

**Cruise Report for the
Surface Waters Ambient Monitoring Program (SWAMP)
Bioaccumulation of Mercury in
Small Prey Fish in Lakes of California to
Assess Biomagnification Factors in Grebes**

Sampling Dates: May 2012- September 2012

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Updated: February, 2013**

1.0 Introduction

This report describes the first year sampling activities of a two year study of small prey fish species in lakes of California. Because many fish-eating wildlife such as grebes, terns, cormorants, and mergansers eat fish smaller than those that were sampled previously by BOG, and since fish mercury concentrations are not always indicative of wildlife exposure to mercury, the current BOG surveys do not address whether wildlife beneficial uses may be impaired by mercury in these water bodies.

The plan is to sample birds and small prey fish over two consecutive field seasons in 2012 and 2013 in collaboration with the United States Geological Society (USGS). In 2012 USGS will sample grebes at 12 lakes immediately followed by CDFG/MPSL sampling the small prey fish. Collection is to take place during the breeding season when birds are particularly vulnerable to potential mercury-induced reproductive impairment. Using these data, we will relate mercury levels in breeding grebes to small prey fish and estimate a biomagnification factor for wildlife. The development of this relationship will address whether the biomagnification factor is an appropriate indicator of wildlife exposure to mercury. Also, we will address whether the biomagnification factor can be applied state wide or do we need to incorporate the type of water body and/or geographic region. Specifically, we have three main objectives:

- 1) Sample grebes at 24 California lakes (over two years) to determine mercury levels in a species near the top of the food chain, and compare these data to known effects-thresholds for birds.
- 2) Simultaneously with grebe sampling, collect small fish (<100 mm) at these same 24 lakes to determine if mercury concentrations are above current wildlife diet objectives.
- 3) Use these data in Objectives 1 and 2 to calculate a bird biomagnification factor, evaluate the biomagnification factor's usefulness for estimating wildlife exposure, and assess whether the biomagnification factor differs by lake type or geographic region.

Additionally, one predator fish species will be collected for follow-up mercury analysis. These lakes have previously been sampled by BOG for predator fish species and mercury analysis during the 2007 and 2008 sampling seasons. Confirmation of tissue concentrations or trends can be assessed with this additional mercury data.

The State Water Quality Control Board (SWQCB) work was authorized via FY 11-12 in support of Work Order 11SWBG01.

1.0 Cruise Report

1.1 Objectives

Year one's objectives were to collect small (<100mm) prey fish samples within two weeks of USGS's grebe sampling in 12 California lakes. Up to five different prey species were collected in each lake to attempt to find a common species within the 12 lakes. Due to budget constraints, twenty individual fish from two species were analyzed for mercury at each lake. An additional, 10 predator fish were collected for mercury analysis at each lake. The fish tissue was analyzed as directed by BOG and SWQCB in Work Order No. 11SWBG01 (see Section 1.3 below). Sample sites were reached by boating and fish were collected by electro-shocking and by nets.

1.2 Sampling personnel

Dylan Service	MPSL/CDFG	Crew Lead
Gary Ichikawa	MPSL/CDFG	Crew Lead
Sean Goetzl	MPSL/CDFG	Research Tech
Edward Parras	MPSL/CDFG	Research Tech

1.3 Authorization to collect samples

All sampling personnel are MPSL staff (through San Jose State University Foundation and the California Department of Fish and Game) contracted through CDFG to conduct the sample collection activities listed herein. The funding and authorization to collect the samples described herein is contained in the State Water Resources Control Board (SWRCB) Work Order 11SWBG01, including the description of the number samples and species necessary to be collected at each lake.

1.4 Station reconnaissance and selection

USGS conducted the pre-sample collection reconnaissance activities by locating breeding grebes. Breeding grebe lakes were determined from local knowledge and desktop reconnaissance. BOG and SWQCB authorized all lakes for bird/fish collection and for mercury analyses as set forth in the Work Order 11SWBG01.

1.5 Summary of types of samples authorized to be collected

Up to five species of prey fish were collected to attempt to find a common prey species at all the lakes. For better biomagnification estimates, the prey fish collections were attempted within two weeks of the grebe collections. Additionally, one predator fish species were collected for follow-up mercury analysis.

Physical parameters were collected for each individual fish, which included: weight, total length, fork length, standard length and presence of any abnormalities. Each fish was placed in an individually labeled zipper-closure bag and stored on dry ice for the duration of the trip. At the MPSL/DFG lab, samples were stored in a freezer until they were processed for authorized analysis, per appropriate SOP's. Analysis authorization dictates tissue analysis (QA/QC requirements-preservatives, dissecting, cooling, etc.). For more detailed information reference section "E 1." of the BOG Grebe Study QAPP.

1.6 Discussion

The absence of grebes, bad weather, equipment malfunctions and scheduling difficulties were problems encountered during prey fish sampling. Due to the above mentioned issues, fifteen lakes were sampled for prey fish. At three of the lakes, prey fish were collected but grebes were scarce and not collected. Still the samples were collected for 12 lakes for biomagnification estimates.

1.7 Results

Prey fish samples were collected for the twelve lakes authorized.

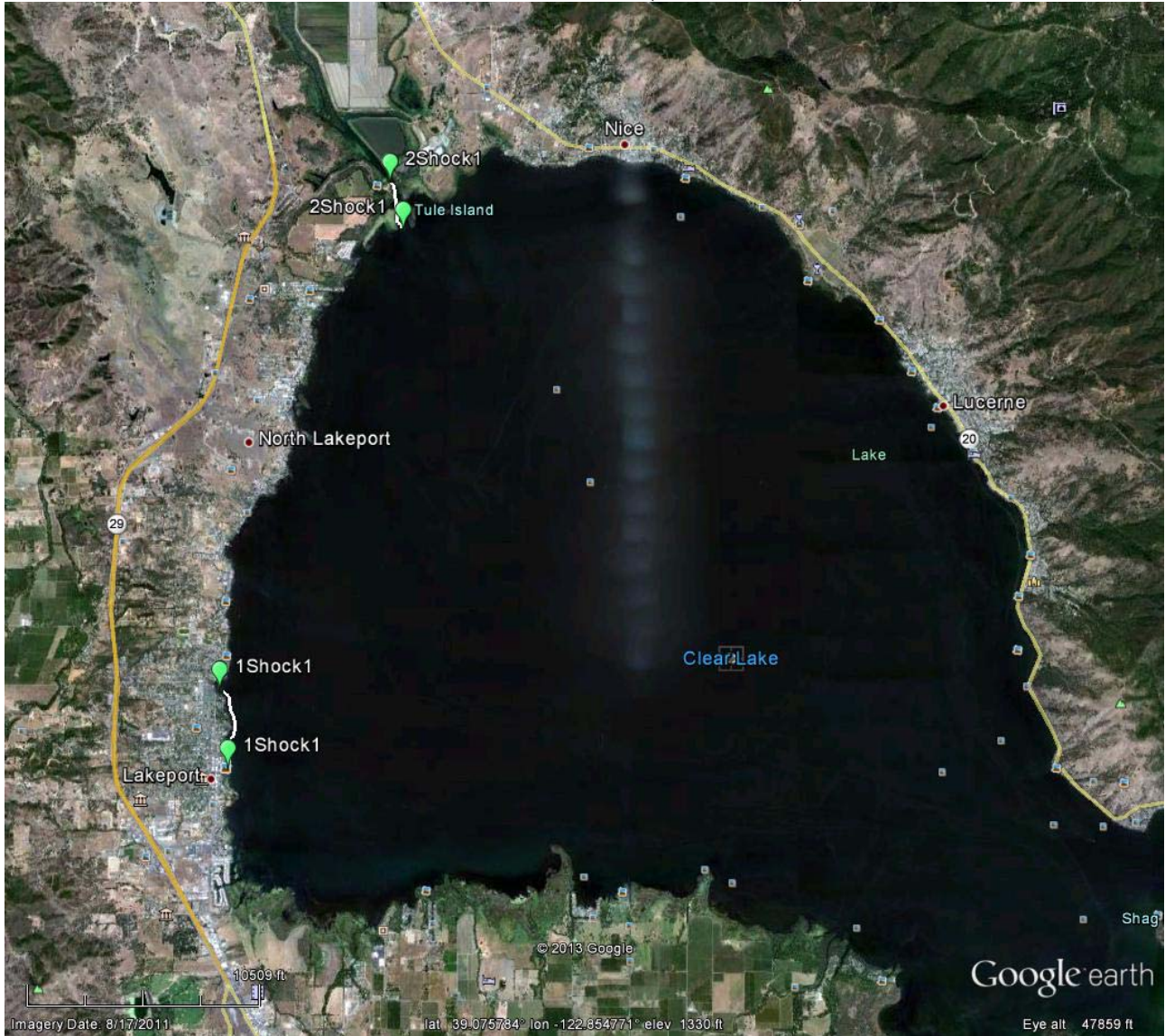
1.8 Description of Sample Collection Stations

