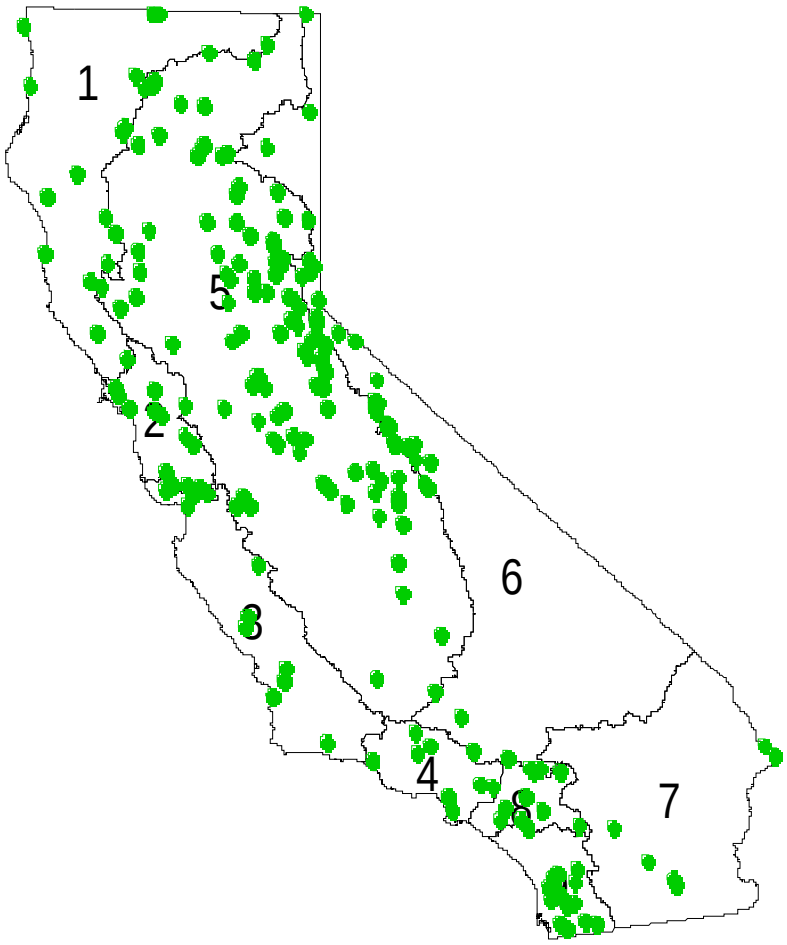


Figure 2. Inclusion probability variation with size of the lake.

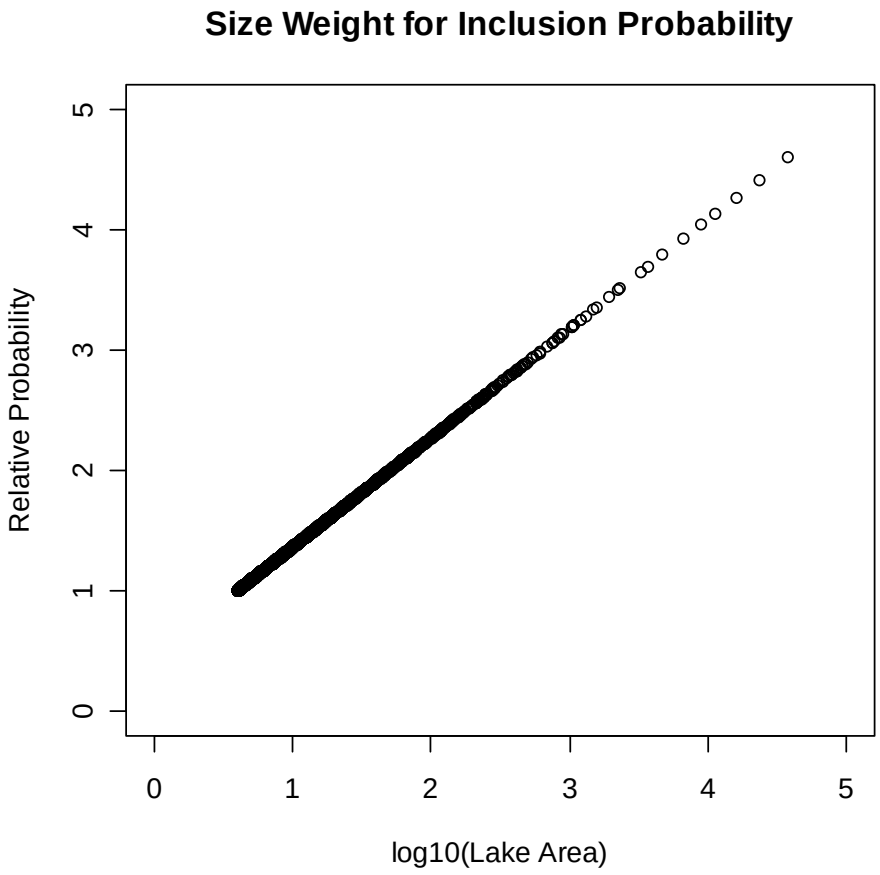


Figure 3. A representative small lake – Lake Piru in Ventura County. The area of the lake is 484 ha. The width of the lake (line shown in the figure) is 2.2 miles. One sampling location is representative of a relatively large fraction of the area of the lake, and is considered to provide an adequate sample of the lake. Diameter of circle shown is 1 mile.

Figure 4. A representative medium lake – Pardee Reservoir in Amador County. The area of the lake is 884 ha. The width of the lake is 4 miles. Two sampling locations are representative of a relatively large fraction of the area of the lake, and are considered to provide an adequate sample of the lake. Diameter of circles shown is 1 mile. Locations shown are hypothetical.

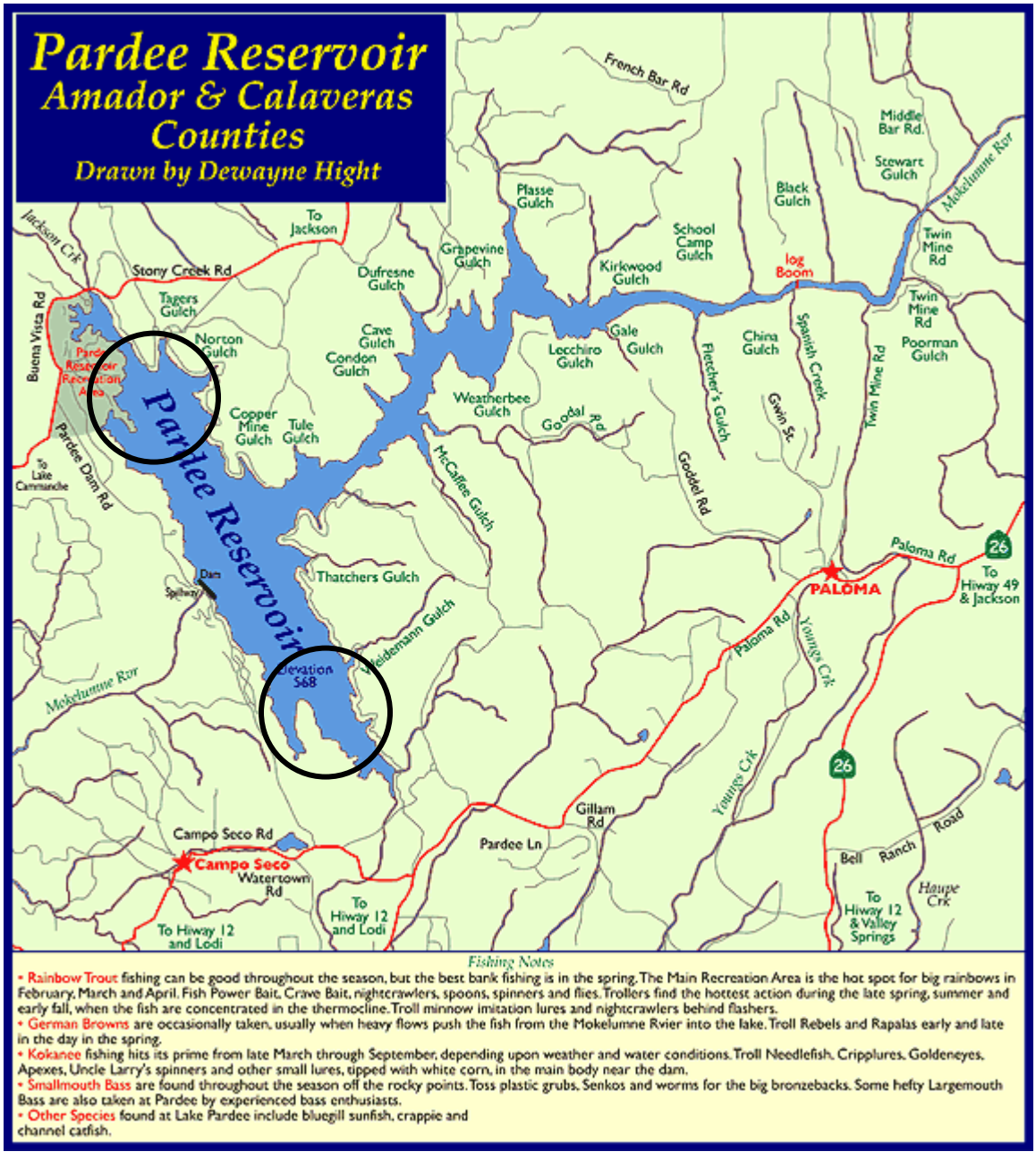


Figure 5. A representative large lake – Black Butte Lake in Tehama County. The area of the lake is 1824 ha. The width of the lake (line drawn on map) is 5 miles. Two to four sampling locations would be needed to provide an adequate sample of the lake. Diameter of circles shown is 1 mile. Locations shown are hypothetical.

