SRSP Science Webinar – Sacramento River Fish Trends
March 29, 2024

Winter-run Chinook Salmon in the Upper Sacramento River in 2023

Carcass and Redd Surveys
Methods, Analysis, and Results

DOUG KILLAM
California Dept of Fish and Wildlife

Winter-run Chinook past and present

- Originally existed only in the Sacramento River system that included the Little Sacramento, Fall, Pit and McCloud Rivers and Battle Creek.
- Require cool clean fresh water under 56 degrees over the summer months.
- Only exist in this area….no where else in world... genetically unique
- Livingston Stone was a federal biologist who developed the Baird Hatchery on the McCloud River and eggs from this hatchery were sent around the world.
- Currently only occur in the Sacramento River watershed below Keswick Dam. Shasta Dam blocks all access to winter-run habitat upstream. Winter-run spawners downstream of Keswick first noted in May of 1945 after completion of dam. Cool tailrace water substituted for headwater springs transferring habitat upstream of Shasta to the Redding area.
- Listed as Endangered in 1989 as drought, pollution, water diversions, and fishing pressure impacted their survival.
- Planning for winter-run includes the ongoing re-introduction above Shasta Reservoir and jumpstart reintroduction in Battle Creek.

Big 8-Page Special: Where and How to Camp

MARCH 1970 50¢

Outdoor Life

March for the Kings
'New' Salmon Run

Raccoons Go West

Chug Up Lake Trout
Ice-Fishing Boom

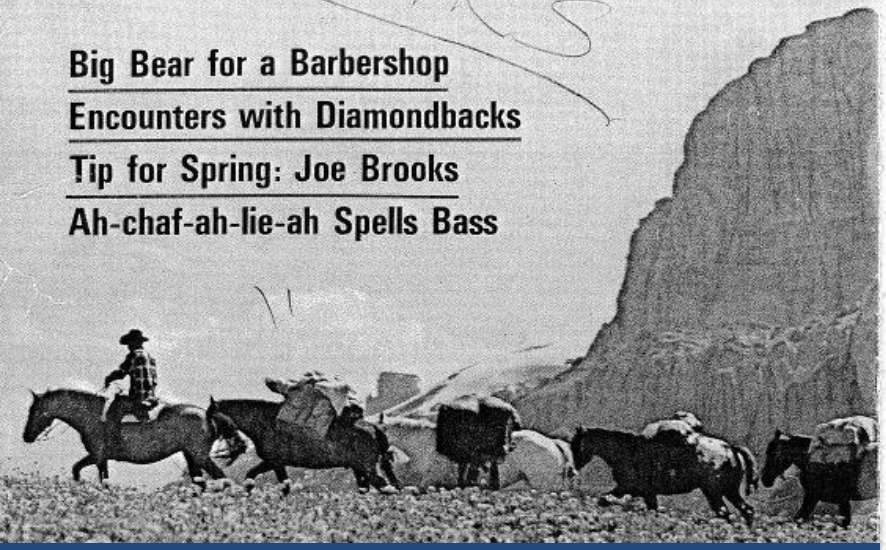
The Turkey Madness

Big Bear for a Barbershop

Encounters with Diamondbacks

Tip for Spring: Joe Brooks

Ah-chaf-ah-lie-ah Spells Bass



Walt Kauk grimaces as he nets John Reginato's king in replay, for camera, of action we got on upper Sacramento River, California

A key to success: plug sweetened with sardine

March with The Kings

By MIKE HAYDEN

Nobody is sure how this winter run started or why it's growing. But anchor-fishermen love these royal salmon

WITH COLD, numb fingers I flipped open the bail on my spinning reel and made my first cast from Walter Kauk's outboard-powered runabout. My lure was a large banana-shaped plug baited with a sliver of fresh sardine.

I remained on my feet long enough to watch the silver plug rocket a short distance through drifting tendrils of morning mist before it plunged and vanished in a glassy slick downstream. Then I planted myself in the stern beside John Reginato and gratefully accepted a cup of hot coffee from Walter Kauk, who sat up front at the wheel.

As I turned to take the steaming cup with my right hand, the cork butt of my seven-foot glass rod suddenly sprang skyward and threatened to catapult from the grasp of my left hand. For an instant I froze, caught with my arms crossed awkwardly. Then, in one uninterrupted motion,