Multiple CDFG/MPSL teams sampled the twelve authorized lakes. Descriptions and maps of sample collection for all lakes and species sampled are linked to Table 1.8.1 below.

1.8.1 Table of Contents for Prey Fish Lakes

<u>Lake Name</u>	<u>Page Number</u>
Clear Lake (513PCL173)	4
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Tule Lake (105TTO361)	28
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2012 BOG Clear Lake (513PCL173)



Latitude: 39.04420

Longitude: -122.91309

Collection Method: Electrofisher boat

Date (s) of Collection: May 30, 2012

Samplers: Gary Ichikawa and Dylan Service

Prey Fish caught: Location 1: Bluegill Sunfish										
TL (mm)	71	67	66	81	87	89	91	104	117	139

Predator Fish caught: Location 1: Largemouth Bass										
TL (mm)	509	414	453	442	436	412	432	435	426	416

Prey Fish caught: Location 2: Inland Silverside										
TL (mm)	56	49	62	51	52	74	58	61	56	57
Prey Fish caught: Location 2: Sacramento Sucker										
TL (mm)	94	89	82	82	96	87	93	99	91	124

Comments: The sampling vessel was launched from the downtown ramp on 3rd Street. Three samples of prey fish were collected in addition to a predator species, largemouth bass, using the electrofisher boat at two locations. Hitch, catfish and warmouth sunfish were seen.

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2012 BOG Lake Berryessa (511PLB077)



Latitude: 38.626735

Longitude: -122.286694

Collection Method: Electrofisher boat

Date (s) of Collection: May 31, 2012

Samplers: Gary Ichikawa and Dylan Service

Prey Fish caught: Location 1: Bluegill Sunfish										
TL (mm)	44	42	44	49	56	54	49	56	57	61
Prey Fish caught: Location 1: Inland Silverside										
TL (mm)	72	84	86	73	69	76	66	69	76	67
Prey Fish caught: Location 1: Warmouth										

TL (mm)	73	92	87	90	84	110	108	113	117	141	
Prey Fish caught: Location 1: Largemouth Bass											
TL (mm)	127	113	107	115	121	117	132	142	114	112	
Prey Fish caught: Location 1: Smallmouth Bass											
TL (mm)	113	114	111	121	124	134	136	136	142	149	
Prey Fish caught: Location 1: Threadfin Shad											
TL (mm)	74	73	76	76	80	79	79	87	91	107	
Predator Fish caught: Location 1: Largemouth Bass											
TL (mm)	322	371	426	372	401	371	396	416	392	420	

Comments: The sampling vessel was launched from the Visitor's Center ramp off Berryessa Knoxville Road. Five samples of prey fish were collected in addition to a predator species, largemouth bass, using the electrofisher boat at one location. Threadfin shad were the only other fish seen.

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2012 BOG Lake San Antonio (309PSA164)



Latitude: 35.878974

Longitude: -121.013148

Collection Method: Electrofisher boat

Date (s) of Collection: June 7, 2012

Samplers: Dylan Service and Edward Parras

Prey Fish caught: Location 1: Bluegill Sunfish										
TL (mm)	54	51	56	53	55	60	65	67	70	76
Prey Fish caught: Location 1: Warmouth										
TL (mm)	67	70	75	74	74	77	79	76	85	83

Prey Fish caught: Location 1: Largemouth Bass											
TL (mm)	36	34	36	39	41	47	43	44	43	111	
Prey Fish caught: Location 1: Threadfin Shad											
TL (mm)	71	74	72	76	87	95	94	98	97	99	
Prey Fish caught: Location 1: Inland Silverside											
TL (mm)	73	72	79	68	72	69	67	66	72	79	
Predator Fish caught: Location 1: Largemouth Bass											
TL (mm)	360	382	384	399	380	478	441	410	491	469	
Predator Fish caught: Location 1: Striped Bass											
TL (mm)	730	752	756	751	794	714	741	750	694		

Comments: The sampling vessel was launched from the Lynch Road ramp. Four samples of prey fish were collected in addition to two predator species using the electrofisher boat. No other fish were seen.

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2012 BOG Lake Cachuma (314PLC191)



Latitude: 34.56511

Longitude: -119.93246

Collection Method: Electrofisher boat

Date (s) of Collection: June 20, 2012

Samplers: Gary Ichikawa and Dylan Service

Prey Fish caught: Location 1: Bluegill Sunfish										
TL (mm)	54	63	74	75	76	81	91	130	125	135
Prey Fish caught: Location 1: Warmouth										
TL (mm)	75	83	82	91	100	103	105	107	130	140