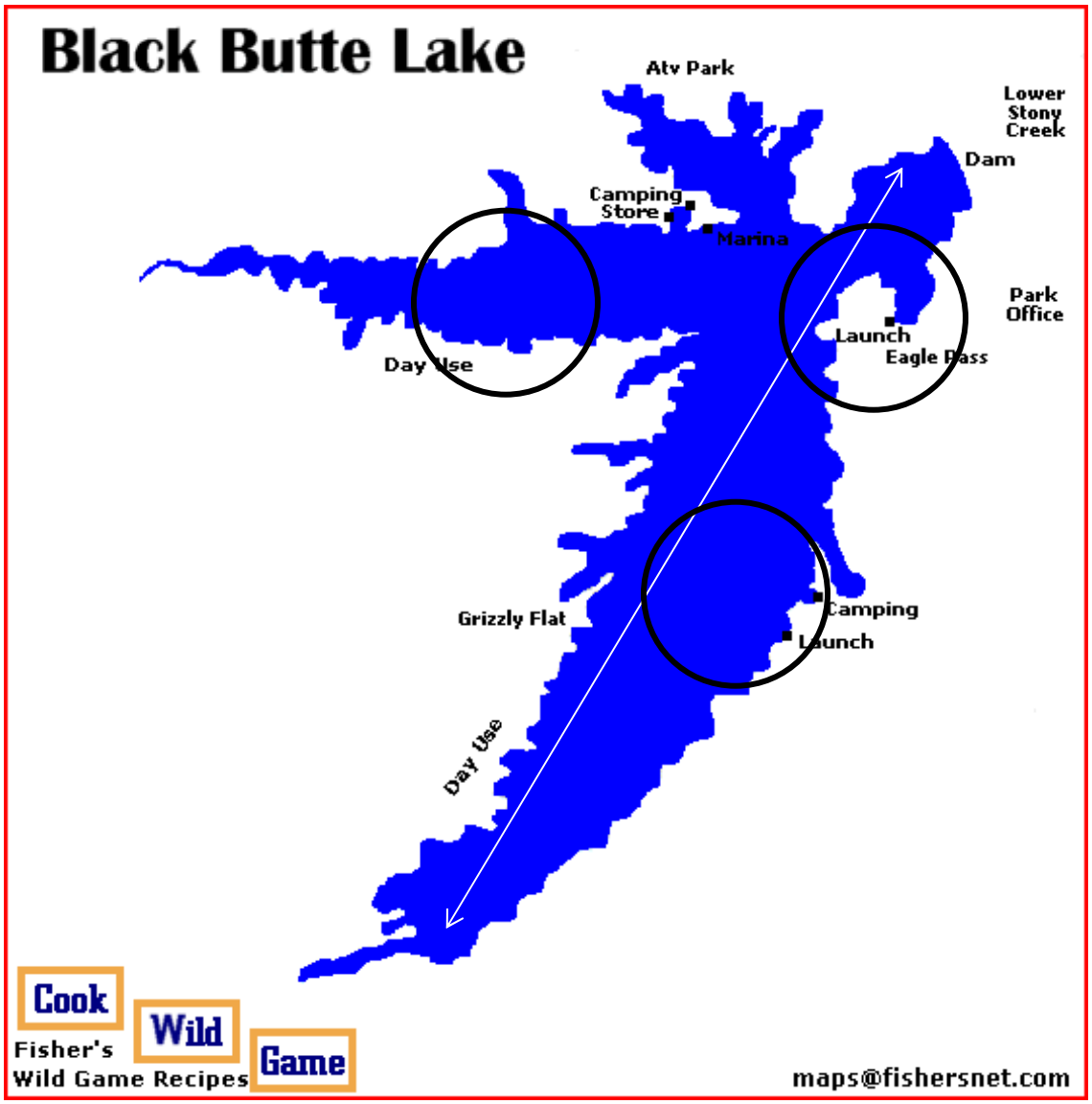


Figure 6. A representative very large lake – Lake Berryessa in Napa County. The area of the lake is 6800 ha. The width of the lake (line drawn on map) is 13 miles. Two to four sampling locations would be needed to provide an adequate sample of the lake. Diameter of circles shown is 1 mile. Locations shown are hypothetical.

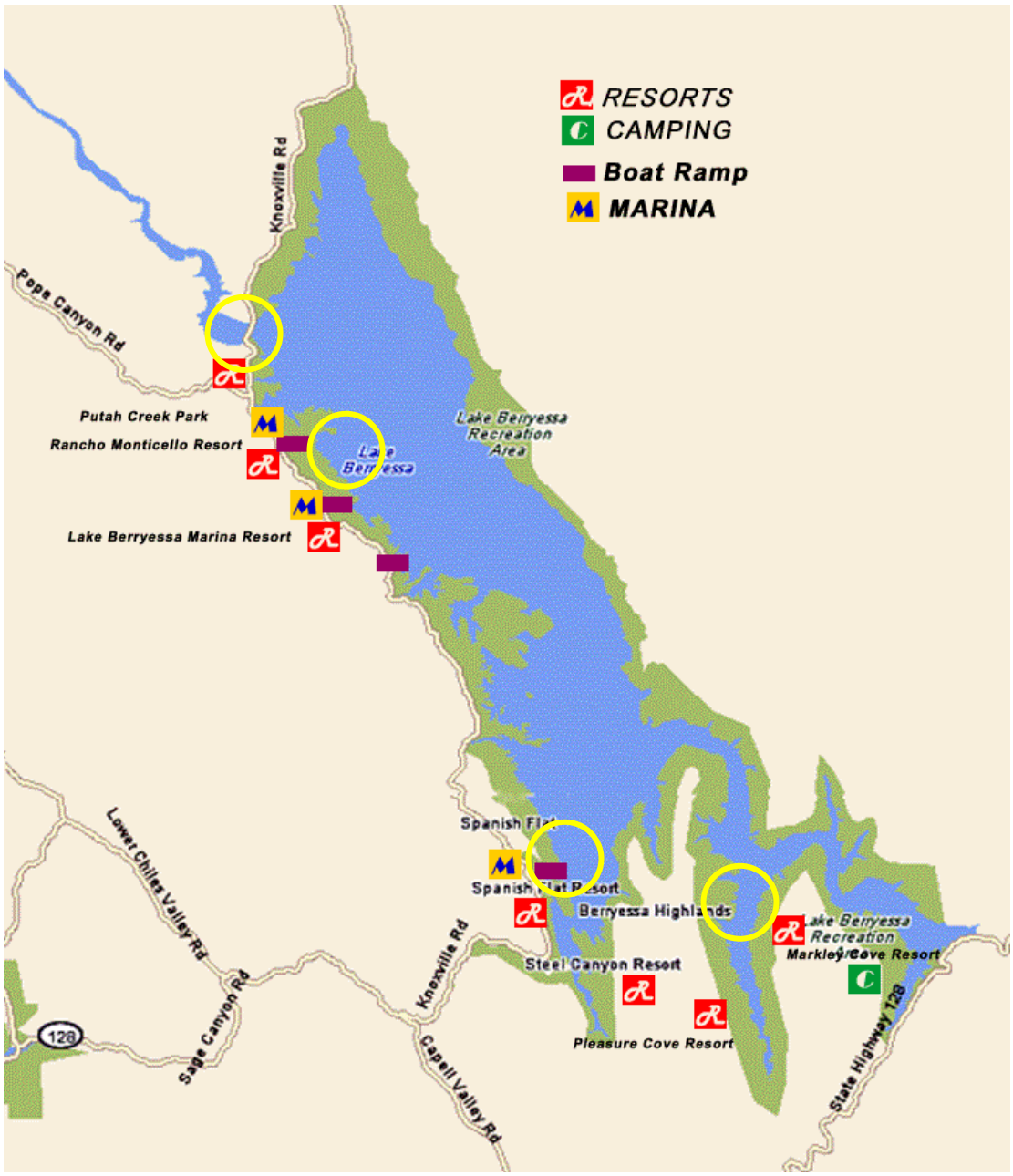


Figure 7. Sampling strategy for small lakes.

