7b BIOLOGICAL EFFECTS OF THE GRASSLAND BYPASS PROJECT AT SITES E, G, H AND R

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ABSTRACT

In its sixteenth, seventeenth and eighteenth years of operation (2012-2014), the Grassland Bypass Project continued to reduce the risk of selenium toxicity in the ecosystem from which the Project removed agricultural subsurface drainwater. However, it also continued to cause elevated risk in the waterway into which the drainwater has been diverted by the Project.

In Mud Slough (north) (Site E) downstream from the outfall of the San Luis Drain (SLD), mean selenium concentrations in bait fish and invertebrates continued to exceed thresholds of concern. All bait fish samples exceeded 4 µg Se/g (dry weight) threshold of concern in whole-body fish and seven of thirteen samples exceeded the toxicity level (9 µg/g dry weight). Selenium concentrations did not exceed the 2 µg/g (wet weight) fish consumption guideline in five composite samples of carp (*Cyprinus carpio*) muscle tissue collected in 2012 in Mud Slough (north). No carp was caught in 2013 and 2014 because of extreme low flows as a result of the drought. In 2012 and 2013, both Siberian freshwater shrimp (*Exopalaemon modestus*) samples exceeded 3 µg Se/g (dry weight) waterbird dietary threshold and above the 7 µg/g (dry weight) dietary toxicity threshold.

In the San Joaquin River at Fremont Ford (Site G), upstream of Mud Slough (north), mean selenium concentrations in bait fish and invertebrates remained below thresholds of concern. All carp muscle tissue samples collected at this site in 2012 and 2013 remained below the 2 µg Se/g (wet weight) fish consumption guideline. No carp was caught at this site in 2014. All Siberian freshwater shrimp samples were below the 3 µg Se/g (dry weight) level of concern.

In the San Joaquin River at Hills Ferry (Site H), downstream of the Mud Slough (north), two of four mean selenium concentrations in whole-body bait fish exceeded the 4 µg/g (dry weight) threshold of concern in samples collected in 2012. One sample of Siberian freshwater shrimp was slightly above the 3 ug Se/g level of concern. All eight samples of carp muscle tissue collected at this site were below the 2 µg Se/g fish consumption guideline. No carp was collected at Site H in 2013. Last monitoring at this site was May 2013.

The U.S. Bureau of Reclamation (Reclamation) moved the location for collecting biological samples in the San Joaquin River from Hills Ferry upstream to a point within the CDFW Grasslands Wildlife Area China Island Unit (Site R). The reason for this change is to obtain samples from that portion of the river that is most likely affected by the conveyance of agricultural drain water from the Grasslands Drainage Area (GDA).

Monitoring at Site R started in July 2013. In the San Joaquin River at China Island, upstream from Hills Ferry, some selenium concentrations in whole-body bait fish exceeded the 4 µg/g (dry weight) threshold of concern but below the toxicity level (9 µg/g dry weight) in all samples collected in 2013 and 2014. All selenium concentrations of Siberian freshwater shrimp were slightly above the 3 ug/g level of concern. There were no carp muscle tissue collected at this site in 2013 and 2014 due to very low flows.

In 2012, 2013 and 2014, selenium in all seed samples collected along Mud Slough (Site E) remained below the 3 µg/g (dry weight) dietary level of concern for waterbirds. Boron concentrations in all seed samples along Mud Slough were above the 30 µg/g (dry weight) threshold of concern as diet for waterbirds.

Along the San Joaquin River above the Mud Slough confluence (near Fremont Ford) (Site G), the concentrations of selenium in bulrush seed remained well below the 3 µg/g (dry weight) dietary level of concern for waterbirds.

However, in 2013, boron concentrations in bulrush seed in two of three samples were above the 30 µg/g (dry weight) threshold of concern as diet for waterbirds. No samples exceeded the threshold of concern in 2012 and 2014.

Along the San Joaquin River below the Mud Slough confluence (Hills Ferry) (Site H) and at the San Joaquin River at China Island (Site R), the concentrations of selenium in bulrush seed heads remained below the 3 ug/g level of concern. Boron concentrations of in all samples of bulrush seeds collected in 2012 were above the 30 µg Se/g (dry weight) threshold of concern as diet for waterbirds.

METHODS

Agency Responsibilities

The California Department of Fish and Wildlife (CDFW) agreed to conduct the biomonitoring portion of the Compliance Monitoring Program for three sites. The methods used by the CDFW are described in the Quality Assurance Project Plan (QAPP) for Use and Operation of the Grassland Bypass Project (USBR, 2001). These methods are also based on standard operating procedures described in Standard Operation Procedures for Environmental Contaminant Operations (USFWS, 1995) and standards used by the other agencies participating in the compliance monitoring program.

Matrices Sampled

Samples of the biota were collected at each site and analyzed for selenium and boron. Aquatic specimens were collected with dip nets, seine nets, funnel nets and by electro fishing. Mosquitofish (Gambusia affinis), inland silversides (Menidia beryllina), red shiners (Cyprinella lutrensis), carp (Cyprinus carpio), white catfish (Ameiurus catus), bluegill (Lepomis macrochirus), fathead minnow (Pimephales promelas) and bigscale logperch (Percina macrolepida) were the principal species of fish collected. Waterboatmen (family: Corixidae), backswimmers (family: Notonectidae), and red swamp crayfish (Procambarus clarkii) and Siberian freshwater shrimp (Exopalaemon modestus) were the principal invertebrates collected.

Separation of biological samples from unwanted material also collected in the nets was accomplished by using Teflon sieves. To the extent possible, three replicate, composite samples (minimum 5 individuals totaling at least 2 grams (preferably 5 grams) for each composite) of each primary species listed above were collected. Bait fish were analyzed as composite whole-body samples and muscle tissue from carp were analyzed.

Analyses of fish samples collected from the San Joaquin River (Sites G, H and R) and Mud Slough (Site E) were prioritized to first meet the objectives of the Compliance Monitoring Plan (Section 4.5.1.4).

The seed heads of wetland plants that provide food for waterfowl were collected in the late summer (August) of each year. This plant material was analyzed for boron as well as selenium.

Plankton and aquatic insect composite samples were collected from Site E, G, H and R using two plankton nets of similar diameter and mesh size. The nets were left in the river at a specific length of time depending on the flow (measured using Global Water Flow Probe Model FP111). Monitoring started in May 2013. The objective was to consistently sample 0.092 acre foot (30,000 gallons) of equivalent water flow at each location and sampling period.

All biota samples were kept on ice or on dry ice while in the field then kept frozen to zero degrees centigrade (0°C) during storage and shipment. For all samples, after freeze drying, homogenization, and nitric digestion, total selenium was determined by hydride generation atomic absorption spectrophotometry and boron was determined by inductively coupled (argon) plasma spectroscopy.

Sampling Sites

Site E is located where Mud Slough crosses State Highway 140 and is located upstream from the confluence with the San Joaquin River. This site represents the lower reach of the slough that is contaminated by the operation of the Project. This point along Mud Slough is within the flood plain of the San Joaquin River, so flows are slower. Flood waters of the San Joaquin River periodically back up into slough, providing some flushing.

Site G is located on the San Joaquin River and State Highway 140 at Freemont Ford, upstream of the Mud Slough confluence. This site represents the reach of the San Joaquin River that is no longer contaminated with agricultural

drainwater from the Grassland Drainage Area as a result of the GBP.

Site H is located at Hills Ferry on the San Joaquin River about two river miles downstream of the Mud Slough confluence. This site represents the reach of the San Joaquin River most strongly influenced by agricultural drain water discharged by the GBP. One of the environmental commitments of the GBP is that it will not worsen water quality in the San Joaquin River. For practical reasons of year-round accessibility, the site was located just upstream of the Merced River confluence; Merced River waters have relatively low concentrations of selenium. Monitoring ceased at Site H and no samples have been collected after May 2013.

It was suggested Merced River flows influence the selenium results at Site H. To determine if Merced River had any influence, the sampling site was moved 1.5 river miles upstream from Site H to within the China Island Wildlife Area (Site R). Sampling started July 2013 and had been suggested to show the full influence of the Grassland Bypass Project on the river.

Sampling Times

Since 1995, CDFW biota sampling has been synchronized to occur during the months of November (December), March, June, and August (September).

Departures from the Monitoring Plan and Quality Assurance Project Plan

All biological samples beginning in 1999 have been analyzed at the Water Pollution Control Laboratory of the CDFW in Rancho Cordova, California, after this laboratory was screened and approved by the GBP Quality Control Officer.