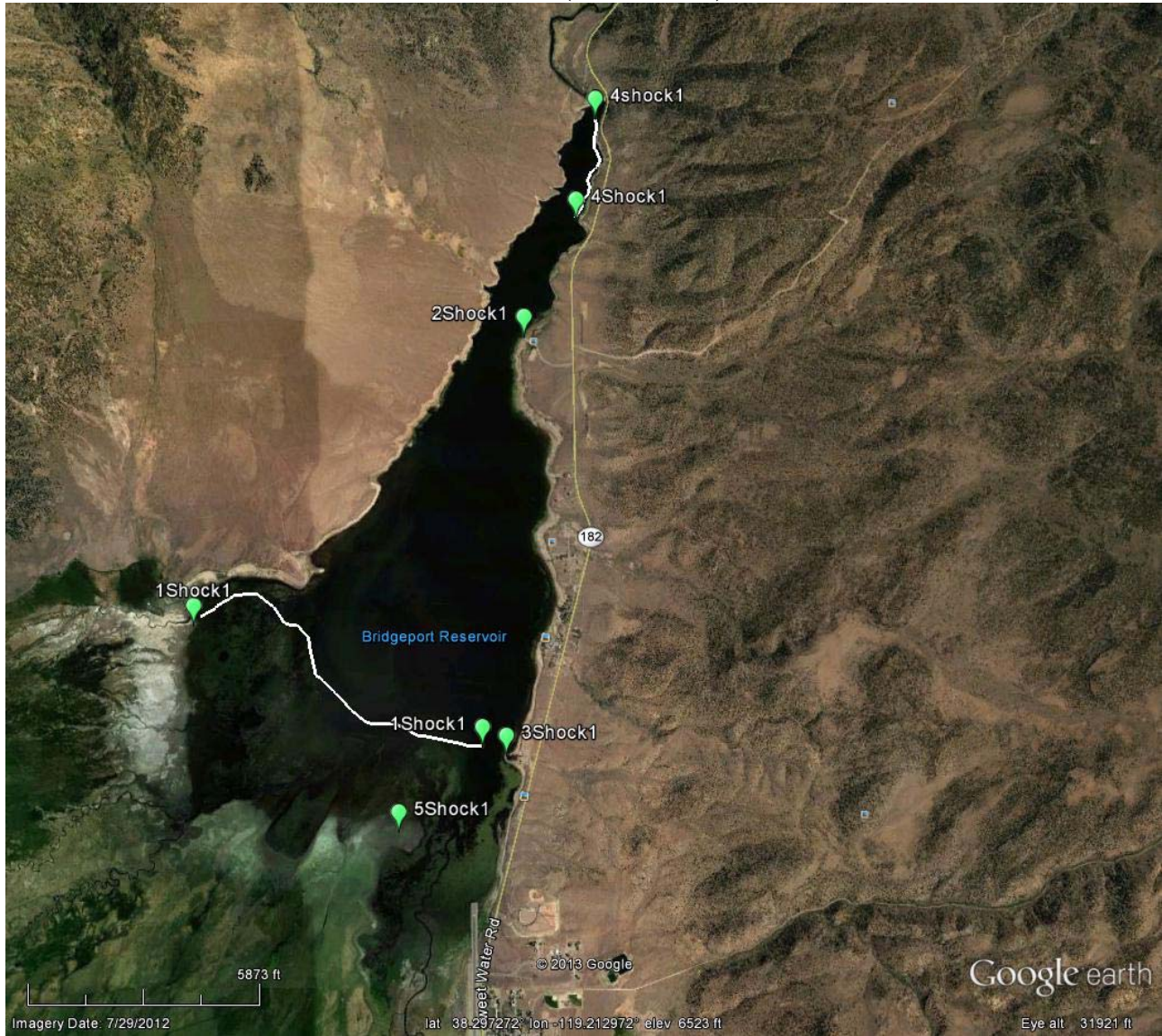
Prey Fish caught: Location 1: Spotted Bass										
TL (mm)	44	51	91	91	104	106	111	100	119	109
Prey Fish caught: Location 1: Threadfin Shad										
TL (mm)	75	73	76	80	75	82	74	81	81	91

Predator Fish caught: Location 1: Largemouth Bass										
TL (mm)	310	349	356	369	360	400	405	403	435	420

Comments: The sampling vessel was launched from the main ramp off Lakeview Drive. Four samples of prey fish were collected in addition to a predator species using the electrofisher boat. Sculpins were the only other fish seen.

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2012 BOG Bridgeport Reservoir(630PBR199)



Latitude: 38.28146

Longitude: -119.22202

Collection Method: Electrofisher boat

Date (s) of Collection: June 26, 2012

Samplers: Gary Ichikawa and Sean Goetzl

Date (s) of Collection: August 28, 2012

Samplers: Dylan Service and Edward Parras

Prey Fish caught: Location 1: Sacramento Perch										
TL (mm)	58	61	68	74	73	79	81	84	92	146

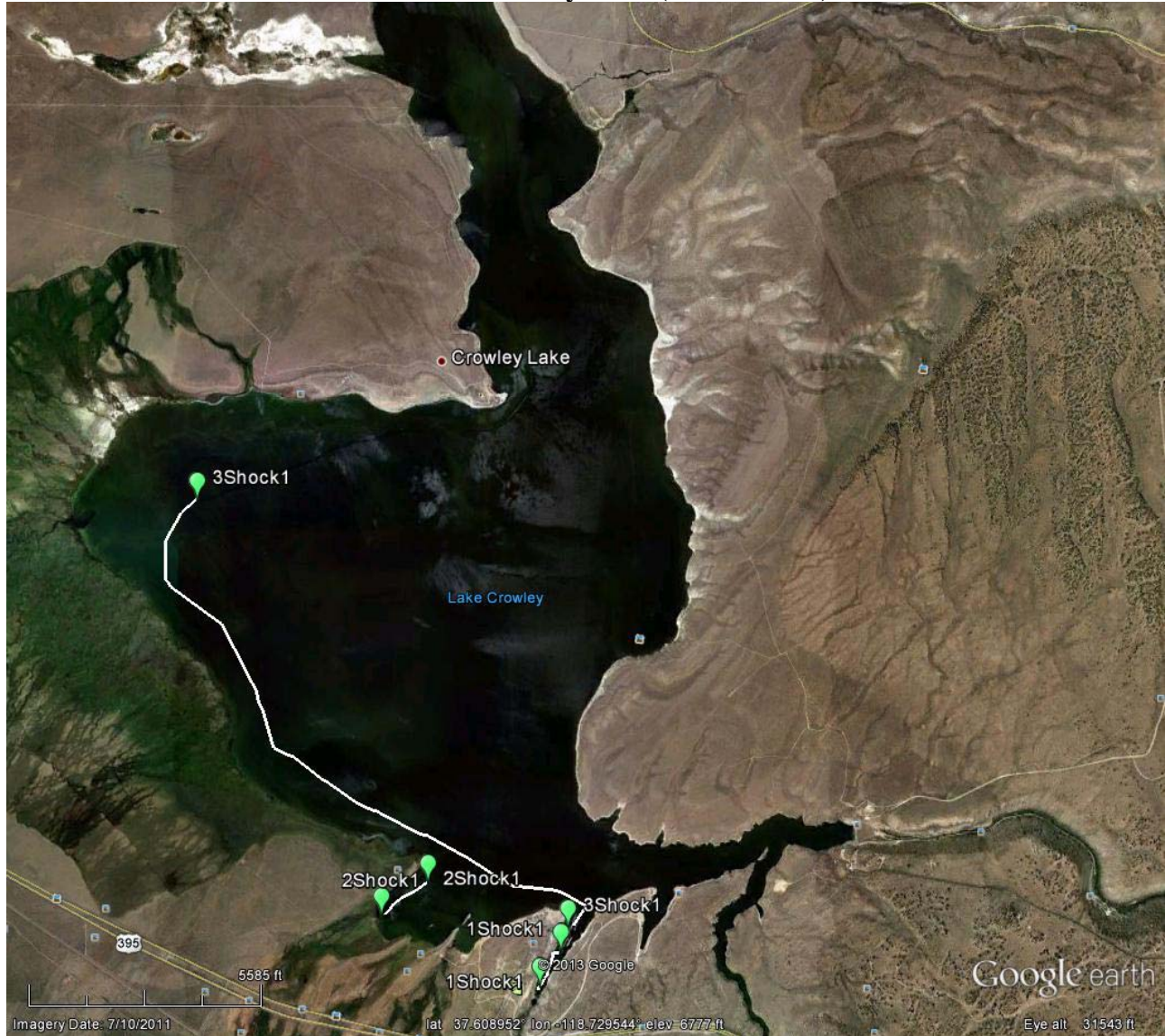
Prey Fish caught: Location 4: Sacramento Perch											
TL (mm)	33	36	38	37	38	45	51	57	55	59	
Prey Fish caught: Location 4: Golden Shiner											
TL (mm)	31	40	45	58	67	66	67	72	73	74	

