Abundance and Distribution of Chinook Salmon and Other Catch in the Sacramento-San Joaquin Estuary

2009 ANNUAL REPORT
STOCKTON FISH AND WILDLIFE OFFICE
U.S. FISH AND WILDLIFE SERVICE
STOCKTON, CALIFORNIA

U.S. FISH & WILDLIFE SERVICE

DEPARTMENT OF THE INTERIOR

February 2012

USBR • USFWS • SWRCB • DFG • USGS • NMFS • USACE • USEPA • DWR

TABLE OF CONTENTS

Acknowledgments

This sampling was conducted for and funded by the Interagency Ecological Program for the Sacramento-San Joaquin Estuary. Members of the Interagency Ecological Program include three state agencies (California Department of Water Resources, California Department of Fish and Game, and State Water Resources Control Board), and six federal agencies (U.S. Bureau of Reclamation, U.S. Geological Survey, U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Army Corps of Engineers, and the U.S. Environmental Protection Agency).

We extend particular gratitude to the many biological science field technicians and boat operators who spent countless hours under all environmental conditions to collect these data.

List of Acronyms

The following acronyms have been used in the following report:

CDEC – California Data Exchange Center
CDFG – California Department of Fish & Game
CDWR – California Department of Water Resources
CNFH – Coleman National Fish Hatchery
CPUE – Catch Per Unit Effort
CVP – Central Valley Project
CWT – Coded Wire Tag
DJFMP – Delta Juvenile Fish Monitoring Program
FL – Fork Length
FRFH – Feather River Fish Hatchery
KDTR – Kodiak Trawl
MWTR – Mid-water Trawl
NMFS – National Marine Fisheries Service
RM – River Mile
SE – Standard Error
SJRGA – San Joaquin River Group Authority
STFWO – Stockton Fish & Wildlife Office
SWP – State Water Project
USFWS – United States Fish & Wildlife Service
USGS – United States Geological Survey

Introduction

The Delta Juvenile Fish Monitoring Program (DJFMP) of the Stockton Fish and Wildlife Office (STFWO) has monitored the relative abundance and distribution of juvenile Chinook salmon (*Oncorhynchus tshawytscha),* which is henceforth referred to as salmon throughout this report, in the lower Sacramento River and Delta since the mid-1970s. The program's objectives have evolved since its inception based on water management actions and endangered species listings. Prior to 1982, the program focused on monitoring juvenile salmon relative abundance and determining how reduced river flows associated with a Peripheral canal would affect the abundance, distribution and survival of juvenile salmon in the Delta. After the defeat of the Peripheral Canal proposal in1982, the program's focus was changed to evaluate the impact of through-Delta water conveyance on juvenile salmon abundance, distribution and survival. The greatest change in the program occurred in 1992-1993 in response to the Federal Endangered Species listing of winter-run salmon. The Sacramento River winter-run race was listed by the State of California as "endangered" in 1989 (CDFG 2005), and federally listed as "endangered" by the National Marine Fisheries Service (NMFS) in 1994 (NMFS 2009). The listing resulted in the Interagency Ecological Program increasing funding for the monitoring of all races of juvenile salmon in the lower Sacramento River and Delta between October 1 and June 30 of each year. Other listings of salmonids in the Central Valley followed. In 1998, the Central Valley steelhead (*Oncorhynchus mykiss)* was federally listed as "threatened" and spring-run salmon were listed as "threatened" by both the State of California and NMFS in 1999 (CDFG 2005; NMFS 2009). In response to a review of the program in 2000, the program changed its name from the Salmon Monitoring Program to the DJFMP and expanded the sampling to be year-round to increase our ability to detect trends of non-salmonid species and to document the presence or absence of juvenile salmonids in the Delta during the summer months. Although the DJFMP had historically sampled other species of juvenile fishes, it was not until 2001 that the program's objectives were broadened to reflect the value of gathering information on non-salmonid species. Past annual reports, primarily focused on juvenile salmon, have been written each year to document sampling effort and summarize findings and are available from the STFWO.

Currently, the DJFMP samples fishes throughout the year at the entry (Sacramento and Mossdale) and exit (Chipps Island) points of the Delta and at other specific sites through-out the lower Sacramento and San Joaquin Rivers, Delta, and Bay. This report focuses on unmarked juvenile salmonids and reports on catches of five other fish species of concern: delta smelt (*Hypomesus transpacificus*), longfin smelt (*Spirinchus thaleichthys)*, striped bass (*Morone saxatilis)*, threadfin shad (*Dorosoma petenense)*, and steelhead.

Field sampling and special studies for this field season (2009) were conducted between August 1, 2008 and July 31, 2009, as juveniles were reared and migrated through the lower Sacramento and San Joaquin Rivers, Delta, and Bay.

The objectives of the 2009 field season were to:

1. Determine the relative abundance, distribution, and timing of juvenile salmon migrating through the lower Sacramento and San Joaquin Rivers, Delta, and portions of the San Francisco and San Pablo Bays.

2. Report the relative abundance, distribution, and timing of non-salmonid species of concern within the Sacramento and San Joaquin Rivers, Delta, and portions of the San Francisco and San Pablo Bays.

3. Relate the relative abundance of juvenile salmon and other fish species of concern to river flow.

General Methods

Marked and Unmarked Fish

For this report juvenile salmon and steelhead with missing (i.e., clipped) adipose fins were considered marked fish. The majority of all marked juvenile salmon are hatchery reared and coded wire tagged (CWT). As a result, unmarked juvenile salmon were considered to be wild (i.e., spawned outside of a hatchery) or unmarked hatchery reared salmon. Conversely, all hatchery steelhead have their adipose fins clipped but are not necessarily CWT. As a result, unmarked juvenile steelhead were considered wild.

Race Delineation

The DJFMP conducts one of several salmon monitoring programs within the Central Valley that uses size at date of capture to estimate the race of juvenile salmon. The river size criterion used by the STFWO was developed by Frank Fisher of the California Department of Fish and Game (CDFG) in 1992 as a weekly model of juvenile salmon growth (Fisher 1992) and was later modified to a daily criterion by the California Department of Water Resources (CDWR; Greene 1992). At this time, it is the only tool used by the DJFMP to determine the race of juvenile salmon in the field. However, several problems exist regarding the validity of the size at date criterion (please see USFWS 1995). For these reasons, the race designations used in this report should be used only as a rough approximation and not interpreted as definitive. Research on various markers for genetic differentiation of races is ongoing and may help determine the true race of Central Valley salmon juveniles sampled in the future (e.g., Hedgecock et al. 2001; Greig et al. 2003). It should be noted that a different size criterion (i.e., delta size criteria) is used to distinguish race for juvenile salmon sampled at the State and Federal Fish facilities.

In this report, spring- and fall-run races were combined into a “spring-/fall-run” group due to the close overlap in size and emigration timing of the two races. However, spring-run yearlings originating from Deer or Mill Creeks are likely categorized as late fall- or winter-run based on size criteria.

Late fall-run salmon enter the Delta on their way to the Pacific Ocean either as fry in spring and summer or as smolts/yearlings in fall and winter. These different life-history characteristics within a brood year cause catches from multiple brood years to occur in one field year (August-July). As a result, in addition to total late fall-run catch, we report individuals from each brood year class for late fall-run fish.

Life Stage Delineation

In the field, juvenile salmon were classified as sac fry, fry, parr, silvery parr, smolt, and adult life stages based on external characteristics: the presence or absence of an external yolk sac, visible parr marks, or deciduous scales. However, for this report, fork length (FL) was used as a simplified classification scheme to provide a rough estimate of life stage. We defined fry as individuals ≤70 mm FL. Individuals >70 mm FL were defined as smolts based on the approximate length at which they begin undergoing behavioral and physiological changes in preparation for transition to salt water. However, because designation of life stages of juvenile salmon depends primarily on the physiological state of a fish, FL does not always define life stage accurately. Therefore, life-stage designation in this report should be interpreted only as a rough approximation.

Flow Data

Flow data for this report were obtained from the United States Geological Survey (USGS) website (USGS 2009) and the Dayflow website (CDWR 2009a). We obtained mean daily flow and calculated mean monthly flow at Colusa (River Mile (RM) 144) and Freeport (RM 48) on the lower Sacramento River and at Vernalis (RM 114) on the San Joaquin River (Figure 1a-c). Further, we obtained net Delta outflow estimates as calculated by Dayflow to estimate flow past Chipps Island towards the San Francisco Bay (Figure 1d). Water year classifications were obtained from the California Data Exchange Center (CDWR 2009b). The 2009 water year (October 2008 through September 2009) was classified as a dry year in the Sacramento Valley and below normal in the San Joaquin Valley.

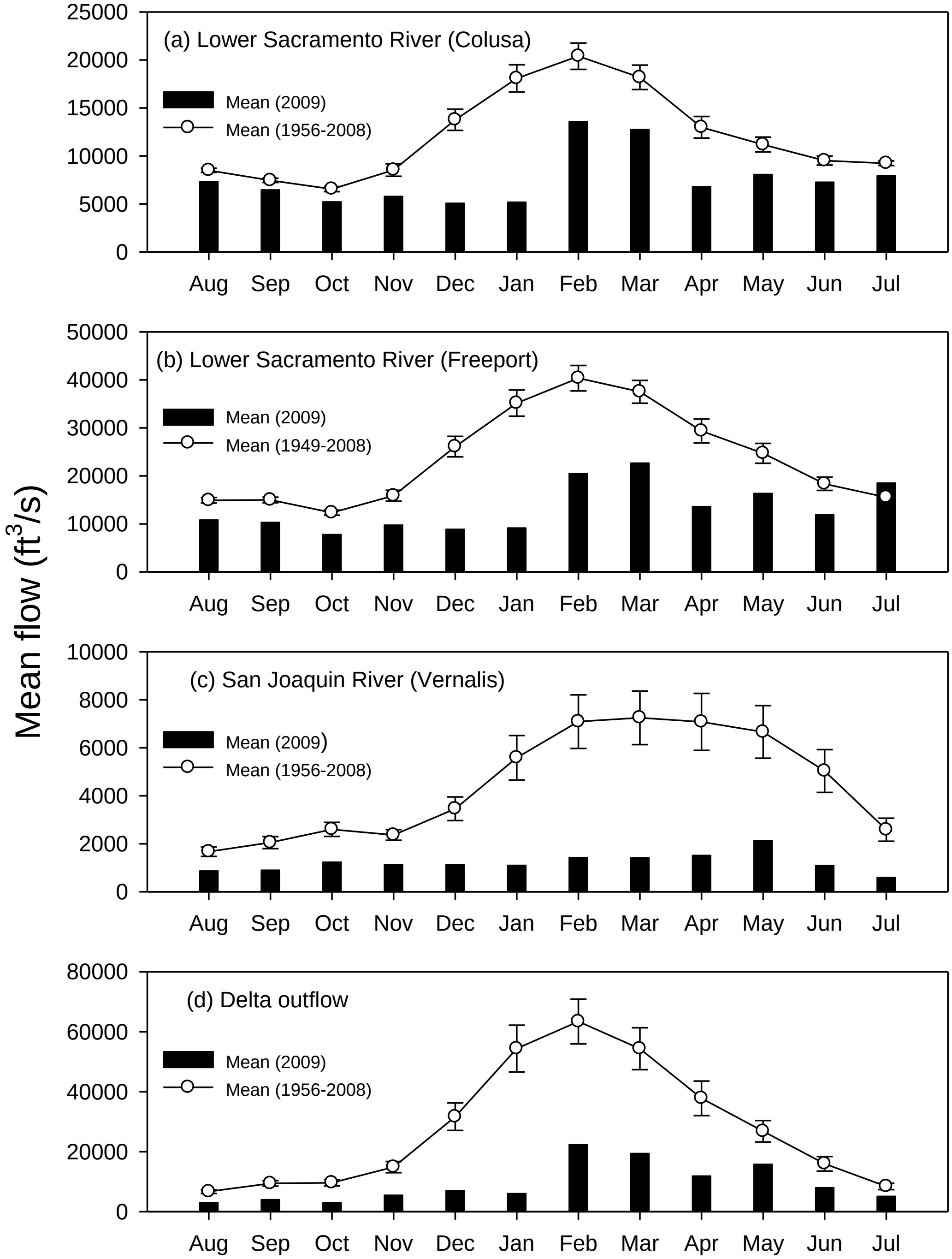

Figure 1. Mean daily flow (ft^3/s) by month for the 2009 field season on the lower Sacramento River at (a) Colusa and (b) Freeport, (c) on the San Joaquin River at Vernalis, and (d) total calculated Delta outflow near Chipps Island. Historical means for each site are included for comparative purposes. Error bars are ±1 standard error (SE).

Fish Sampling

Different sized juvenile fish have distinct spatial and temporal distributions making them vulnerable to capture by different gear types. Beach seines, mid-water trawls (MWTR), and Kodiak trawls (KDTR) were used at varying times and locations in the lower Sacramento and San Joaquin Rivers, Delta and parts of San Francisco and San Pablo Bays for assessing the relative abundance and distribution of juvenile fishes.

Monitoring Locations

The DJFMP has sampled at the majority of sites on the Sacramento River and Delta since the mid-1970s to document the relative abundance of juvenile salmon between years (Table 1; Figure 2). Sites have been added through time as more information has been needed. The sampling area is currently divided into six regions to facilitate our understanding of fish abundance throughout the system: (1) Lower Sacramento River (between Colusa and Elkhorn), (2) North Delta (Discovery Park to Antioch on the Sacramento River and the San Joaquin River), (3) Central Delta (between the San Joaquin River and Sacramento River), (4) South Delta (adjacent to and south of the confluence of the Sacramento and San Joaquin Rivers), (5) San Joaquin River (between Mossdale and the Tuolumne River) and (6) San Francisco/San Pablo Bays (downstream of Pittsburg to Tiburon in San Francisco Bay). Regions were originally established as areas where fish-movement patterns should be similar and are delineated by locations of canals or water bypasses where fish may be diverted from historical migration routes.

Additional beach seining was conducted on the Sacramento River in the lower Sacramento region between October and January to increase our sampling effort for less abundant races of juvenile salmon. This region included sites from regions 1 and 2 plus three additional sites (Miller Park, Sand Cove, and Sherwood Harbor) and was sampled three times per week. During the remainder of the year, sites at Verona and Elkhorn were grouped with region 1 and Discovery Park, American River, and Garcia Bend were grouped with region 2 sampling (Table 1).

New sites that can be accessed by land were added on the San Joaquin River Region in June 2008 between Mossdale and Tuolumne River to facilitate sampling within this region when flows in the San Joaquin River are less than 1800 ft^3/s and beach seine sites are no longer accessible by boat. These sites included Critchett Road, Durham Bridge, Sturgeon Bend Alternate, and Stanislaus RV Park. Durham Bridge and Stanislaus RV Park sampling sites were eliminated in August of 2008 because the sites were not conducive to effective beach seining.

All of our sample sites are influenced by either the Sacramento or San Joaquin Rivers. Different watersheds have different drainage patterns resulting in flow conditions specific to locality. We attempted to relate each region to the closest water flow measurement station available on USGS and Dayflow web sites (CDWR 2009a; USGS 2009). Therefore, the lower Sacramento River Region was related to the flow measured at Colusa, the San Joaquin River Region was related to the flow measured at Vernalis, the Delta Regions were related to the flow measured at Freeport, and the San Francisco/San Pablo Bays Region was related to the net Delta outflow estimates.

Table 1. Sites sampled by DJFMP during the 2009 field season organized by region. Station codes refer to body of water (first 2 letters; AR = American River, DS = Disappointment Slough, GS = Georgiana Slough, LP = Little Potato Slough, MK = Mokelumne River, MR = Middle River, MS = Mayberry Slough, OR = Old River, SA = San Francisco Bay, SB = Suisun Bay, SF = South Fork of Mokelumne River, SJ = San Joaquin River, SP=San Pablo Bay, SR = Sacramento River, SS = Steamboat Slough, TM = Three Mile Slough, WD = Werner Dredger Cut, or XC = Delta Cross Channel), River Mile (3 digits), and location within site (last letter; N = north, S = south, W = west, E = east, or M = middle). For example, Colusa State Park is on the Sacramento River (SR) at river mile 144 on the west bank (W).

Site	Station Code	Site	Station Code
Region 1. Lower Sacramento River		**Region 4. South Delta**	
Colusa State Park	SR144W	Dos Reis	SJ051E
Ward's Landing	SR138E	Dad's Point	SJ041N
South Meridian	SR130E	Lost Isle	SJ032S
Knight's Landing	SR090W	Medford Island	SJ026S
Reels Beach	SR094E	Frank's Tract	OR003W
Verona*	SR080E	Veale Tract	WD002W
Elkhorn*	SR071E	Cruiser Haven	OR014W
		Old River	OR019E
Region 2. North Delta		Union Island	OR023E
Discovery Park*	SR060E	Woodward Island	MR010W
American River*	AM001S		
Garcia Bend*	SR049E	**Region 5. San Joaquin River**	
Clarksburg	SR043W	N. of Tuolumne River	SJ083W
Steamboat Slough (mouth)	SS011N	Route 132	SJ077E
Koket	SR024E	Sturgeon Bend	SJ074W
Isleton	SR017E	Durham Site	SJ068W
Rio Vista	SR014W	Big Beach	SJ063W
Sandy Beach	SR012W	Wetherbee	SJ058W
		Mossdale	SJ056E
Region 3. Central Delta		Sturgeon Bend Aternate[c]	SJ074A
Antioch Dunes	SJ001S	Critchett Road[c]	SJ065W
B&W Marina	MK004W		
Brannan Island	TM001N	**Region 6. San Francisco/San Pablo Bays**	
Delta Cross Channel	XC001N	Berkeley Frontage Rd	SA007E
Eddo's	SJ005N	China Camp	SP001W
Georgiana Slough	GS010E	Keller Beach	SA009E
King's Island	DS002S	McNear's Beach	SP000W
Sherman Island	MS001N	Paradise Beach	SA008W
Terminous	LP003E	Point Pinole East	SP003E
Wimpy's	SF014E	San Quentin Beach	SA010W
		Tiburon Beach	SA004W
Sacramento Seine (seasonal sites)		Treasure Island	SA001M
Sand Cove	SR062E		
Sherwood Harbor	SR055E	**Trawls**	
Miller Park	SR057E	Chipps Island	SB01BM,N,&S
		Mossdale	SJ054M
		Sacramento	SR055M

* Indicates site switched to Sacramento Seine Region during periods with more intense sampling (3 days per week, Oct. – Jan.).

[c] Alternate sites sampled when San Joaquin River flows are below 1800 ft^3/s.

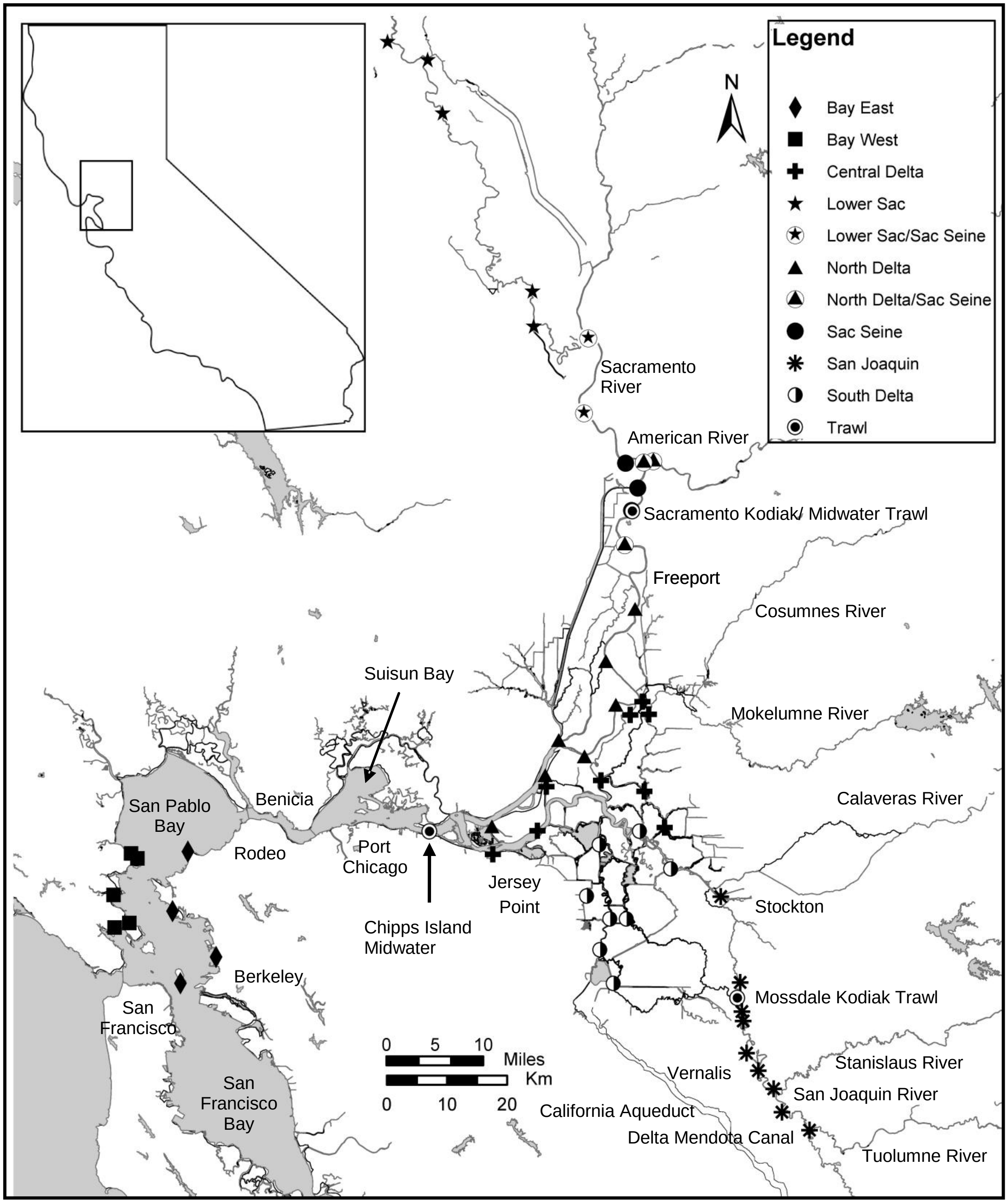

Figure 2. Trawl and beach seine sites for the 2009 field season. Sites are identified by region or gear type.