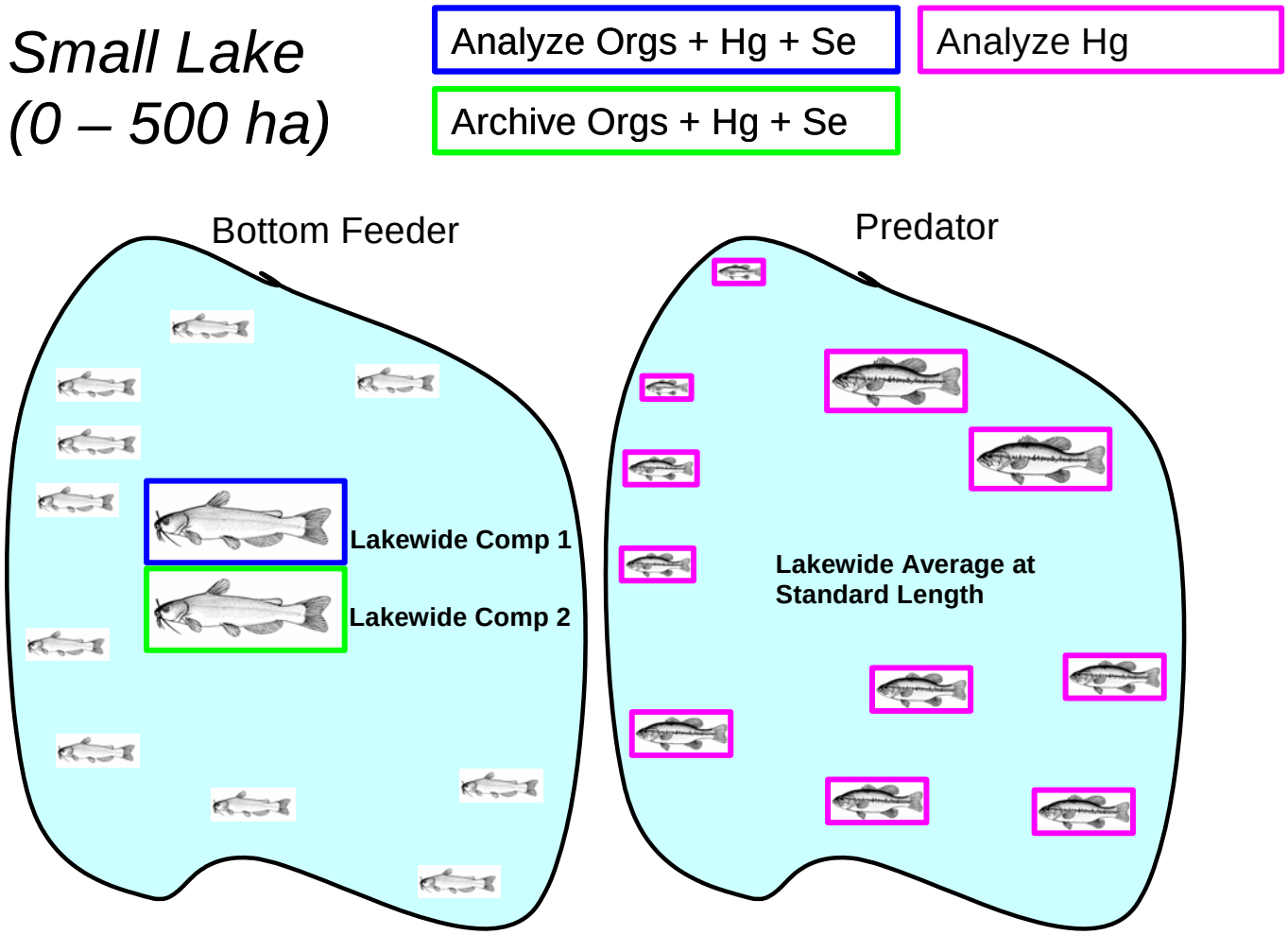


Figure 8. Sampling strategy for medium lakes.

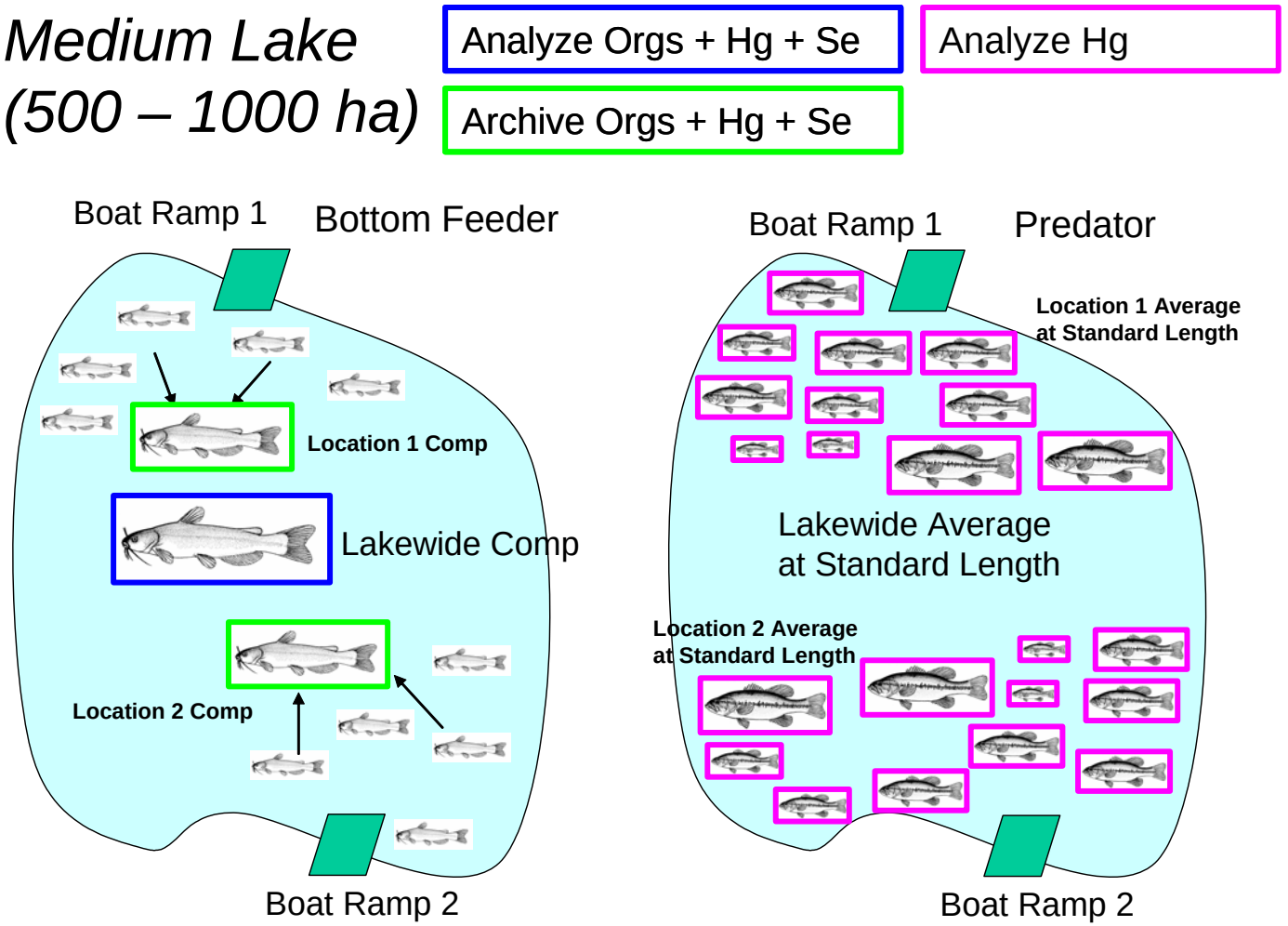


Figure 9. Sampling strategy for large lakes: bottom feeder.