Predator Fish caught: Location 2: Rainbow Trout											
TL (mm)	294	306	280	279	282	318	296	328	308	323	
Predator Fish caught: Location 5: Brown Trout											
TL (mm)	440	436	471	470	515	511	499	556	564	726	

Comments: The sampling vessel was launched from the Bridgeport Reservoir RV and Marina ramp and the public ramp off of Ramp Road. Four samples of prey fish were collected in addition to two predator species using the electrofisher boat. Carp were the only other fish were seen.

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2012 BOG Crowley Lake (603PCW207)



Latitude: 37.57977

Longitude: -118.73175

Collection Method: Electrofisher boat

Date (s) of Collection: June 26, 2012

Samplers: Gary Ichikawa and Sean Goetzl

Date (s) of Collection: August 27, 2012

Samplers: Dylan Service and Edward Parras

Prey Fish caught: Location 3: Sacramento Perch										
TL (mm)	21	22	27	30	27	32	32	32	31	31

Prey Fish caught: Location 3: Golden Shiner											
TL (mm)	51	87	86	85	92	90	89	95	88	95	

Predator Fish caught: Location 1: Rainbow Trout											
TL (mm)	297										

Predator Fish caught: Location 1: Sacramento Perch											
TL (mm)	229	230	255								

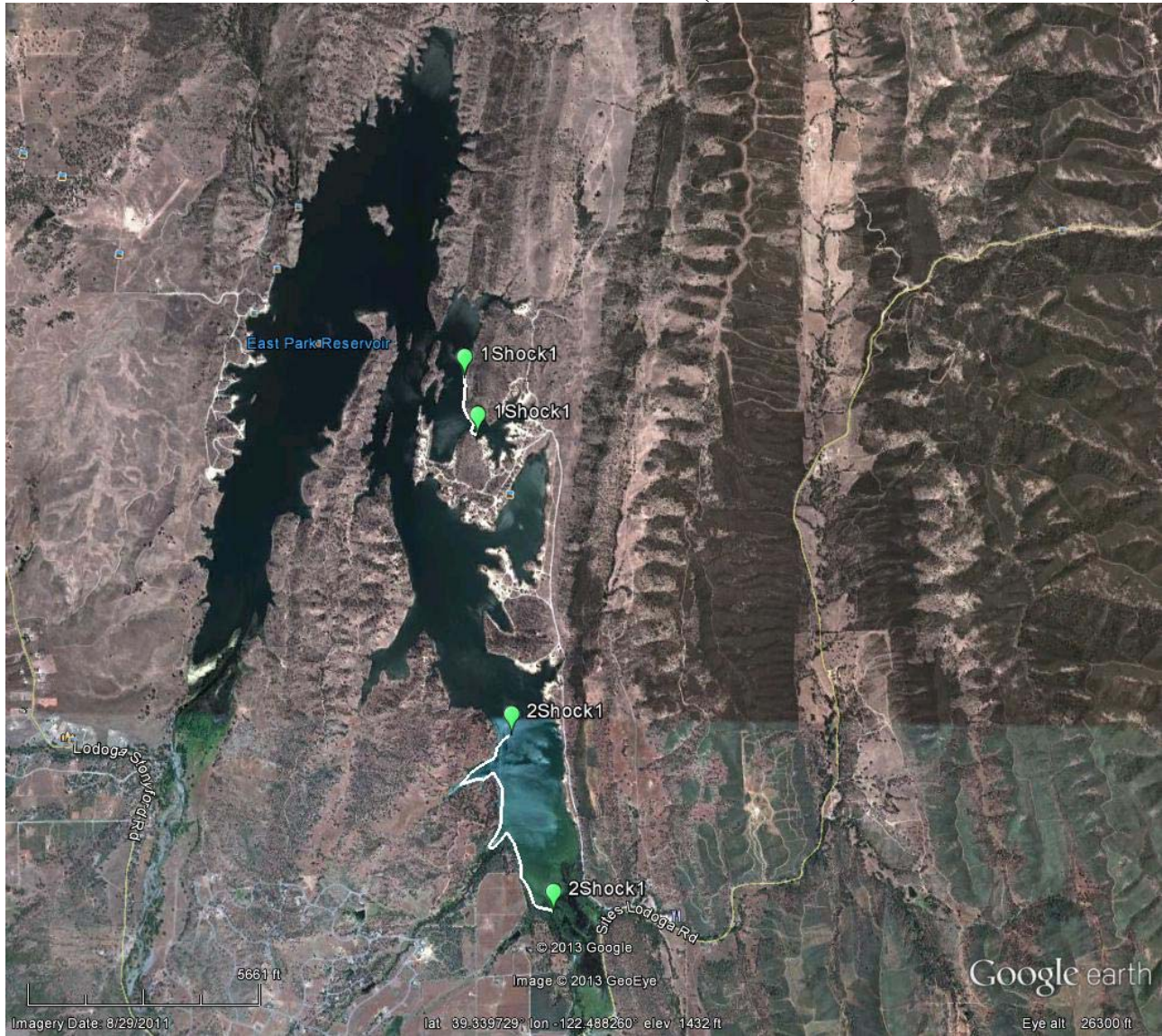
Predator Fish caught: Location 2: Sacramento Perch											
TL (mm)	312										

Predator Fish caught: Location 3: Rainbow Trout											
TL (mm)	320	390	456	430	425	466	441	548	491	544	

Comments: The sampling vessel was launched from the Fish Camp boat ramp. Two samples of prey fish were collected in addition to a predator species using the electrofisher boat. Brown trout were the only other fish were seen.