RESULTS

Mud Slough at Highway 140 (Site E)

Selenium in Fish

The concentration of selenium from the only sample of whole-body mosquitofish collected during 2012 was 5.23 µg/g (dry weight) (**Table 1**). In 2013, five composite samples of whole-body mosquitofish collected ranged from 4.67 to 11.8 µg Se/g (dry weight). Eleven composite samples of whole-body mosquitofish collected during 2014 ranged from 8.57 to 20.9 µg Se/g (dry weight) (**Table 1**). In 2013, mean concentrations were 4.67, 8.54 and 11.8 µg/g (dry weight) and in 2014 were 9.70, 8.69, 20.6 and 12.1 µg/g (dry weight) (**Table 1**).

There were three composite inland silverside samples collected in 2012 and six composite samples collected in 2013. Three composite samples ranged from 4.22 to 8.01 µg Se/g (dry weight) in 2012 and from 10.1 to 18.7 µg/g (dry weight) in 2013 (**Table 1**). No inland silverside was collected at Site E in 2014.

In 2013, there were three composite samples each of fathead minnow and red shiner collected at Site E. The selenium concentrations in fathead minnows ranged from 9.32 to 9.82 µg/g (dry weight) and the red shiners had selenium concentration ranged from 5.11 to 5.76 µg/g (dry weight) **(Table 1**). There were no samples for both species collected in 2012 and 2014.

Selenium in Invertebrates

One composite red crayfish sample was collected at Site E in 2012 and had a selenium concentration of 4.72 µg/g (dry weight) and in 2014, two composite sample ranged from 3.92 µg/g (dry weight) to 9.74 µg/g (dry weight) (**Table 1**). No red crayfish was collected in 2013.

Three Siberian freshwater shrimp composite samples collected in 2012 ranged from 9.23 to 10.7 µg Se/g (dry weight) and one composite sample collected in 2013 had 10.4 µg Se/g (dry weight) (**Table 1**). No shrimp samples were collected in 2014. In 2014, two composite snail samples had a mean concentration of 2.43 µg Se/g (dry weight) (**Table 1**). Only one sample of aquatic insects was collected in 2012 (5.02 µg Se/g dry weight) and one in 2014 (15.4 µg Se/g dry weight). There were thirteen composite plankton invertebrate samples collected in 2013 and 2014 at Site E that ranged from 0.516 to 9.03 µg Se/g (dry weight) (**Table 1**).

Selenium in Plants

All nine composite samples of bulrush seed heads that were collected in Site E in 2012, 2013 and 2014 (see **Table 1**) ranged from 0.102 to 2.8 µg Se/g (dry weight).

Boron in Plants

The mean boron concentration collected at this site in 2012 was 58.6 µg/g (dry weight); in 2013 was 75.8 µg/g (dry weight); and in 2014 was 137 µg/g (dry weight) (**Table 1**).

Site E Summary

In summary, all eight mean selenium concentrations for mosquitofish (**Table 1**) were above the level of concern for whole-body warm water fish (4 µg/g dry weight) and four were above the toxicity threshold of 9 µg/g (dry weight) (**Table 1**). All five fathead minnow, red shiner and silverside means were above 4 ug Se/g and three were above 9 ug Se/g (**Table 1**). All three red crayfish means were above 3 µg Se/g waterbird dietary level of concern and one was above 7 µg Se/g waterbird dietary toxicity threshold (**Table 1**). Both Siberian freshwater shrimp were above the 7 µg Se/g threshold. Five of seven composite sample means were below the 3 µg Se/g threshold and two samples were above 3 µg Se/g, but were below the 7 ug Se/g threshold (**Table 1**). Both aquatic insect samples were above 3 µg/g with one sample above the 7 ug/g threshold (**Table 1**). All three plant samples were below 3 µg Se/g threshold. All three plant samples were above the 30 µg/g threshold for boron (**Table 1**).

Total discharge into the San Luis Drain at Site A has decreased from 52,820 acre-feet (ac-ft)(years 2006-08) and 41,870 ac-ft (years 2009-11) to 22,680 ac-ft for years 2012 to 2014. The same is true for discharge in to Mud Slough at Site B decreasing from 59,740 ac-ft and 45,650 ac-ft to 28,550 ac-ft across the same years. Flows during 2014 were non-existence during the year as a result of source control reduction activities by the Grassland Basin Drainers and the long term drought. There was an increase in aquatic biota selenium concentrations from 2012 to 2014 which is most likely from evapotranspiration and shallow groundwater seepage, which is eight to twelve feet below the ground surface, which has elevated salts and trace elements.

San Joaquin River at Fremont Ford (Site G)

Selenium in Fish

Selenium concentrations in samples of fish collected from this site during 2012, 2013 and 2014 continued to reflect removal of selenium-laden drainwater. Twenty-four composite samples of whole-body mosquitofish collected during 2012, 2013 and 2014 ranged from 1.24 to 1.72 µg/g (dry weight) (**Table 1**). Three composite bigscale logperch samples were collected in 2012 with a range from 2.04 to 2.14 µg Se/g (dry weight) (**Table 1**). In 2013, four composite inland silverside samples were collected and one composite sample in 2014. Selenium concentrations ranged from 1.21 to 1.49 µg/g (dry weight) (**Table 1**). There was no sample collected in 2012. Three red shiner composite samples were collected in 2013 and four in 2014 and ranged from 1.34 to 2.09 µg Se/g (dry weight) (**Table 1**).

Selenium in Invertebrates

Selenium concentrations in all invertebrates collected from this site during 2012, 2013 and 2014 continue to be well below the threshold of concern for invertebrates as prey items. Composite samples of red crayfish, Siberian freshwater shrimp, snails, aquatic insects (waterboatmen, dragonfly nymph and giant water bug) and a tadpole were collected in Site G. There were seven composite red crayfish samples collected in Site G in 2012, 2013 and 2014. The selenium concentrations ranged from 0.71 to 1.50 µg/g (dry weight) (**Table 1**). Eight composite Siberian freshwater shrimp samples were collected in 2012 and 2013. The selenium concentration ranged from 1.86 to 2.89 µg/g (dry weight) (**Table 1**). There was no sample collected in 2014. Only two composite snail samples were collected in 2012 and the selenium mean concentration was 0.779 µg/g (dry weight) (**Table 1**). No sample was collected in 2013 and 2014. A tadpole composite sample was collected in 2013 and the selenium concentration was 1.60 µg/g (dry weight) (**Table 1**). Two composite aquatic insect samples were collected in 2012 and 2013. The composite aquatic insect samples were waterboatmen, dragonfly nymph and giant water bug and ranged from 0.781 and 1.05 µg Se/g (dry weight) (**Table 1**). There were sixteen composite plankton samples collected in 2013 and 2014 and ranged from 0.163 to 2.39 µg Se/g (dry weight) (**Table 1**).

Selenium in Plants

Nine composite bulrush seed heads were collected in 2012, 2013 and 2014 had selenium mean concentrations of 0.143, 0.067 and 0.76 µg/g (dry weight), respectively and ranged from 0.056 to 1.92 µg Se/g across years (**Table 1**).

Boron in Plants

There were nine composite bulrush seedheads collected at Site G in 2012, 2013 and 2014 and the mean boron concentrations were 22.9, 42.7 and 26.4 µg/g (dry weight), respectively. In 2013, the mean concentration exceeded the 30 ug/g (dry weight) threshold of concern (**Table 1**). The composite boron concentrations ranged from 27.4 to 57.1 µg/g (dry weight).

Summary

In summary, all mean selenium concentrations for mosquitofish, red shiners, silversides and bigscale logperch were below the level of concern for whole-body warm water fish (4 µg/g dry weight) and the toxicity threshold of 9 µg/g (dry weight) (**Table 1**). Selenium concentrations in whole-body mosquitofish have consistently been below the 4 µg/g (dry weight) level of concern since the GBP began September 1996. All red crayfish, Siberian freshwater shrimp, tadpole, aquatic insects and plants were below the threshold of concern (3 µg/g dry weight) for birds that may forage on these invertebrates and the dietary toxicity threshold (7 µg/g dry weight) (**Table 1**). One plant sample was above the 30 µg/g threshold for boron (**Table 1**).

San Joaquin River Below Mud Slough (Site H)

Selenium in Fish

The selenium concentration from the only mosquitofish sample caught in 2012 was 4.22 µg/g (dry weight) (**Table 1**). In 2012 and 2013, six inland silverside composite samples ranged from 2.47 to 4.67 µg Se/g (dry weight) (**Table 1**). In 2013, three red shiner composite samples ranged from 2.04 to 2.40 µg Se/g (dry weight) (**Table 1**).