Beach Seines

Methods

Beach seining was conducted to estimate the relative abundance of near-shore benthic and pelagic juvenile fish populations. A 15 x 1.2 m (50 x 4') beach seine with 3 mm (1/8") delta square mesh and a 1.2 m (4') bag was used for all beach seining. One seine haul was conducted at each site per sample session. Sites were accessed by vehicle or small vessel.

To allow for region-specific comparisons, our goal was to seine established historical sites. In this dynamic system, occasional changes in flow, habitat, or environmental conditions prevent sampling or make it necessary to temporarily relocate sites. If new sites were needed, we attempted to relocate to an area within 100 meters of the original location containing similar habitat characteristics (i.e., substrate, vegetation). More information on sample site relocations or other sampling modifications can be found in the STFWO Metadata file at http://www.fws.gov/stockton/jfmp/datamanagement.asp.

Catches were corrected for effort by standardizing to catch-per-unit effort (CPUE; fish/10,000m^3) using the following equation:

$$Seine\ CPUE = \frac{Catch}{\frac{1}{2} Depth \times Width \times Length} \times 10{,}000 \qquad (1)$$

Effort was measured by volume of water sampled. Our measure of depth was the mean value of depth measured at the two deepest corners (Figure 3). By assuming a constant slope from shore to the corners where depth measurements were taken, we calculated the volume of the wedge of water sampled by taking ½ x depth in calculations. The units of CPUE were chosen for ease of viewing only.

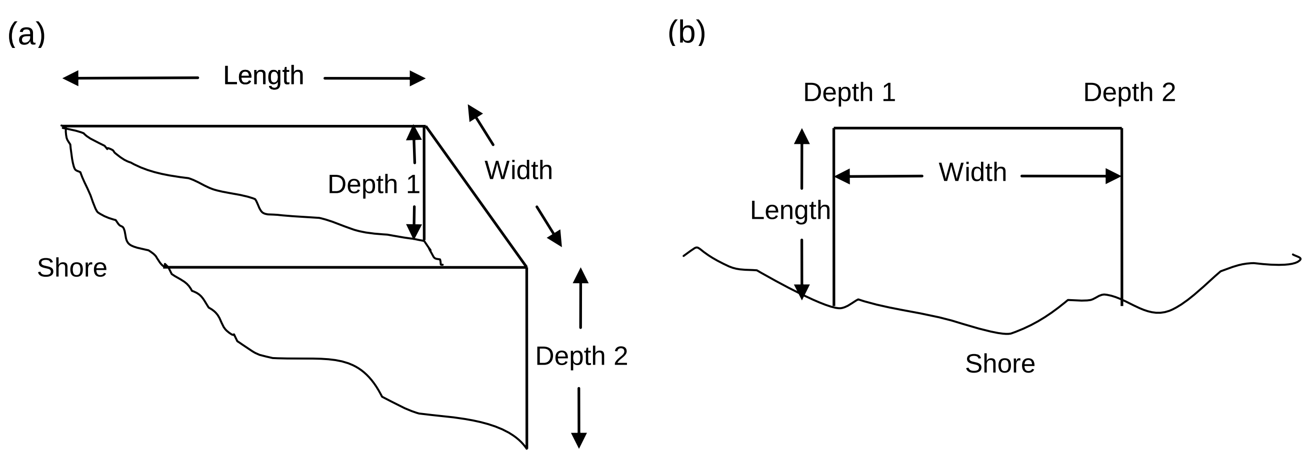

Figure 3. Schematic diagram of beach seine measurements: (a) three-dimensional view, (b) overhead view.

Mean CPUE calculations for beach seines

In all CPUE calculations, species of interest (i.e., species of concern and races of salmon (Winter, Late Fall, and Fall/Spring)) and regions were treated separately. Data from north, central, and south Delta regions were combined into a single "Delta" Region.

Because the number and location of sites sampled within a region varied within and among years, we calculated mean weekly and monthly CPUE estimates for each region. The mean weekly CPUE for each of the sites within a region were averaged yielding mean weekly CPUE for a region. To calculate mean monthly CPUE for each region, the mean weekly CPUE estimates for a region were averaged across weeks within a month. We plotted these weekly and monthly CPUE estimates against flow data of the same time period.

Region 1. Lower Sacramento River Beach Seines

Methods

Beach seining was conducted at five to seven sites per week from August 1, 2008 through July 31, 2009 for the 2009 field season to estimate densities of juvenile salmon and other juvenile fish in the lower Sacramento River. Sites were sampled one to three times per week, with more extensive sampling occurring between October 1, 2008 and January 31, 2009 when winter-run salmon were likely present in the system. In addition, two sites (Verona and Elkhorn) were regularly sampled up to three times per week during October-January as part of our Sacramento seine sampling (see below for Sacramento area beach seine).

Results

Seventeen winter-run salmon were captured in Region 1 beach seines during the 2009 field season (Figure 4a). Peak weekly CPUE was observed during the week of February 1, 2009 when six winter-run salmon were captured. During the 2009 field season, most winter-run salmon were captured between January and March. The highest average river flows were observed during the months of February and March. The mean of the weekly mean CPUE for winter-run salmon in 2009 was the fourth lowest since 1993 (Table 2a).

During the 2009 field season, 790 spring/fall-run salmon were captured in Region 1 beach seines (Figure 4b). Peak weekly CPUE occurred during the week of March 8, 2009 when 162 spring/fall-run salmon were captured, which coincided with peak flow. The mean of the weekly mean CPUE for spring/fall-run salmon in 2009 was the lowest since 1993 (Table 2b).

A total of two late fall-run salmon were captured in Region 1 beach seines during the 2009 field season (Figure 4c). Both individuals were yearlings from the 2009 brood year (Table 2c). One late fall-run salmon was caught during the weeks of May 10, 2009 and May 17, 2009. The mean of the weekly mean CPUE for late fall-run salmon in 2009 was the second lowest since 1993 (Table 2c).

Six hatchery reared steelhead were captured at Verona (SR080E) in Region1 beach seines during a period of peak river flows (February and March; Figure 5a). However, no wild steelhead were captured in Region 1.

One striped bass was captured in Region 1 beach seines during the 2009 field season. Threadfin shad were captured throughout the 2009 field season in Region 1 (n = 545 fish; Figure 5b) and peak weekly CPUE was observed during the week of July 26, 2009 when 119 individuals were captured at Knight's Landing during a period of relatively low flows (SR090W).

No delta or longfin smelt were captured in Region 1 beach seines.

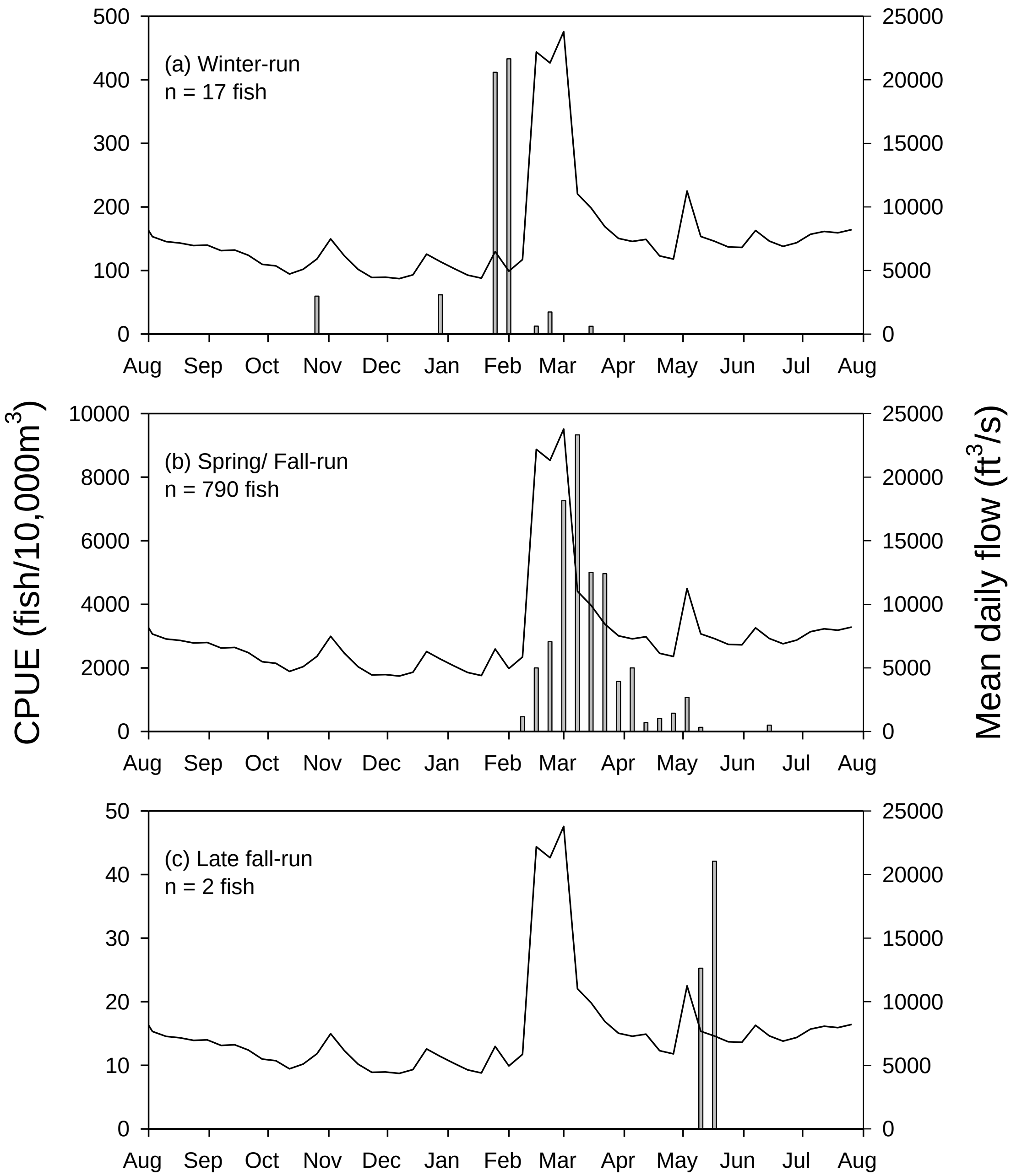

Figure 4. Mean weekly catch-per-unit effort (CPUE) of (a) winter-, (b) spring-/fall-, and (c) late fall-run salmon in beach seines and mean daily flow at Colusa in Region 1 (lower Sacramento River) during the 2009 field season. Fall- and spring-run salmon were combined because of difficulties in distinguishing between them at this size.

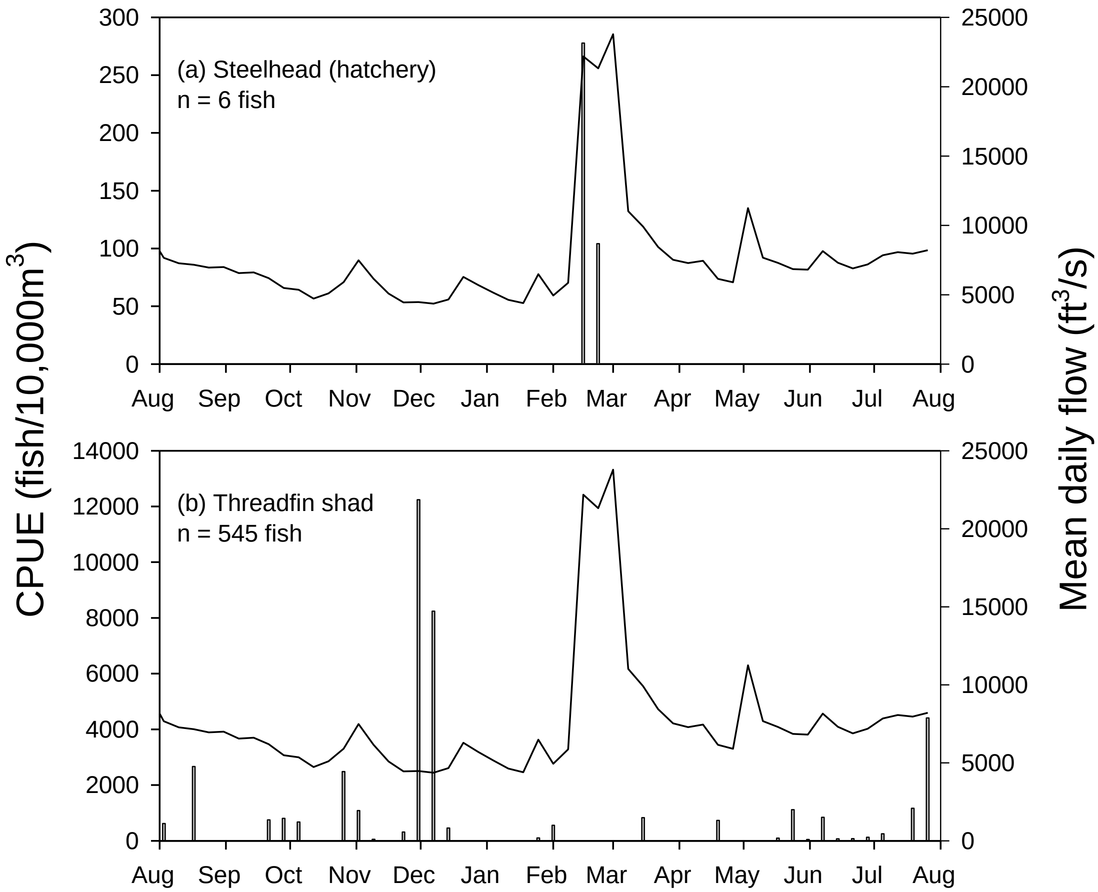

Figure 5. Mean weekly catch-per-unit effort (CPUE) of (a) steelhead, and (b) threadfin shad in beach seines and mean daily flow at Colusa in Region 1 (lower Sacramento River) during the 2009 field season.

Table 2. Summary table of CPUE (fish/10,000m^3) of (a) winter-, (b) fall-/spring-run, and (c) late fall-run salmon in Region 1 beach seines (lower Sacramento River region) by month and year. Yearly mean and standard error (SE) values were calculated using years as replicates (n = 15-16). Weekly mean and SE values were calculated using weeks as replicates (n = 44-53). Shaded boxes indicate peak monthly CPUE. Water year (CDWR 2009b): AN = above normal; BN = below normal; C = critical; D = dry; W = wet

(a) Winter-run

Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
1993	AN	--	34	0	137	112	227	224	0	0	0	0	0	73.9 (18.9)
1994	C	0	0	1.05	0	4	51.2	56.5	0	0	0	0	0	11.2 (6.65)
1995	W	0	0	0	18.5	8.56	156	37.6	49.6	0	0	0	0	17.9 (8.61)
1996	W	0	0	0	0	238	197	45.1	11.6	2.47	0	0	0	42 (16.1)
1997	W	0	0	0	0	148	0	38.6	27.0	0	0	0	0	27.6 (12.1)
1998	W	0	0	6.35	352	336	316	0	0	0	0	0	0	76.3 (32.2)
1999	W	0	35.3	0	890	415	294	153	4.96	0	0	0	0	158 (59.3)
2000	AN	0	0	0	3.31	7.26	160	42.8	0	0	0	0	0	15.6 (7.48)
2001	D	0	0	5.25	238	33.1	1780	267	0	0	0	0	0	167 (90.6)
2002	D	0	0	0	1580	1230	190	70.0	0	0	0	0	0	262 (119)
2003	AN	0	0	0	0	64.4	42	18.0	9.9	0	0	0	0	21.8 (9.89)
2004	BN	0	0	0	92.2	3050	80.7	75.0	0	0	0	0	0	310 (165)
2005	BN	0	0	0	344	781	338	32.1	13.3	0	0	0	0	184 (83.5)
2006	W	0	0	23.3	279	1467	163	66.8	4.45	0	0	0	0	182 (59.6)
2007	D	0	23.8	0	477	1071	658	332	0	0	0	0	0	192 (60.9)
2008	C	0	0	0	0	81.5	140	165	39.7	0	0	0	0	37.8 (16.9)
Yearly mean 1993-2008 (SE)		0 (0)	5.82 (3.18)	2.25 (1.49)	275.69 (106.15)	565.43 (204.10)	299.56 (106.06)	101.47 (24.49)	10.0 (3.88)	0.15 (0.15)	0 (0)	0 (0)	0 (0)	111 (24.15)
2009	D	0	0	14.88	0	15.43	103	120	2.45	0	0	0	0	19.7 (11.4)

Table 2. Continued.

(b) Spring/ Fall-run

Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
1993	AN	--	0	0	0	244	2890	2740	3570	3690	429	62.6	0	1500 (327)
1994	C	5.67	0	0.70	0	1030	1360	7420	4820	830	142	0	0	1430 (401)
1995	W	0	0	0	0	48.70	7270	7710	8530	2960	1760	207	5.43	3080 (774)
1996	W	6.58	0	0	0	1880	5940	15000	7900	2230	318	0	2.48	2790 (716)
1997	W	0	0	0	0	640	5140	3010	2950	737	58.7	4.70	0	1410 (409)
1998	W	0	0	0	0	623	6770	1500	4470	2950	2770	183	5.91	1900 (477)
1999	W	4.51	0	0	12.9	1300	8140	20900	29400	6930	627	33.9	23.5	7240 (2180)
2000	AN	0	0	0	0	183	6960	16800	11500	1820	559	13	0	3730 (1090)
2001	D	0	0	0	0	8.680	4420	18700	5320	292	35.30	22.3	0	27600 (11600)
2002	D	0	0	0	57.5	3170	16400	8730	8240	1590	90.90	0	0	40500 (1630)
2003	AN	0	0	0	0	4170	13200	14100	10800	2530	1090	0	18.1	44200 (10800)
2004	BN	0	0	0	0	5240	26600	14900	12500	2760	127	0	0	53400 (17000)
2005	AN	0	0	0	0	1020	5750	5180	5690	1900	883	107	0	23800 (5670)
2006	W	0	0	0	15.2	3611	7582	4055	3595	2183	1905	95.3	0	2726 (681)
2007	D	0	0	0	0	277	3584	20737	6126	1749	235	0	30.7	2812 (994)
2008	C	0	0	0	0	220	3760	8260	3019	623	46	0	0	1470 (470)
Yearly mean 1993-2008 (SE)		1.12 (0.61)	0 (0)	0.04 (0.04)	5.35 (3.68)	1479 (415)	7860 (1562)	10609 (1664)	8027 (1616)	2236 (393)	692 (202)	45.55 (17.01)	5.38 (2.44)	13724 (4505)
2009	D	0	0	0	0	0	0	1320	5624	815	240	50	0	732 (262)

Table 2. Continued.

(c) Late fall-run

		Previous field season's brood year								Current field season's brood year				
Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
1993	AN	--	0	2.19	6.54	26.5	4.45	2.24	0	40.2	22.6	0	0	8.75 (3.29)
1994	C	2.84	1.72	35.3	6.72	18.4	0.86	11.9	0	0	0	0	0	6.81 (3.02)
1995	W	0	0	0	9.45	21.1	22.4	0	0	0	13.6	0	0	5.27 (1.82)
1996	W	14.1	0	0	0	25.1	8.56	0	0	0	0	4.99	0	4.50 (1.90)
1997	W	0	0	0	5.79	26.3	0	0	0	0	0	0	0	4.09 (2.58)
1998	W	0	0	0	45.6	78.7	3.38	0	0	0	40.3	88.1	0	21.0 (6.58)
1999	W	11.1	0	0	308	77.4	0	0	0	49.6	24.1	0	0	39.9 (17.9)
2000	AN	0	0	0	0	0	8.28	0	0	0	0	0	0	0.478 (0.48)
2001	D	0	0	0	68.0	0	3.05	0	0	0	0	0	0	50.2 (45.1)
2002	D	0	0	0	32.7	40.2	0	0	0	0	0	0	0	69.8 (36.5)
2003	AN	0	0	0	35.3	10.1	0	0	0	0	296	0	0	140 (68.8)
2004	BN	0	0	0	0	40.7	14.7	0	0	31.4	0	0	0	77.5 (35.8)
2005	BN	0	0	10.3	9.02	29.8	0	0	0	0	419	0	0	193 (81.0)
2006	W	0	0	0	17.4	23.7	0	0	0	43.5	13.0	0	0	11.1 (5.0)
2007	D	0	0	0	54.4	71.2	0	0	0	0	0	0	0	7.90 (4.59)
2008	C	0	0	0	0	81.5	7.44	0	0	0	0	0	0	1.93 (1.35)
Yearly mean 1993-2008 (SE)		1.87 (1.15)	0.11 (0.11)	2.99 (2.25)	37.43 (18.82)	35.67 (6.82)	4.57 (1.61)	0.88 (0.75)	0 (0)	10.29 (4.68)	51.79 (30.51)	5.82 (5.49)	0 (0)	21.08 (7.58)
2009	D	0	0	0	0	0	0	0	0	0	13.47	0	0	1.30 (0.94)

Regions 2-4. Interior Delta Beach Seines (North, Central, and South Delta)

Methods

We conducted beach seining weekly at nine sites in Region 2 (North Delta), nine sites in region 3 (Central Delta), and ten sites in Region 4 (South Delta) between August 1 through July 31 during the 2009 field season. Three sites from Region 2 (Garcia Bend, American River, and Discovery Park) were sampled up to three times per week during October-January as part of our Sacramento seine sampling (see below for Sacramento area beach seine).