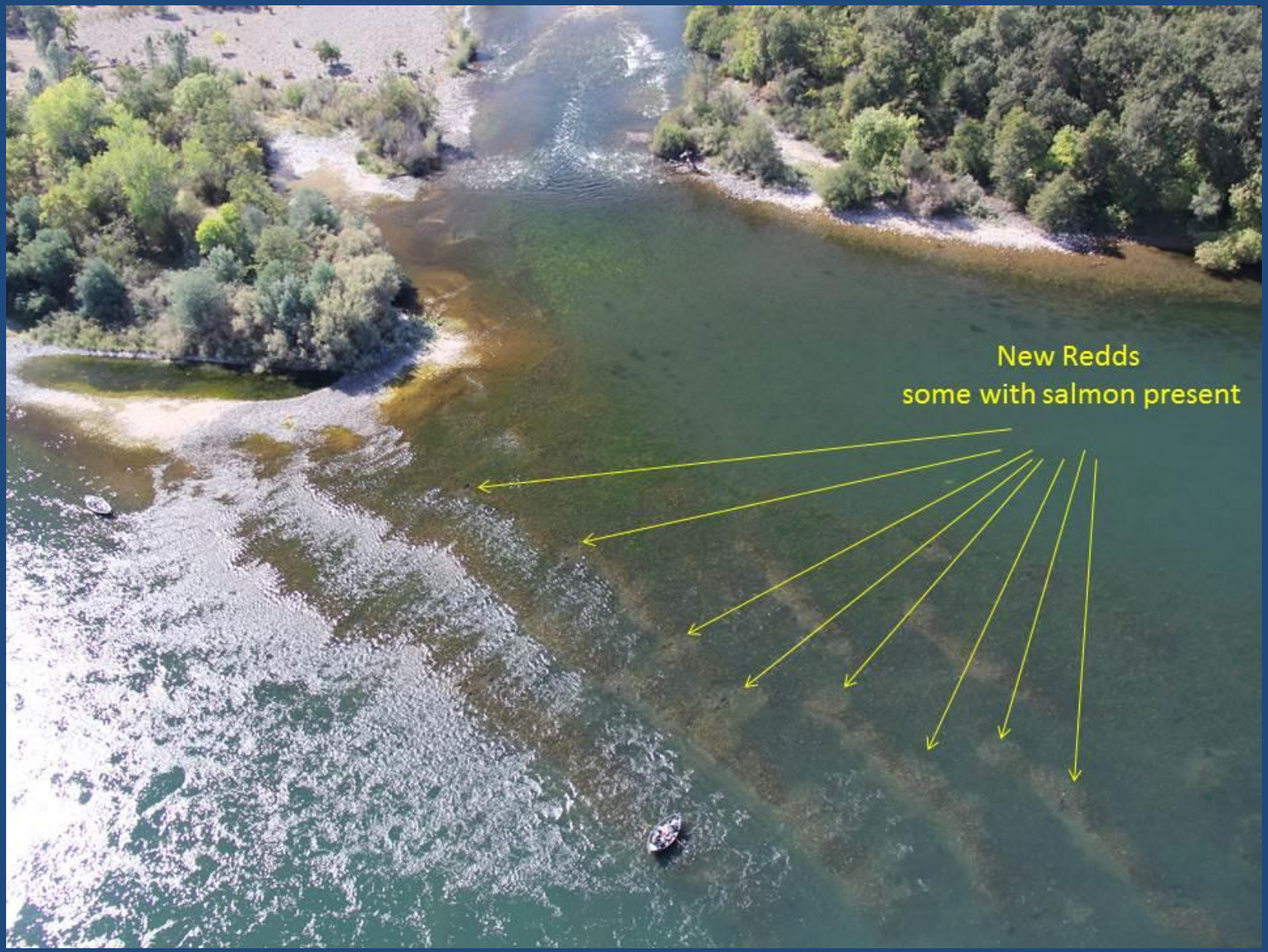
Mt. Shasta forms backdrop in this view of anchor-fishermen at Ball's Ferry

Monitoring of Winter-run: Adults

- No long-term monitoring prior to the 40 years of the Red Bluff Diversion Dam (RBDD) 1967-2008.
- Balls Ferry Weir (1940's) lasted only 3 years.
- Carcass surveys begin in 1990's and become "official" for winter-run in 2001.

- CURENT YEARS: 2003-2023
  - Boat based carcass surveys begin in late April and run into September.
  - Helicopter surveys to count salmon redds occur weekly- May to August.
  - Keswick trap removes adults for LSNFH from February through June.
  - Redd dewatering monitoring begins in June and goes into November- began 2013.
  - Colusa Basin Drain monitoring now regularly occurs on salmon straying into irrigation canals

Aerial Redd Survey: Used to determine the timing and extent of spawning in the river. The proportion of redds outside the carcass survey (if any) is used to expand the carcass survey numbers. Redd location and timing also inform water temperature management actions.