Selenium in Invertebrates

Selenium concentrations in two composite Siberian freshwater shrimp samples were 3.62 and 3.45 µSe/g (dry weight) (**Table 1**). No composite shrimp sample collected in 2013. Three plankton composite plankton samples collected at Site H in 2012 and 2013 ranged from 1.06 to 3.26 µg Se/g (dry weight) (**Table 1**).

Selenium in Plants

In 2012, bulrush seed head composite samples ranged from 0.427 to 0.502 µg Se/g (dry weight) and the mean was 0.468 µg Se/g (dry weight) (**Table 1**).

Boron in Plants

Boron concentrations in all three composite samples collected in 2012 ranged from 31.2 to 36.1 µg/g (dry weight) .

Summary

In summary, mean selenium concentrations in mosquitofish was a little above the level of concern for whole-body warm water fish (4 µg/g dry weight) and below the toxicity threshold of 9 µg/g (dry weight) (**Table 1**). The red shiner was below 4 µg Se/g. One of two silverside was below 4 ug/g and both were below 9 ug/g (**Table 1**). The only Siberian freshwater shrimp mean concentration was above the 3 µg/g threshold, but below the 7 ug/g threshold (**Table 1**). All three plant samples were below 3 µg Se/g threshold (**Table 1**) and all three plant samples were above the 30 µg/g threshold for boron (**Table 1**).

San Joaquin River at China Island Wildlife Area (Site R)

Selenium in Fish

Sixteen composite mosquitofish samples were collected in 2013 and 2014 and the selenium concentrations ranged from 3.15 to 6.98 µg/g (dry weight) (**Table 1**). In 2013, four composite inland silverside samples ranged from 4.35 to 8.13 µg Se/g (dry weight) (**Table 1**). No samples were collected in 2014. In 2014, four composite red shiner samples ranged from 3.24 to 4.25 µg Se/g (dry weight) (**Table 1**). No red shiners were caught in 2013.

Selenium in Invertebrates

Four composite red crayfish samples were collected during 2014 ranged from 2.23 to 4.78 µg Se/g (dry weight) (**Table 1**). No red crayfish sample was collected at Site R in 2013. Six composite Siberian freshwater shrimp samples were collected in 2013 where the selenium concentrations ranged from 3.42 to 4.68 µg/g (dry weight). The only composite sample collected in 2014 had 4.20 µg Se/g (dry weight) (**Table 1**). In 2013 and 2014, the fourteen composite plankton samples had selenium concentrations ranging from 0.070 to 2.85 µg/g (dry weight) (**Table 1**).

Selenium in Plants

In 2013 and 2014, three composite samples of white sweet clover seed heads and three composite samples of bulrush seed heads were collected, respectively. The selenium concentrations ranged from 0.117 to 0.193 µg/g (dry weight) (**Table 1**).

Boron in Plants

Boron concentrations in all composite samples of waterbird forage plant material (seed heads) collected in 2013 and 2014 ranged from 35.5 to 88.9 µg/g (dry weight) (**Table 1**).

Site R Summary

In summary, one of six mean selenium concentrations for mosquitofish was below the level of concern for whole-body warm water fish (4 µg/g dry weight) but all were below the 9 µg/g toxicity threshold (**Table 1**). One of four composite samples of red shiner and all four composite samples of inland silversides were above 4µg/g. All red shiner and silverside samples were below 9µg/g (**Table 1**). Two red crayfish were above the threshold of concern (3 µg/g dry weight) for birds that may forage on these invertebrates and below the dietary toxicity threshold (7 µg/g dry weight) (**Table 1**). All four Siberian freshwater shrimp were above the 3 µg/g threshold. Both plant samples means were below the 3 µg Se/g threshold and were above the 30 µg/g threshold for boron (**Table 1)**.

Fish Community Assessment

Fish community assessments are conducted to describe species richness, abundance and community structure. Fish populations were sampled in Mud Slough at Highway 140 (Site E), San Joaquin River at Fremont Ford (Site G), San Joaquin River below Mud Slough (Site H) and San Joaquin River at China Island Wildlife Area (Site R).

Tables 2a-2e is a compilation of the 44 fish species (n = 49,146), that have been collected at these sites between March 2001 and December 2014. Twelve species of native fish have been caught. The native species were Sacramento blackfish (*Orthodon macrolepidotus*), splittail (*Pogonichthys macrolepidotus*), Sacramento sucker (*Catostomus occidentalis*), prickly sculpin (*Cottus asper*), Chinook salmon (*Oncorhynchus tshawystcha*), Sacramento pikeminnow (*Ptychocheilus grandis*), hitch (*Lavinia exilicauda*), California roach (*Hesperoleucus symmetricus*), Tule perch (*Hysteocarpus traski*), hardhead (*Mylopharodon conocephalus*) and the riffle sculpin (*Cottus golosus*). From 2012 to 2014, only three species of native fish had been caught. At Site E, two Sacramento splittail were caught in 2013. At Site G, four riffle sculpin and seven Sacramento sucker were caught in 2012. At Site H, there were three Sacramento sucker and four riffle sculpin caught in 2012.

There is a fish screen, which is set up in September through early December, at Site H to prevent fall-run salmon from moving upstream to the sampling sites for this project.

Sacramento blackfish was the most abundant native fish at the three sites throughout the study. The most common non-native fish were mosquitofish, inland silversides, carp, and red shiner.

Assessment of Risk to Public Health from Consumption of Fish

A public health advisory on consumption of fish is in effect for the Grasslands area (OEHHA 2001):

Because of elevated selenium levels, no one should eat more than four ounces of fish from the Grassland area, in any two-week period. Women who are pregnant or may become pregnant, nursing mothers, and children age 15 and under should not any eat fish from this area.

To assess current human health risks due to selenium in gamefish, carp were collected from Mud Slough (Site E) and the San Joaquin River (Sites G, H and R). Samples of skinless fillets from these fish were analyzed for selenium and compared with the 2 µg/g wet weight interim internal guidance and screening level for selenium established by the Office of Environmental Health Hazard Assessment (OEHHA).

Selenium concentrations from five composite carp muscle samples collected at Site E during 2012 ranged from 0.507 to 1.46 µg/g (wet weight) (**Table 1**). There were no carp collected at Site E in 2013 and 2014 due to low water flows. At Site G there were ten composite samples collected in 2012 and two samples in 2013. No carp were collected in 2014. The 2012 selenium concentrations ranged from 0.398 to 0.653 µg/g (wet weight) and in 2013 ranged from 0.510 and 0.611 µg/g (wet weight) (**Table 1**). At Site H, there were eight composite carp muscle tissue collected in 2012 which ranged from 0.356 to 1.19 µg Se /g (wet weight) (**Table 1**). There were no carp collected at Sites H and R in 2013 and 2014. The concentrations of selenium in all carp muscle tissue collected at Site H remained well below the 2µg/g health screening level for human consumption(**Table 1**).

Acknowledgments

We greatly appreciate the assistance provided in the field by Abimael Leon Cardona and Erica Rhyne-Christensen from California Department of Water Resources; Stacy Brown and Gabe Poduska from the Bureau of Reclamation and Kelley Aubushon, Matt Bigelow, Kyle Brinsendine, Pat Ferguson, Kevin Gipson, Mike Grill, Thomas Gromis, Eric Guzman, Abigail Gwinn, Mike Hubble, Steve Hulbert, Ken Johnson, Amy Krisch, Ben Lewis, Brian Mahardja, Jamie McGrath-Castro, Sara Morrison, John Shelton, Todd Stansberry, Kyle Stoner, Erin Tennant, Dyana Valencourt, Jim Vang and Rachel Walker helped collect samples for CDFW.

Tables

TABLE 1. BIOTIC SELENIUM AND BORON RESULTS FOR THE GRASSLAND BYPASS PROJECT AT MUDSLOUGH AND THE SAN JOAQUIN RIVER.