Results

Seven winter-run salmon were captured in Regions 2-4 beach seines during the 2009 field season (Figure 6a). Peak weekly CPUE of winter-run salmon occurred the week of January 25, 2009, which was more than 30 days prior to peak flows. Peak monthly CPUE for winter-run salmon occurred in January 2009 and was the second lowest since 1993 (Table 3a).

There were 1,096 spring/fall-run salmon captured in Regions 2-4 in 2009 (Figure 6b). Peak weekly CPUE occurred the week of March 01, 2009 seven days after peak flows. The mean of the weekly mean CPUE for 2009 was the lowest since 1993 (Table 3b). Peak monthly CPUE occurred in March 2009 and was the lowest since 1993 (Table 3b).

A total of five late fall-run sized salmon were captured in Regions 2-4 beach seines in 2009 (Figure 6c) and all five were late-fall yearlings from the 2008 brood year. Peak weekly CPUE occurred the week of May 17, 2009. Peak monthly CPUE occurred in May and was one of the lowest since 1993 (Table 3c). The mean of the weekly mean CPUE for late fall-run salmon in 2009 was the lowest since 1993 (Table 3c).

In 2009, 35 delta smelt were captured in Regions 2-4 beach seines (Figure 7a). Weekly CPUE peaked the week of August 17, 2008 when nine delta smelt were captured at Sandy Beach (SR012W). No longfin smelt were captured in Regions 2-4 beach seines during 2009.

One wild steelhead and ten hatchery reared steelhead were captured in Regions 2-4 beach seines in 2009 (Figure 7b). The wild steelhead was caught the week of March 29, 2009 at American River (AM001S). Peak weekly CPUE for hatchery steelhead occurred the week of February 22, 2009 when eight hatchery reared steelhead were captured at Wimpy's during a period of peak flows (SF014E).

In the 2009 field season, 206 striped bass were captured in Regions 2-4 beach seines (Figure 7c). Peak weekly CPUE occurred the week of June 23, 2009 when 20 striped bass were captured at Sherman Island (MS001N) during a period of increasing flows.

Threadfin shad were the most abundant non-salmonid species captured in Region 2-4 beach seines during the 2009 field season (n = 3,819 fish; Figure 7d). Peak weekly CPUE occurred during a period of relatively low flows (Figure 7d).

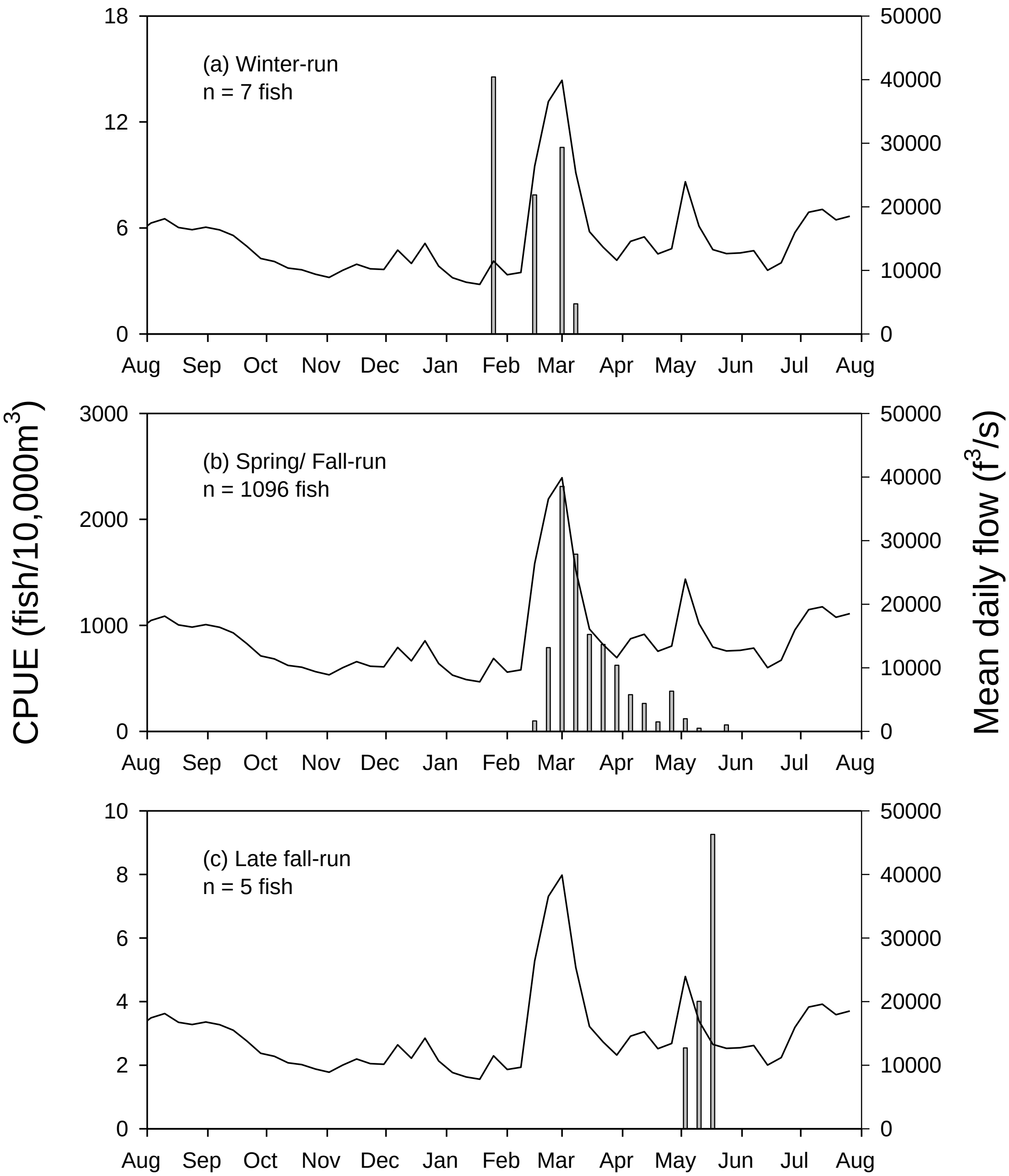

Figure 6. Mean weekly catch-per-unit effort (CPUE) of (a) winter-, (b) spring-/fall-, and (c) late fall-run salmon in beach seines and concurrent mean daily flow at Freeport in Regions 2-4 (Interior Delta; North, Central, and South) during the 2009 field season.

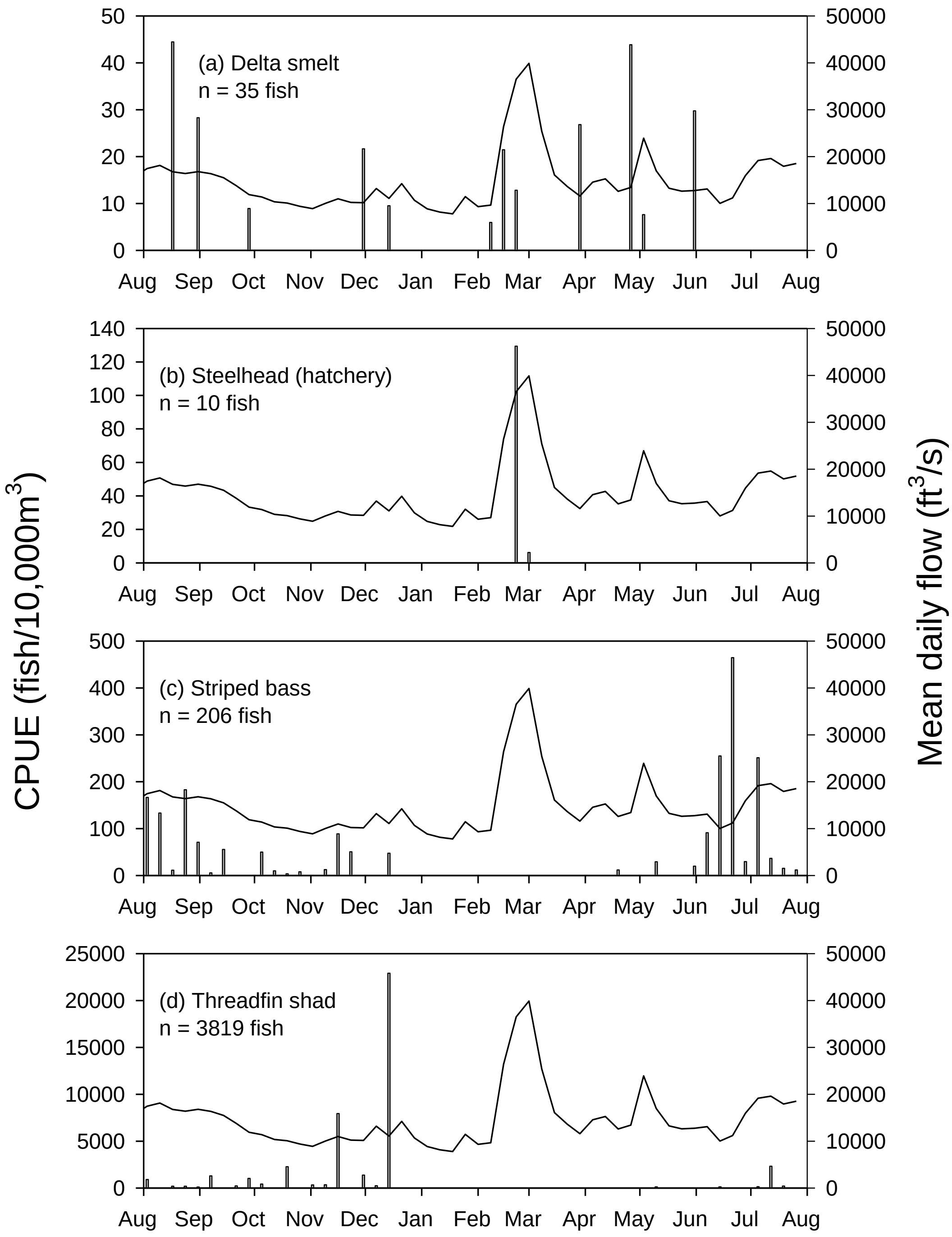

Figure 7. Mean weekly catch-per-unit effort (CPUE) of (a) Delta smelt (b) steelhead, (c) striped bass, and (d) threadfin shad in beach seines and mean daily flow at Freeport in Regions 2-4 (Interior Delta; North, Central, and South) during the 2009 field season.

Table 3. Summary table of CPUE (fish/10,000m^3) of (a) winter-, (b) fall-/spring-run, and (c) late fall-run salmon in Regions 2-4 beach seines (Interior Delta; North, Central, and South) combined by month and year. Yearly mean and standard error (SE) values were calculated using years as replicates (n = 14-16). Weekly mean and SE values were calculated using weeks as replicates (n = 39-53). Shaded boxes indicate peak monthly CPUE. Water year (CDWR 2009b): AN = above normal; BN = below normal; C = critical; D = dry; W = wet.

(a) Winter-run

Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
1993	AN	--	0	0	37.7	8.78	58.0	35.1	6.61	0	0	0	--	19.6 (7.76)
1994	C	--	0	0	0	0	0	4.67	0	0	0	0	0	0.55 (0.55)
1995	W	0	0	0	0	0	9.76	4.16	0.43	0	0	0	0	1.38 (0.56)
1996	W	0	0	0	0	33	27.5	17.2	1.99	3.22	0	0	0	7.85 (2.63)
1997	W	0	0	0	0.25	7.91	7.59	2.82	13.4	0	0	0	0	3.94 (1.63)
1998	W	0	0	0	2.07	44.7	48.4	5.84	3.96	0	0	0	0	9.49 (4.04)
1999	W	0	3.94	1.85	41.7	66.9	17.1	12.2	12.7	0	0	0	0	20.2 (7.96)
2000	AN	0	0	0	0	2.98	36.8	29.87	19.0	0	0	0	0	7.15 (2.87)
2001	D	1.16	0	0	0.48	0	5.67	14.7	8.56	0	0	0	0	3.56 (1.08)
2002	D	0	0	0	51.8	125	44.1	6.44	0	0	0	0	0	32.10 (13.6)
2003	AN	0	0	0	0	31	36.1	12.1	0	0	0	0	0	10.2 (4.05)
2004	BN	0	0	0	0	80	29.3	44.6	1.60	0	0	0	0	18.9 (6.63)
2005	BN	0	0	0	0.89	33.8	49.1	24.3	4.34	0	0	0	0	18.6 (7.80)
2006	W	0	0	2.97	45.2	151	31.2	5.42	6.41	1.53	0	0	0	25.8 (8.9)
2007	D	0	4.10	1.47	0.79	35.4	4.45	73.4	0	0	0	0	0	12.2 (7.58)
2008	C	0	0	0	0	0	5.64	4.89	1.51	0	0	0	0	1.24 (0.59)
Yearly mean 1993-2008 (SE)		0.08 (0.08)	0.50 (0.34)	0.39 (0.22)	11.31 (4.94)	38.78 (11.52)	25.67 (4.70)	18.61 (4.80)	5.03 (1.44)	0.30 (0.22)	0 (0)	0 (0)	0 (0)	12.05 (2.38)
2009	D	0	0	0	0	0	3.64	1.97	2.45	0	0	0	0	0.67 (0.37)

Table 3. Continued.

(b) Spring-/fall-run

Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
1993	AN	--	0	0	0	41.6	1320	1630	4960	2670	405	124	--	1240 (346)
1994	C	--	0	0	6.64	36.3	325	4000	1430	496	53	2.58	0	723 (150)
1995	W	0	1.93	0	0	31.1	8760	5260	6350	2640	499	65.9	2.81	2560 (876)
1996	W	0	0	0	0	894	3300	9260	5360	1780	327	16	8.23	1960 (511)
1997	W	0	0	0	0	1000	2490	2640	2170	886	83.5	5.54	0	961 (206)
1998	W	1.56	0	0	0	60.4	4620	7690	4990	2710	754	121	0	1820 (425)
1999	W	0	0	0	13.6	429	3100	6870	7980	2770	572	51.3	0.86	2080 (495)
2000	AN	0	5.79	0	0	4.42	7340	34400	8970	3840	445	2.24	0	4860 (1640)
2001	D	0	14.9	12.4	0	1.19	1610	3820	40900	398	64.2	4.93	1.37	21000 (6170)
2002	D	0	0	0	11.2	519	2190	2470	4180	460	212	19	1.67	19600 (5130)
2003	AN	0	0	0	0	420	5150	8430	2240	603	394	33.7	1.02	35700 (11900)
2004	BN	0	0	0	0	1078	4980	6880	6880	1670	389	13.8	0	49200 (10600)
2005	BN	0	0	0	0	181	2060	3840	3810	2530	661	114	3.19	30100 (6230)
2006	W	0	0	0	0.51	1080	2710	3860	6640	6930	585	92.3	0	2724 (640)
2007	D	0	0	0	0	64.8	401	5420	2860	249	275	0	0	862 (361)
2008	C	0	0	0	0	3.29	1160	1930	1390	93.5	67.2	3.31	0	430 (118)
Yearly mean 1993-2008 (SE)		0.11 (0.11)	1.41 (0.97)	0.78 (0.78)	1.99 (1.10)	365 (105)	3220 (600)	6775 (1932)	6944 (2336)	1920 (443)	362 (55.76)	41.85 (11.64)	1.28 (0.57)	10989 (3845)
2009	D	0	0	0	0	0	0	223	1268	270	41.7	0	0	164 (60)

Table 3. Continued.

(c) Late fall-run

	Previous field season's brood year									Current field season's Brood year				
Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
1993	AN	--	0	0	4.82	3.83	5.14	0	0	9.51	1.44	5.61	--	3.92 (1.47)
1994	C	--	0	0	0	6.12	6.65	0	0	0	0	0	0	1.39 (0.81)
1995	W	0	0	0	0.23	8.63	11.4	2.41	0	3.99	10.3	0	0	2.77 (1.14)
1996	W	0	0	0	0	1.79	0.61	0.88	0	2.31	17.1	0	1.39	1.77 (0.83)
1997	W	0	0	0	3.47	3.01	9.08	0	0	0	2.39	0	0	3.32 (2.4)
1998	W	0	0	0	1.5	7.79	0	0	0	73.1	13.3	7.81	0	9.38 (4.99)
1999	W	0	0	0.99	10.5	13.5	1.39	0	0	44.7	4.79	0	0	8.80 (3.82)
2000	AN	0	0	0	0	6.09	0	3.90	0	0	2.47	0	0	1.19 (0.55)
2001	D	0	0	0	0	1.39	0	0	0	3.80	0	0	0	17.5 (8.88)
2002	D	0	0	0	4.71	19.0	0	0	0	0	0	13.9	1.82	102 (36.8)
2003	AN	0	0	0	0	0	0	0	0	10.8	118	0	0	240 (146)
2004	BN	0	0	0	0	3.03	0	0	0	50.1	8.47	0	0	122 (50.6)
2005	BN	0	0	0	0	1.76	0	0	0	48.8	15.2	12.8	0	187 (62.7)
2006	W	0	0	0	1.49	4.22	0	0	0	226	25.9	1.54	1.09	37.1 (16.2)
2007	D	0	0	0	0	0.34	2.6	0	0	3.92	0	0	0	0.69 (0.46)
2008	C	4.13	0	0	0	3.92	0	0	0	0	0	0	0	0.84 (0.46)
Yearly mean 1993-2008 (SE)		0.30 (0.30)	0 (0)	0.06 (0.06)	1.67 (0.73)	5.28 (1.26)	2.31 (0.93)	0.45 (0.28)	0 (0)	29.81 (14.34)	13.71 (7.22)	2.60 (1.20)	0.29 (0.16)	46.23 (18.88)
2009	D	0	0	0	0	0	0	0	0	0	3.16	0	0	0.30 (0.20)

Region 5. Lower San Joaquin River Beach Seines

Methods

The San Joaquin River beach seine sampling began in 1994 to document the distribution and abundance of juvenile salmon in the San Joaquin River. Prior to 2000, sampling on the San Joaquin River was typically conducted from January to June of each year. Starting in 2000, sampling was conducted year-round. In 2009, sampling at most sites was conducted once every other week from July through December and once a week from December through June of each field season. Beach seining was conducted at two to seven sites per sampling event during the 2009 field season.

Spring-run salmon were extirpated from three San Joaquin River tributaries (Stanislaus, Tuolumne, and Merced Rivers) and from the mainstem by the late 1940s because of dam construction (Fry 1961; Yoshiyama et al. 1998). As a result, all juvenile salmon in the San Joaquin River are classified in this report as fall-run salmon regardless of their size at a given date.

Results

No fall-run salmon, delta smelt, longfin smelt, or steelhead were captured in Region 5 beach seines during the 2009 field season (Table 4).

A total of 28 striped bass were captured in Region 5 beach seines (Figure 8a). Peak weekly CPUE occurred the week of July 26, 2009 when 12 striped bass were captured, 11 at Mossdale (SJ056E) and one at Weatherbee (SJ058W), during a period of low flows (Figure 8a).

Sixty eight threadfin shad were captured in Region 5 during the 2009 field season (Figure 8b). Peak weekly CPUE occurred April 19, 2009 and June 07, 2009 when 17 threadfin shad were captured during each week. The majority of threadfin shad were captured before and after during peak flows that occurred in May.