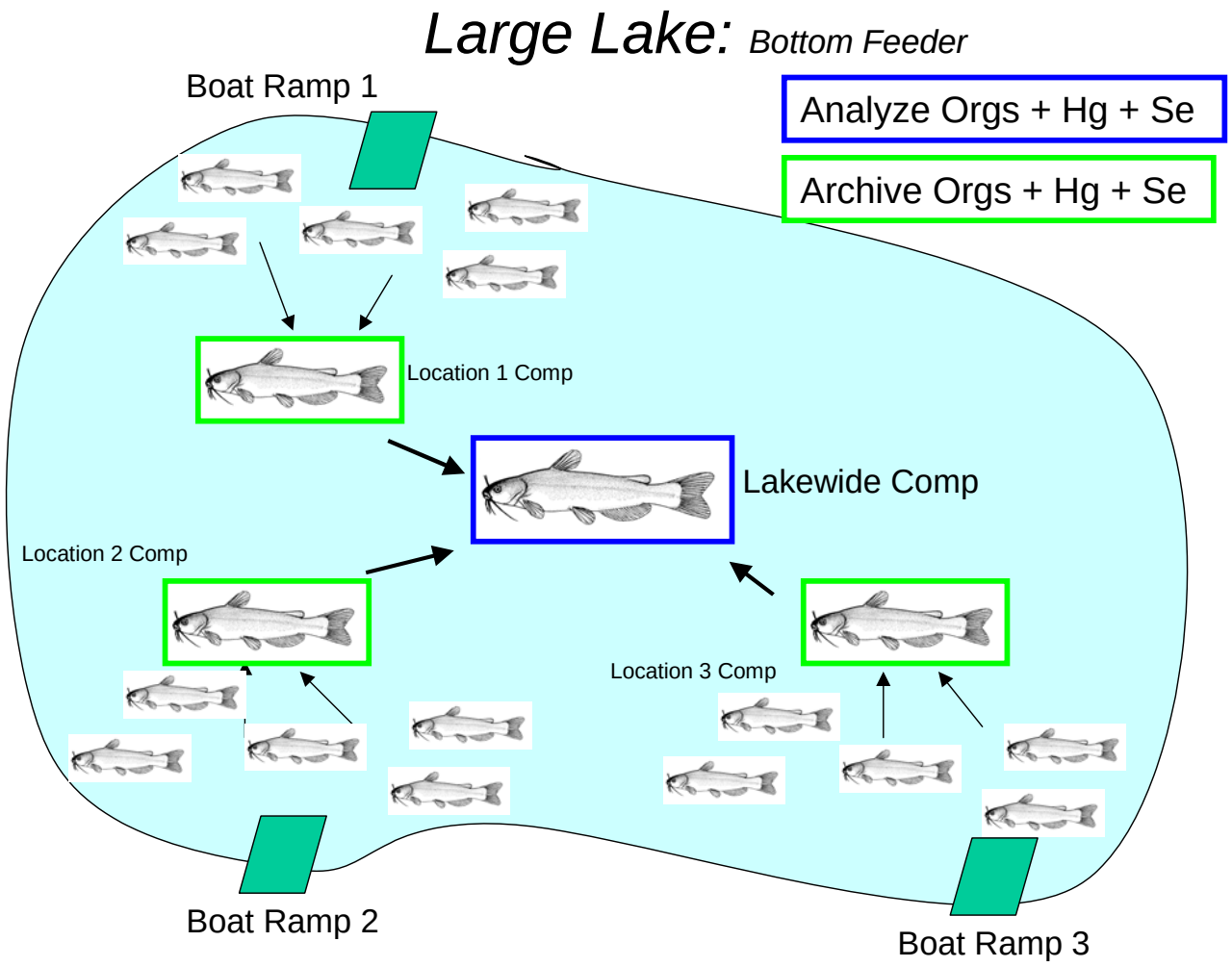


Figure 10. Sampling strategy for large lakes: predator.

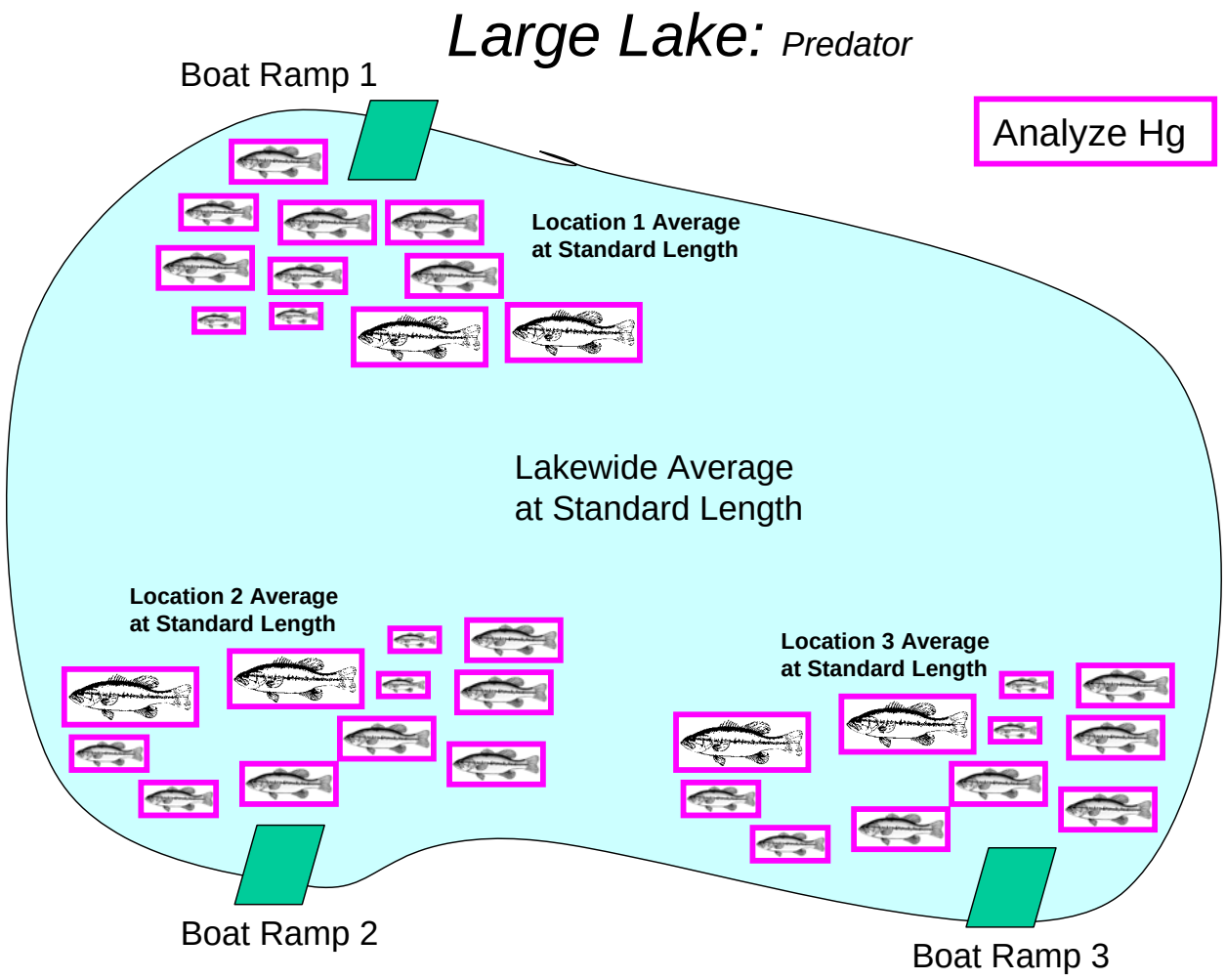


Figure 11. Target Analysis, Composite and Archive Weights for Predator and Bottom Fish
Red boxes indicate immediate analysis, black indicate archive jars. The number inside each box represents the number of individuals or archives needed per site.