				FISH (MG/G WET WT.)	FISH (MG/G DRY WT.)						INVERTEBRATES (MG/G DRY WT.)					PLANTS (MG/G DRY WT.)	
SITE	YEAR		MONTH	CARP	BIGSCALE LOGPERCH	MOSQUITOFISH	FATHEAD MINNOW	RED SHINERS	INLAND SILVERSIDE	BULLFROG/TADPOLE	RED CRAYFISH	SIBERIAN FRESWATER SHRIMP	SNAILS	COMPOSITE	AQUATIC INSECTS	(SE)	(B)
Site E (Mudslough)	2012																
			MAR	1.46													
				0.607													
		Mean		**1.03**													
			JUN	0.885													
				0.924													
		Mean		**0.905**		**5.23**					**4.72**				**5.02 1**		
			AUG						4.67			9.78				0.209 4	61.2 4
									4.22			9.23				0.153 4	56.8 4
									8.01			10.7				0.123 4	57.9 4
		Mean							**5.63**			**9.90**				**0.162**	**58.6**
			DEC														
		Mean		**0.507**													
	2013		MAY			4.67		5.11						4.89			
								5.76						9.03			
								5.45									
		Mean						**5.44**						**6.96**			
			JUL			8.24								1.68			
						8.47								3.27			
						8.9											
		Mean				**8.54**								**2.48**			
			OCT			11.8	9.35		18.0					0.516		0.237 4	80.3 4
							9.32		18.7							0.196 4	65.6 4
							9.82		17.0							0.102 4	81.6 4
		Mean					**9.50**		**17.9**							**0.178**	**75.8**
			DEC						12.7					3.7			
									12.6					0.927			
									10.1								
		Mean							**11.8**			**10.4**		**2.31**			
	2014		MAR			9.46							2.53	2.78			
						9.45							2.32	2.9			
						10.2											
		Mean				**9.70**					**3.92**		**2.43**	**2.84**			
			JUN			8.6								5.37			
						8.57								1.74			
						8.9											
		Mean				**8.69**								**3.56**			
			AUG			20.3										2.49 4	161 4
						20.9										2.8 4	139 4
																1.39 4	110 4
		Mean				**20.6**					**9.74**				**15.4 2**	**2.23**	**137**
			DEC			13.0								3.16			
						12.4								2.71			
						10.9											
		Mean				**12.1**								**2.94**			

TABLE 1. BIOTIC SELENIUM AND BORON RESULTS FOR THE GRASSLAND BYPASS PROJECT AT MUDSLOUGH AND THE SAN JOAQUIN RIVER. (CONT.)

				FISH (MG/G WET WT.)	FISH (MG/G DRY WT.)						INVERTEBRATES (MG/G DRY WT.)					PLANTS (MG/G DRY WT.)	
SITE	YEAR		MONTH	CARP	BIGSCALE LOGPERCH	MOSQUITOFISH	FATHEAD MINNOW	RED SHINERS	INLAND SILVERSIDE	BULLFROG/TADPOLE	RED CRAYFISH	SIBERIAN FRESWATER SHRIMP	SNAILS	COMPOSITE	AQUATIC INSECTS	(SE)	(B)
Site G (SJR @ Hwy 140)	2012		MAR	0.398	2.04												
				0.653	2.11												
				0.398	2.14												
		Mean		**0.483**	**2.10**												
			JUN	0.504		1.6					1.47		0.811				
				0.482		1.65					1.5		0.746				
						1.69					1.47						
		Mean		**0.493**		**1.65**					**1.48**		**0.779**				
			AUGt	0.475		1.36									0.781 1	0.176 4	20.1 4
				0.448		1.42										0.117 4	25.3 4
				0.403		1.72										0.137 4	23.3 4
		Mean		**0.442**		**1.50**						**2.31**				**0.143**	**22.9**
			DEC	0.561								2.89					
				0.425								1.86					
												2					
		Mean		**0.493**		**1.72**						**2.25**					
	2013		MAY					1.34						2.39			
								1.46						1.71			
								1.51									
		Mean				**1.38**		**1.44**	**1.27**					**2.05**			
			JUL	0.611		1.47						2.16		0.724			
				0.51		1.38						1.93		3			
						1.32						1.96					
		Mean		**0.561**		**1.39**				**1.60**	**1.17**	**2.02**		**1.86**	**1.05 3**		
			OCT			1.48			1.21					0.428		0.056 4	43.5 4
						1.35			1.39					0.581		0.067 4	27.4 4
						1.24			1.49							0.078 4	57.1 4
		Mean				**1.36**			**1.36**					**0.505**		**0.067**	**42.7**
			DEC			1.3								1.01			
						1.49								3.5			
						1.31											
		Mean				**1.37**						**2.06**		**2.26**			
	2014		MAR			1.46								1.36			
						1.56								1.43			
						1.49											
		Mean				**1.50**								**1.40**			
			JUN					1.73						0.426			
								1.82						0.234			
								1.81									
		Mean						**1.79**						**0.330**			
			AUG			1.29								0.163		0.17 4	28.4 4
						1.44								0.188		0.2 4	25.3 4
						1.37										1.92 4	25.4 4
		Mean				**1.37**								**0.176**		**0.760**	**26.4**
			DEC								0.71			0.565			
											1.16			0.662			
											0.912						
		Mean				**1.41**		**2.09**	**1.38**		**0.927**			**0.614**			

TABLE 1. BIOTIC SELENIUM AND BORON RESULTS FOR THE GRASSLAND BYPASS PROJECT AT MUDSLOUGH AND THE SAN JOAQUIN RIVER. (CONT.)

				FISH (MG/G WET WT.)	FISH (MG/G DRY WT.)						INVERTEBRATES (MG/G DRY WT.)					PLANTS (MG/G DRY WT.)	
SITE	YEAR		MONTH	CARP	BIGSCALE LOGPERCH	MOSQUITOFISH	FATHEAD MINNOW	RED SHINERS	INLAND SILVERSIDE	BULLFROG/TADPOLE	RED CRAYFISH	SIBERIAN FRESWATER SHRIMP	SNAILS	COMPOSITE	AQUATIC INSECTS	(SE)	(B)
Site H (SJR @ Hills Ferry)	2012		MAR	0.486					2.47								
				0.522					3.64								
				0.486					2.88								
		Mean		**0.498**					**3.00**								
			JUN	0.742								3.62					
				1.03								3.45					
				1.19													
		Mean		**0.987**								**3.54**		**3.26**			
			AUG						4.67							0.474 4	36.1 4
									4.46							0.427 4	33.7 4
									3.96							0.502 4	31.2 4
		Mean				**4.22**			**4.36**							**0.468**	**33.7**
			DEC	0.356													
				0.554													
		Mean		**0.455**													
	2013		MAY					2.4						1.71			
								2.04						1.06			
								2.14									
		Mean						**2.19**						**1.39**			
Site R (SJR @ China Island Wildlife Area)	2013		JUL			3.17						3.42		0.773			
						3.41						3.52		0.742			
						3.15						3.43					
		Mean				**3.24**						**3.46**		**0.758**			
			OCT			5.15			4.81			4.56		0.791		0.127 5	79.9 5
						5.06			4.91					0.607		0.117 5	84.3 5
						4.64			4.35							0.122 5	88.9 5
		Mean				**4.95**			**4.69**					**0.699**		**0.122**	**84.4**
			DEC			3.91			8.13			4.13		0.356			
						4.58						4.68		2.85			
		Mean				**4.25**						**4.41**		**1.60**			
	2014		MAR			4.47					2.23			0.597			
						4.14					2.34			0.451			
		Mean				**4.31**		**4.25**			**2.29**	**4.20**		**0.524**			
			JUN					3.94						0.07			
								3.24						0.073			
								3.53									
		Mean						**3.57**						**0.072**			
			AUG			3.98								0.355		0.186 4	36.3 4
						3.91								0.07		0.193 4	44.4 4
						4.13										0.186 4	35.5 4
		Mean				**4.01**								**0.213**		**0.188**	**38.7**
			DEC			6.06					3.95			0.677			
						6.98					4.78			1.23			
						4.54											
		Mean				**5.86**					**4.37**			**0.954**			

1 Backswimmers and Waterboatman

2 Dragonfly nymph

3 Dragonfly nymph and Giant waterbug

4 Bulrush

5 White sweet clover

TABLE 2a. COMMUNITY ASSESSMENT OF FISH CAUGHT BY CDFG 2001 - 2015. MUD SLOUGH AT HIGHWAY 140 (SITE E)