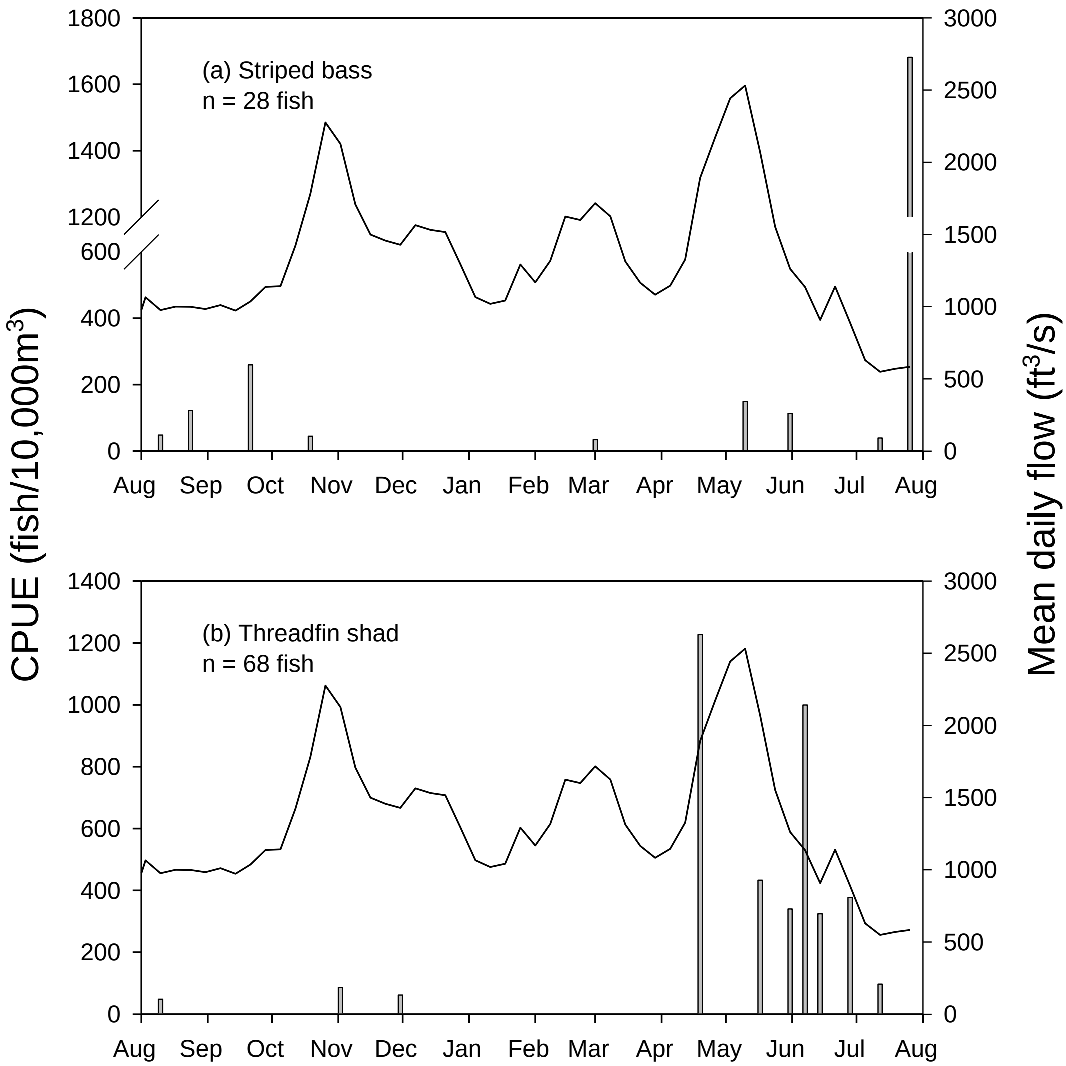

Figure 8. Mean weekly catch-per-unit effort (CPUE) of (a) striped bass and (b) threadfin shad in beach seines and mean daily flow at Vernalis in Region 5 (San Joaquin River) during the 2009 field season.

Table 4. Summary table of CPUE (fish/10,000m^3) of fall-run salmon in Region 5 beach seines (San Joaquin River) by month and year. Yearly mean and standard error (SE) values were calculated using years as replicates (n = 9-15). Weekly mean and SE values were calculated using weeks as replicates (n = 10 - 40). Shaded boxes indicate peak monthly CPUE. Water year (CDWR 2009b): AN = above normal; BN = below normal; C = critical; D = dry; W = wet.

Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
1994	C	--	--	--	--	--	--	--	0	453	0	0	--	189 (150)
1995	W	--	--	--	--	--	--	190	332	0	32.6	154	--	131 (44)
1996	W	--	--	--	--	--	0	42.1	9.08	99.8	0	0	--	287 (12.9)
1997	W	--	--	--	--	--	0	0	416	161	0	0	--	244 (182)
1998	W	--	--	--	--	--	899	4100	167	448	22.3	0	--	707 (210)
1999	AN	--	--	--	--	--	1650	6330	2420	753	110	19.8	--	1700 (480)
2000	AN	0	0	0	0	0	0	641	734	247	59.5	0	0	182 (53.7)
2001	D	0	0	0	0	0	0	12.1	998	39.5	24.3	0	0	647 (445)
2002	D	0	0	0	0	0	43.4	0	8.5	0	8.50	0	0	18.90 (10.8)
2003	BN	0	0	0	0	0	0	45.5	14.9	6.61	0	0	0	34.80 (18.8)
2004	D	0	0	0	0	0	0	19.8	127	8.88	0	0	0	89.50 (49.5)
2005	W	0	0	0	0	0	10.6	309	71.8	47.9	0	0	0	179 (84.3)
2006	W	0	0	0	0	50.1	101	314	859	65.7	0	0	0	202 (60.2)
2007	C	0	0	0	0	0	0	0	15.40	0	0	0	0	1.92 (1.35)
2008	C	0	0	0	0	0	19.8	0	0	10.8	0	0	0	3.09 (2.17)
Yearly mean 1994-2008 (SE)		0 (0)	0 (0)	0 (0)	0 (0)	5.57 (5.57)	210 (138)	857 (509)	412 (168)	156 (58.26)	17.15 (8.00)	11.59 (10.26)	0 (0)	308 (113)
2009	BN	0	0	0	0	0	0	0	0	0	0	0	0	0 (0)

Region 6. San Francisco/San Pablo Bay Beach Seines

Methods

Beach seining in the San Francisco and San Pablo Bays was originally conducted by the DJFMP between December and May during 1980-1982. The CDFG also sampled monthly year-round in the bays during 1980-1986, but no sampling was conducted during 1987-1996. Beach seining was resumed by the DJFMP in 1997 to document the presence of juvenile salmon fry in downstream bays between December and May.

Seining was conducted year-round for the first time by the DJFMP in the 2000 field season. Ten seine sites were separated into two seine routes of five sites sampled per week (Figure 2). As a result, each individual site was sampled once every two weeks. In the 2003 field season, one site was eliminated (Pt. Molate, SP000E) based on inaccessibility. Data from 2009 are presented in biweekly increments in an attempt to include all sites in calculations. Sites sampled during 2009 were a subset of those sampled by CDFG in the 1980s (Orsi 1999).

Results

We did not capture any salmon, steelhead, delta smelt, or threadfin shad in Region 6 beach seines during the 2009 field season (Table 5). A total of one longfin smelt and one striped bass were captured in Region 6 beach seines in 2009. Both individuals were captured during the week of January 01, 2009 at China Camp (SP001W).

Table 5. Summary table of CPUE (fish/10,000m^3) of spring-/fall-run salmon in Region 6 beach seines (San Francisco/San Pablo Bays) by month and year. Yearly mean and standard error (SE) values were calculated using years as replicates (n = 6-7 for 1981-1987; n = 9-12 for 1997-2008). Weekly mean and SE values were calculated using one week periods as replicates (n = 5-18) for 1981-1987 data and two week periods as replicates for 1997-2008 data (n = 4-52). Calculations of SE were not possible when n = 1. Data from 1980-1986 were collected by the CDFG; data from 1997-2009 were collected by the STFWO. No race other than spring-/fall-run has ever been collected in bay seines in this sampling. Shaded boxes indicate peak monthly CPUE. Water year (CDEC, 2009): AN = above normal; BN = below normal; D = dry; W = wet.

Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
1981	D	0	0	0	0	0	0	260	28.4	520	77.7	0	0	74.4 (41.6)
1982	W	0	0	0	0	0	24.4	206	28.6	47.4	6.31	2.72	0	27.2 (15)
1983	W	0	0	0	0	0	0	302	477	215	63.3	55.8	61.3	74.5 (34.7)
1984	W	0	0	0	0	0	15.3	0	0	0	0	1.86	55.8	8.71 (5.66)
1985	D	0	0	0	0	0	0	0	0	0	0	0	0	0 (0)
1986	W	0	55.6	0	0	0	43.3	768	52.4	22.9	8.65	7.44	0	57.7 (44.7)
1987	D	0	0	0	0	0	--	--	--	--	--	--	--	0 (0)
Yearly mean 1981-1987 (SE)		0 (0)	7.94 (7.94)	0 (0)	0 (0)	0 (0)	13.8 (7.20)	256 (115)	97.70 (76.20)	134 (83.80)	26 (14.30)	11.30 (8.96)	19.50 (12.40)	34.6 (12.7)
1997	W	--	--	--	--	--	88.9	93	13	--	--	--	--	64.3 (37)
1998	W	--	--	--	--	--	239	385	240	--	--	--	--	280 (97.7)
1999	W	--	--	--	0	0	0	21.8	37.9	15.2	5.56	0	0	9.88 (4.95)
2000	AN	0	0	0	0	0	0	29.9	22.2	6.31	0	0	0	5.31 (3.19)
2001	D	0	0	0	0	0	0	0	0	0	40.2	0	0	33 (19.4)
2002	D	0	0	0	0	0	4.88	0	0	0	0	0	0	5.43 (5.43)
2003	AN	0	0	0	0	0	0	0	0	0	0	4.12	0	2.74 (2.74)
2004	BN	0	0	0	0	0	5.41	0	380	56.1	12.2	0	0	332 (188)
2005	BN	0	0	0	0	0	0	0	0	0	7.72	0	0	4.75 (4.75)
2006	W	0	0	0	0	0	279	19.1	20.6	24.5	34.2	41.2	0	34.6 (17.3)
2007	D	0	0	0	0	0	0	0	0	0	0	0	0	0 (0)
2008	C	0	0	0	0	0	0	0	0	0	0	0	0	0 (0)
Yearly avg. 1997-2008 (SE)		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	51.43 (29.02)	45.73 (31.80)	59.48 (35.04)	10.21 (5.75)	9.99 (4.75)	4.53 (4.09)	0 (0)	64.33 (33.21)
2009	D	0	0	0	0	0	0	0	0	0	0	0	0	0 (0)

Sacramento Area Beach Seines

Methods

Starting in the 1994 field season, sampling intensity was increased during October-January at eight sites near the city of Sacramento. The goal was to increase detection of entry into the Delta by less common races and life stages of juvenile salmon, particularly winter-run fry and winter, spring, and late fall-run yearlings. This effort was put forth in order to provide additional information to managers of water-project operations (i.e., Delta Cross Channel). Two sites were chosen from the lower Sacramento region (Elkhorn and Verona), three from the North Delta region (American River, Discovery Park, and Garcia Bend) and three additional sites (Sherwood Harbor, Miller Park, and Sand Cove), all of which were on the Sacramento River (Table 1: Figure 2). Sampling was conducted up to three times per week during October-January during the 2009 field season. Because the goal of seining in the Sacramento area was to target less common juvenile salmon races, we separated spring-run sized from fall-run sized fish and do not report on fall-run sized individuals.

Results

No winter-run fry or yearling salmon were captured in the Sacramento area beach seines in the 2009 field season (Table 6a-b).

In 2009, we captured one spring-run fry salmon in Sacramento area beach seines (January 18, 2009; Table 6c). No spring-run yearling salmon were captured (Table 6d).

Consistent with previous years of Sacramento area beach seines, there were no late fall-run salmon fry captured between October and January of field season 2009 (Table 6e). There were two late fall-run salmon yearlings captured from early November through late December (Table 6f).

No steelhead, delta smelt, striped bass, or longfin smelt were captured in Sacramento area beach seines during the 2009 field season. We did capture 24 threadfin shad from October through December (Figure 9). Peak weekly CPUE of threadfin shad occurred the week of November 02, 2008 during a period of relatively low flows.

Table 6. Summary table of CPUE (fish/10,000m^3) of less common juvenile salmon races by age class during the 1995-2009 field seasons in Sacramento area beach seines by month and year. Yearly mean and standard error (SE) values were calculated using years as replicates (n = 7-14). Weekly mean and SE values were calculated using weeks as replicates (n = 12-24). Shaded boxes indicate peak monthly CPUE. Water year (CDEC, 2009): AN = above normal; BN = below normal; D = dry; W = wet

(a) Winter-run fry

Field Season	Water year	Oct	Nov	Dec	Jan	Feb	Weekly mean (SE)
1995	W	0	0	0	2.63	0	0.75 (0.75)
1996	W	0	0	49.7	2.48	0	10.9 (8.69)
1997	W	0	0	16.5	0	0	4.19 (2.91)
1998	W	0	34.8	56.2	6.39	0	17.2 (9.75)
1999	W	6.94	223	137	9.77	0	86 (51.7)
2000	AN	0	3.31	2.21	3.34	0	1.75 (0.97)
2001	D	4.59	7.19	0	0	0	6.36 (5.05)
2002	D	3.09	365	689	112	--	376 (176)
2003	AN	0	0	34.4	18.8	--	22.0 (9.88)
2004	BN	0	7.49	693	3.23	--	283 (192)
2005	BN	2.0	58.1	72.5	12.6	--	43.9 (15.9)
2006	W	11.1	145	423	13.7	--	121 (47.2)
2007	D	14.2	6.05	222	4.54	--	49.8 (29.5)
2008	C	1.83	0	0	0	--	0.44 (0.44)
Yearly mean 1995-2008 (SE)		3.13 (1.23)	60.71 (29.38)	171 (66.48)	13.53 (7.73)	0 (0)	73.09 (30.93)
2009	D	0	0	0	0	--	0 (0)

(b) Winter-run yearlings

Field Season	Water year	Oct	Nov	Dec	Jan	Feb	Weekly mean (SE)
1995	W	0	0	2.58	57.7	12.6	19 (7.78)
1996	W	0	0	157	74.3	90.5	65.7 (22.3)
1997	W	0	0.89	128	8.13	17.8	44.8 (18.7)
1998	W	0	57.1	153	189	0	79.2 (28.2)
1999	W	0	169	239	96	177	148 (44.1)
2000	AN	0	0	4.47	92.7	28.2	22.2 (11.1)
2001	D	0	0	0	103	205	122 (64.6)
2002	D	0	59.6	174	126	--	104 (32)
2003	AN	0	0	90	89.2	--	51.9 (20.1)
2004	BN	0	3.97	519	43.7	--	207 (116)
2005	BN	0	12.1	259	264	--	175 (66.1)
2006	W	0	24.4	200	122	--	146 (55.7)
2007	D	0	0	195	9.92	--	38.4 (21.1)
2008	C	0	0	0	88.2	--	22.4 (16.3)
Yearly mean 1995-2008 (SE)		0 (0)	23.36 (12.51)	152 (37.29)	97.42 (17.91)	75.87 (31.82)	88.97 (16.52)
2009	D	0	0	0	0	--	0 (0)

Table 6. Continued.

(c) Spring-run fry

Field Season	Water year	Oct	Nov	Dec	Jan	Feb	Weekly mean (SE)
1995	W	0	0	50.7	332	756	234 (79.5)
1996	W	0	0	415	568	224	276 (77.9)
1997	W	0	0	593	1010	451	488 (130)
1998	W	0	0	335	208	0	116 (38)
1999	W	0	39.2	435	149	137	163 (44.4)
2000	AN	0	0	63.4	450	336	177 (52.9)
2001	D	0	0	1.58	29.4	29.8	28.1 (11.1)
2002	D	0	74.2	587	261	--	278 (74.6)
2003	AN	0	0	529	737	--	460 (148)
2004	BN	0	0	1340	293	--	622 (277)
2005	BN	0	0	716	224	--	288 (119)
2006	W	0	18.5	415	700	--	261 (87.8)
2007	D	0	0	98.6	100	--	51.7 (20.6)
2008	C	0	0	11.9	38.6	--	17.3 (9.51)
Yearly mean 1995-2008 (SE)		0 (0)	9.42 (5.81)	399 (97.04)	364 (78.19)	276 (100)	247 (47.80)
2009	D	0	0	0	4.73	--	1.05 (1.05)

(d) Spring-run yearlings

Field Season	Water year	Oct	Nov	Dec	Jan	Feb	Weekly mean (SE)
1995	W	0	0	0	0	14.7	2.84 (2.00)
1996	W	0	0	0	0	8.24	2.02 (1.34)
1997	W	0	0	0	0	27.5	3.95 (3.37)
1998	W	0	0	0	0	0	0 (0)
1999	W	0	0	0	0	0	0 (0)
2000	AN	0	0	0	0	0	0 (0)
2001	D	0	0	0	0	0	0 (0)
2002	D	0	0	0	0	--	0 (0)
2003	AN	0	0	0	0	--	0 (0)
2004	BN	0	0	0	0	--	0 (0)
2005	BN	0	0	0	0	--	0 (0)
2006	W	0	0	0	0	--	0 (0)
2007	D	0	0	0	0	--	0 (0)
2008	C	0	0	0	0	--	0 (0)
Yearly mean 1995-2008 (SE)		0 (0)	0 (0)	0 (0)	0 (0)	7.21 (4.01)	0.63 (0.35)
2009	D	0	0	0	0	--	0 (0)

Table 6. Continued.

(e) Late fall-run fry

Field Season	Water year	Oct	Nov	Dec	Jan	Feb	Weekly mean (SE)
1995	W	0	0	0	0	0	0 (0)
1996	W	0	0	0	0	0	0 (0)
1997	W	0	0	0	0	0	0 (0)
1998	W	0	0	0	0	0	0 (0)
1999	W	0	0	0	0	0	0 (0)
2000	AN	0	0	0	0	0	0 (0)
2001	D	0	0	0	0	0	0 (0)
2002	D	0	0	0	0	--	0 (0)
2003	AN	0	0	0	0	--	0 (0)
2004	BN	0	0	0	0	--	0 (0)
2005	BN	0	0	0	0	--	0 (0)
2006	W	0	0	0	0	--	0 (0)
2007	D	0	0	0	0	--	0 (0)
2008	C	0	0	0	0	--	0 (0)
Yearly mean 1995-2008 (SE)		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
2009	D	0	0	0	0	--	0 (0)

(f) Late fall-run yearlings

Field Season	Water year	Oct	Nov	Dec	Jan	Feb	Weekly mean (SE)
1995	W	0	0.61	33.4	35.0	0	13.20 (5.20)
1996	W	0	0	22.5	4.02	3.53	6.07 (3.82)
1997	W	0	5.82	29	0	0	9.37 (4.83)
1998	W	0	5.24	43.2	3.38	0	9.40 (5.77)
1999	W	3.72	78.6	73.6	2.63	0	35.90 (19.3)
2000	AN	0	0	9.14	0	0	1.63 (1.31)
2001	D	0	0	8.07	6.19	0	3.19 (1.52)
2002	D	0	22.17	34.6	6.8	--	17.60 (7.06)
2003	AN	0	0	1.16	0	--	0.31 (0.31)
2004	BN	0	0	35.7	3.28	--	14.50 (7.79)
2005	BN	2.53	2.98	23.5	0	--	8.38 (4.64)
2006	W	0	7.67	9.49	0	--	3.20 (1.90)
2007	D	0	0	12.8	11.4	--	6.13 (3.09)
2008	C	0	0	19.6	6.8	--	4.80 (3.11)
Yearly mean 1995-2008 (SE)		0.45 (0.31)	8.79 (5.60)	25.41 (4.98)	5.68 (2.44)	0.50 (0.50)	9.55 (2.43)
2009	D	0	2.12	2.06	0	--	1.05 (0.72)

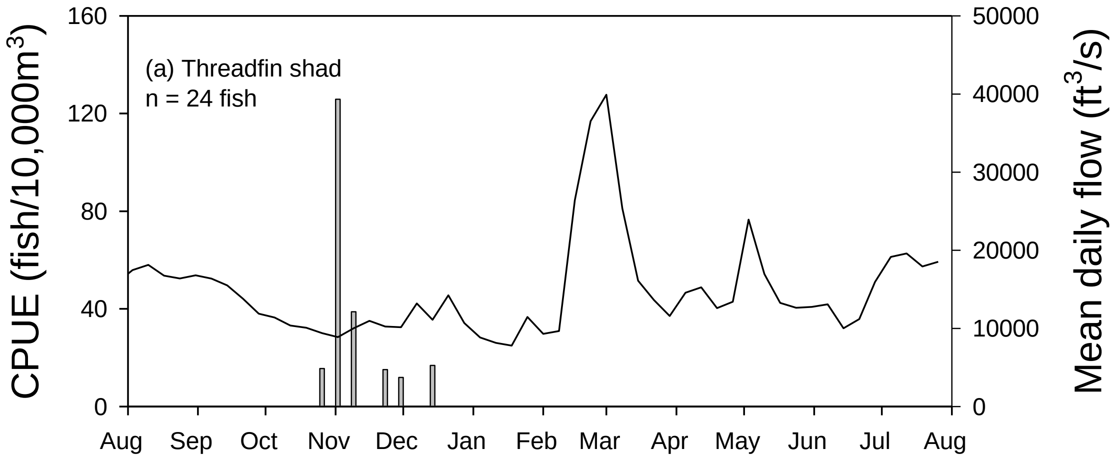

Figure 9. Mean weekly catch-per-unit effort (CPUE) of threadfin shad in Sacramento area beach seines and concurrent mean daily flow at Freeport in the Sacramento River during the 2009 field season.

Trawls

Methods

The MWTR net was used to estimate the relative abundance of juvenile fishes that are assumed to use the top portion of the water column. Different sized MWTR nets were used depending on the site. Although called a “mid-water trawl,” the net was actually towed in the top few meters of the water column.

The MWTR net used at Sacramento is composed of six panels, each decreasing in mesh size towards the cod end (Figure 10). Mesh size ranged from 20.3 cm (8”) stretch at the mouth to 0.6 cm (1/4”) stretch just before the cod end. The cod end was composed of 0.3 cm (1/8”) weave mesh. The fully extended mouth size was 4.57 x 1.83 m (15 x 6'). Depressors were made of 0.7 cm (1/4”) stainless steel (one on each side of the net lead line) and attached to the net with shackles to spread the bottom line of the mouth. Hydrofoils were made of 0.7 cm (1/4”) aluminum plates with split floats (one on each side of the net float line) and attached to the net with shackles to spread the top of the net at the surface. On each side, the depressor and hydrofoil were connected to the boat using two 30.5 m (100’) Amsteel rope bridles (0.6 cm diameter). Bridles were attached to 61 m (200’) Amsteel rope backing (1 cm diameter) using 0.8 cm (5/16”) stainless steel quick links. The net was fished 31 m (100’) behind the boat. Actual fishing dimensions of the net can vary with environmental conditions (USFWS 1993).