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2012 BOG East Park Reservoir (522PEP025)



Latitude: 38.34942

Longitude: -122.49891

Collection Method: Electrofisher boat

Date (s) of Collection: July 2, 2012

Samplers: Gary Ichikawa and Edward Parras

Prey Fish caught: Location 1: Bluegill										
TL (mm)	57	62	70	72	71	70	70	81	82	72
Prey Fish caught: Location 1: Warmouth										
TL (mm)	65	61	63	65	61	64	65	67	71	76

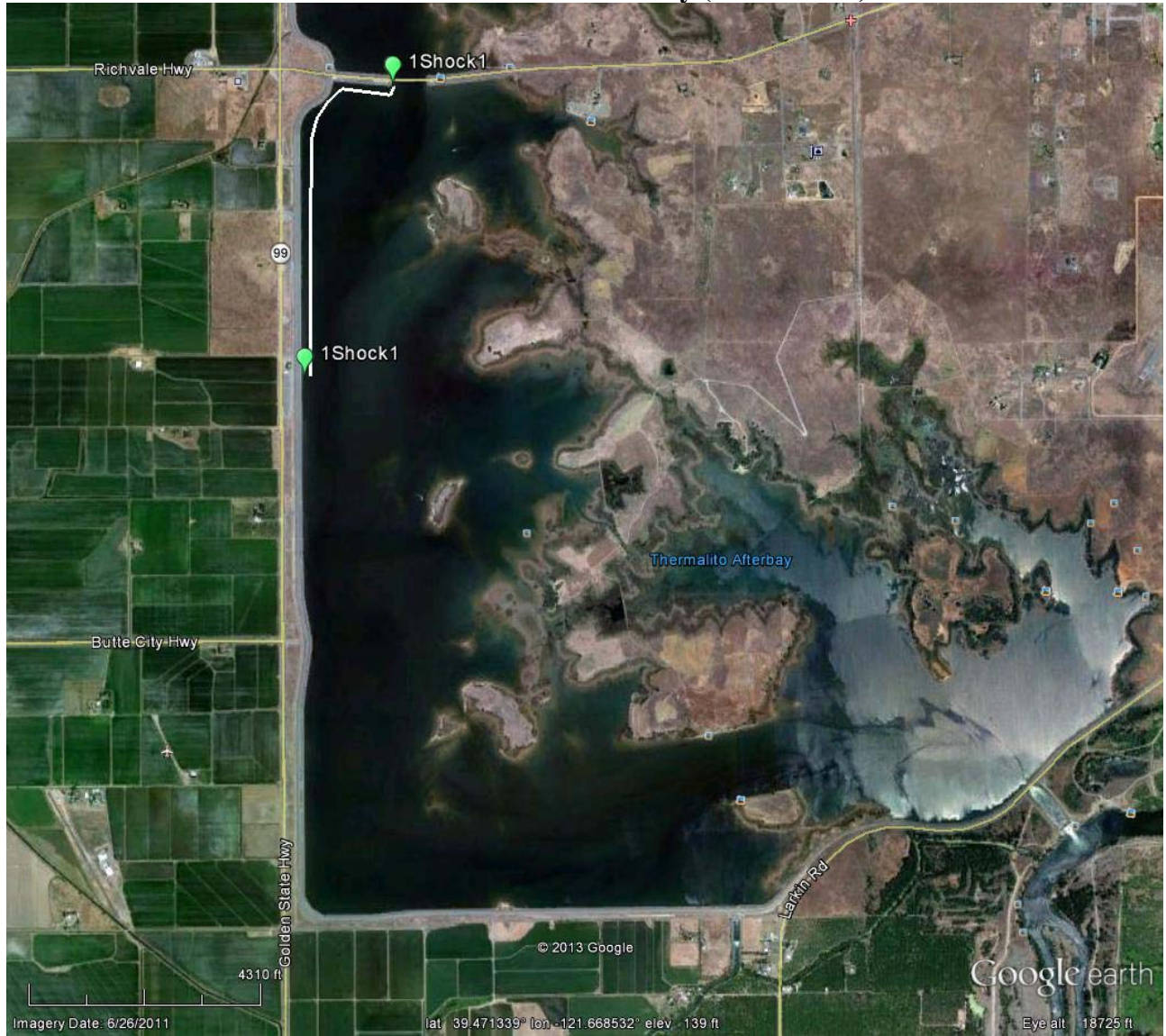
Prey Fish caught: Location 1: Largemouth Bass											
TL (mm)	45	48	50	57	52	57	57	62	63	61	
Prey Fish caught: Location 1: Island Silverside											
TL (mm)	68	72	63	65	61	65	65	66	63	65	

Predator Fish caught: Location 2: Largemouth Bass											
TL (mm)	340	344	338	365	346	395	460	409	444	464	

Comments: The sampling vessel was launched from off the bank in the campground. Four samples of prey fish were collected in addition to one predator species using the electrofisher boat. Carp and goldfish were the only other fish were seen.

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2012 BOG Thermalito Afterbay (515TTO326)



Latitude: 39.49332

Longitude: -121.68121

Collection Method: Electrofisher boat

Date (s) of Collection: July 2, 2012

Samplers: Gary Ichikawa and Edward Parras

Prey Fish caught: Location 1: Bluegill										
TL (mm)	75	77	90	97	100	83	86	91	95	105
Prey Fish caught: Location 1: Hitch										
TL (mm)	46	46	41	51	51	48	51	55	53	52

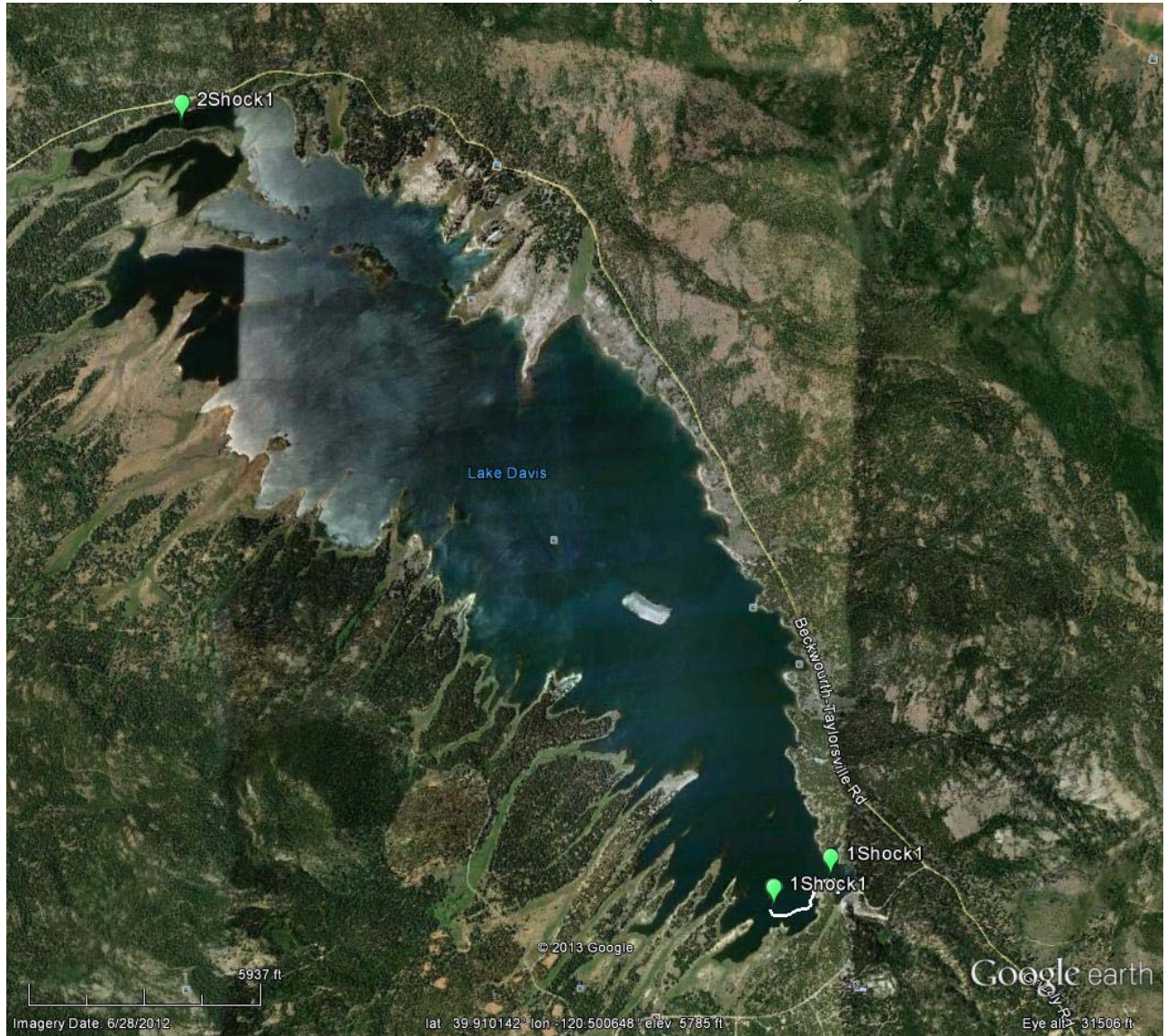
Prey Fish caught: Location 1: Island Silverside										
TL (mm)	35	35	37	41	36	42	45	44	47	44