COMMON NAME	SCIENTIFIC NAME	ORIGIN	TROPHIC	TOLERANCE TO DEGRADATION	LIFE STYLE*	STATUS*	FROM	MOYLE REFERENCE	TOTAL SAMPLED
Mosquitofish	Gambusia affinis	Introduced	I	T	F	IIE	E USA	pp.317-321	11,952
Carp	Cyprinus carpio	Introduced	O	T	F	IIE	Europe	pp.172-175	1,175
Red shiner	Cyprinella lutrensis	Introduced	O	T	F	IIE	M USA	pp.168-170	654
Inland silverside	Menidia beryllina	Introduced	I	M	F	IIE	SE USA	pp.307-311	697
Goldfish	Carrrassius auratus	Introduced	O	T	F	IID	Japan	pp.170-172	255
Snail sp.		Introduced	O						193
Shrimp species		Introduced	O	M	E,F	IIE			161
White catfish	Ameiurus catus	Introduced	I/P	T	F	IID	E USA	pp.214-216	133
Red crayfish	Procambarus (Scapulicambarus) clarkii	Introduced	O	T	F	IIE			123
Fathead minnow	Pimephales promelas	Introduced	O	T	F	IIE	M USA	pp.166-168	120
Largemouth bass	Micropterus salmoides	Introduced	P	T	F	IID	M USA	pp.397-401	77
Bluegill	Lepomis macrochirus	Introduced	I	T	F	IID	M USA	pp.381-384	53
Green sunfish	Lepomis cyanellus	Introduced	I/P	T	F	IID	M USA	pp.389-391	28
Brown bullhead	Ameiurus nebulosus	Introduced	I/P	T	F	IID	M USA	pp.210-212	21
Threadfin shad	Dorosama petenese	Introduced	I	M	F	IID	SE USA	pp.114-117	21
Sacramento blackfish	Orthodon microlepidotus	Native	O	T	F	IE		pp.144-146	18
Spotted bass	Micropterus punctulatus	Introduced	P	M	F	IIE	SE USA	pp.404-406	15
Channel catfish	Ictalurus punctatus	Introduced	I/P	M	F	IID	M USA	pp.216-218	12
Prickly sculpin	Cottus asper	Native	I	M	AM,E,F	IE		pp.346-349	11
Redear sunfish	Lepomis microlophus	Introduced	I	M	F	IID	SE USA	pp.385-386	11
Golden Shiner	Notemigonus crysoleucas	Introduced	I	M	F	IIE	E USA	pp.164-166	9
Black bullhead	Ameiurus melas	Introduced	I/P	T	F	IID	E USA	pp.208-210	7
Hardhead	Mylopharodon conocephalus	Native	O	M	F	IC		pp.151-154	6
Black crappie	Pomoxis nigromaculatus	Introduced	I/P	M	F	IID	M USA	pp.395-397	5
California roach	Hesperoleucus symmetricus symmetricus	Native	I	M	F	ID		pp.139-144	5
Striped bass	Morone saxatilis	Introduced	P	M	AN	IID	E USA	pp.364-373	3
White crappie	Pomoxis annularis	Introduced	I/P	T	F	IID	M USA	pp.393-395	3
Sacramento Splittail	Pogonichthys macrolepidotus	Native	O	M	E,F	IB		pp.146-150	4
Hitch	Lavinia exilicauda	Native	O	M	F	ID		pp.136-139	1
Mirror carp	Cyprinus carpio	Introduced	O	T	F	IIE	Europe	pp.172-175	1
Sacramento pikeminnow	Ptychocheilus grandis	Native	I/P	M	F	IE		pp.154-158	1
Sacramento sucker	Catostomus occidentalis	Native	O	M	F	IF		pp.185-188	1
Smallmouth bass	Micropterus dolomieui	Introduced	I/P	M	F	IID	M USA	pp.401-404	1
American shad	Alosa sapidissima	Introduced	I	M	AN	IID	E USA	pp.117-120	-
Bigscale logperch	Percina macrolepida	Introduced	I	T	F	IID	SW USA	pp.409-411	-
Bullfrog	Rana catesbeiana	Introduced	O	T		IIE			-
Chinook salmon	Oncorhynchus tshawytscha	Native	I	I	AN, F	IB		pp.251-263	-
Green x Redear	Lepomis ssp.	Introduced	I	M	F	IID			-

TABLE 2a. COMMUNITY ASSESSMENT OF FISH CAUGHT BY CDFG 2001 - 2015. MUD SLOUGH AT HIGHWAY 140 (SITE E) (CONT.)

COMMON NAME	SCIENTIFIC NAME	ORIGIN	TROPHIC	TOLERANCE TO DEGRADATION	LIFE STYLE*	STATUS*	FROM	MOYLE REFERENCE	TOTAL SAMPLED
Green sunfish/ Bluegill Hybrid									-
Pacific lamprey	Lampetra tridentata	Native	O	T	AN, F	ID		pp.96-99	-
Pacific staghorn sculpin	Leptocottus armatus	Native	I	M	E,F	IE		pp.361-363	-
Pumpkin seed	Lepomis gibbosus	Introduced	I	T	F	IID		pp.387-389	-
Riffle sculpin	Cottus gulosus	Native	I	M	F	ID		pp. 350-352	-
River lamprey	Lampetra ayresi	Native	O	M	AN, F	ID		pp.101-103	-
Shimofuri goby	Tridentiger bifasciatus	Introduced	O	M	E	IIE	Japan	pp.437-440	-
Speckled dace (Sacramento)	Rhinichthys osculus carringtoni	Native	I	T	F	IE		pp.160-164	-
Threespine stickleback	Gasterostreus aculeatus	Native	O	M	AN, E, F	IE		pp.338-343	-
Tule perch	Hysteocarpus traski	Native	I	I	E,F	ID		pp.424-429	-
Turtle, pond									-
Warmouth	Lepomis gulosus	Introduced	I	M	F	IIC	M USA	pp.392-393	-
Yellowfin goby	Acanthogobius flavimanus	Introduced	O	M	F	IID	E Asia	pp.436-437	-
Total Samples									15,777

Data source: California Department of Fish and Game.
Community Assessment of Fish Caught By CDFG 19 Mar 2001 - 01 Dec 2011 (34 trips)

Abbreviations

Trophic Level:
O: omnivorous (includes omnivores, herbivores, general planktivores)
I: invertivore (includes invertivores, zooplanktivores
I/P: carnivore (includes piscivores, large invertebrates (crayfish), amphibian, and mammalian predators

Tolerance to Degradation:
I: intolerant
M: moderately tolerant
T: Tolerant

Life Style*:
AM: amphidromous
AN: anadromous
E: estuarine resident
F: freshwater resident

Status*:
I. Native species
A. Extinct/extirpated
B. Threatened or endangered
C. Special concern
D. Watch list
E. Stable of increasing

*Adapted from Moyle, Peter, 2002. Inland Fishes of California. University of California Press. Berkeley, California.

TABLE 2b. COMMUNITY ASSESSMENT OF FISH CAUGHT BY CDFG 2001 - 2015.
SAN JOAQUIN RIVER AT FREMONT FORD (SITE G)

COMMON NAME	SCIENTIFIC NAME	ORIGIN	TROPHIC	TOLERANCE TO DEGRADATION	LIFE STYLE*	STATUS*	FROM	MOYLE REFERENCE	TOTALS
Mosquitofish	Gambusia affinis	Introduced	I	T	F	IIE	E USA	pp.317-321	11,704
Carp	Cyprinus carpio	Introduced	O	T	F	IIE	Europe	pp.172-175	917
Red shiner	Cyprinella lutrensis	Introduced	O	T	F	IIE	M USA	pp.168-170	959
Shrimp species		Introduced	O	M	E,F	IIE			842
Bluegill	Lepomis macrochirus	Introduced	I	T	F	IID	M USA	pp.381-384	776
White catfish	Ameiurus catus	Introduced	I/P	T	F	IID	E USA	pp.214-216	613
Largemouth bass	Micropterus salmoides	Introduced	P	T	F	IID	M USA	pp.397-401	513
Inland silverside	Menidia beryllina	Introduced	I	M	F	IIE	SE USA	pp.307-311	423
Red crayfish	Procambarus (Scapulicambarus) clarkii	Introduced	O	T	F	IIE			268
Goldfish	Carrrassius auratus	Introduced	O	T	F	IID	Japan	pp.170-172	238
Threadfin shad	Dorosama petenese	Introduced	I	M	F	IID	SE USA	pp.114-117	200
Green sunfish	Lepomis cyanellus	Introduced	I/P	T	F	IID	M USA	pp.389-391	169
Channel catfish	Ictalurus punctatus	Introduced	I/P	M	F	IID	M USA	pp.216-218	152
Redear sunfish	Lepomis microlophus	Introduced	I	M	F	IID	SE USA	pp.385-386	129
Spotted bass	Micropterus punctulatus	Introduced	P	M	F	IIE	SE USA	pp.404-406	120
Fathead minnow	Pimephales promelas	Introduced	O	T	F	IIE	M USA	pp.166-168	112
Snail sp.		Introduced	O						64
Bigscale logperch	Percina macrolepida	Introduced	I	T	F	IID	SW USA	pp.409-411	45
Bullfrog	Rana catesbeiana	Introduced	O	T		IIE			48
Striped bass	Morone saxatilis	Introduced	P	M	AN	IID	E USA	pp.364-373	30
Black crappie	Pomoxis nigromaculatus	Introduced	I/P	M	F	IID	M USA	pp.395-397	25
Sacramento blackfish	Orthodon microlepidotus	Native	O	T	F	IE		pp.144-146	20
Sacramento sucker	Catostomus occidentalis	Native	O	M	F	IF		pp.185-188	16
Hitch	Lavinia exilicauda	Native	O	M	F	ID		pp.136-139	9
Sacramento Splittail	Pogonichthys macrolepidotus	Native	O	M	E,F	IB		pp.146-150	6
Brown bullhead	Ameiurus nebulosus	Introduced	I/P	T	F	IID	M USA	pp.210-212	4
Riffle sculpin	Cottus gulosus	Native	I	M	F	ID		pp. 350-352	4
Black bullhead	Ameiurus melas	Introduced	I/P	T	F	IID	E USA	pp.208-210	3
Warmouth	Lepomis gulosus	Introduced	I	M	F	IIC	M USA	pp.392-393	3
California roach	Hesperoleucus symmetricus symmetricus	Native	I	M	F	ID		pp.139-144	2
Prickly sculpin	Cottus asper	Native	I	M	AM,E,F	IE		pp.346-349	2
Chinook salmon	Oncorhynchus tshawytscha	Native	I	I	AN, F	IB		pp.251-263	1