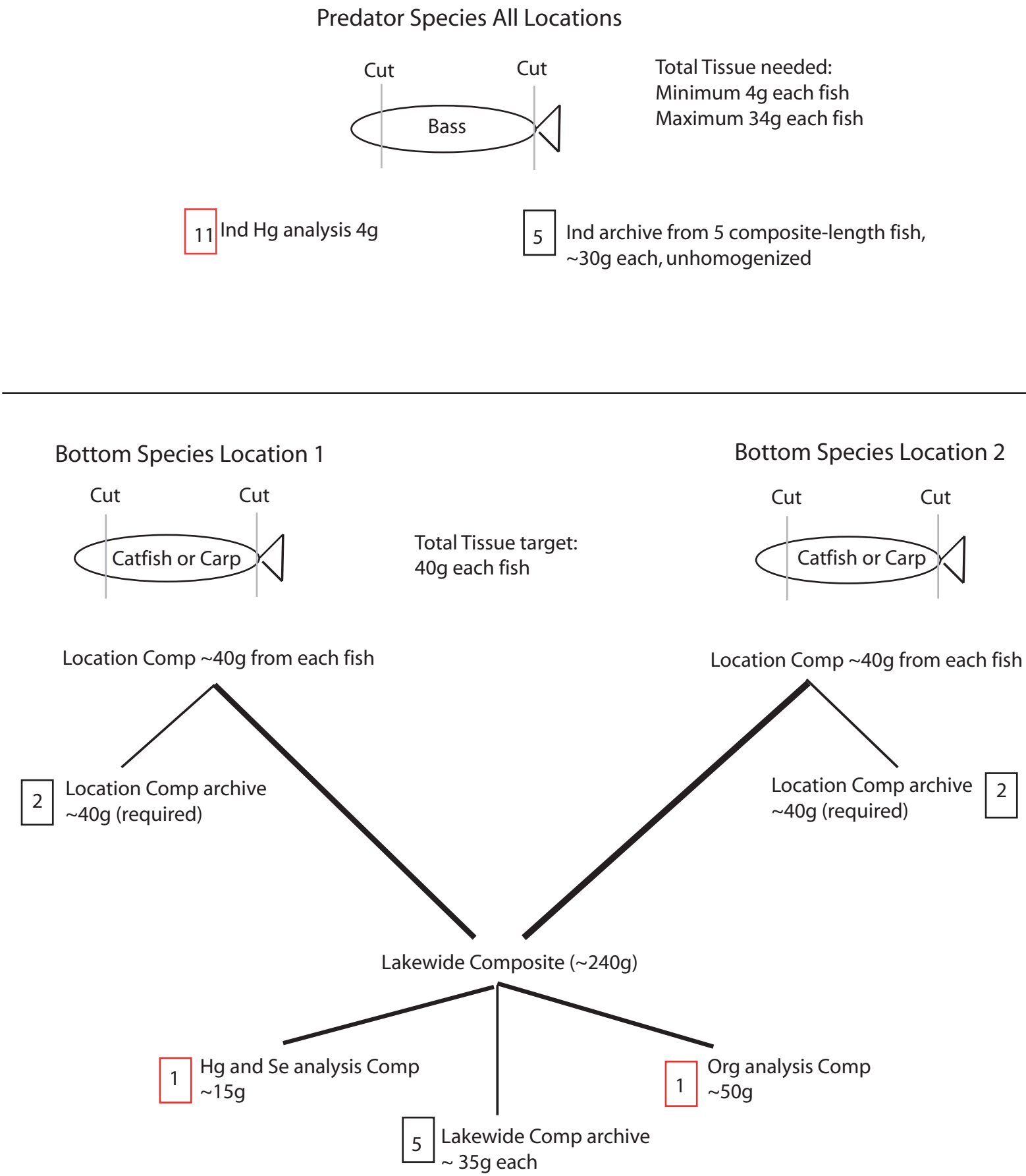
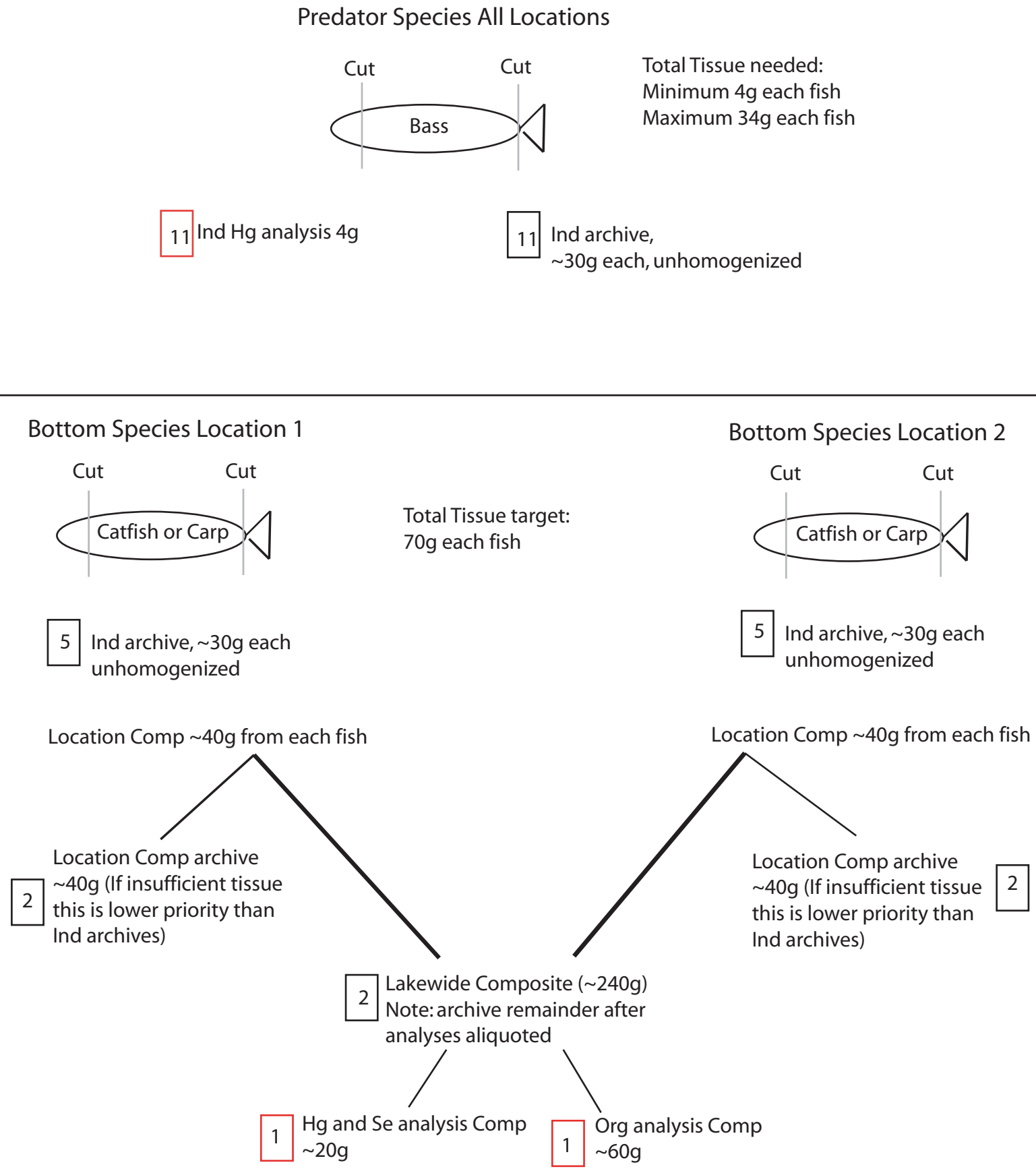


Figure 12. Target Analysis, Composite and Archive Weights for Predator and Bottom Fish at Trend Sites
Red boxes indicate immediate analysis, black indicate archive jars. The number inside each box represents the number of individuals or archives needed per site.



APPENDIX III: List of referenced MPSL-DFG SOPs

Procedure/equipment	SOP number	Revision Date
MPSL-DFG EPA Modifications and Laboratory Procedures		
Modifications to EPA 3052		Feb 2006
Protocol for Glassware and Equipment Cleaning	MPSL-101	Mar 2007
Protocol for Tissue Sample Collection and Transport	MPSL-102a Tis Collection	Mar 2007
Protocol for Sample Receiving and Storage	MPSL-104 Receipt and Check-in	Feb 2006
Protocol for Tissue Sample Preparation	MPSL-105 Tissue Preparation	Mar 2007

APPENDIX IV: List of referenced DFG-WPCL SOPs

Procedure/equipment	SOP number	Revision Date
DFG-WPCL EPA Modifications and Laboratory Procedures		
Determination of OC and PCB in Sediment and Tissue (Modifications to EPA 8081A and 8082)	SO-TISS	Mar 2005
Procedures for Disposal of Waste	WPCL Method # 49	Sept 2003
Protocol for Corrective Action Procedures		
Data Reduction		

APPENDIX V: List of referenced MPSL-MLML SOPs

Procedure/equipment	Revision Date	Link
SWAMP SOP Field Data Verification V2.1	Dec 2004	http://mpsl.mlml.calstate.edu/SWAMP_SOP_Field_Data_Verification_v2.1.pdf
SWAMP SOP Chemistry Data Verification V1.1	Dec 2004	http://mpsl.mlml.calstate.edu/SWAMP_SOP_Chemistry_Data_Verification_v1.1.pdf

ATTACHMENT 1: BOG REQUEST FOR ANALYSIS AND CHAIN OF CUSTODY (COC) RECORD MPSL-DFG

Fiscal Year:	06	**Project ID:**	06SWSBG1	Contact Person:	Autumn Bonnema
Region:		**Season:**		Phone:	831-771-4175
Field Crew:		**Date:**		email:	bonnema@mlml.calstate.edu
				Mailing Address:	7544 Sandholdt Rd. Moss Landing, CA 95039

StationCode	Station Name	LabID	Sample Date	Tissue THg	Tissue Se	Tissue SO*	Aging Otolith	# of Containers Plastic Bag	Preservation Frozen
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
			TOTAL	0	0	0	0	25	25

Comments: Please do not process until Analysis Authorization is received.
* Analysis will be performed by DFG-WPCL, dissect and send homogenate

Samples Relinquished by:		**Samples Received by:**		
Name (Print and Sign)	**Date**	**Name (Print and Sign)**		**Date**

SWAMP REQUEST FOR ANALYSIS AND CHAIN OF CUSTODY (COC) RECORD DFG-WPCL

Fiscal Year:	06	**Project ID:**	06SWSBG1	Contact Person:	Autumn Bonnema		
Region:		**Season:**		Phone:	831-771-4175		
Field Crew:		**Date:**		email:	bonnema@mlml.calstate.edu		
				Mailing Address:	7544 Sandholdt Rd. Moss Landing, CA 95039		

StationCode	Station Name	LabID	Sample Date	Tissue THg*	Tissue Se*	Tissue SO	Aging Otolith	# of Containers Plastic Bag	Preservation Frozen
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
								1	x
			TOTAL	0	0	0	0	25	25

Comments: Please do not process until Analysis Authorization is received.
* Analysis will be performed by MPSL-DFG, dissect and send homogenate

Samples Relinquished by:		**Samples Received by:**	
Name (Print and Sign)	**Date**	**Name (Print and Sign)**	**Date**