A larger MWTR net was used at Chipps Island (Figure 11). The net was similar in construction to the MWTR net used at Sacramento and had a mouth dimension of 9 x 3 m (30 x 10'). There were six panels, each with decreasing mesh size towards the cod end. Mesh size ranged from 10.2 cm (4”) stretch at the mouth to 1.3 cm (1/2”) stretch just before the cod end. The cod end was composed of 0.8 cm (5/16”) knotless material. Prior to 1997 the cod end mesh was 0.7 cm (1/4”). Between 1997 and 2001 the cod end mesh varied between 0.8 cm (5/16”) and 0.7 cm (1/4”). We assume that the change in mesh size would not affect our catch efficiency for juvenile salmon smolts, but recognize that the change in mesh size could affect our effectiveness at sampling smaller species or early life-stages (fry) of juvenile salmon. It was our intent to reduce the capture of larval delta smelt. Depressors and hydrofoils were appropriately larger and were connected identically to those on the Sacramento MWTR. The net was fished 46 m (150’) behind the boat (100’ bridle and 50’ backing).

Catches were corrected for effort by standardizing to catch-per-unit effort (CPUE; fish/10,000m^3) using the following equation:

$$Trawl\ CPUE = \frac{catch\ per\ tow}{net\ mouth\ area\ x\ distance\ traveled}\ \text{x}\ 10{,}000 \qquad (2)$$

Because the MWTR nets do not open completely while under tow and net mouth dimensions vary within and among tows, we used previously quantified estimates of mean net mouth area (Sacramento: 5.08 m^2, Chipps Island: 18.58 m^2; USFWS 1993).

The measure of distance traveled was recorded with a mechanical flow meter (General Oceanics, Model #2030, Miami, Florida).

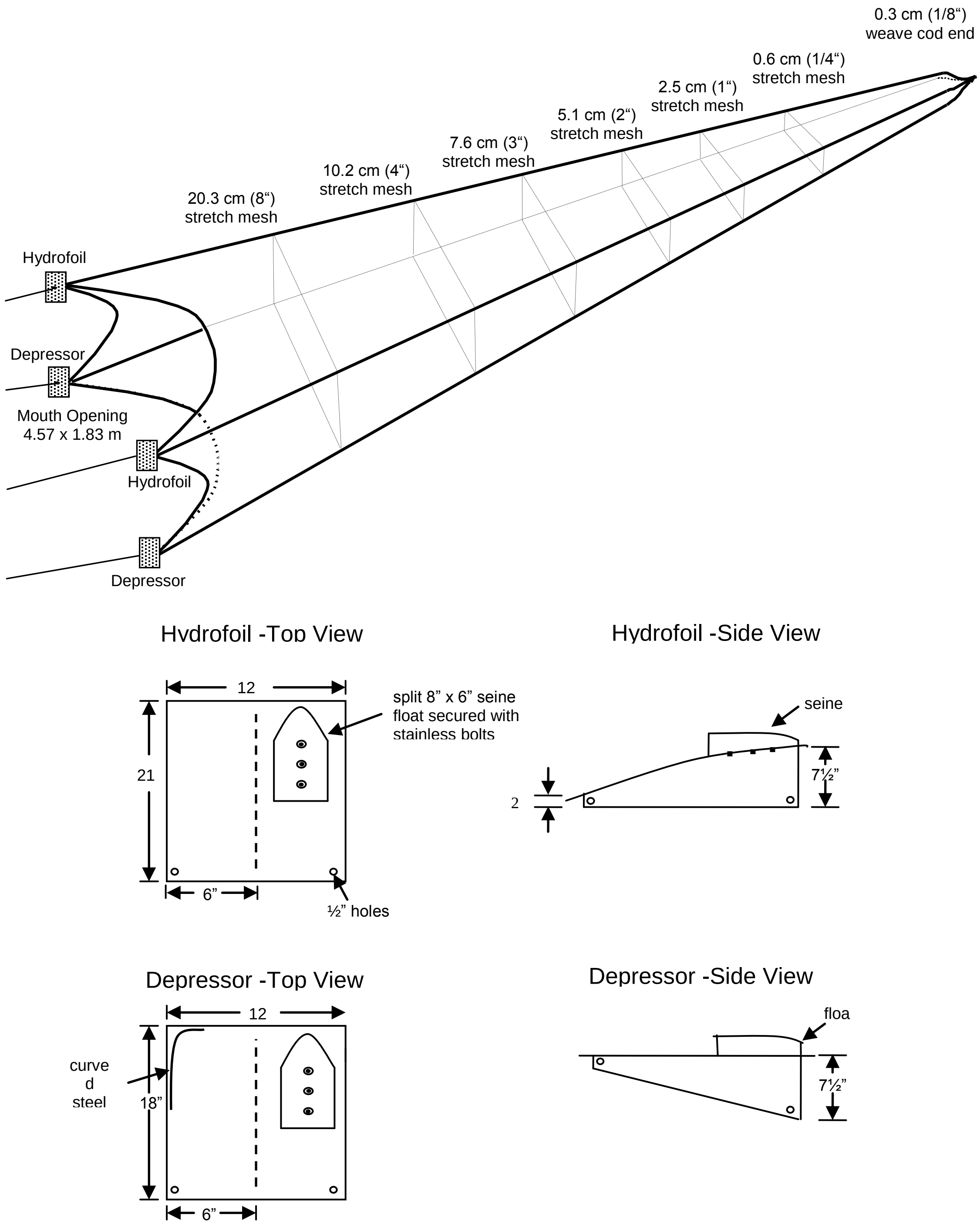

Figure 10. Schematic drawing of mid-water trawl net (top), and hydrofoils and depressors (bottom) used at Sacramento during 2009 field season.

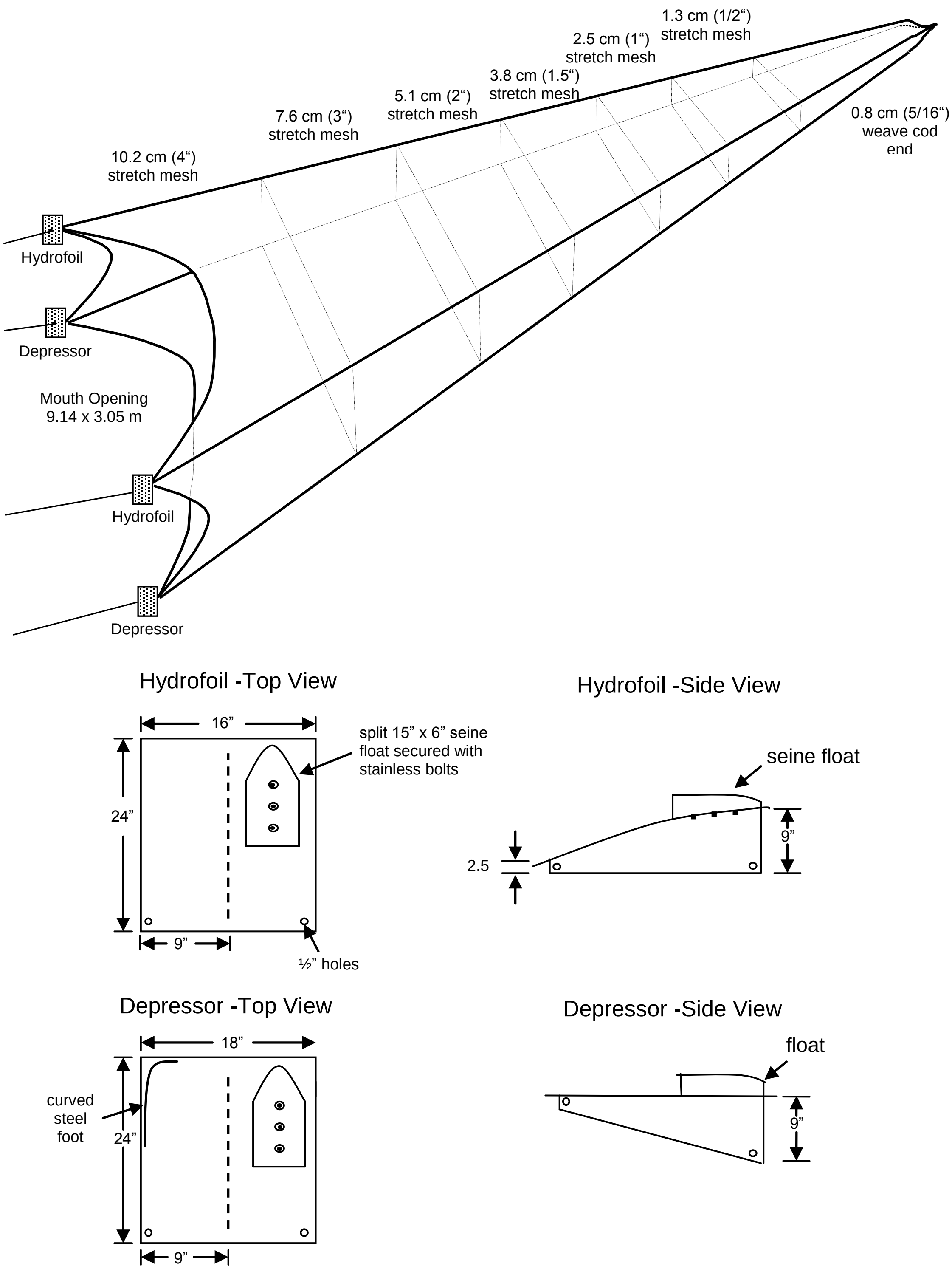

Figure 11. Schematic drawing of mid-water trawl net (top) and hydrofoils and depressors (bottom) used at Chipps Island during 2009 field season.

A KDTR net was used at Mossdale and Sacramento to collect pelagic fish in the top 1.83 m (6') of the water column. The KDTR net was larger than the mid-water trawl net used at Sacramento, allowing for larger volumes of water to be sampled. Nets were made of variable mesh with a fully expanded mouth opening of 7.62 x 1.83 m (25 x 6'; Figure 12). A float line and lead line enable the net to fish the top 1.83 m of the water column. The net was fished 33 m (108') from the boat. At the front of each wing was a 1.83 m (6') bar with floats at the top and weights at the bottom to keep depth constant. An aluminum live box at the cod end minimized fish mortality. Two boats towed the net through the water, one pulling each wing. At the end of each tow, the boats came together and the trawl line was transferred to one of the boats. The field crew on the other boat retrieved the live box from the cod end of the net and removed fish for processing. Calculations of Trawl CPUE for the KDTR employed the same equation as the MWTR (Equation 2), with a mean net mouth area of 12.54 m^2 (USFWS 1993).

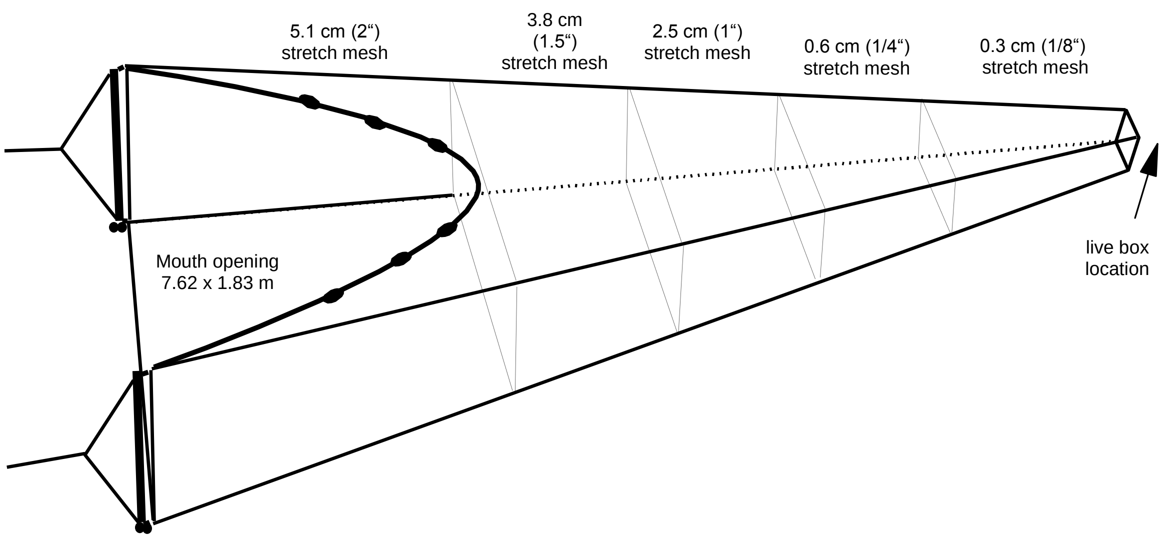

Figure 12. Schematic drawing of Kodiak trawl net used at Sacramento during 2009 field season.

Mean CPUE calculations for Kodiak and mid-water trawls

In all calculations, species of interest (i.e., species of concern and races of salmon (Winter, Late Fall, and Spring/Fall), gear type (i.e., MWTR and KDTR) and trawl locations were treated separately.

Because the number of trawls at a site varied within and among weeks, we calculated mean weekly and monthly CPUE estimates for each site. First, the CPUE for each of the trawls were averaged daily within a site. Next, the mean daily CPUE estimates were averaged weekly for a site. To calculate mean monthly CPUE for each site, the mean weekly CPUE estimates were averaged across weeks within a month. We plotted the mean daily CPUE estimates against discharge data of the same time period. Monthly mean CPUE values were compared to historical monthly mean CPUE.

Sacramento Trawls

Methods

Data from the MWTR and KDTR have been used to estimate the relative abundance and timing of juvenile salmon entering the Delta from the Sacramento River. Trawling has been conducted at Sherwood Harbor (SR055M), approximately 5 km downstream of Sacramento, since 1988, except during 1990, when sampling was conducted approximately 34 km downstream near Courtland, CA (SR027M). Sampling was conducted only during spring from 1988-1993, but has been conducted year-round since 1994. Ten 20-minute tows were generally conducted three days/week to index the relative abundance of juvenile salmon entering the Delta, but on April 1st, 15th and May 1st, 24 hr. sampling was conducted at Sherwood Harbor (SR055M) during the 2009 field season to evaluate the catch efficiency of the trawl using juvenile salmon embedded with CWT (Speegle & Brandes, 2009).

Since December of 1994, KDTR were usually conducted from October through March and MWTR were conducted the remainder of the year. During periods of high flows when large debris moves downstream, MWTR were used in place of KDTR for safety reasons based on their smaller size and better maneuverability.

All trawling was conducted in the middle of the channel facing upstream against the current within 1.5 km of Sherwood Harbor. Occasionally, inclement weather, mechanical problems, excessive fish catch, or some other uncontrollable event, reduced tow times or number of tows on a given sampling day.

Results

We captured 16 winter-run salmon in Sacramento trawls between November and March during the 2009 field season (Figure 13a). Peak daily CPUE occurred on February 15, 2009, coinciding with peak flows in the Sacramento River. Peak monthly CPUE occurred in February (Table 7a). All winter-run salmon captured in 2009 field season were captured while using the KDTR.

During the 2009 field season, 2,010 spring/fall-run salmon were captured in Sacramento trawls, 1,497 in MWTR and 513 in KDTR (Figure 13b). Peak daily CPUE occurred on April 26, 2009 during a period of relatively low or decreasing flows in the Sacramento River. Peak monthly CPUE was observed in May and was the lowest peak monthly average of April and May combined since before 1993 (Table 7b).

A total of two late fall-run salmon were captured in Sacramento trawls, none in MWTR and two in KDTR (Figure 13c). Both late fall-run salmon were yearlings from the 2008 brood year and were captured on November 02, 2008 and December 28, 2008, during a period of increasing flows. Peak monthly CPUE was observed in December (Table 7c).

Two wild steelhead were caught in Sacramento trawls during the 2009 field season, two in MWTR and none in KDTR (Figure 14a). The individuals were caught on April 26, 2009 and May 03, 2009 during a period of increasing flows.

A total of 60 hatchery steelhead were captured in Sacramento trawls during the 2009 field season, 59 in KDTR and one in MWTR (Figure 14b). Peak daily CPUE occurred on February 15, 2009, during peak flows.

During the 2009 field season, two striped bass were captured in Sacramento trawls, but no delta smelt, or longfin smelt were captured.

A total of 116 threadfin shad were captured in Sacramento trawls during the 2009 field season, 14 in MWTR and 103 in KDTR (Figure 14c). Peak daily CPUE occurred on April 04, 2009 during a period of relatively low or decreasing flows.

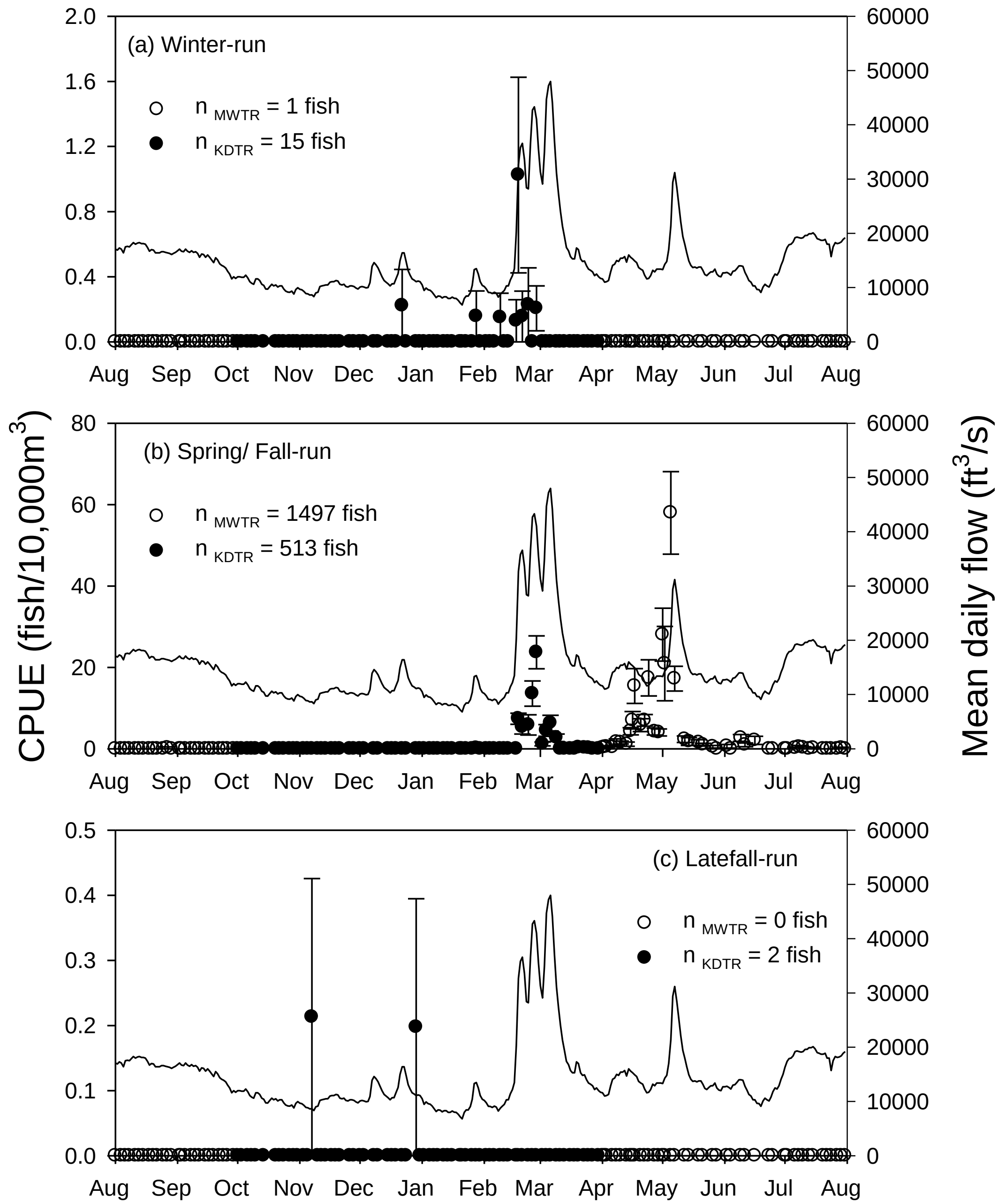

Figure 13. Mean daily catch-per-unit effort (CPUE) of (a) winter-, (b) spring/fall-, and (c) late fall-run salmon in trawls at Sherwood Harbor (Sacramento trawls) and concurrent mean daily flow at Freeport in the Sacramento River during the 2009 field season. Error bars are ± 1 standard error (SE).