TABLE 2b. COMMUNITY ASSESSMENT OF FISH CAUGHT BY CDFG 2001 - 2015. SAN JOAQUIN RIVER AT FREMONT FORD (SITE G). (CONT.,)

COMMON NAME	SCIENTIFIC NAME	ORIGIN	TROPHIC	TOLERANCE TO DEGRADATION	LIFE STYLE*	STATUS*	FROM	MOYLE REFERENCE	TOTALS
Golden Shiner	Notemigonus crysoleucas	Introduced	I	M	F	IIE	E USA	pp.164-166	1
Green sunfish/ Bluegill Hybrid									1
Green x Redear	Lepomis ssp.	Introduced	I	M	F	IID			1
Pumpkin seed	Lepomis gibbosus	Introduced	I	T	F	IID		pp.387-389	1
Sacramento pikeminnow	Ptychocheilus grandis	Native	I/P	M	F	IE		pp.154-158	1
White crappie	Pomoxis annularis	Introduced	I/P	T	F	IID	M USA	pp.393-395	1
American shad	Alosa sapidissima	Introduced	I	M	AN	IID	E USA	pp.117-120	-
Hardhead	Mylopharodon conocephalus	Native	O	M	F	IC		pp.151-154	-
Hybrid green/ bluegill	Lepomis ssp.	Introduced	I	M	F	IID			-
Mirror carp	Cyprinus carpio	Introduced	O	T	F	IIE	Europe	pp.172-175	-
Pacific lamprey	Lampetra tridentata	Native	O	T	AN, F	ID		pp.96-99	-
Pacific staghorn sculpin	Leptocottus armatus	Native	I	M	E,F	IE		pp.361-363	-
River lamprey	Lampetra ayresi	Native	O	M	AN, F	ID		pp.101-103	-
Shimofuri goby	Tridentiger bifasciatus	Introduced	O	M	E	IIE	Japan	pp.437-440	-
Smallmouth bass	Micropterus dolomieui	Introduced	I/P	M	F	IID	M USA	pp.401-404	3
Speckled dace (Sacramento)	Rhinichthys osculus carringtoni	Native	I	T	F	IE		pp.160-164	-
Threespine stickleback	Gasterostreus aculeatus	Native	O	M	AN, E, F	IE		pp.338-343	-
Tule perch	Hysteocarpus traski	Native	I	I	E,F	ID		pp.424-429	-
Turtle, pond									-
Yellowfin goby	Acanthogobius flavimanus	Introduced	O	M	F	IID	E Asia	pp.436-437	-
Totals									18,426

Data source: California Department of Fish and Game.

Community Assessment of Fish Caught By CDFG 19 Mar 2001 - 01 Dec 2011 (34 trips)

Abbreviations

Trophic Level:
- O: omnivorous (includes omnivores, herbivores, general planktivores)
- I: invertivore (includes invertivores, zooplanktivores
- I/P: carnivore (includes piscivores, large invertebrates (crayfish), amphibian, and mammalian predators

Tolerance to Degradation:
- I: intolerant
- M: moderately tolerant
- T: Tolerant

Life Style*:
- AM: amphidromous
- AN: anadromous
- E: estuarine resident
- F: freshwater resident

Status*:
- I. Native species
- A. Extinct/extirpated
- B. Threatened or endangered
- C. Special concern
- D. Watch list
- E. Stable of increasing

*Adapted from Moyle, Peter, 2002. Inland Fishes of California. University of California Press. Berkeley, California.

TABLE 2c. COMMUNITY ASSESSMENT OF FISH CAUGHT BY CDFG 2001 - 2015. SAN JOAQUIN RIVER AT HILLS FERRY (SITE H)

COMMON NAME	SCIENTIFIC NAME	ORIGIN	TROPHIC	TOLERANCE TO DEGRADATION	LIFE STYLE*	STATUS*	FROM	MOYLE REFERENCE	TOTAL SAMPLES
Mosquitofish	Gambusia affinis	Introduced	I	T	F	IIE	E USA	pp.317-321	9,017
Shrimp species		Introduced	O	M	E,F	IIE			1,163
Carp	Cyprinus carpio	Introduced	O	T	F	IIE	Europe	pp.172-175	888
White catfish	Ameiurus catus	Introduced	I/P	T	F	IID	E USA	pp.214-216	700
Red shiner	Cyprinella lutrensis	Introduced	O	T	F	IIE	M USA	pp.168-170	837
Inland silverside	Menidia beryllina	Introduced	I	M	F	IIE	SE USA	pp.307-311	489
Bluegill	Lepomis macrochirus	Introduced	I	T	F	IID	M USA	pp.381-384	450
Goldfish	Carrrassius auratus	Introduced	O	T	F	IID	Japan	pp.170-172	238
Largemouth bass	Micropterus salmoides	Introduced	P	T	F	IID	M USA	pp.397-401	201
Threadfin shad	Dorosama petenese	Introduced	I	M	F	IID	SE USA	pp.114-117	201
Spotted bass	Micropterus punctulatus	Introduced	P	M	F	IIE	SE USA	pp.404-406	189
Redear sunfish	Lepomis microlophus	Introduced	I	M	F	IID	SE USA	pp.385-386	134
Channel catfish	Ictalurus punctatus	Introduced	I/P	M	F	IID	M USA	pp.216-218	59
Green sunfish	Lepomis cyanellus	Introduced	I/P	T	F	IID	M USA	pp.389-391	59
Striped bass	Morone saxatilis	Introduced	P	M	AN	IID	E USA	pp.364-373	51
Red crayfish	Procambarus (Scapulicambarus) clarkii	Introduced	O	T	F	IIE			48
Fathead minnow	Pimephales promelas	Introduced	O	T	F	IIE	M USA	pp.166-168	36
Bigscale logperch	Percina macrolepida	Introduced	I	T	F	IID	SW USA	pp.409-411	31
Black crappie	Pomoxis nigromaculatus	Introduced	I/P	M	F	IID	M USA	pp.395-397	29
Sacramento Sucker	Catostomus occidentalis	Native	O	M	F	IF		pp.185-188	24
Sacramento Black-fish	Orthodon microlepidotus	Native	O	T	F	IE		pp.144-146	20
Bullfrog	Rana catesbeiana	Introduced	O	T		IIE			18
Smallmouth bass	Micropterus dolomieui	Introduced	I/P	M	F	IID	M USA	pp.401-404	11
Tule perch	Hysteocarpus traski	Native	I	I	E,F	ID		pp.424-429	11
Golden shiner	Notemigonus crysoleucas	Introduced	I	M	F	IIE	E USA	pp.164-166	9
Sacramento Splittail	Pogonichthys macrolepidotus	Native	O	M	E,F	IB		pp.146-150	6
Prickly sculpin	Cottus asper	Native	I	M	AM,E,F	IE		pp.346-349	5
Sacramento Pike-minnow	Ptychocheilus grandis	Native	I/P	M	F	IE		pp.154-158	5
Riffle sculpin	Cottus gulosus	Native	I	M	F	ID		pp. 350-352	4
White crappie	Pomoxis annularis	Introduced	I/P	T	F	IID	M USA	pp.393-395	3
Green x Redear	Lepomis ssp.	Introduced	I/P	T	F	IID	M USA	pp.389-391	2
Bluegill x Redear		Introduced	I	T	F	IID	M USA	pp.381-384	1
Chinook Salmon	Oncorhynchus tshawytscha	Native	I	I	AN, F	IB		pp.251-263	1
Mirror Carp	Cyprinus carpio	Introduced	O	T	F	IIE	Europe	pp.172-175	1
Turtle, pond		Introduced	O						1
Warmouth	Lepomis gulosus	Introduced	I	M	F	IIC	M USA	pp.392-393	1
American shad	Alosa sapidissima	Introduced	I	M	AN	IID	E USA	pp.117-120	-

TABLE 2c. COMMUNITY ASSESSMENT OF FISH CAUGHT BY CDFG 2001 - 2015. SAN JOAQUIN RIVER AT HILLS FERRY (SITE H) (CONT.)