ATTACHMENT 2: BOG Field Data Sheets

SWAMP Tissue Sampling - Electroshocking and Net (Event Type = TI)				Entered in d-base (initial/date)			Pg of Pgs
***StationCode:** ___ ___ ___ ___ ___ ___ ___ ___ ___	*StationName:			*Group: Small Med Large, Ex	*Purpose Failure Code:		**Agency**
***FundingCode:** ___ ___ ___ ___ ___ ___ ___ ___	*Date (mm/dd/yyyy): / /						
*Sampling Crew:	ArrivalTime: DepartureTime:	WADEABILITY: YES / NO	BEAUFORT SCALE (see attachment):		WIND DIRECTION (from):	N W E S	**PHOTOS** (RB & LB assigned when facing downstream; RENAME to StationCode_yyyy_mm_dd_uniquecode)
WATERBODY TYPE:	Bay/Harbor ,Coastal/BayShoreline, Estuary, Lake/Reservoir, Ocean, River/Stream, Wetland						1: (RB / LB / BB / US / DS / ##)
SITE ODOR:	None,Sulfides,Sewage,Petroleum,Mixed,Other_____		PRECIPITATION:	None, Foggy, Drizzle, Rain, Snow			
DOMINANTSUBSTRATE:	Concrete,Cobble,Gravel,Sand,Mud,Other_____,unk		WATERCOLOR:	Colorless, Green, Yellow, Brown			2: (RB / LB / BB / US / DS / ##)
OBSERVED FLOW:	NA, Dry Waterbody Bed, No Observed Flow, Isolated Pool, 0.1 - 1cfs, 1 - 5 cfs, 5 - 20 cfs, 20 - 50 cfs, 50 - 200 cfs, >200cfs						
Comments:							3: (RB / LB / BB / US / DS / ##)

Tissue Collection

COLLECTION DEVICE: RV _____Masta-Blasta, Big E, Sparky , Backpack Model _____, Net (length & mesh) _____

Target:	**Lat (dd.ddddd)**		**Long (dd.ddddd)**	-	
GPS Model:	Datum: **NAD83** WGS84 Other _____		*GPS / DGPS	Elevation (ft):	

Location	*StreamDepth (m):	*StreamWidth (m):	Distance from Bank (m):		Accuracy (ft / m)	Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, Fyke net, gill net, seine, hook & line		Start Time	Coord. 1				
SAMPLE LOCATION:	Bank, Thalweg, Midchannel, Open Water, NA			Coord. 2				
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert,		End Time	Coord. 3				
HYDROMODLOC(to sample):	US / DS / NA/ WI	Other _____ Geoshape: Line Poly Point		Coord. 4				
Location	*StreamDepth (m):	*StreamWidth (m):	Distance from Bank (m):			Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, Fyke net, gill net, seine, hook & line		Start Time	Coord. 1				
SAMPLE LOCATION:	Bank, Thalweg, Midchannel, Open Water, NA			Coord. 2				
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert,		End Time	Coord. 3				
HYDROMODLOC(to sample):	US / DS / NA/ WI	Other _____ Geoshape: Line Poly Point		Coord. 4				
Location	*StreamDepth (m):	*StreamWidth (m):	Distance from Bank (m):			Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, Fyke net, gill net, seine, hook & line		Start Time	Coord. 1				
SAMPLE LOCATION:	Bank, Thalweg, Midchannel, Open Water, NA			Coord. 2				
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert,		End Time	Coord. 3				
HYDROMODLOC(to sample):	US / DS / NA/ WI	Other _____ Geoshape: Line Poly Point		Coord. 4				

Failure Codes: Dry (no water), Instrument Failure, No Access, Non-sampleable, Pre-abandoned, Other

Comments:

SWAMP Tissue Sampling - Fish Abundance

Entered in d-base (initial/date) | Pg: of Pgs

*StationCode: ___ ___ ___ ___ ___ ___ ___ ___ ___ | StationName: | Date (mm/dd/yyyy): / /

Location #	Organism ID	Tag #	Species Name/Code	Stage	FL (mm)	TL (mm)	Size Range (mm)	Weight (lb)	Weight (g)	Count	Count Est.	Sex	Anomaly	Condition
				A J SA NR								M F U L		
				A J SA NR								M F U L		
				A J SA NR								M F U L		
				A J SA NR								M F U L		
				A J SA NR								M F U L		
				A J SA NR								M F U L		
				A J SA NR								M F U L		
				A J SA NR								M F U L		
				A J SA NR								M F U L		
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				A J SA NR								M F U L		
				A J SA NR								M F U L		
				A J SA NR								M F U L		
				A J SA NR								M F U L		
				A J SA NR								M F U L		

Location #: Match fish with Location # from Tissue Collection sheet | **Organism ID:** Combine composite # and fish # (e.g., fish 1 of composite WC01 is WC01-01) to be unique | **Tag #**: Use if applicable

Species Code: Largemouth Bass (**LMB**), Smallmouth Bass (**SMB**)**,** Spotted Bass **(SPB),**Sacramento Pike Minnow **(SPM)**, Rainbow Trout **(RT),** Brown Trout **(BT),** Brook Trout **(BKT)**, White Catfish **(WC),** Carp **(CAR),** Channel Catfish **(CC)**, Brown Bullhead **(BRB)**, Sacramento Sucker **(SS)**, Redear (**RES)**, Black Crappie (**CRP**), Bluegill (**BG**), Tilapia **(TIL)**, Green Sunfish **(GRS),** Kokanee **(KOK)**

Stage: Adult (A), Juvenile (J), Subadult (SA), Not Recorded (NR) | **Count Est**: If appropriate, add < or > if count is estimated | **Condition** upon collection: Alive, Dead, NR

Anomalies: Ambicoloration (A), Albinism (B), Cloudiness (CL), Deformity-skeletal (D), Discoloration (DC), Depression (DS), Fin Erosion (F), Gill Erosion (T), Hemorrhage (H), Lesion (L), Parasite (P), Popeye (PE), Tumor (T), Ulceration (U), White Spots (W), and any combination | **Sex**:unk(**U**),taken at Lab(**L**) | **BodyLocation**: Branchial Chamber(BRC), Buccal Cavity(BC), Eyes(E), Musculoskeleton(M), Skin/Fins(SF)

Comments: Mark fish requiring further ID; **SEPARATE FISH BY LOCATION AND INDICATE LOCATION # ON LABEL**

d

Modified 06/19/07

ATTACHMENT 3: BOG Lab Data Sheets

SWAMP Lab Data Sheet - FISH	ProjectID:	PrepPres: Skin ON/OFF; Scales ON/OFF	LabID:	Pg: 1 of 2 Pgs
StationCode:	Tissue: Whole Body, Whole Body (- head, guts, tail), Fillet		Entered d-base (initial/date)	
StationName:	Homog. Method: BUCCHI POLYTRON OTHER_____		Staff: Diss. Homog.	
Species Name:	Date Diss. (mm/dd/yyyy): / /		Date Homog. (mm/dd/yyyy): / /	

#	Tissue/Bag ID	Fish #	Organism ID	Composite / Individual ID	Frk Length (mm)	Ttl Length (mm)	Whole Fish Wt (g)	Part Wt (g)	Sex	Part	Anomaly	Body Location
1									M / F / Unk	T / L / O		
2									M / F / Unk	T / L / O		
3									M / F / Unk	T / L / O		
4									M / F / Unk	T / L / O		
5									M / F / Unk	T / L / O		
6									M / F / Unk	T / L / O		
7									M / F / Unk	T / L / O		
8									M / F / Unk	T / L / O		
9									M / F / Unk	T / L / O		
10									M / F / Unk	T / L / O		
11									M / F / Unk	T / L / O		
12									M / F / Unk	T / L / O		
13									M / F / Unk	T / L / O		
14									M / F / Unk	T / L / O		
15									M / F / Unk	T / L / O		
16									M / F / Unk	T / L / O		
17									M / F / Unk	T / L / O		
18									M / F / Unk	T / L / O		
19									M / F / Unk	T / L / O		
20									M / F / Unk	T / L / O		
21									M / F / Unk	T / L / O		
22									M / F / Unk	T / L / O		
23									M / F / Unk	T / L / O		
24									M / F / Unk	T / L / O		
25									M / F / Unk	T / L / O		

OrganismID: xxxxxxxxxLLXX##YYYzz-ZZ; unique code - StationCode (xxxxxxxxx), Location (LL), Project (XX), ProjectYear (##), OrganismCode (YYY), Bag # (zz), Fish # (ZZ); ex. 203SRF101L1SW04CAR01-01

TissueID: Differentiates different parts from same fish or differentiates composited vs. individual fish

Part: Tissue (T), Liver (L), Other (O) - list in Comments

Comp/IndID: Unique code; include Agency code in the ID; e.g., 2003-1823-MLML or C031501-MLML

Anomalies: Ambicoloration (A), Albinism (B), Cloudiness (CL), Deformity-skeletal (D), Discoloration (DC), Depression (DS), Fin Erosion (F), Gill Erosion (T), Hemorrhage (H), Lesion (L), Parasite (P),

Body Locations: Branchial Chamber (BRC), Buccal Cavity (BC), Eyes (E), Musculoskeleton (M), Skin/Fins (SF) Popeye (PE), Tumor (T), Ulceration (U), White Spots (W), and any combination

Comments: Measure length to nearest 1 mm; Measure weight to nearest 0.01 g; Keep archive tissue if possible; If a duplicate is made, use DupID as identification for analysis