Predator Fish caught: Location 1: Largemouth Bass										
TL (mm)	380	409	428	390	419	520	438	440	492	540

Comments: The sampling vessel was launched from off the Thermalito Afterbay public launch ramp off Oroville Dam Blvd. The water level was very low, which made boat launching very challenging. Three samples of prey fish were collected in addition to one predator species using the electrofisher boat. Carp was the other fish were seen.

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2012 BOG Lake Davis (518PLD123)



Latitude: 39.88503

Longitude: -120.47831

Collection Method: Electrofisher boat

Date (s) of Collection: July 24, 2012

Samplers: Gary Ichikawa, Dylan Service and Amber Coates

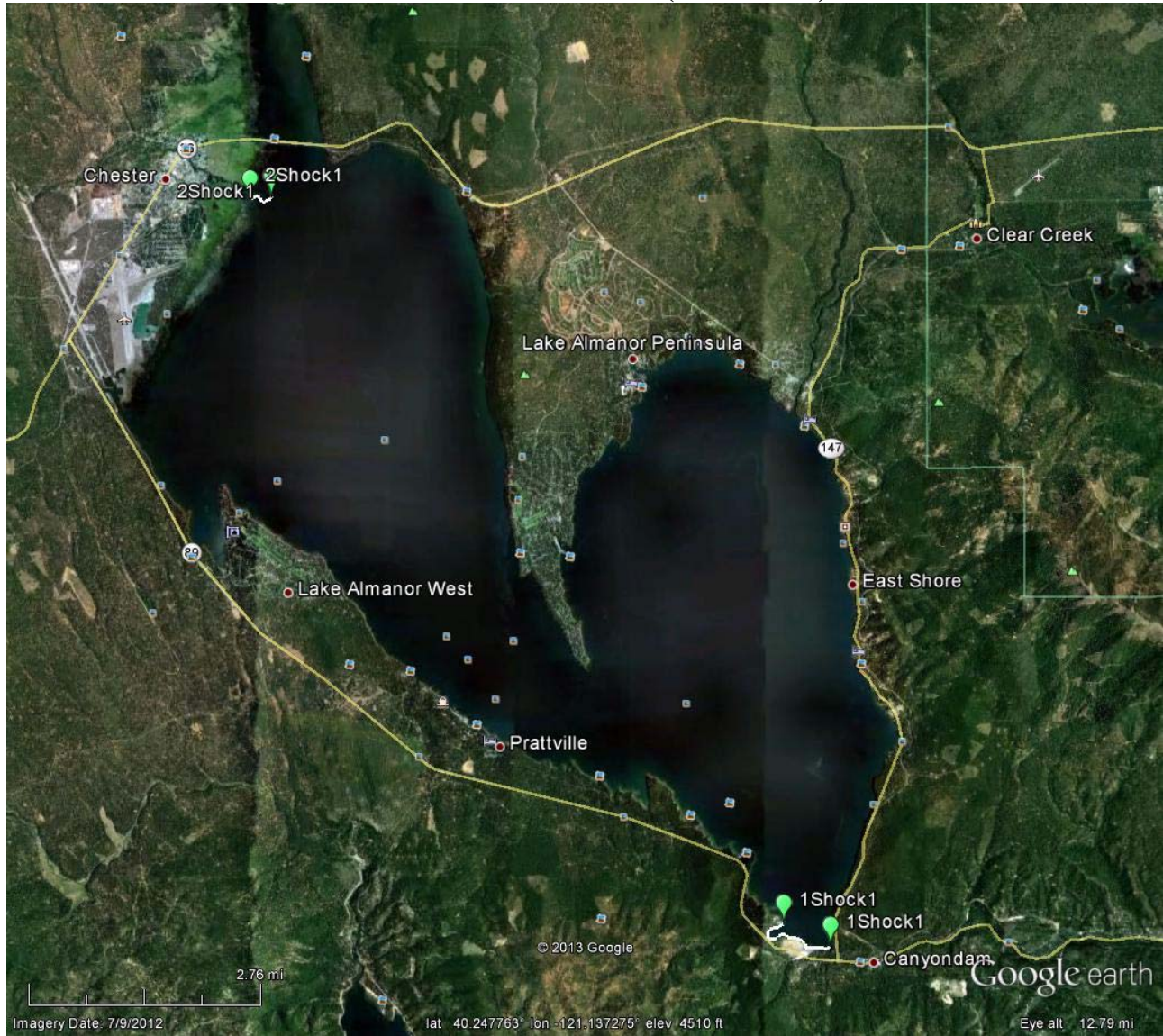
Prey Fish caught: Location 1: Pumpkinseed Sunfish										
TL (mm)	48	59	58	65	60	59	60	58	62	61
Prey Fish caught: Location 1: Golden Shiner										
TL (mm)	71	69	79	74	73	73	72	73	84	87

Predator Fish caught: Location 1: Rainbow Trout										
TL (mm)	280	366	409	402	392	381				
Predator Fish caught: Location 2: Rainbow Trout										
TL (mm)	412	394	371	406						

Comments: The sampling vessel was launched from the public launch ramp at Honker Cove. Two samples of prey fish were collected in addition to one predator species using the electrofisher boat. No other fish were seen.