COMMON NAME	SCIENTIFIC NAME	ORIGIN	TROPHIC	TOLERANCE TO DEGRADATION	LIFE STYLE*	STATUS*	FROM	MOYLE REFERENCE	TOTAL SAMPLES
Black bullhead	Ameiurus melas	Introduced	I/P	T	F	IID	E USA	pp.208-210	-
Brown bullhead	Ameiurus nebulosus	Introduced	I/P	T	F	IID	M USA	pp.210-212	-
California roach	Hesperoleucus symmetricus symmetricus	Native	I	M	F	ID		pp.139-144	-
Green sunfish/Blue-gill Hybrid									-
Hardhead	Mylopharodon conocephalus	Native	O	M	F	IC		pp.151-154	-
Hitch	Lavinia exilicauda	Native	O	M	F	ID		pp.136-139	-
Pacific lamprey	Lampetra tridentata	Native	O	T	AN, F	ID		pp.96-99	-
Pacific Staghorn sculpin	Leptocottus armatus	Native	I	M	E,F	IE		pp.361-363	-
Pumpkin Seed	Lepomis gibbosus	Introduced	I	T	F	IID		pp.387-389	-
River lamprey	Lampetra ayresi	Native	O	M	AN, F	ID		pp.101-103	-
Shimofuri goby	Tridentiger bifasciatus	Introduced	O	M	E	IIE	Japan	pp.437-440	-
Snail sp.		Introduced	O						-
Speckled dace (Sac-ramento)	Rhinichthys osculus carringtoni	Native	I	T	F	IE		pp.160-164	-
Threespine stick-leback	Gasterostreus aculeatus	Native	O	M	AN, E, F	IE		pp.338-343	-
Yellowfin goby	Acanthogobius flavimanus	Introduced	O	M	F	IID	E Asia	pp.436-437	-
Totals									14,943

Data source: California Department of Fish and Game.

Community Assessment of Fish Caught By CDFG 19 Mar 2001 - 01 Dec 2011 (34 trips)

Abbreviations

Trophic Level:
- O: omnivorous (includes omnivores, herbivores, general planktivores)
- I: invertivore (includes invertivores, zooplanktivores
- I/P: carnivore (includes piscivores, large invertebrates (crayfish), amphibian, and mammalian predators

Tolerance to Degradation:
- I: intolerant
- M: moderately tolerant
- T: Tolerant

Life Style*:
- AM: amphidromous
- AN: anadromous
- E: estuarine resident
- F: freshwater resident

Status*:
- I. Native species
- A. Extinct/extirpated
- B. Threatened or endangered
- C. Special concern
- D. Watch list
- E. Stable of increasing

*Adapted from Moyle, Peter, 2002. Inland Fishes of California. University of California Press. Berkeley, California.

TABLE 2d. COMMUNITY ASSESSMENT OF FISH CAUGHT BY CDFG 2001 - 2013. SAN JOAQUIN RIVER AT HILLS FERRY (SITE H)

COMMON NAME	SCIENTIFIC NAME	ORIGIN	TROPHIC	TOLERANCE TO DEGRADATION	LIFE STYLE*	STATUS*	FROM	MOYLE REFERENCE	TOTAL SAMPLES
Mosquitofish	Gambusia affinis	Introduced	I	T	F	IIE	E USA	pp.317-321	7,162
Shrimp species		Introduced	O	M	E,F	IIE			1,110
Carp	Cyprinus carpio	Introduced	O	T	F	IIE	Europe	pp.172-175	888
White catfish	Ameiurus catus	Introduced	I/P	T	F	IID	E USA	pp.214-216	700
Red shiner	Cyprinella lutrensis	Introduced	O	T	F	IIE	M USA	pp.168-170	705
Bluegill	Lepomis macrochirus	Introduced	I	T	F	IID	M USA	pp.381-384	450
Inland silverside	Menidia beryllina	Introduced	I	M	F	IIE	SE USA	pp.307-311	441
Goldfish	Carrrassius auratus	Introduced	O	T	F	IID	Japan	pp.170-172	238
Largemouth bass	Micropterus salmoides	Introduced	P	T	F	IID	M USA	pp.397-401	200
Threadfin shad	Dorosama petenese	Introduced	I	M	F	IID	SE USA	pp.114-117	200
Spotted bass	Micropterus punctulatus	Introduced	P	M	F	IIE	SE USA	pp.404-406	189
Redear sunfish	Lepomis microlophus	Introduced	I	M	F	IID	SE USA	pp.385-386	134
Channel catfish	Ictalurus punctatus	Introduced	I/P	M	F	IID	M USA	pp.216-218	59
Green sunfish	Lepomis cyanellus	Introduced	I/P	T	F	IID	M USA	pp.389-391	59
Striped bass	Morone saxatilis	Introduced	P	M	AN	IID	E USA	pp.364-373	51
Fathead minnow	Pimephales promelas	Introduced	O	T	F	IIE	M USA	pp.166-168	36
Red crayfish	Procambarus (Scapulicambarus) clarkii	Introduced	O	T	F	IIE			36
Bigscale logperch	Percina macrolepida	Introduced	I	T	F	IID	SW USA	pp.409-411	31
Black crappie	Pomoxis nigromaculatus	Introduced	I/P	M	F	IID	M USA	pp.395-397	29
Sacramento Sucker	Catostomus occidentalis	Native	O	M	F	IF		pp.185-188	24
Sacramento Blackfish	Orthodon microlepidotus	Native	O	T	F	IE		pp.144-146	20
Bullfrog	Rana catesbeiana	Introduced	O	T		IIE			18
Tule perch	Hysteocarpus traski	Native	I	I	E,F	ID		pp.424-429	11
Smallmouth bass	Micropterus dolomieui	Introduced	I/P	M	F	IID	M USA	pp.401-404	9
Golden shiner	Notemigonus crysoleucas	Introduced	I	M	F	IIE	E USA	pp.164-166	9
Sacramento Splittail	Pogonichthys macrolepidotus	Native	O	M	E,F	IB		pp.146-150	6
Prickly sculpin	Cottus asper	Native	I	M	AM,E,F	IE		pp.346-349	5
Sacramento Pikeminnow	Ptychocheilus grandis	Native	I/P	M	F	IE		pp.154-158	5
Riffle sculpin	Cottus gulosus	Native	I	M	F	ID		pp. 350-352	4
White crappie	Pomoxis annularis	Introduced	I/P	T	F	IID	M USA	pp.393-395	3
Green x Redear	Lepomis ssp.	Introduced	I/P	T	F	IID	M USA	pp.389-391	2
Bluegill x Redear		Introduced	I	T	F	IID	M USA	pp.381-384	1
Chinook Salmon	Oncorhynchus tshawytscha	Native	I	I	AN, F	IB		pp.251-263	1
Mirror Carp	Cyprinus carpio	Introduced	O	T	F	IIE	Europe	pp.172-175	1
Turtle, pond		Introduced	O						1
Warmouth	Lepomis gulosus	Introduced	I	M	F	IIC	M USA	pp.392-393	1
American shad	Alosa sapidissima	Introduced	I	M	AN	IID	E USA	pp.117-120	-
Black bullhead	Ameiurus melas	Introduced	I/P	T	F	IID	E USA	pp.208-210	-
Brown bullhead	Ameiurus nebulosus	Introduced	I/P	T	F	IID	M USA	pp.210-212	-
California roach	Hesperoleucus symmetricus symmetricus	Native	I	M	F	ID		pp.139-144	-

TABLE 2d. COMMUNITY ASSESSMENT OF FISH CAUGHT BY CDFG 2001 - 2013. SAN JOAQUIN RIVER AT HILLS FERRY (SITE H) (CONT.)

COMMON NAME	SCIENTIFIC NAME	ORIGIN	TROPHIC	TOLERANCE TO DEGRADATION	LIFE STYLE*	STATUS*	FROM	MOYLE REFERENCE	TOTAL SAMPLES
Green sunfish/ Bluegill Hybrid									-
Hardhead	Mylopharodon conocephalus	Native	O	M	F	IC		pp.151-154	-
Hitch	Lavinia exilicauda	Native	O	M	F	ID		pp.136-139	-
Pacific lamprey	Lampetra tridentata	Native	O	T	AN, F	ID		pp.96-99	-
Pacific Staghorn sculpin	Leptocottus armatus	Native	I	M	E,F	IE		pp.361-363	-
Pumpkin Seed	Lepomis gibbosus	Introduced	I	T	F	IID		pp.387-389	-
River lamprey	Lampetra ayresi	Native	O	M	AN, F	ID		pp.101-103	-
Shimofuri goby	Tridentiger bifasciatus	Introduced	O	M	E	IIE	Japan	pp.437-440	-
Snail sp.		Introduced	O						-
Speckled dace (Sacramento)	Rhinichthys osculus carringtoni	Native	I	T	F	IE		pp.160-164	-
Threespine stick-leback	Gasterostreus aculeatus	Native	O	M	AN, E, F	IE		pp.338-343	-
Yellowfin goby	Acanthogobius flavimanus	Introduced	O	M	F	IID	E Asia	pp.436-437	-
Totals									12,839

Data source: California Department of Fish and Game.