SWAMP Lab Data Sheet - FISH ProjectID:	PrepPres: Skin ON/OFF; Scales ON/OFF	LabID:	Pg: 1 of 2 Pgs
StationCode:	Tissue: Whole Body, Whole Body (- head, guts, tail), Fillet	Entered d-base (initial/date)	
StationName:	Homog. Method: BUCCHI POLYTRON OTHER___________	Staff: Diss.	Homog.
Species Name:	Date Diss. (mm/dd/yyyy): / /	Date Homog. (mm/dd/yyyy): / /	

CHEMISTRY JARS

Composite/Individual ID:	**Composite/Individual ID**:	**Composite/Individual ID**:
Analysis: Mercury Organics Archive	**Analysis:** Mercury Organics Archive	**Analysis:** Mercury Organics Archive
Jar Weight Full (g):	Jar Weight Full (g):	Jar Weight Full (g):
Jar Weight Empty (g):	Jar Weight Empty (g):	Jar Weight Empty (g):
Comp Tissue Wt (Jar Full - Empty; g):	Comp Tissue Wt (Jar Full - Empty; g):	Comp Tissue Wt (Jar Full - Empty; g):
Duplicate: Yes / No **DUP ID:**	**Dup**: Yes / No **DUP ID:**	**Duplicate**: Yes / No **DUP ID:**
Composite/Individual ID:	**Composite/Individual ID**:	**Composite/Individual ID**:
Analysis: Mercury Organics Archive	**Analysis:** Mercury Organics Archive	**Analysis:** Mercury Organics Archive
Jar Weight Full (g):	Jar Weight Full (g):	Jar Weight Full (g):
Jar Weight Empty (g):	Jar Weight Empty (g):	Jar Weight Empty (g):
Comp Tissue Wt (Jar Full - Empty; g):	Comp Tissue Wt (Jar Full - Empty; g):	Comp Tissue Wt (Jar Full - Empty; g):
Duplicate: Yes / No **DUP ID:**	**Dup**: Yes / No **DUP ID:**	**Duplicate**: Yes / No **DUP ID:**
Composite/Individual ID:	**Composite/Individual ID**:	**Composite/Individual ID**:
Analysis: Mercury Organics Archive	**Analysis:** Mercury Organics Archive	**Analysis:** Mercury Organics Archive
Jar Weight Full (g):	Jar Weight Full (g):	Jar Weight Full (g):
Jar Weight Empty (g):	Jar Weight Empty (g):	Jar Weight Empty (g):
Comp Tissue Wt (Jar Full - Empty; g):	Comp Tissue Wt (Jar Full - Empty; g):	Comp Tissue Wt (Jar Full - Empty; g):
Duplicate: Yes / No **DUP ID:**	**Dup**: Yes / No **DUP ID:**	**Duplicate**: Yes / No **DUP ID:**
Composite/Individual ID:	**Composite/Individual ID**:	**Composite/Individual ID**:
Analysis: Mercury Organics Archive	**Analysis:** Mercury Organics Archive	**Analysis:** Mercury Organics Archive
Jar Weight Full (g):	Jar Weight Full (g):	Jar Weight Full (g):
Jar Weight Empty (g):	Jar Weight Empty (g):	Jar Weight Empty (g):
Comp Tissue Wt (Jar Full - Empty; g):	Comp Tissue Wt (Jar Full - Empty; g):	Comp Tissue Wt (Jar Full - Empty; g):
Duplicate: Yes / No **DUP ID:**	**Dup**: Yes / No **DUP ID:**	**Duplicate**: Yes / No **DUP ID:**
Composite/Individual ID:	**Composite/Individual ID**:	**Composite/Individual ID**:
Analysis: Mercury Organics Archive	**Analysis:** Mercury Organics Archive	**Analysis:** Mercury Organics Archive
Jar Weight Full (g):	Jar Weight Full (g):	Jar Weight Full (g):
Jar Weight Empty (g):	Jar Weight Empty (g):	Jar Weight Empty (g):
Comp Tissue Wt (Jar Full - Empty; g):	Comp Tissue Wt (Jar Full - Empty; g):	Comp Tissue Wt (Jar Full - Empty; g):
Duplicate: Yes / No **DUP ID:**	**Dup**: Yes / No **DUP ID:**	**Duplicate**: Yes / No **DUP ID:**

Comments: Keep archive tissue if possible; If a duplicate is made, use Dup ID as identification for analysis

f

ATTACHMENT 4: BOG Sample Authorization Form

MPSL-DFG

Analysis Authorization
Fiscal Year: 0607
Region:

Project ID: SWAMP_SB_BOG
Season:
Date:

Contact Person: Autumn Bonnema
Phone: 831-771-4175
email: bonnema@mlml.calstate.edu
Mailing Address:

Dissect and Analyze									Dissect and Send to WPCL							
Station	SpeciesCode	CompositeIDText	Tissue Flesh Hg	Tissue Flesh Comp Hg	Tissue Flesh Comp Se	Tissue Flesh %Moisture	Weight/Sex	Otolith Age	Tissue Flesh OC	Tissue Flesh PCB	Tissue Flesh PBDE	Tissue Flesh %Moisture	Tissue Flesh %Lipid	Archive Individuals	Archive Location Comp	Archive Lakewide Comp
Total			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

DFG-WPCL

Analysis Authorization **Project ID:** SWAMP_SB_BOG
Fiscal Year: 0607 **Season:**
Region: **Date:**

Contact Person: Autumn Bonnema
Phone: 831-771-4175
email: bonnema@mlml.calstate.edu
Mailing Address:

			Dissect and Analyze					
Station	Species	CompositeIDText	Tissue Flesh OC	Tissue Flesh PCB	Tissue Flesh PBDE	Tissue Flesh %Moisture	Tissue Flesh %Lipid	Otolith Extraction
Total			**0**	**0**	**0**	**0**	**0**	**0**

Dissect and Send to MPSL					
Tissue Flesh Ind Hg	Tissue Flesh Comp Hg	Tissue Flesh Comp Se	Archive Individuals	Archive Location Comp	Archive Lakewide Comp
0	**0**	**0**	**0**	**0**	**0**

ATTACHMENT 5: WPCL Data Validation, Verification, Calibration and Corrective Action Forms

CALIBRATION

C ICAL or ICAL Summary & ICV/CCV included
C ICAL, ICV/CCV criteria met
C Standards labeled or correctly identified by data system
C Tune criteria met and copy included (GCMS only)

QAQC VERIFICATION

C Method blank and LCS frequencies were met
C LCS and MB copies are included if applicable
C LCS and Mb data are within control limits
C SRM data complete
C SRM data within control limits
C MS/MSD data complete if applicable
C MS/MSD data within control limits
C Precision results within control limits
C Holding times were met
C All samples within tune time (GCMS only)
C If the batch QC data did not meet criteria, appropriate
comments were made

SAMPLE ANALYSIS

C Logbooks/Prep bench sheets are properly filled out
C Manual integrations are reviewed
C All raw data is included
C All analytes are reported correctly
C Correct reporting limits were used
C Surrogate recovery data complete
C Surrogate recovery data within control limits
C Spectra are present for all positive analytes (GCMS only)

LIMS

C Results were entered into LIMS correctly
C The prepared and analytical dates was correct
C The correct MB/DCS/LCS data were entered
C The correct footnotes were used
C The data sheets are complete and included
C Method blanks are included with correct prep and analyzed dates
C Anomalies are written and entered

SIGNATURES BELOW INDICATE THE ABOVE CRITERIA HAVE BEEN MET

CHEMIST _____ DATE _____

REVIEWER _____ DATE _____

SEE ELECTRONIC ANOMALY: _____

NO ANOMALIES: _____

COMMENTS

Summary Information

Name of Reviewer: D. Crane Title: Lab Director
Bench Sheet Numbers: _____ Samples Received: _____

Required Samples		Sample Results Provided	
Sample Location or Sample ID	Analyte(s)	Sample Location or Sample ID	Analyte(s)

Pesticide Data Inspection Checklist

1. Extraction Method Used / Extraction Completion Date(s):

2. Number of Samples Analyzed:

3. Number of concentrations levels used for instrument calibration:

4. Total No. of CCVs Required: C Total No. of CCVs Reported: C
   (One for each 10-15 analyses)

5. Total No. of CCBs Required: C Total No. of CCBs Reported: C
   (One for each CCV)

6. Total No. of Field Blanks Required: C Total No. of Field Blanks Reported: C
   (One per site or per 10 samples, whichever is more frequent)

7. Total No. of Method Blanks Required: C Total No. of Method Blanks Reported: C
   (One per batch)

8. Total No. of SRM analyses Required: C Total No. of SRM Analyses Reported: C
   (One per batch)

9. Total No. of MS/D samples Required: C Total No. of MS/D samples Reported: C
   (One MS/MSD per batch)

10. Total No. sample Duplicates Required C Total No. of sample Dup Reported: C
    (One per 20 samples)

11. Initial Calibration

    a. Was a multiple point initial calibration performed*? Yes No

    b. Were all sample concentrations reported within the calibration range? Yes No

    c. If no, list method and analytes for which initial calibration was not performed or which exceeded the calibration range.