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2012 BOG Lake Almanor (518PLA165)



Latitude: 40.17826

Longitude: -121.09299

Collection Method: Electrofisher boat

Date (s) of Collection: August 1, 2012

Samplers: Gary Ichikawa and Dylan Service

Prey Fish caught: Location 1: Smallmouth Bass										
TL (mm)	39	43	40	46	52	51	53	52	53	71
Prey Fish caught: Location 1: Inland Silverside										
TL (mm)	34	36	47	48	52	53	53	44	53	53
Prey Fish caught: Location 1: Sacramento Sucker										

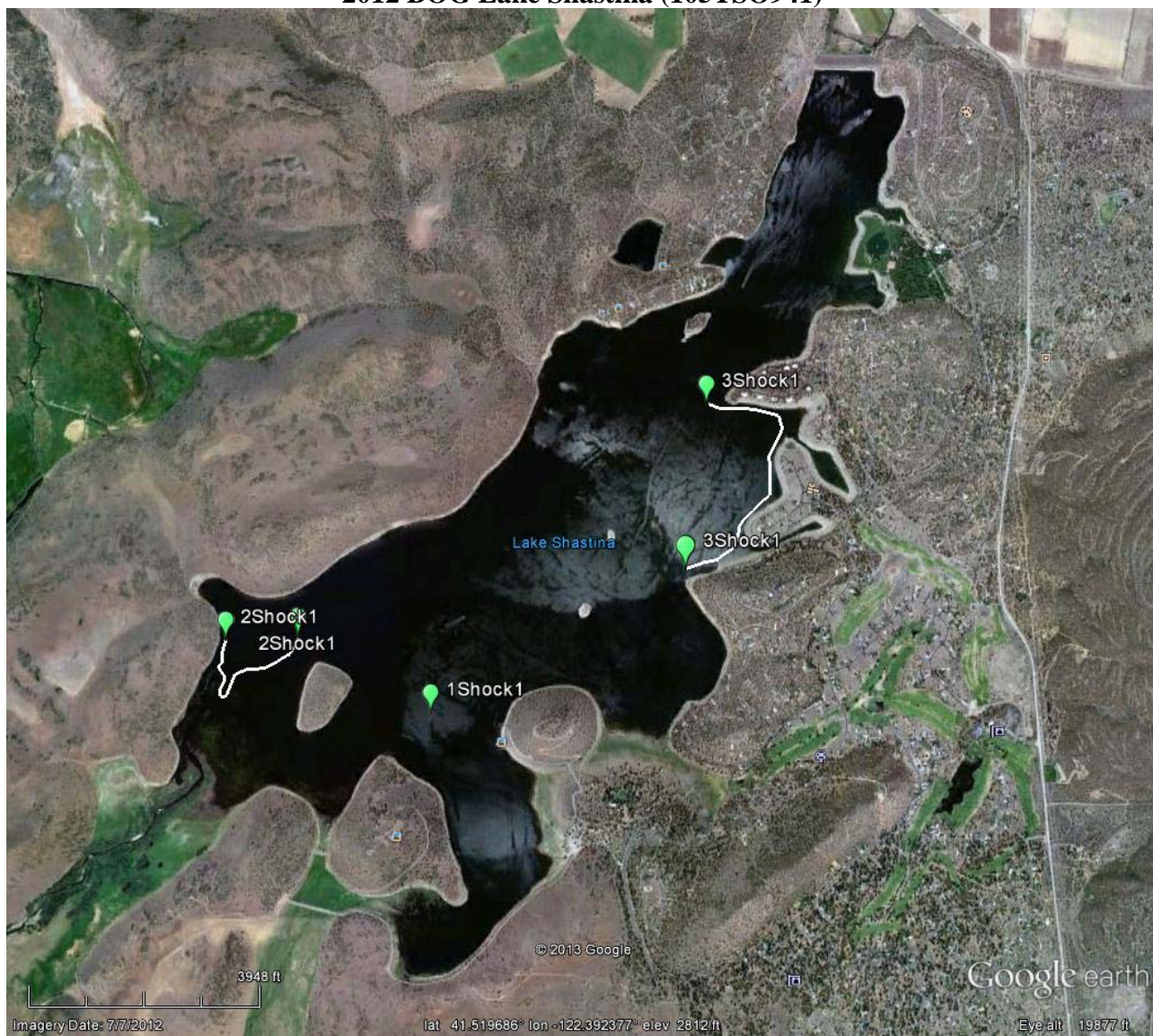
TL (mm)	64	58	65	66	54	53	61	68	56	67	

Predator Fish caught: Location 2: Rainbow Trout											
TL (mm)	257	426	401	389	516	526	469	461	474	420	

Comments: For location 1, the sampling vessel was launched from the public launch ramp off Highway 89 near the dam. For location 2, the sampling vessel was launched from the North Shore Campground launch ramp off Highway 36. Three samples of prey fish were collected in addition to one predator species using the electrofisher boat. Brown trout and carp fish were seen.

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2012 BOG Lake Shastina (105TSO941)



Latitude: 41.51080

Longitude: -122.40193

Collection Method: Electrofisher boat

Date (s) of Collection: August 20, 2012

Samplers: Gary Ichikawa and Dylan Service

Prey Fish caught: Location 1: Largemouth Bass										
TL (mm)	63	74	76	97	92	84	74	82	87	94
Prey Fish caught: Location 2: Inland Silverside										
TL (mm)	55	74	75	82	76	76	78	77	78	90

Predator Fish caught: Location 2: Largemouth Bass										
TL (mm)	436									

Comments: The sampling vessel was launched from the public launch ramp off Dwinnel Way. Very few fish were seen compared to past years sampling. Two samples of prey fish were collected in addition to one predator largemouth bass using the electrofisher boat. No other fish were seen. No fish were analyzed because of the lack of grebes available.

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2012 BOG Eagle Lake (637PEL213)



Latitude: 40.55949

Longitude: -120.78296

Collection Method: Electrofisher boat and hook and line

Date (s) of Collection: September 4, 2012 for electrofisher; September 7, 9, 13, 14, 15, 2012

Samplers: Gary Ichikawa and Dylan Service for electrofisher; various volunteers under supervision of fishing guide Val Aubrey.