Community Assessment of Fish Caught By CDFG 19 Mar 2001 - 01 Dec 2011 (34 trips)

Abbreviations

Trophic Level:
O: omnivorous (includes omnivores, herbivores, general planktivores)
I: invertivore (includes invertivores, zooplanktivores
I/P: carnivore (includes piscivores, large invertebrates (crayfish), amphibian, and mammalian predators

Tolerance to Degradation:
I: intolerant
M: moderately tolerant
T: Tolerant

Life Style*:
AM: amphidromous
AN: anadromous
E: estuarine resident
F: freshwater resident

Status*:
I. Native species
A. Extinct/extirpated
B. Threatened or endangered
C. Special concern
D. Watch list
E. Stable of increasing

*Adapted from Moyle, Peter, 2002. Inland Fishes of California. University of California Press. Berkeley, California.

TABLE 2e. COMMUNITY ASSESSMENT OF FISH CAUGHT BY CDFG 2013-2015. SAN JOAQUIN RIVER AT CHINA ISLAND (SITE R)

COMMON NAME	SCIENTIFIC NAME	ORIGIN	TROPHIC	TOLERANCE TO DEGRADATION	LIFE STYLE*	STATUS*	FROM	MOYLE REFERENCE	TOTAL SAMPLES
Mosquitofish	Gambusia affinis	Introduced	I	T	F	IIE	E USA	pp.317-321	1,855
Red shiner	Cyprinella lutrensis	Introduced	O	T	F	IIE	M USA	pp.168-170	132
Shrimp species		Introduced	O	M	E,F	IIE			53
Inland silverside	Menidia beryllina	Introduced	I	M	F	IIE	SE USA	pp.307-311	48
Red crayfish	Procambarus (Scapulicambarus) clarkii	Introduced	O	T	F	IIE			12
Smallmouth bass	Micropterus dolomieui	Introduced	I/P	M	F	IID	M USA	pp.401-404	2
Threadfin shad	Dorosama petenese	Introduced	I	M	F	IID	SE USA	pp.114-117	1
Largemouth bass	Micropterus salmoides	Introduced	P	T	F	IID	M USA	pp.397-401	1
Bluegill	Lepomis macrochirus	Introduced	I	T	F	IID	M USA	pp.381-384	-
Carp	Cyprinus carpio	Introduced	O	T	F	IIE	Europe	pp.172-175	-
White catfish	Ameiurus catus	Introduced	I/P	T	F	IID	E USA	pp.214-216	-
Goldfish	Carrrassius auratus	Introduced	O	T	F	IID	Japan	pp.170-172	-
Spotted bass	Micropterus punctulatus	Introduced	P	M	F	IIE	SE USA	pp.404-406	-
Redear sunfish	Lepomis microlophus	Introduced	I	M	F	IID	SE USA	pp.385-386	-
Green sunfish	Lepomis cyanellus	Introduced	I/P	T	F	IID	M USA	pp.389-391	-
Channel catfish	Ictalurus punctatus	Introduced	I/P	M	F	IID	M USA	pp.216-218	-
Striped bass	Morone saxatilis	Introduced	P	M	AN	IID	E USA	pp.364-373	-
Fathead minnow	Pimephales promelas	Introduced	O	T	F	IIE	M USA	pp.166-168	-
Black crappie	Pomoxis nigromaculatus	Introduced	I/P	M	F	IID	M USA	pp.395-397	-
Sacramento Sucker	Catostomus occidentalis	Native	O	M	F	IF		pp.185-188	-
Bigscale log-perch	Percina macrolepida	Introduced	I	T	F	IID	SW USA	pp.409-411	-
Sacramento Blackfish	Orthodon microlepidotus	Native	O	T	F	IE		pp.144-146	-
Bullfrog	Rana catesbeiana	Introduced	O	T		IIE			-
Tule perch	Hysteocarpus traski	Native	I	I	E,F	ID		pp.424-429	-
Sacramento Splittail	Pogonichthys macrolepidotus	Native	O	M	E,F	IB		pp.146-150	-
Prickly sculpin	Cottus asper	Native	I	M	AM,E,F	IE		pp.346-349	-
Sacramento Pikeminnow	Ptvychocheilus grandis	Native	I/P	M	F	IE		pp.154-158	-
Golden shiner	Notemigonus crysoleucas	Introduced	I	M	F	IIE	E USA	pp.164-166	-
Green x Redear	Lepomis ssp.	Introduced	I	M	F	IID			-
Bluegill x Redear									-
Chinook Salmon	Oncorhynchus tshawytscha	Native	I	I	AN, F	IB		pp.251-263	-
Mirror Carp	Cyprinus carpio	Introduced	O	T	F	IIE	Europe	pp.172-175	-
Turtle, pond									-
Warmouth	Lepomis gulosus	Introduced	I	M	F	IIC	M USA	pp.392-393	-
American shad	Alosa sapidissima	Introduced	I	M	AN	IID	E USA	pp.117-120	-
Black bullhead	Ameiurus melas	Introduced	I/P	T	F	IID	E USA	pp.208-210	-
Brown bullhead	Ameiurus nebulosus	Introduced	I/P	T	F	IID	M USA	pp.210-212	-
California roach	Hesperoleucus symmetricus symmetricus	Native	I	M	F	ID		pp.139-144	-

TABLE 2e. COMMUNITY ASSESSMENT OF FISH CAUGHT BY CDFG 2013-2015. SAN JOAQUIN RIVER AT CHINA ISLAND (SITE R) (CONT.)

COMMON NAME	SCIENTIFIC NAME	ORIGIN	TROPHIC	TOLERANCE TO DEGRADATION	LIFE STYLE*	STATUS*	FROM	MOYLE REFERENCE	TOTAL SAMPLES
Hardhead	Mylopharodon conocephalus	Native	O	M	F	IC		pp.151-154	-
Hitch	Lavinia exilicauda	Native	O	M	F	ID		pp.136-139	-
Pacific lamprey	Lampetra tridentata	Native	O	T	AN, F	ID		pp.96-99	-
Pacific Staghorn sculpin	Leptocottus armatus	Native	I	M	E,F	IE		pp.361-363	-
Pumpkin Seed	Lepomis gibbosus	Introduced	I	T	F	IID		pp.387-389	-
Riffle sculpin	Cottus gulosus	Native	I	M	F	ID		pp. 350-352	-
River lamprey	Lampetra ayresi	Native	O	M	AN, F	ID		pp.101-103	-
Shimofuri goby	Tridentiger bifasciatus	Introduced	O	M	E	IIE	Japan	pp.437-440	-
Snail sp.		Introduced	O						-
Speckled dace (Sacramento)	Rhinichthys osculus carringtoni	Native	I	T	F	IE		pp.160-164	-
Threespine stickleback	Gasterostreus aculeatus	Native	O	M	AN, E, F	IE		pp.338-343	-
White crappie	Pomoxis annularis	Introduced	I/P	T	F	IID	M USA	pp.393-395	-
Yellowfin goby	Acanthogobius flavimanus	Introduced	O	M	F	IID	E Asia	pp.436-437	-
Totals									2,104

Data source: California Department of Fish and Game.
Community Assessment of Fish Caught By CDFG 19 Mar 2001 - 03 Dec 2009 (33 trips)

Abbreviations

Trophic Level:
O: omnivorous (includes omnivores, herbivores, general planktivores)
I: invertivore (includes invertivores, zooplanktivores
I/P: carnivore (includes piscivores, large invertebrates (crayfish), amphibian, and mammalian predators

Tolerance to Degradation:
I: intolerant
M: moderately tolerant
T: Tolerant

Life Style*:
AM: amphidromous
AN: anadromous
E: estuarine resident
F: freshwater resident

Status*:
I. Native species
A. Extinct/extirpated
B. Threatened or endangered
C. Special concern
D. Watch list
E. Stable of increasing

*Adapted from Moyle, Peter, 2002. Inland Fishes of California. University of California Press. Berkeley, California.