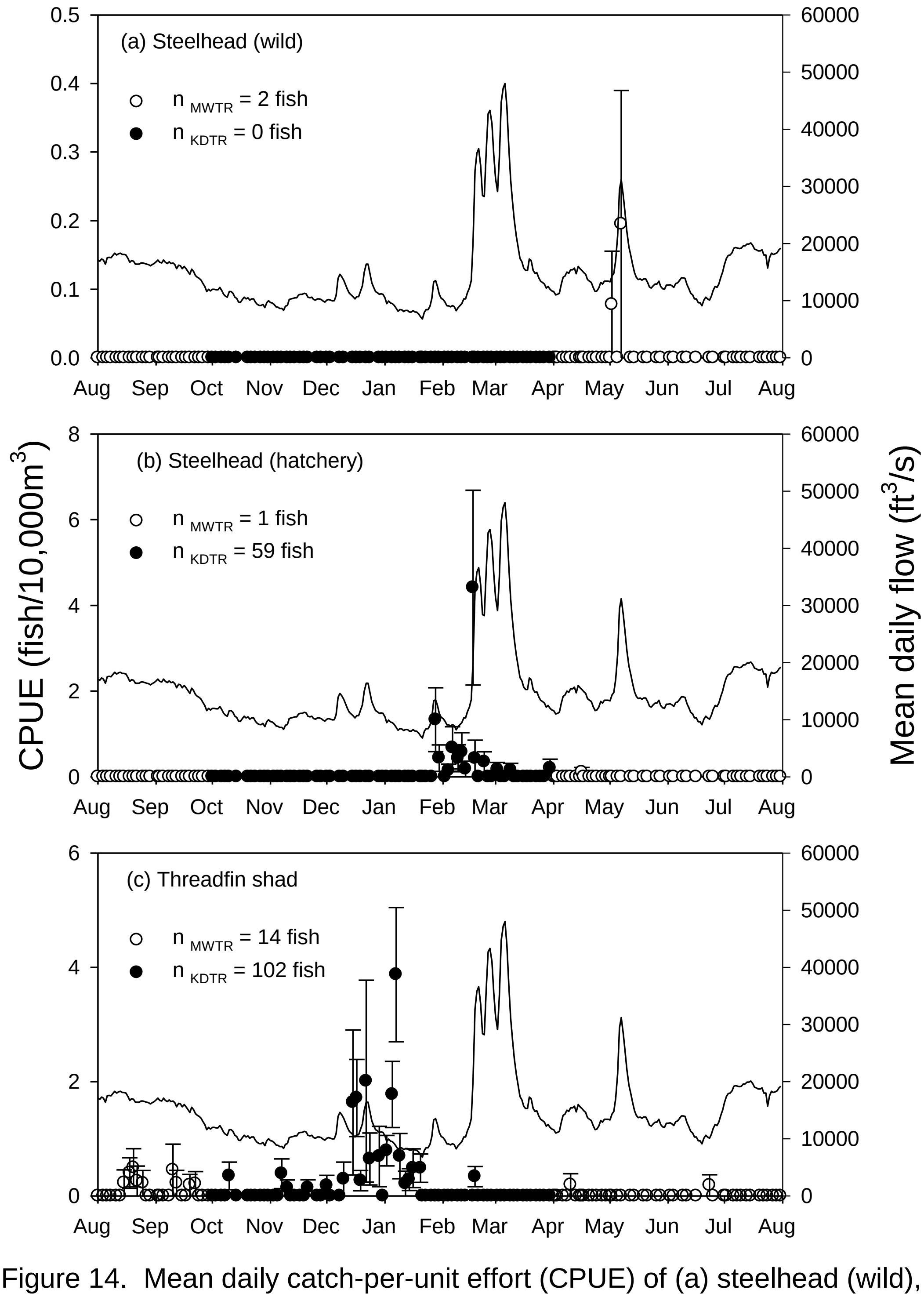

Figure 14. Mean daily catch-per-unit effort (CPUE) of (a) steelhead (wild), (b) steelhead (hatchery), and (c) threadfin shad in trawls at Sherwood Harbor (Sacramento trawls) and concurrent mean daily flow at Freeport in the Sacramento River during the 2009 field season. Error bars are ± 1 standard error (SE).

Table 7. Summary table of CPUE (fish/10,000m^3) of (a) winter-, (b) fall/spring-run, and (c) late fall-run salmon in mid-water and Kodiak trawls at Sherwood Harbor (Sacramento trawls) by month and year. Yearly mean and standard error (SE) values were calculated using years as replicates (n = 3-14 for MWTR, n = 2-14 for KDTR). Weekly mean and SE values were calculated using weeks as replicates (n = 20-42 for MWTR, n = 16-29 for KDTR). Shaded boxes indicate peak monthly CPUE. Water year (CDEC, 2009): AN = above normal; BN = below normal; C = critical; D = dry; W = wet.

(a) Winter-run

Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
1993 MWTR	AN	--	0	0	0	0.046	0.112	0.178	0.650	0.366	0	0	--	0.144 (0.052)
1994 MWTR	C	--	0	0	0	0	0	0.107	0.024	0.054	0	0	--	0.019 (0.019)
1995 MWTR	W	--	0	0	0	0	--	--	0.274	0.281	0	0	0	0.054 (0.039)
1995 KDTR	W	--	--	0	0	0.026	0.033	0.268	0.892	0.344	--	--	--	0.269 (0.037)
1996 MWTR	W	0	0	0	--	--	--	--	--	0.013	0	0	0	0.002 (0.003)
1996 KDTR	W	--	--	0	0	0.239	0.137	0.201	0.769	0.060	--	--	--	0.249 (0.011)
1997 MWTR	W	0	0	0	--	--	0	0.041	0	0.018	0	0	0	0.005 (0.004)
1997 KDTR	W	--	--	0	0.011	0.046	0	0.200	0.144	--	--	--	--	0.054 (0.013)
1998 MWTR	W	0	0	0	--	--	--	--	0	0.074	0	0	--	0.013 (0.010)
1998 KDTR	W	--	0	0	0.068	0.081	0.019	0.125	0	--	--	--	--	0.083 (0.020)
1999 MWTR	W	--	--	--	--	0.532	--	--	0.109	0.008	0	0	0	0.032 (0.006)
1999 KDTR	W	--	0	0.016	0.475	0.145	0.046	0.031	0.106	--	--	--	--	0.124 (0.014)
2000 MWTR	AN	0	0	0	--	--	--	--	0.164	0	0	0	0	0.006 (0.006)
2000 KDTR	AN	--	--	0	0	0	0.147	0.218	0.206	--	--	--	--	0.102 (0.039)
2001 MWTR	D	0	0	--	--	--	--	--	0	0.023	0	0	0	0.011 (0.011)
2001 KDTR	D	--	--	0	0	0	0.069	0.519	0.133	--	--	--	--	0.136 (0.067)
2002 MWTR	D	0	0.022	--	--	--	--	--	0	0.014	0	0	0	0.054 (0.031)
2002 KDTR	D	--	--	0	0.587	0.314	0.019	0.187	0	--	--	--	--	0.167 (0.072)

Table 7. Continued.

(a) Winter-run Continued.

Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
2003 MWTR	AN	0	0	--	--	--	--	--	--	0.066	0	0	0	0.032 (0.019)
2003 KDTR	AN	--	0	0	0.011	0.341	0.104	0.183	0.186	--	--	--	--	0.154 (0.067)
2004 MWTR	BN	0	0	--	--	--	--	0.419	0.077	0	0	0	0	0.069 (0.054)
2004 KDTR	BN	--	--	0	0	0.701	0.142	0.049	0.080	--	--	--	--	0.177 (0.110)
2005 MWTR	AN	0	0	--	--	--	--	--	--	0.012	0	0	0	0.007 (0.007)
2005 KDTR	AN	--	--	0	0.052	0.291	0.192	0.136	0.060	--	--	--	--	0.116 (0.045)
2006 MWTR	W	0	0	--	--	--	--	--	--	0.064	0	0	0	0.010 (0.006)
2006 KDTR	W	--	--	0	0.247	0.455	0.030	0.169	0.271	--	--	--	--	0.189 (0.108)
2007 MWTR	D	0	0	--	--	--	--	--	--	0	0	0	0	0 (0)
2007 KDTR	D	--	--	0	0.171	1.190	0.135	0.813	0	--	--	--	--	0.378 (0.124)
2008 MWTR	C	0	0	--	--	--	--	--	--	0	0	0	0	0 (0)
2008 KDTR	C	--	--	0	0	0	0.807	0.752	0.096	--	--	--	--	0.256 (0.087)
Yearly mean 1993-2008 MWTR (SE)		0 (0)	0.002 (0.002)	0 (0)	0 (0)	0.145 (0.130)	0.037 (0.037)	0.186 (0.083)	0.130 (0.065)	0.062 (0.027)	0 (0)	0 (0)	0 (0)	0.029 (0.009)
Yearly mean 1995-2008 KDTR (SE)		--	0 (0)	0.001 (0.001)	0.116 (0.051)	0.273 (0.089)	0.134 (0.054)	0.275 (0.065)	0.210 (0.074)	0.202 (0.142)	--	--	--	0.175 (0.023)
2009 MWTR	D	0	0	--	--	--	--	--	--	0	0	0	0	0 (0)
2009 KDTR	D	--	--	0	0	0.028	0.013	0.158	0	--	--	--	--	0.033 (0.025)

Table 7. Continued.

(b) Spring-/Fall-run

Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
1993 MWTR	AN	--	0.018	0	0.042	0.263	1.8	2.47	2.38	50.9	58.3	8.37	--	12.0 (4.87)
1994 MWTR	C	--	0.042	0	0.007	0.087	2.61	14.1	0.781	93.7	30.8	1.53	--	15.9 (7.75)
1995 MWTR	W	--	0	0	0	0.086	--	--	18.0	18.1	13.6	4.06	0.293	5.87 (1.74)
1995 KDTR	W	--	--	--	--	0	12.4	8.17	58.8	9.43	--	--	--	14.5 (4.33)
1996 MWTR	W	0.083	0	0	--	--	--	--	--	31.4	30.8	1.47	0.204	8.96 (3.47)
1996 KDTR	W	--	--	0	0	2.52	32.5	172	18.2	51.2	--	--	--	36.7 (17.2)
1997 MWTR	W	0	0	0	--	--	2.48	0.913	1.67	56.6	13.2	0.881	0.598	9.35 (4.12)
1997 KDTR	W	--	--	0	0.010	1.22	20.4	4.23	3.33	--	--	--	--	2.27 (0.982)
1998 MWTR	W	0.167	0	0	--	--	--	--	7.35	25.9	19.3	8.77	--	10.0 (3.06)
1998 KDTR	W	--	--	0	0.013	0.309	72.6	53.0	12.2	--	--	--	--	28.8 (13.1)
1999 MWTR	W	--	--	--	--	0	--	--	5.46	32.8	52.6	2.07	0.14	17.9 (6.88)
1999 KDTR	W	--	0	0	0.017	0.145	14.500	35.4	4.57	--	--	--	--	8.02 (3.02)
2000 MWTR	AN	0.064	0	0	--	--	--	--	17.5	55.8	12.2	0.321	0.021	9.38 (5.23)
2000 KDTR	AN	--	--	0	0	0	12.3	18.6	4.72	--	--	--	--	6.18 (2.06)
2001 MWTR	D	0	0	--	--	--	--	--	0.251	23.5	29.9	0.803	0.93	22.8 (11.8)
2001 KDTR	D	--	--	0	0	0	3.28	40.8	7.01	--	--	--	--	9.34 (4.58)
2002 MWTR	D	0.061	0.047	--	--	--	--	--	1.35	33.2	17.0	0.957	0.203	22.1 (14.3)
2002KDTR	D	--	--	0	0.026	0.857	4.43	14.4	3.66	--	--	--	--	4.02 (1.9)
2003 MWTR	AN	0	0	--	--	--	--	--	--	48.2	6.25	0.573	0.046	25.7 (15.1)
2003 KDTR	AN	--	0	0	0	2.9	10.1	10.1	6.15	--	--	--	--	5.06 (1.59)
2004 MWTR	BN	0.030	0	--	--	--	--	57.8	25.5	83.3	21.0	0.601	0.051	50.2 (27.3)

Table 7. Continued.

(b) Spring-/Fall-run Continued.

Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
2004 KDTR	BN	--	--	0	0	9.5	7.83	22.1	11.8	--	--	--	--	6.80 (2.23)
2005 MWTR	AN	0.036	0.032	--	--	--	--	--	--	21	49.1	0.939	0.129	28.4 (12.8)
2005 KDTR	AN	--	--	0	0	0.572	1.96	4.44	6.94	--	--	--	--	2.29 (0.762)
2006 MWTR	W	0.011	0	--	--	--	--	--	--	6.59	35.0	2.09	0.459	6.99 (1.82)
2006 KDTR	W	--	--	0	0	1.52	2.88	3.59	4.34	--	--	--	--	2.19 (0.548)
2007 MWTR	D	0.414	0	--	--	--	--	--	--	12.9	16.9	2.08	1.82	5.59 (2.35)
2007 KDTR	D	--	--	0	0	0.081	0.158	18.3	2.36	--	--	--	--	3.26 (2.33)
2008 MWTR	C	0.32	0	--	--	--	--	--	--	4.32	13.6	1.42	0.165	3.02 (2.35)
2008 KDTR	C	--	--	0	0	0	1.260	1.26	0.0002	--	--	--	--	2.24 (0.89)
Yearly mean 1993-2006 MWTR (SE)		0.099 (0.039)	0.009 (0.004)	0 (0)	0.016 (0.013)	0.109 (0.055)	2.297 (0.251)	18.821 (13.322)	8.024 (2.851)	37.388 (6.445)	26.222 (3.933)	2.308 (0.651)	0.389 (0.139)	15.885 (2.996)
Yearly mean 1995-2006 KDTR (SE)		--	0 (0)	0 (0)	0.005 (0.002)	1.402 (0.673)	14.043 (5.085)	29.028 (11.746)	10.291 (3.937)	30.315 (20.885)	--	--	--	9.405 (2.829)
2009 MWTR	D	0.013	0	--	--	--	--	--	--	8.127	8.295	0.967	0.109	2.919 (1.680)
2009 KDTR	D	--	--	0	0	0	0.013	4.647	1.084	--	--	--	--	0.096 (0.759)

Table 7. Continued.

(c) Late fall-run

		Previous season brood year								Current season brood year				
Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
1993 MWTR	AN	--	0	0	0.591	0.101	0.007	0.007	0	0.020	0	0	--	0.071 (0.052)
1994 MWTR	C	--	0.173	0.183	0.007	0.055	0.014	0.028	0	0	0	0	--	0.040 (0.019)
1995 MWTR	W	--	0	0	0.012	0.446	--	--	0	0	0	0	0.013	0.053 (0.039)
1995 KDTR	W	--	--	--	--	0.048	0.090	0	0	0	--	--	--	0.054 (0.089)
1996 MWTR	W	0.013	0.016	0	--	--	--	--	--	0.007	0	0	0	0.006 (0.003)
1996 KDTR	W	--	--	0	0	0.070	0.042	0	0	0	--	--	--	0.021 (0.074)
1997 MWTR	W	0	0	0	--	--	0.096	0	0	0	0	0	0	0.004 (0.004)
1997 KDTR	W	--	--	0	0.037	0.053	0.15	0.014	0	--	--	--	--	0.027 (0.019)
1998 MWTR	W	0.0823	0.058	0.056	--	--	--	--	0	0.016	0	0.014	--	0.037 (0.010)
1998 KDTR	W	--	--	0	0.108	0.043	0	0	0	0	--	--	--	0.028 (0.028)
1999 MWTR	W	--	--	--	--	0.107	--	--	0	0.015	0	0	0	0.009 (0.006)
1999 KDTR	W	--	0	0.007	0.134	0.064	0	0	0	--	--	--	--	0.031 (0.067)
2000 MWTR	AN	0.031	0.023	0	--	--	--	--	0	0	0	0	0	0.007 (0.005)
2000 KDTR	AN	--	--	0	0.008	0.006	0.007	0	0	--	--	--	--	0.004 (0.002)
2001 MWTR	D	0	0.023	--	--	--	--	--	0	0	0	0	0	0.008 (0.008)
2001 KDTR	D	--	--	0	0	0.054	0.035	0	0	--	--	--	--	0.015 (0.008)
2002 MWTR	D	0.023	0.045	--	--	--	--	--	0	0	0	0	0	0.028 (0.016)
2002 KDTR	D	--	--	0	0.197	0.057	0.010	0	0	--	--	--	--	0.036 (0.027)
2003 MWTR	AN	0.016	0.043	--	--	--	--	--	--	0.032	0.048	0	0	0.054 (0.031)
2003 KDTR	AN	--	0	0	0	0.206	0	0	0	--	--	--	--	0.046 (0.040)

Table 7. Continued.

(c) Late fall-run Continued.

Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
2004 MWTR	BN	0	0	--	--	--	--	0	0	0	0	0	0	0 (0)
2004 KDTR	BN	--	--	0	0	0.035	0	0	0	--	--	--	--	0.006 (0.005)
2005 MWTR	AN	0	0	--	--	--	--	--	--	0	0.162	0	0	0.054 (0.046)
2005 KDTR	AN	--	--	0.009	0	0.050	0.008	0	0	--	--	--	--	0.010 (0.006)
2006 MWTR	W	0.012	0	--	--	--	--	--	--	0.0153	0	0	0.012	0.006 (0.006)
2006 KDTR	W	--	--	0	0	0.025	0	0	0	--	--	--	--	0.003 (0.003)
2007 MWTR	D	0.210	0.147	--	--	--	--	--	--	0.159	0	0	0.551	0.233 (0.103)
2007 KDTR	D	--	--	0	0	0.088	0.0718	0	0	--	--	--	--	0.027 (0.019)
2008 MWTR	C	0	0	--	--	--	--	--	--	0	0	0	0	0 (0)
2008 KDTR	C	--	--	0	0	0	0.112	0	0	--	--	--	--	0.017 (0.017)
Yearly mean 1993-2008 MWTR (SE)		0.0323 (0.018)	0.0352 (0.014)	0.034 (0.030)	0.203 (0.194)	0.177 (0.090)	0.039 (0.029)	0.009 (0.007)	0 (0)	0.017 (0.010)	0.013 (0.010)	0.001 (0.001)	0.044 (0.042)	0.038 (0.014)
Yearly mean 1995-2008 KDTR (SE)		--	0 (0)	0.001 (0.0009)	0.037 (0.018)	0.057 (0.013)	0.038 (0.013)	0.001 (0.001)	0 (0)	0 (0)	--	--	--	0.023 (0.004)
2009 MWTR	D	0	0	--	--	--	--	--	--	0	0	0	0	0 (0)
2009 KDTR	D	--	--	0	0.014	0.016	0	0	0	--	--	--	--	0.005 (0.003)

Mossdale Trawls

Methods

The KDTR at Mossdale has been conducted since the 1997 field season to document juvenile salmon moving into the Delta from the San Joaquin River and tributaries. All San Joaquin River juvenile salmon captured in the KDTR are classified as fall-run in this report. CDFG has sampled at Mossdale in place of the DJFMP during spring months (April, May and June) since 1989 (SJRGA 2005). Data from both DJFMP and CDFG KDTR sampling at Mossdale are included in this report.

Results

We captured 644 fall-run salmon in Mossdale trawls in the 2009 field season (Figure 15). Peak daily CPUE occurred on May 03, 2009, during a period of increasing flows in the San Joaquin River. Peak monthly CPUE occurred in May and was the second lowest monthly peak since 1997 (Table 8).

A total of one wild steelhead was captured in Mossdale trawls during the 2009 field season. The wild steelhead was captured on April 05, 2009. There were no hatchery-reared steelhead captured in Mossdale trawls.

In the 2009 field season, no delta smelt, or longfin smelt were captured while trawling in the San Joaquin River at Mossdale.

We captured 1,072 striped bass at Mossdale during the 2009 field season (Figure 16a). Peaked daily CPUE occurred on June 21, 2009, when 478 striped bass were captured. Most striped bass were captured during periods of relatively low or decreasing flow in the San Joaquin River.

A total of 4,095 threadfin shad were captured in Mossdale trawls during the 2009 field season (Figure 16b). Peak daily CPUE occurred on June 21, 2009 when 856 threadfin shad were captured. Like striped bass mentioned above, most threadfin shad were captured during periods of relatively low or decreasing flow in the San Joaquin River.

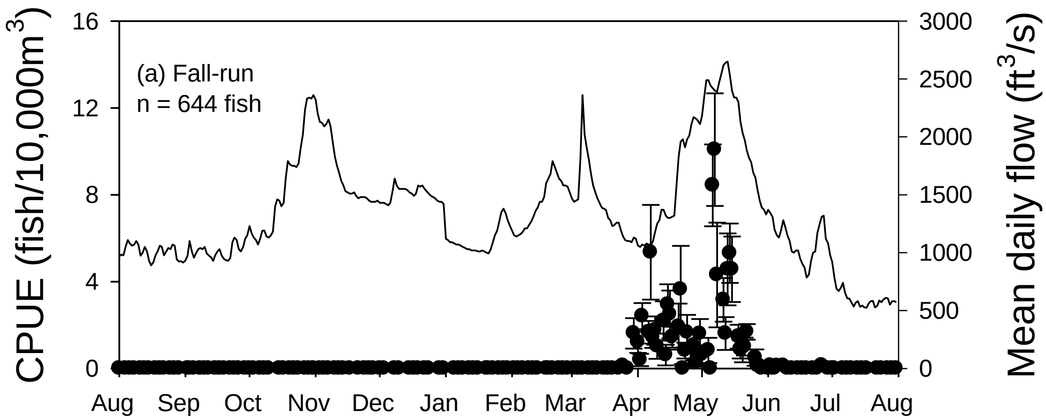

Figure 15. Mean daily catch-per-unit effort (CPUE) of fall-run salmon juveniles in Kodiak trawls at Mossdale and concurrent mean daily flow at Vernalis in the San Joaquin River during the 2009 field season. Error bars are ± 1 standard error (SE).