Analyte	No ICAL (Y/N)	Exceeded ICAL Range (Y/N)

    d. Did the initial calibration meet acceptance criteria? $R^2 \geq 0.995$ Yes No

*A three point (minimum) initial calibration should be performed for each Analyte; the RSD of the RFs of calibration standards ≤ 20%.

12. Method Detection Limit (MDL)/Minimum Level (ML)

a. Did the laboratory demonstrate their ability to achieve the required MDL? Yes No

b. Did the initial calibration range encompass the ML? Yes No

c. Were all field samples detected below the ML reported as non-detects? Yes No

d. If the answer to item a, b, or c above was Ano@, describe problem:

13. Initial Calibration Verification (ICV) Initial Calibration Blanks (ICB):

a. Was an ICV run prior to field samples? Yes No

b. Were ICV results within the specified windows? (75-125% Rec) Yes No

c. Was the ICV followed by an ICB? Yes No

d. Was the ICB free from contamination? Yes No

e. If any item in a-d above was answered Ano@, list problems below:

Analyte	Failed ICV Recovery	Concentration Detected in ICB	Affected Samples

14. Continuing Calibration Verification (CCV)/Continuing Calibration Blank (CCB)

a. Were CCVs run prior to each batch of 10-15 analyses on each instrument? Yes No

b. Were all CCV results within the specified windows@ (75-125% Rec) Yes No

c. Was each CCV followed by a CCB? Yes No

d. Was each CCB free from contamination? Yes No

e. If any item in a-d above was answered "no," list problems below:

Analyte	Affected Samples	Shifting Missing CCV/CCB	Failed CCV/CCB ID

15. Laboratory (Method) Blanks

a. Was a method blank analyzed for each instrument & sample batch? Yes No

b. Was each method blank demonstrated to be free from contamination? (<RL) Yes No

c. Were equipment blanks demonstrated to be free from contamination? Yes No

d. If the answer to item a or b was ”no“, document problems below:

Analyte	Affected Samples	Blank Concentration Reported	Shift Missing MB

16. Field Blanks

a. Was a field blank analyzed for each 10 samples per site? Yes No

b. Was each field blank demonstrated to be free from contamination? <RL Yes No

c. If the answer to item a or b was ”no,” document problems below:

Analyte	Affected Samples	Blank Concentration Reported	Shift Missing FB

17. SRM Results

a. Was appropriate SRM analyzed? Yes No

b. Were SRM recoveries within specified windows? (70-130% of 95% CI) Yes No

c. Was appropriate corrective action employed on affected samples? Yes No

d. If the answer was ”no,” to items a-d above, document affected samples:

Analyte	SRM % R	SRM % R	Affected Samples

18. MS/MSD Results

a. Were appropriate number of MS/MSD pairs analyzed? Yes No

b. Were all MS/MSD recoveries within specified windows? (∃50% Rec) Yes No

c. Were all RPDs within the specified window? (RPD # 50%) Yes No

d. Was appropriate corrective action employed on affected samples? Yes No

e. If the answer was ”no,” to items a-d above, document affected samples:

Analyte	MS % R	MSD % R	MS/MSD RPD	Affected Samples

19. Surrogate Recoveries

a. Were appropriate surrogates analyzed? Yes No

b. Were all surrogate recoveries within specified windows? (≥50% Rec) Yes No

c. Were all target analyte concentrations corrected for surrogate recovery? Yes No

d. Was appropriate corrective action employed on affected samples? Yes No

e. If the answer was ”no“ to items a-d above, document affected samples:

Surrogate	Surrogate % R	Affected Samples

Pesticide Data Inspection Checklist

20. Duplicate Sample Precision

a. Did duplicate sample analyses demonstrate acceptable precision? RPD ≥ 50% Yes No

b. Did field duplicate demonstrate acceptable precision? Yes No

c. If the answer was ”no,” to items a-d above, document affected samples:

Analyte	Sample	Sample Dup.	RPD	Affected Samples

21. Narrative

Corrective Action Taken?

22. Corrective Action Taken

PCB Data Inspection Checklist

1. Extraction Method Used / Extraction Completion Date(s):

2. Number of Samples Analyzed:

3. Number of concentrations levels used for instrument calibration:

4. Total No. of CCVs Required: C Total No. of CCVs Reported: C
   (One for each 10-15 analyses)

5. Total No. of CCBs Required: C Total No. of CCBs Reported: C
   (One for each CCV)

6. Total No. of Field Blanks Required: C Total No. of Field Blanks Reported: C
   (One per site or per 10 samples, whichever is more frequent)

7. Total No. of Method Blanks Required: C Total No. of Method Blanks Reported: C
   (One per batch)

8. Total No. of SRM analyses Required: C Total No. of SRM Analyses Reported: C
   (One per batch)

9. Total No. of MS/D samples Required: C Total No. of MS/D samples Reported: C
   (One MS/MSD per batch)

10. Total No. sample Duplicates Required C Total No. of sample Dup Reported: C
    (One per 20 samples)

11. Initial Calibration

    a. Was a multiple point initial calibration performed*? Yes No

    b. Were all sample concentrations reported within the calibration range? Yes No

    c. If no, list method and analytes for which initial calibration was not performed or which exceeded the calibration range.

Analyte	No ICAL (Y/N)	Exceeded ICAL Range (Y/N)

    d. Did the initial calibration meet acceptance criteria? $R^2 \geq 0.995$ Yes No

*A three point (minimum) initial calibration should be performed for each Analyte; the RSD of the RFs of calibration standards ≤ 20%.

PCB Data Inspection Checklist

12. Method Detection Limit (MDL)/Minimum Level (ML)

a. Did the laboratory demonstrate their ability to achieve the required MDL? Yes No

b. Did the initial calibration range encompass the ML? Yes No

c. Were all field samples detected below the ML reported as non-detects? Yes No

d. If the answer to item a, b, or c above was Ano@, describe problem:

13. Initial Calibration Verification (ICV) Initial Calibration Blanks (ICB):

a. Was an ICV run prior to field samples? Yes No

b. Were ICV results within the specified windows? (75-125% Rec) Yes No

c. Was the ICV followed by an ICB? Yes No

d. Was the ICB free from contamination? Yes No

e. If any item in a-d above was answered ”no”, list problems below:

Analyte	Failed ICV Recovery	Concentration Detected in ICB	Affected Samples

14. Continuing Calibration Verification (CCV)/Continuing Calibration Blank (CCB)

a. Were CCVs run prior to each batch of 10-15 samples on each instrument? Yes No

b. Were all CCV results within the specified windows@ (75-125% Rec) Yes No

c. Was each CCV followed by a CCB? Yes No

d. Was each CCB free from contamination? Yes No

e. If any item in a-d above was answered ”no,” list problems below:

Analyte	Affected Samples	Shifting Missing CCV/CCB	Failed CCV/CCB ID

PCB Data Inspection Checklist

15. Laboratory (Method) Blanks

a. Was a method blank analyzed for each instrument & sample batch? Yes No

b. Was each method blank demonstrated to be free from contamination? (<RL) Yes No

c. Were equipment blanks demonstrated to be free from contamination? Yes No

d. If the answer to item a or b was ”no,” document problems below:

Analyte	Affected Samples	Blank Concentration Reported	Shift Missing MB

16. Field Blanks

a. Was a field blank analyzed for each 10 samples per site? Yes No

b. Was each field blank demonstrated to be free from contamination? <RL Yes No

c. If the answer to item a or b was ”no,” document problems below:

Analyte	Affected Samples	Blank Concentration Reported	Shift Missing FB

17. SRM Results

a. Was appropriate SRM analyzed? Yes No

b. Were SRM recoveries within specified windows? (70-130% of 95% CI) Yes No

c. Was appropriate corrective action employed on affected samples? Yes No

d. If the answer was ”no,” to items a-d above, document affected samples:

Analyte	SRM % R	SRM % R	Affected Samples

PCB Data Inspection Checklist

18. MS/MSD Results

a. Were appropriate number of MS/MSD pairs analyzed? Yes No

b. Were all MS/MSD recoveries within specified windows? (≥50% Rec) Yes No

c. Were all RPDs within the specified window? (RPD ≤ 50%) Yes No

d. Was appropriate corrective action employed on affected samples? Yes No

e. If the answer was ”no,” to items a-d above, document affected samples:

Analyte	MS % R	MSD % R	MS/MSD RPD	Affected Samples

19. Surrogate Recoveries

a. Were appropriate surrogates analyzed? Yes No

b. Were all surrogate recoveries within specified windows? (≥50% Rec) Yes No

c. Were all target analyte concentrations corrected for surrogate recovery? Yes No

d. Was appropriate corrective action employed on affected samples? Yes No

e. If the answer was ”no,” to items a-d above, document affected samples:

Surrogate	Surrogate % R	Affected Samples

20. Duplicate Sample Precision

a. Did duplicate sample analyses demonstrate acceptable precision? RPD ≤ 50% Yes No

b. Did field duplicate demonstrate acceptable precision? Yes No

c. If the answer was ”no,” to items a-d above, document affected samples:

Analyte	Sample	Sample Dup.	RPD	Affected Samples

21. Narrative

Corrective Action Taken?

22. Corrective Action Taken