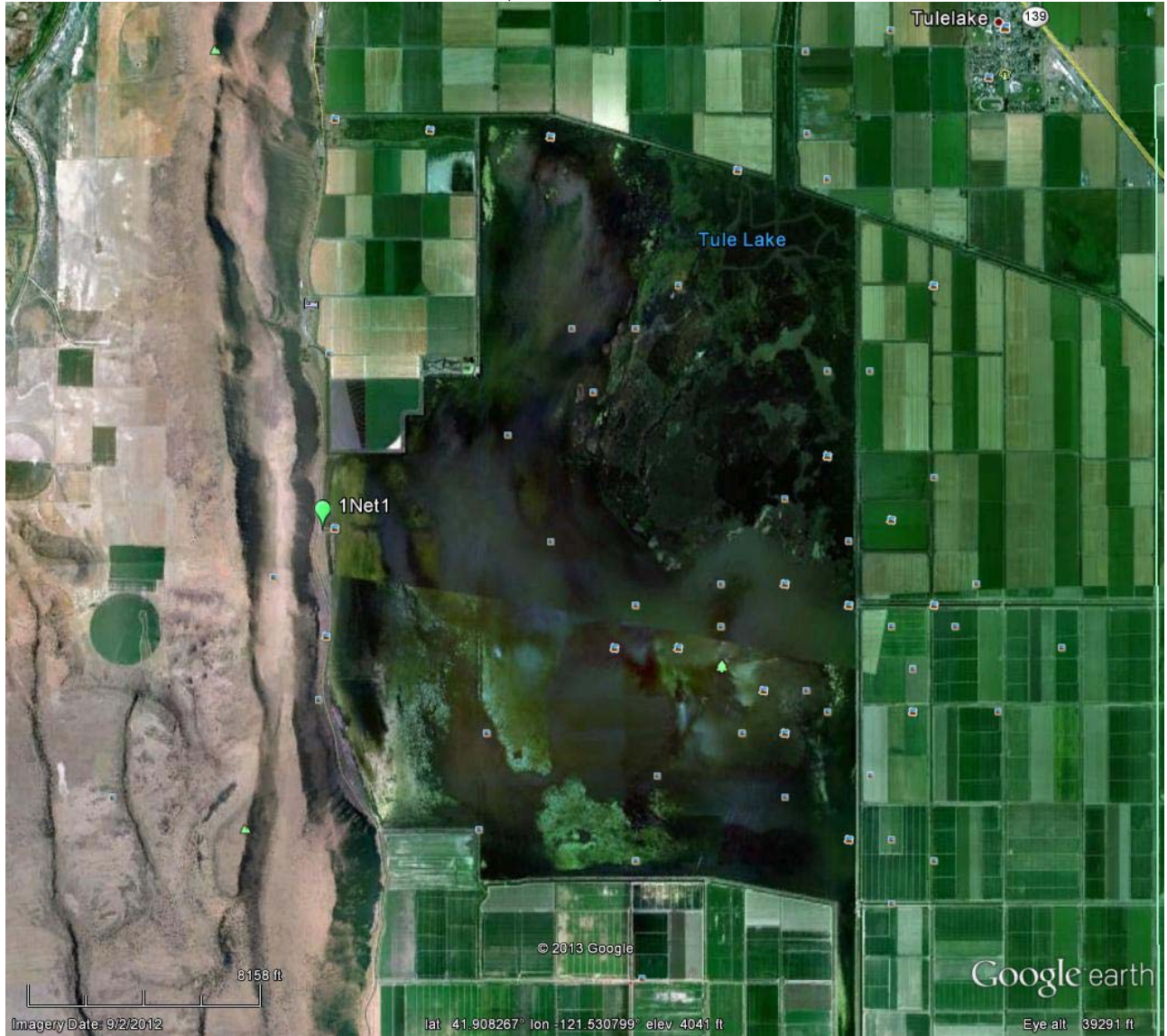
Prey Fish caught: Shock Location 1: Tui Chub										
TL (mm)	54	52	59	76	73	57	79	79	86	93
Prey Fish caught: Shock Location 1: Tahoe Sucker										

TL (mm)	56	61	99	89	91	79	90	92	93	94	
Prey Fish caught: Shock Location 1: Speckled Dace											
TL (mm)	46	49	52	49	49	67					
Predator Fish caught: Shock Location 1: Eagle Lake Trout											
TL (mm)	468	443									
Predator Fish caught: Hook Location 1: Eagle Lake Trout											
TL (mm)	462	488	455								
Predator Fish caught: Hook Location 2: Eagle Lake Trout											
TL (mm)	392										
Predator Fish caught: Hook Location 3: Eagle Lake Trout											
TL (mm)	405										
Predator Fish caught: Hook Location 4: Eagle Lake Trout											
TL (mm)	453	425	477								

Comments: The electrofish sampling vessel was launched from the boat ramp at Eagle Lake Marina. Three samples of prey fish were collected in addition to two rainbow trout using the electrofisher boat. The remaining 8 rainbow trout were collected by the fishing guide Val Aubrey on various days.

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**2012 Tule Lake
(105TTO361)**



Latitude: 41.90726

Longitude: -121.56477

Collection Method: Nets

Date (s) of Collection: August 21, 2012

Samplers: USFWS personnel under direction of Josh Rasmussen

Prey Fish caught: Location 1: Tui Chub										
TL (mm)	42	51	49	57	59	50	45	44	59	47
Prey Fish caught: Location 1: Sacramento Perch										
TL (mm)	64	66	43	44	41	44	41	44	53	46



Comments: The two prey fish species were collected by USFWS personnel under direction of Josh Rasmussen. Tule Lake has endangered fish species and no sportfishing is allowed. No grebes were collected from this site, therefore no fish were analyzed.

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2012 BOG O'Neill Forebay (541POF104)



Latitude: 37.07229

Longitude: -121.056162

Collection Method: Electrofisher boat

Date (s) of Collection: September 20, 2012

Samplers: Dylan Service and Edward Parras

Prey Fish caught: Location 1: Sacramento Perch										
TL (mm)	43	40	40	45	68	66	68	94	90	99
Prey Fish caught: Location 1: Threadfin Shad										
TL (mm)	85	88	84	89	86	91	90	91	88	90
Prey Fish caught: Location 1: Largemouth Bass										

TL (mm)	56	53	60	75	77	84	90	85	87	93	
Prey Fish caught: Location 1: Island Silverside											
TL (mm)	48	55	51	65	55	51	52	64	63	66	
Predator Fish caught: Location 2: Largemouth Bass											
TL (mm)	325	360	340	372	435	501	461	474	585		

Comments: The electrofisher sampling vessel was launched from the public boat ramp off Highway 152. Four samples of prey fish were collected in addition to one predator species using the electrofisher boat. No grebes were collected from this site, therefore no fish were analyzed.

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2012 BOG Black Butte Lake (504PBB125)



Latitude: 39.80628

Longitude: -122.34278

Collection Method: Electrofisher boat

Date (s) of Collection: October 10, 2012

Samplers: Gary Ichikawa and Dylan Service

Prey Fish caught: Location 1: Warmouth										
TL (mm)	48	60	60	69	84	79	86	90	88	48
Prey Fish caught: Location 1: Smallmouth Bass										
TL (mm)	70	65	64	64	70	74	90	84	89	64
Prey Fish caught: Location 2: Threadfin Shad										

TL (mm)	66	64	58	66	66	53	67	73	64	64	
Prey Fish caught: Location 2: Island Silverside											
TL (mm)	76	68	74	72	60	54	66	69	79	64	
Predator Fish caught: Location 1: Smallmouth Bass											
TL (mm)	341	400	399	350	326	356	357	379	360	409	

Comments: The electrofish sampling vessel was launched from the public Eagle Pass boat ramp. Four samples of prey fish were collected in addition to one predator species using the electrofisher boat. Largemouth bass, carp, crappie, catfish and Sacramento perch were also seen.

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References

Bonnema, A. 2012. Quality Assurance Project Plan:
INCORPORATING WILDLIFE METHYLMERCURY EXPOSURE AND RISK ESTIMATES
USING BIOMAGNIFICATION FACTORS INTO CALIFORNIA LAKE MONITORING. Moss
Landing Marine Labs. Prepared for SWAMP BOG, 40 pages plus appendices and attachments.