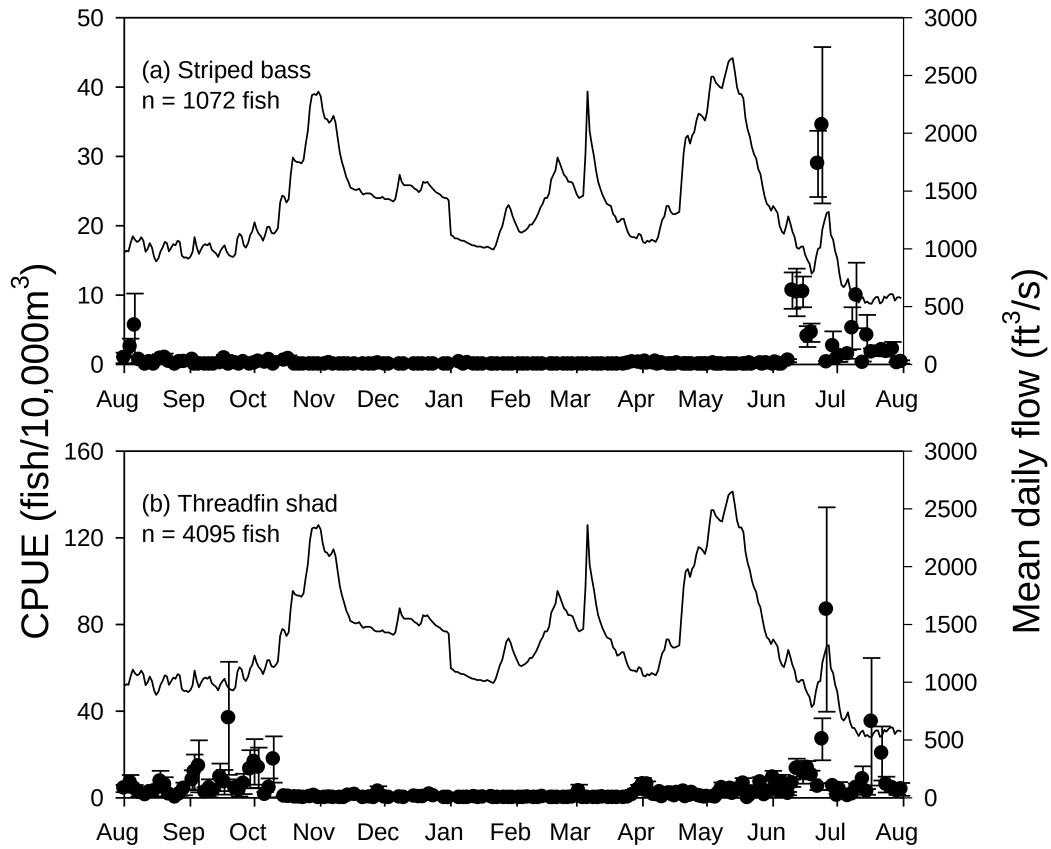

Figure 16. Mean daily catch-per-unit effort (CPUE) of (a) striped bass and (b) threadfin shad in Kodiak trawls at Mossdale and concurrent mean daily flow at Vernalis in the San Joaquin River during the 2009 field season. Error bars are ± 1 standard error (SE).

Table 8. Summary table of CPUE (fish/10,000m^3) of fall-run salmon in Mossdale Kodiak trawls by month and year. Yearly mean and standard error (SE) values were calculated using years as replicates (n = 6-12). Weekly mean and SE values were calculated using weeks as replicates (n = 14-37). Standard error calculations were not possible when n = 1. Shaded boxes indicate peak monthly CPUE for each year. Shaded boxes indicate peak monthly CPUE. Water year (CDEC, 2009): AN = above normal; BN = below normal; D = dry; W = wet.

Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
1997	W	--	0	0	0	0	--	--	0.325	2.14	1.06	0.393	--	0.493 (0.154)
1998	W	--	--	--	--	--	--	--	--	2.58	6.09	2.50	--	3.47 (0.802)
1999	AN	--	--	--	0	0	0.810	3.090	0.630	1.32	1.94	0.962	--	1.04 (0.231)
2000	AN	--	--	0	0	0	0.113	3.260	0.681	2.92	2.05	0.372	--	1.03 (0.349)
2001	D	--	--	--	--	--	--	0.125	0.455	8.62	7.07	0.409	0.016	2.82 (0.940)
2002	D	0	0	--	--	--	0.014	0	0	1.97	9.61	0.207	0	1.62 (0.815)
2003	BN	--	--	--	--	0	1.23	0	0.332	4.15	3.52	0.044	0	1.12 (0.359)
2004	D	0	0	0	0	0	0.01	0.115	2.22	2.65	2.72	0	0	0.591 (0.200)
2005	W	0	0	0	0	0	0.264	0.218	0.37	0.929	4.17	0.539	0.020	0.514 (0.175)
2006	W	0	0	0	0	0.010	0.016	0.022	0.150	0.591	3.34	4.30	0.109	1.120 (0.187)
2007	C	0	0	0	0	0	0	0.100	0.186	9.06	6.72	1.44	0	1.370 (0.461)
2008	C	0	0	0	0	0	0.180	0.180	0.086	3.90	8.78	0.717	0	1.130 (0.395)
Yearly mean 1997-2008 (SE)		0 (0)	0 (0)	0 (0)	0 (0)	0.001 (0.001)	0.293 (0.145)	0.711 (0.412)	0.494 (0.184)	3.403 (0.795)	4.756 (0.815)	0.990 (0.362)	0.018 (0.013)	1.360 (0.262)
2009	D	0	0	0	0	0	0	0	0.305	1.682	1.999	0.022	0	0.334 (0.206)

Chipps Island Trawls

Methods

The DJFMP has conducted mid-water trawling at Chipps Island since May 1976. Sampling was initiated as a way to gain information about fall-run juvenile salmon emigrating from the Delta towards the Pacific Ocean. Originally, ten 20-minute tows were conducted three to seven days each week from April to July. Sampling was conducted seven days/week for the recapture of marked fish during experimental releases. In many years, CWT salmon have been released in, December-January and in April-May for salmon survival experiments. In 1996, we began sampling year round to better understand the temporal patterns of juvenile salmon emigration downstream. Between 1998 and 2006, the DJFMP conducted 20, 20-minuet, tows per day in split shifts to increase the number of CWT salmon recovered from survival experiments. Since 2007,effort in April to May has been maintained at roughly three days a week, ten 20-minute tows per day at Chipps Island as we have transitioned away from the use of CWT's to estimate survival through the Delta.

Trawls were conducted within a 3 km section of river upstream of the western tip of Chipps Island. Trawls were conducted in both directions (upstream and downstream) regardless of tide in three channel locations: north, south, and middle. Occasionally, inclement weather, mechanical problems, or excessive catch reduced tow duration or number of tows per day.

During the 2009 field season, ten 20-minute tows were conducted three days per week. Sampling generally was conducted three days/week, except during CWT recapture periods. On April 8th, 22nd and May 8th of 2009, 24 hr. sampling was conducted at Chipps Island (SB018X) to evaluate the catch efficiency and survival of juvenile salmon with CWTs for groups of CWT salmon released specifically for efficiency calculations (Speegle & Brandes, 2009).

Results

We captured 73 winter-run salmon from January through April in the 2009 field season (Figure 17a). Daily CPUE peaked on March 22, 2009 during decreasing delta outflow. Peak monthly CPUE occurred in March at the second lowest since 1994 (Table 9a).

A total of 2,005 spring/fall-run salmon were captured during the 2009 field season (Figure 17b). Peak daily CPUE occurred on May 03, 2009, 60 days after peak delta outflow. Peak monthly CPUE of spring/fall-run salmon occurred in May of the 2009 field season (Table 9b).

During the 2009 field season, we captured 10 late fall-run salmon in trawls at Chipps Island (Figure 17c). All late fall-run salmon captured were yearlings from the 2008 Brood Year. Peak daily CPUE occurred on January 04, 2009 when five individuals

were captured. Peak monthly CPUE occurred in January during a period of relatively low delta outflow (Table 9c).
We captured 119 delta smelt during the 2009 field season in Chipps Island trawls (Figure 18a). Peak daily CPUE occurred on July 12, 2009 when 21 delta smelt were captured during a period of relatively low outflow.

In the 2009 field season, 458 longfin smelt were captured at Chipps Island (Figure 18b). Peaked daily CPUE occurred on December 21, 2008 when 115 longfin smelt were captured during a period of increasing delta outflow.

The DJFMP captured 17 wild steelhead at Chipps Island during 2009 (Figure 18c). Peak daily CPUE occurred May 03, 2009 during a period of increasing delta outflow.

A total of 65 hatchery-reared steelhead also were captured in trawls at Chipps Island (Figure 18d). Peak daily CPUE occurred on February 22, 2009 when 17 hatchery-reared steelhead were captured during the period of increasing delta outflow.

We captured 1,131 striped bass in trawls at Chipps Island during the 2009 field season (Figure 18e). Peak daily CPUE occurred on November 16, 2008 when 259 striped bass were captured during a period of relatively low delta outflow.

The DJMFP captured 989 threadfin shad during the 2009 field season (Figure 18f). Daily CPUE peaked on December 14, 2008 when 342 threadfin shad were captured during a period of increasing delta outflow.

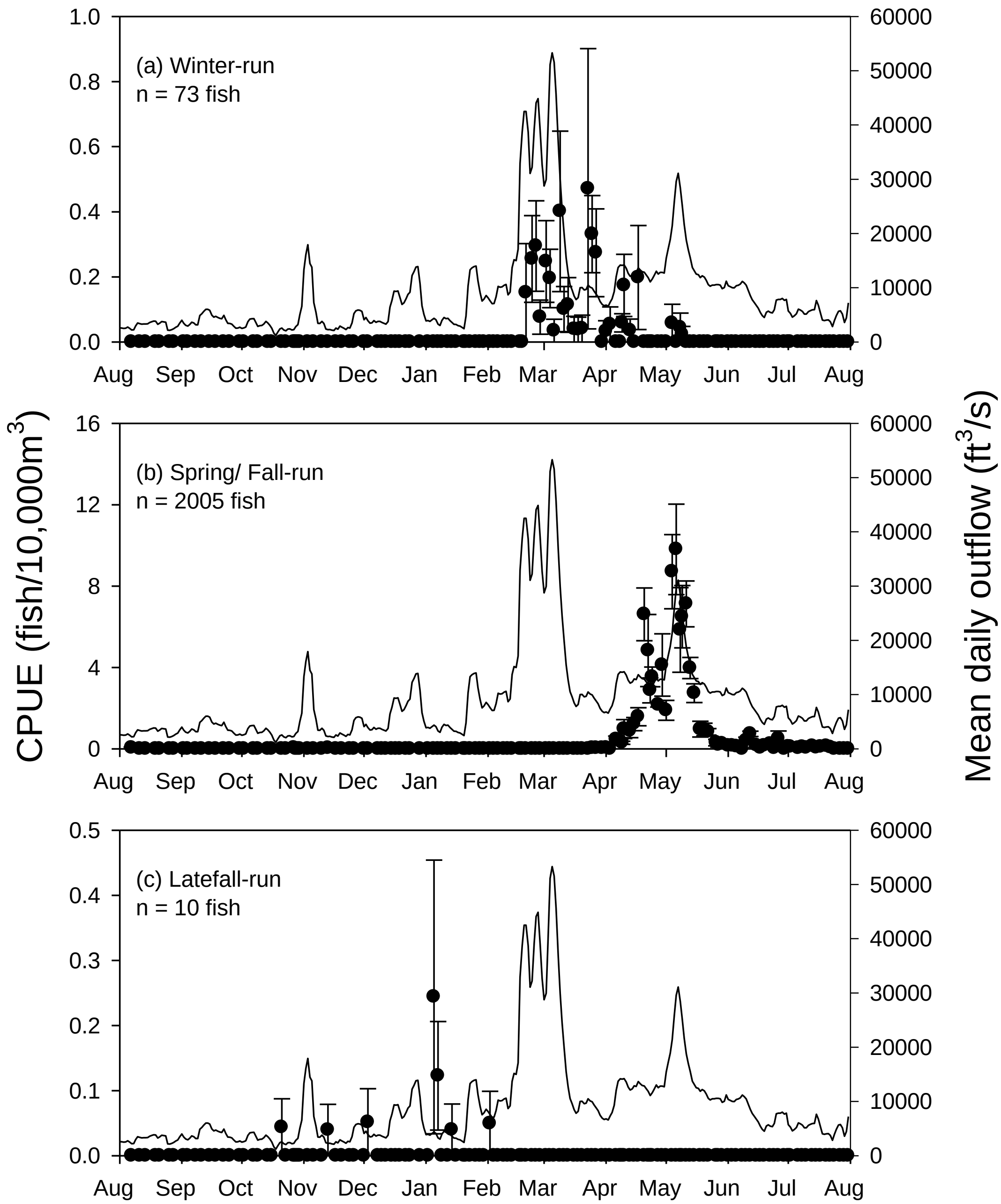

Figure 17. Mean daily catch-per-unit effort (CPUE) of (a) winter-, (b) spring-/fall-, and (c) late fall-run salmon in mid-water trawls at Chipps Island and concurrent daily Delta outflow during the 2009 field season. Error bars are ± 1 standard error (SE).

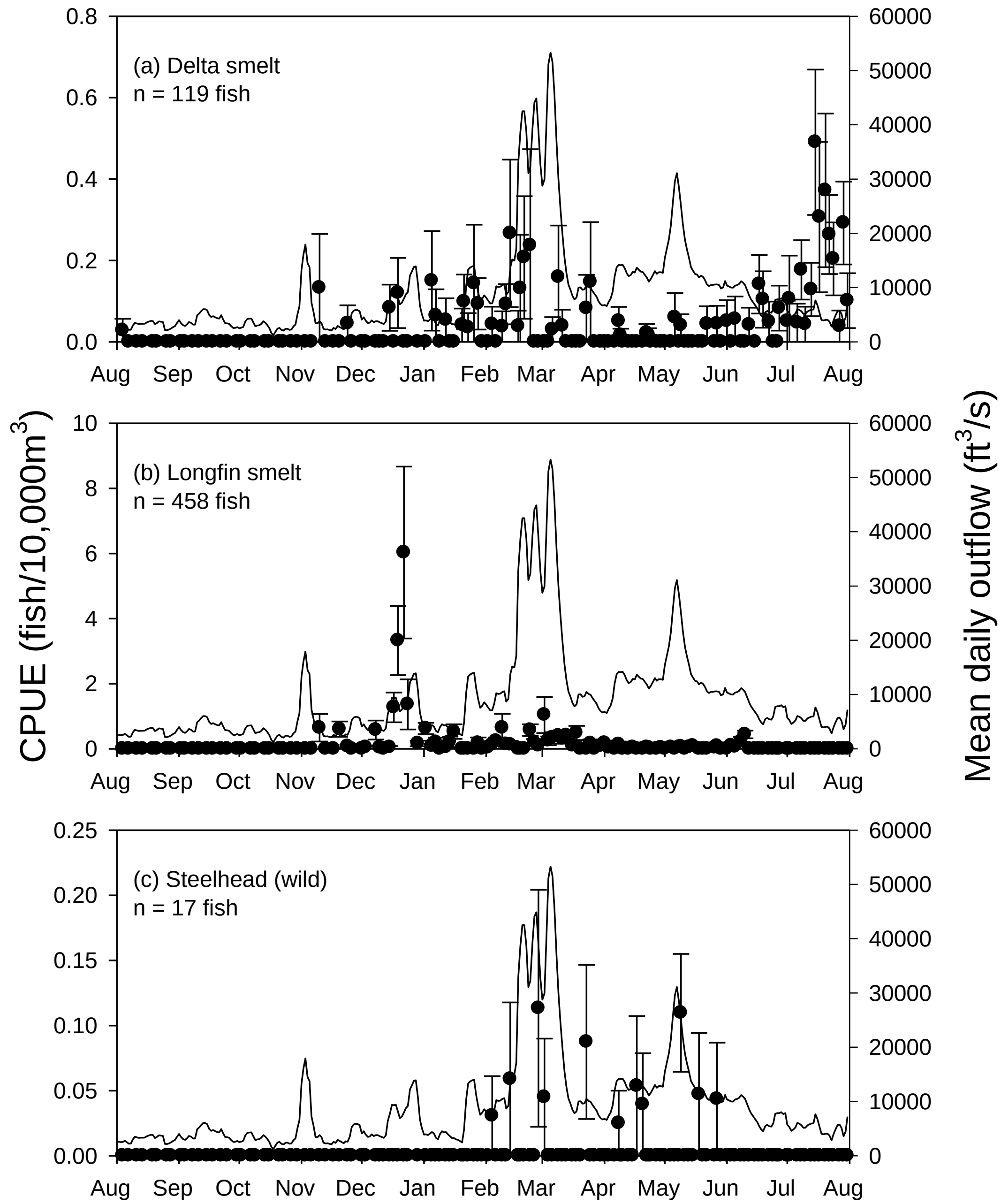

Figure 18. Mean daily catch-per-unit effort (CPUE) of (a) steelhead (wild), (b) steelhead (hatchery), (c) delta smelt, (d) longfin smelt, (e) striped bass, and (f) threadfin shad in mid-water trawls at Chipps Island and concurrent daily Delta outflow during the 2009 field season. Error bars are ± 1 standard error (SE).

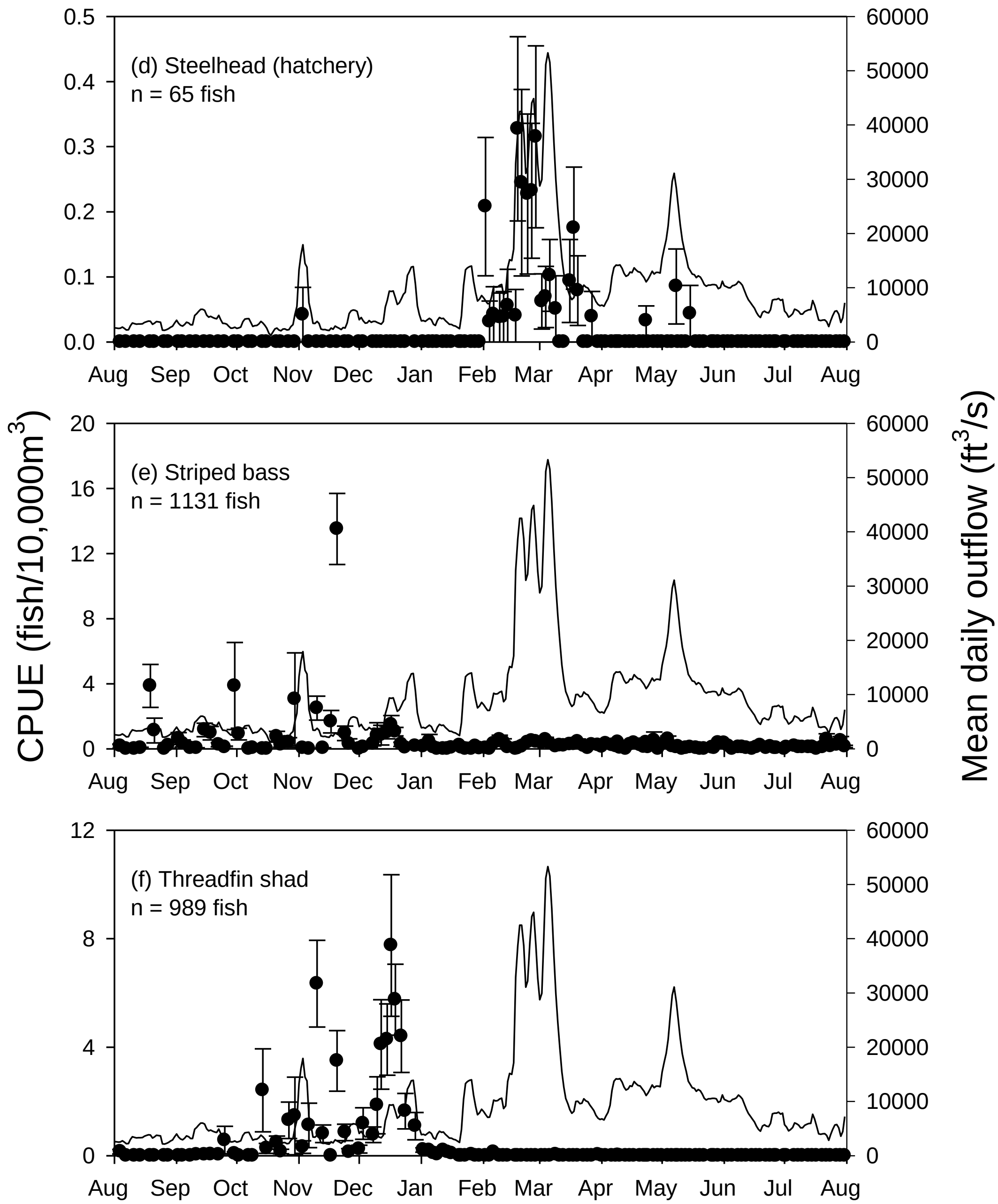

Figure 18. Continued.

Table 9. Summary table of CPUE (fish/10,000m^3) of (a) winter-, (b) spring-/fall-, and (c) late fall-run salmon in mid-water trawls at Chipps Island by month and year. Among-year mean and standard error (SE) values were calculated using years as replicates (n = 11-16). Within-year mean and SE values were calculated using weeks as replicates (n = 14-49). Shaded boxes indicate peak monthly CPUE for each year. Water year (CDWR 2009b): AN = above normal; BN = below normal; C = critical; D = dry; W = wet.

(a) Winter-run

Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
1993	AN	--	--	--	--	--	--	--	--	0.328	0.004	0	0	0.092 (0.051)
1994	C	--	--	--	0	0	0.003	0.007	0.083	0.023	0.001	0	--	0.015 (0.005)
1995	W	--	--	0	0	0	0.014	0.136	0.392	0.291	0.005	0	0	0.084 (0.028)
1996	W	0	0	0	0	0.064	0.075	0.112	0.650	0.076	0.004	0	0	0.085 (0.032)
1997	W	0	--	0	0	0.002	0.024	0.085	0.239	0.068	0.003	0	0	0.042 (0.012)
1998	W	0	0	0	0	0.011	0.029	0.016	0.214	0.044	0.001	0	--	0.032 (0.012)
1999	W	--	0	0	0	0.021	0.011	0.084	0.258	0.087	0	0	0	0.044 (0.019)
2000	AN	0	0	0	0	0	0.012	0.107	0.290	0.066	0.001	0	0	0.040 (0.015)
2001	D	0	0	0	0	0	0.015	0.065	0.254	0.029	0.001	0	0	0.033 (0.012)
2002	D	0	0	0	0	0.021	0.019	0.024	0.153	0.057	0.001	0	0	0.023 (0.008)
2003	AN	0	0	0	0	0.049	0.099	0.150	0.434	0.091	0.003	0	0	0.068 (0.019)
2004	BN	0	0	0	0	0.011	0.014	0.047	0.343	0.015	0	0	0	0.097 (0.017)
2005	BN	0	0	0	0	0.006	0.030	0.101	0.210	0.058	0.001	0	0	0.034 (0.012)
2006	W	0	0	0	0	0.034	0.053	0.439	1.57	1.93	0.003	0	0	0.354 (0.117)
2007	D	0	0	0	0	0	0.033	0.157	0.669	0.126	0	--	--	0.106 (0.036)
2008	C	--	--	0	0	0	0.351	0	0.881	0.327	0	0	0	0.149 (0.050)
Yearly mean 1993-2008 (SE)		0 (0)	0 (0)	0 (0)	0 (0)	0.015 (0.005)	0.052 (0.022)	0.102 (0.027)	0.443 (0.098)	0.219 (0.125)	0.002 (0.0004)	0 (0)	0 (0)	0.080 (0.022)
2009	D	0	0	0	0	0	0	0.065	0.158	0.034	0.006	0	0	0.022 (0.014)

Table 9. Continued.

(b) Spring/fall-run

Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
1993	AN	--	--	--	--	--	--	--	--	7.07	12.9	4.83	0.487	7.25 (1.83)
1994	C	--	--	--	0.043	0	0	0.003	0.016	6.01	2.54	0.200	--	0.977 (0.497)
1995	W	--	--	0.051	0.034	0	0.623	0.416	0.934	8.48	15.1	4.52	0.330	2.870 (0.789)
1996	W	0.041	0.064	0.167	0.013	0.031	0.126	4.420	1.830	8.77	13.3	2.15	0	2.63 (0.648)
1997	W	0.141	--	0	0.009	0.014	0.235	0.005	0.090	3.92	2.15	0.36	0.098	0.634 (0.223)
1998	W	0.039	0.021	0.003	0	0.002	0.466	0.645	2.22	12.4	14.8	4.60	--	3.00 (0.770)
1999	W	--	0.060	0.038	0	0	0.037	0.935	0.516	4.55	9.97	2.60	0.076	1.65 (0.458)
2000	AN	0	0.015	0.275	0.010	0	0.002	0.148	1.04	10.8	5.16	0.633	0.140	1.58 (0.515)
2001	D	0.027	0.057	0.056	0.016	0	0	0.004	0.054	5.38	5.88	0.438	0.089	0.888 (0.390)
2002	D	0.021	0.007	0.005	0	0	0	0	0.032	2.64	5.11	0.576	0.145	0.694 (0.260)
2003	AN	0	0.010	0	0.002	0	0	0	0.718	13.7	9.30	1.06	0.046	1.75 (0.641)
2004	BN	0.020	0.008	0	0	0	0	0.005	0.572	7.80	6.59	0.785	0.079	1.09 (0.453)
2005	BN	0.020	0.009	0.006	0	0	0	0	0.391	11.0	9.83	3.20	0.201	1.87 (0.637)
2006	W	0.068	0.066	0	0	0	0	0.015	0.906	33.59	43.7	11.1	0.790	7.01 (2.52)
2007	D	0.193	0.251	0.033	0	0	0	0	0.144	4.65	3.15	--	--	0.701 (0.272)
2008	C	--	--	0.043	0	0	0	0	0	1.48	2.20	1.32	0.126	0.558 (0.152)
Yearly mean 1993-2008 (SE)		0.052 (0.018)	0.052 (0.021)	0.048 (0.021)	0.009 (0.004)	0.003 (0.002)	0.099 (0.050)	0.440 (0.294)	0.631 (0.174)	8.890 (1.865)	10.110 (2.505)	2.558 (0.744)	0.201 (0.061)	2.197 (0.521)
2009	D	0.004	0	0.005	0.003	0	0	0	0.010	2.235	2.725	0.205	0.053	0.437 (0.278)

Table 9. Continued.

(c) Late fall-run

		Previous field season brood year								Current field season				
Field Season	Water year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Weekly mean (SE)
1993	AN	--	--	--	--	--	--	--	--	0	0	0	0	0 (0)
1994	C	--	--	--	0.028	0.082	0.006	0.017	0	0	0	0.002	--	0.018 (0.006)
1995	W	--	--	0	0.021	0.077	0.044	0	0	0	0.001	0	0	0.013 (0.005)
1996	W	0	0.006	0.012	0	0.184	0.061	0.003	0	0	0.001	0	0	0.021 (0.010)
1997	W	0	--	0	0	0.151	0.030	0	0	0	0	0	0	0.014 (0.007)
1998	W	0.019	0.037	0.020	0.029	0.100	0.028	0	0	0	0	0	--	0.023 (0.063)
1999	W	--	0.066	0	0.233	0.094	0.006	0.003	0	0	0	0	0.019	0.037 (0.013)
2000	AN	0	0.008	0.005	0.045	0.044	0.009	0.011	0	0	0	0	0	0.010 (0.004)
2001	D	0	0	0.005	0.033	0.047	0.014	0.003	0	0	0	0	0.004	0.010 (0.004)
2002	D	0	0.025	0	0.037	0.068	0.006	0	0.004	0	0	0	0.004	0.011 (0.004)
2003	AN	0	0.009	0.009	0.004	0.121	0.035	0	0	0	0	0	0	0.013 (0.006)
2004	BN	0	0.013	0	0.008	0.048	0.014	0	0	0	0	0	0	0.006 (0.002)
2005	BN	0.003	0.003	0	0.008	0.022	0.016	0	0	0	0	0	0	0.004 (0.002)
2006	W	0	0	0.022	0.049	0.137	0.013	0.011	0	0	0	0	0	0.019 (0.006)
2007	D	0	0.041	0.038	0.101	0.193	0.091	0.021	0	0	0	--	--	0.050 (0.014)
2008	C	--	--	0	0.071	0.274	0.138	0	0	0	0	0	0	0.055 (0.017)
Yearly mean 1993-2008 (SE)		0.002 (0.002)	0.019 (0.006)	0.008 (0.003)	0.045 (0.015)	0.109 (0.018)	0.034 (0.010)	0.005 (0.002)	0 (0)	0 (0)	0 (0)	0 (0)	0.002 (0.002)	0.019 (0.004)
2009	D	0	0	0.005	0.009	0	0.034	0.004	0	0	0	0	0	0.004 (0.003)

Other Species Captured During DJFMP Sampling

During the 2009 field season, a total of 249,359 organisms representing 82 different species were captured in the combined efforts of the DJFMP trawls and beach seines (Table 10). Of the 82 different species captured, five species composed 81% of the total catch. Those five species were: inland silverside (*Menidia beryllina;* n = 142,319), red shiner (*Cyprinella lutrensis*; n = 28,939), Sacramento sucker (*Catostomus occidentalis*; n = 12,841), threadfin shad (n = 9,656) and Chinook salmon (n = 8,889). Catch from Chipps Island trawls totaled 20,171 organisms from 31 different species. The Black Sea jellyfish (*Maeotias marginata)* was the most abundant species captured (n = 6,578) in Chipps Island trawls. Mossdale catch totaled 12,936 organisms representing 34 different species. Inland silversides (n = 4,391) were the most abundant species captured in trawls at Mossdale. Catch from Sacramento trawls (Sherwood Harbor) totaled 3,733 organisms representing 24 different species. The Chinook salmon (n = 2,769) was the most abundant species captured in Sacramento trawls. Total catch from Region 1 beach seines was 21,024 organisms representing 35 different species. The Sacramento sucker (n = 8,783) was the most abundant species captured in Region 1 beach seines. Total catch from Region 2-4 beach seines was 132,170 organisms representing a total of 44 different species. The inland silverside (n = 111,981) was the most abundant species captured in Region 2-4 beach seines. Total catch from Region 5 beach seines totaled 51,799 organisms representing 26 different species. The red shiner (n = 26,226) was the most abundant species captured in Region 5 beach seines. Total catch from Region 6 beach seines was 7,526 organisms representing 42 different species. The topsmelt (*Atherinops affinis*; n = 4,649) was the most abundant species captured in Region 6 beach seines.

Table 10. Total of all species captured from all trawl sites and seine Regions during the 2009 field season.

Organism	Trawl sites			Seine Regions			
	Chipps Island	Sherwood Harbor	Mossdale	1	2-4	5	6
American shad, *Alosa sapidissima*	5713	25	11	19	57	0	2
arrow goby, *Clevelandia ios*	0	0	0	0	0	0	358
barred surfperch, *Amphistichus argenteus*	0	0	0	0	0	0	21
bass unknown, *Micropterus* sp.	0	0	7	0	0	0	0
bay pipefish, *Syngathus leptorhynchus*	0	0	0	0	0	0	216
bigscale logperch, *Percina macrolepida*	0	1	6	323	79	10	0
black bullhead, *Ameiurus melus*	0	0	0	9	0	0	0
black crappie, *Pomoxis nigromaculatus*	1	0	12	55	10	6	0
black perch, *Embiotoca jacksoni*	0	0	0	0	0	0	1
Black Sea jellyfish 1, *Maeotias marginata*	6578	0	0	0	1	0	2
Black Sea jellyfish 2, *Blackfordia virginica*	0	0	0	0	0	0	3
blue catfish, *Ictalurus furcatus*	0	0	1	0	0	0	0
bluegill, *Lepomis macrochirus*	0	4	1126	35	335	526	0
brown bullhead, *Ameiurus nebulosus*	0	0	1	0	0	0	0
calico surfperch, *Amphistichus koelzi*	0	0	0	0	0	0	3
chameleon goby, *Tridentiger trigonocephalus*	0	0	0	0	1	0	1
channel catfish, *Ictalurus punctatus*	1	53	348	1	0	2	0
Chinook salmon, *Oncorhynchus tshawytscha*	3186	2769	662	1036	1172	0	0
common carp, *Cyprinus carpio*	1	1	13	73	3	50	0
crevice kelpfish, *Gibbonsia montereyensis*	0	0	0	0	0	0	1
delta smelt, *Hypomesus transpacificus*	119	0	0	0	35	0	0
diamond turbot, *Pleuronichthys guttulatus*	0	0	0	0	0	0	1
dwarf surfperch, *Micrometrus minimus*	0	0	0	0	0	0	39
English sole, *Parophrys vetulus*	0	0	0	0	0	0	30
fathead minnow, *Pimephales promelas*	0	1	0	379	106	94	0
golden shiner, *Notemigonus crysoleucas*	0	3	23	212	921	109	0

Table 10. Continued.

Organism	Trawl sites			Seine Regions			
	Chipps Island	Sherwood Harbor	Mossdale	1	2-4	5	6
goldfish, *Carassius auratus*	0	1	2	3	1	0	0
green sunfish, *Lepomis cyanellus*	0	0	1	3	0	0	0
hardhead, *Mylopharodon conocephalus*	0	0	1	110	5	0	0
hitch, *Lavinia exilicauda*	0	0	0	64	25	0	0
inland silverside, *Menidia beryllina*	1	442	4391	4598	111981	20902	4
jacksmelt, *Atherinopsis californiensis*	0	0	0	0	0	0	6
lamprey unknown, *Lampetra* sp.	0	68	1	0	3	0	0
largemouth bass, *Micropterus salmoides*	3	0	7	145	700	76	0
longfin smelt, *Spirinchus thaleichthys*	458	0	0	0	0	0	1
longjaw mudsucker, *Gillichthys mirabilis*	0	0	0	0	0	0	11
Mediterranean jellyfish, *Moerisia* sp.	0	0	0	0	0	0	7
moon jelly, *Aurelia aurita*	0	0	0	0	0	0	43
northern anchovy, *Engraulis mordax*	250	0	0	0	0	0	74
Pacific herring, *Clupea pallasii*	722	0	0	0	0	0	701
Pacific lamprey, *Lampetra tridentata*	0	92	5	0	0	0	0
Pacific staghorn sculpin, *Leptocottus armatus*	35	0	0	0	86	0	176
penicillate jellyfish, *Polyorchis penicillatus*	0	0	0	0	0	0	1
penpoint gunnel, *Apodichthys flavidus*	0	0	0	0	0	0	2
comb jelly, *Pleurobrachia bachei*	0	0	0	0	0	0	1014
prickly sculpin, *Cottus asper*	0	0	0	4	58	2	2
steelhead, *Oncorhynchus mykiss*	82	62	1	6	11	0	0
rainwater killifish, *Lucania parva*	1	0	0	0	124	0	12
red shiner, *Cyprinella lutrensis*	0	0	58	593	2062	26226	0
redear sunfish, *Lepomis microlophus*	0	1	102	22	387	36	0
redeye bass, *Micropterus coosae*	0	0	0	0	2	0	0
river lamprey, *Lampetra ayresii*	0	5	0	0	0	0	0

Table 10. Continued.

Organism	Trawl sites			Seine Regions			
	Chipps Island	Sherwood Harbor	Mossdale	1	2-4	5	6
Sacramento blackfish, *Orthodon microlepidotus*	0	0	0	1	2	1	0
Sacramento pikeminnow, *Ptychocheilus grandis*	4	55	0	1904	625	1	0
Sacramento sucker, *Catostomus occidentalis*	0	1	1	8783	3862	194	0
saddleback gunnel, *Pholis ornata*	0	0	0	0	0	0	5
sand sole, *Psettichthys melanostictus*	0	0	0	0	0	0	2
shimofuri goby, *Tridentiger bifasciatus*	22	0	0	0	140	0	2
shiner perch, *Cymatogaster aggregata*	1	0	0	0	0	0	44
Shokihaze goby, *Tridentiger barbatus*	1	0	0	0	0	0	0
Siberian prawn, *Exopalaemon modestus*	592	20	548	39	856	35	1
smallmouth bass, *Micropterus dolomieu*	0	0	1	15	24	8	0
splittail, *Pogonichthys macrolepidotus*	36	1	188	1015	1952	124	0
spotted bass, *Micropterus punctulatus*	0	0	6	28	43	13	0
starry flounder, *Platichthys stellatus*	22	0	0	0	2	0	3
striped bass, *Morone saxatilis*	1131	2	1072	1	206	28	1
surf smelt, *Hypomesus pretiosus*	1	0	0	0	0	0	9
thornback ray, *Platyrhinoidis triseriata*	0	0	0	0	0	0	3
threadfin shad, *Dorosoma petenense*	989	116	4095	546	3842	68	0
threespine stickleback, *Gasterosteus aculeatus*	12	0	0	1	132	0	13
tidepool sculpin, *Oligocottus maculosus*	0	0	0	0	0	0	1
topsmelt, *Atherinops affinis*	192	0	0	0	0	0	4649
tule perch, *Hysterocarpus traskii*	7	4	7	52	382	2	0
unid fish, unidentified sp.	0	0	4	0	1	0	4
wakasagi, *Hypomesus nipponensis*	0	2	1	43	88	0	0
walleye surfperch, *Hyperprosopon argenteum*	0	0	0	0	0	0	15
warmouth, *Lepomis gulosus*	0	0	0	0	3	0	0
western mosquitofish, *Gambusia affinis*	0	0	0	883	1345	3280	0

Table 10. Continued.

Organism	Trawl sites			Seine Regions			
	Chipps Island	Sherwood Harbor	Mossdale	1	2-4	5	6
white catfish, *Ameiurus catus*	1	4	228	4	1	1	0
white crappie, *Pomoxis annularis*	0	0	3	19	7	3	0
white sturgeon, *Acipenser transmontanus*	2	0	0	0	0	0	0
yellowfin goby, *Acanthogobius flavimanus*	7	0	3	0	492	2	42

Coded Wire Tag Recoveries in Sampling Gears During the 2009 Field Season

Numerous CWT salmon were released throughout the year in the Central Valley. Many were recovered during DJFMP trawling efforts at Sacramento (Sherwood Harbor) and Chipps Island and beach seining efforts in the lower Sacramento and San Joaquin Rivers and Delta. In addition, the State Water Project (SWP) and the Central Valley Water Project (CVP) facilities recovered CWT's. The DJFMP processed the CWT recoveries from DJFMP sampling efforts and the SWP and CVP facilities.

Results

<u>Fall-run</u>
In the 2009 field season, 7,764,070 CWT fall-run salmon were released in the combined release efforts of the Coleman National Fish Hatchery (CNFH; 3,547,166 fish), Feather River Fish Hatchery (FRFH; 2,444,852 fish), Merced Fish Facility (32,978 fish), Mokelumne River Fish Hatchery (250,300 fish), and Nimbus Fish Hatchery (267,003 fish). There also were 279,451 wild-tagged fall-run salmon released in the Sacramento Tributaries. In addition, the FRFH released 191,608 fall-spring hybrid salmon. The DJFMP recovered 1,537 CWT fall-run salmon during the 2009 field season: 850 (55.3%) in Chipps Island trawls, 626 (40.7%) in trawls at Sherwood Harbor, and 60 (3.9%) in beach seines (Table 11). Half of the fish recovered by beach seines were at one location, Garcia Bend (30 fish) on the Sacramento River. The CVP facility recovered one CWT fall-run salmon and no CWT fall-run salmon were recovered at the SWP facility. A map of these sites is available at (http://www.calfish.org/tabid/104/Default.aspx).

<u>Late fall-run</u>
The CNFH released 1,108,540 CWT late fall-run salmon during the 2009 field season and they were all released at Battle Creek in the months of December and January. There were 101 CWT late fall-run salmon recovered during the 2009 field season (Table 12a). Of the 101 CWT late fall-run salmon recovered, 48 (47.5%) individuals were recovered by the trawling efforts at Chipps Island and Sherwood Harbor, 3 (3.0%) individuals were recovered by beach seining, and 50 (49.5%) individuals were recovered at the SWP and CVP.

<u>Spring-run</u>
The FRFH released 2,021,444 CWT spring-run salmon during the 2009 field season, 1,015,717 were released at Boyd's Pump Ramp, and 1,005,727 were released in San Pablo Bay. There were 245 CWT spring-run salmon recovered during the 2009 field season (Table 12b). Trawling efforts by the DJFMP recovered 231 (94.3%) CWT spring-run salmon and the DJFMP beach seines recovered 14 (5.7%) CWT spring-run salmon. No CWT spring-run salmon were recovered at the CVP and SWP facilities.

<u>Winter-run</u>
The Livingston Stone National Fish Hatchery released 146,211 CWT winter-run salmon in the Sacramento River at Caldwell Park during the 2009 field season. A total of 10 CWT winter-run salmon were recovered during the 2009 field season: three individuals

were recovered in Chipps Island trawls and seven individuals were recovered at the SWP and CVP facilities (Table 12c).

Table 11. Recoveries of coded wire tagged juvenile fall-run salmon during the 2009 field season. Blank cells indicate no fish were recovered by the DJFMP or the CVP and SWP facilities.

Release Locations	Recovery Locations															
	Chipps Island	Sherwood Harbor	Brannan Island	Clarksburg	Colusa St. Park	Discovery Park	Elkhorn	Garcia Bend	Isleton	Koket	Rio Vista	Sandy Beach	Verona	Federal Fish Facility	State Fish Facility	Total
American River	7															7
Battle Creek	335	387		2	1		5			1	1	2	1			735
Benicia	4															4
Caldwell Park																
Elkhorn	4	8		4		6	2	4	1							29
Garcia Bend	27	1						14								42
Jersey Point	16															16
Mare Island	8		1													9
Miller Park	7	126						1								134
Pittsburg	315			1												316
San Pablo Bay	19															19
Sherman Island	88															88
Thermalito Bypass	3													1		4
Tiburon	1															1
West Sacramento	13	104		2				11								130
YoloBypass	3															3
Fall-run Total	850	626	1	9	1	6	7	30	1	1	1	2	1	1		1537

Table 12. Recoveries of coded wire tagged juvenile (a) late fall-, (b) spring-, (c) winter-run, and (d) fall-spring hybrid salmon during the 2009 field season. Blank cells indicate no fish were recovered.

	Recovery Locations								
Release Locations	Chipps Island	Sherwood Harbor	Clarksburg	Elkhorn	Garcia Bend	Reels Beach	Federal Fish Facility	State Fish Facility	Total
(a) Late fall-run									
Battle Creek	41	7				3	14	36	101
Latefall Total	41	7				3	14	36	101
(b) Spring-run									
Boyds Pump Ramp	149	71	1	12	1				234
San Pablo Bay	11								11
Spring Total	160	71	1	12	1				245
(c) Winter-run									
Caldwell Park	3						6	1	10
Winter Total	3						6	1	10
(d) Hybrid									
Mare Island	2								2
Hybrid Total	2								2

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