Winter-Run Aerial Redd and other data available to public in Excel spreadsheets at CALFISH.org

Year 2023 Aerial Redd Counts (New redds only)

This draft data has not yet undergone a final quality control process by CDFW to confirm or otherwise verify its accuracy. As a result, this draft data should not be used, relied upon, or referenced in any way until finalized by CDFW. Upon data finalization by CDFW, the draft data will be superseded and should be deleted. This draft d

NUMBER OF NEW REDDS VIEWED BY AERIAL OBSERVATIONS

DATE	5/15/2023	5/22/2023	5/30/2023	6/5/2023	6/12/2023	6/20/2023	6/26/2023	7/3/2023	7/10/2023	7/18/2023	7/24/2023	8/2/2023	8/9/2023	10/2/2023	10/26/2023	11/9/2023	11/27/2023
Aircraft	helo	helo	helo	helo	helo	helo	helo	helo	helo	helo	helo	helo	helo	helo	helo	helo	helo
Visibility	good	fair	fair	fair	fair	fair	good	fair	good	good	excellent	excellent	excellent	excellent	poor	good	fair
FLOW (noon) from Keswick (KWK)	12,583	12,879	10,086	10,164	9,652	9,423	10,008	11,079	11,325	11,095	11,062	11,276	10,948	6,710	6,607	4,990	4,900
Race	Winter	Winter	Winter	Winter	Winter	Winter	Winter	Winter	Winter	Winter	Winter	Winter	Winter	Spring	Fall	Fall	Fall
Keswick to A.C.I.D. Dam.	0	0	0	0	0	0	2	0	1	10	3	1	0	0	1	0	20
A.C.I.D. Dam to Highway 44 Bridge	1	1	0	0	1	1	2	0	3	19	4	0	0	0	2	0	10
Highway 44 Br. to Airport Rd. Br.	0	0	0	0	0	0	5	1	2	7	0	0	0	1	2	0	27
Airport Rd. Br. to Balls Ferry Br.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	6
Balls Ferry Br. to Battle Creek.	0	n/s	n/s	0	0	0	0	0	0	0	0	0	0	0	5	6	8
Battle Creek to Jellys Ferry Br.	0	n/s	n/s	0	0	0	0	0	0	0	0	0	0	0	1	4	3
Jellys Ferry Br. to Bend Bridge	n/s	n/s	n/s	n/s	n/s	n/s	0	n/s	0	n/s	0	n/s	n/s	0	0	2	4
Bend Bridge to Red Bluff Diversion Dam	n/s	n/s	n/s	n/s	n/s	n/s	0	n/s	0	n/s	0	n/s	n/s	0	0	2	5
Red Bluff Diversion Dam to Tehama Br.	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	0	2	8	7
Tehama Br. To Woodson Bridge	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	0	2	3
Woodson Bridge to Hamilton City Br.	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	0	0	2
Hamilton City Bridge to Ord Ferry Br.	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	9
Ord Ferry Br. To Princeton Ferry.	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	2
TOTALS	1	1	0	0	1	1	9	1	6	36	7	1	0	1	16	28	106
HELICOPTER HOUR ACCOUNTING-PSMFC only	1.0	0.8	0.9	1.0	1.1	1.2	1.6	0.9	1.7	1.1	1.6	1.0	0.9	2.1	CDFW helo	CDFW helo	
14.8																	

2023

TOTALS

Late-Fall redds in this box are from Early this year and Late in previous year.

	Late-Fall	% Dist	WINTER	% Dist.	SPRING	% Dist.	Fall	% Dist	ALL	% Dist.	
Keswick to A.C.I.D. Dam.	93	74.4%	17	4.2%	0	0.0%	21	32.8%	131	15.8%	Keswick to A.C.I.D. Dam.
A.C.I.D. Dam to Highway 44 Bridge	11	8.8%	32	7.9%	0	0.0%	2	3.1%	45	5.4%	A.C.I.D. Dam to Highway 44 Bridge
Highway 44 Br. to Airport Rd. Br.	8	6.4%	15	3.7%	1	100.0%	2	3.1%	26	3.1%	Highway 44 Br. to Airport Rd. Br.
Airport Rd. Br. to Balls Ferry Br.	0	0.0%	0	0.0%	0	0.0%	7	10.9%	7	0.8%	Airport Rd. Br. to Balls Ferry Br.
Balls Ferry Br. to Battle Creek.	1	0.8%	0	0.0%	0	0.0%	11	17.2%	12	1.4%	Balls Ferry Br. to Battle Creek.
Battle Creek to Jellys Ferry Br.	2	1.6%	0	0.0%	0	0.0%	5	7.8%	7	0.8%	Battle Creek to Jellys Ferry Br.
Jellys Ferry Br. to Bend Bridge	0	0.0%	0	0.0%	n/s	n/s	2	3.1%	2	0.2%	Jellys Ferry Br. to Bend Bridge
Bend Bridge to Red Bluff Diversion Dam	2	1.6%	0	0.0%	n/s	n/s	2	3.1%	4	0.5%	Bend Bridge to Red Bluff Diversion Dam
Red Bluff Diversion Dam to Tehama Br.	8	6.4%	n/s	n/s	n/s	n/s	10	15.6%	18	2.2%	Red Bluff Diversion Dam to Tehama Br.
Tehama Br. To Woodson Bridge	0	0.0%	n/s	n/s	n/s	n/s	2	3.1%	2	0.2%	Tehama Br. To Woodson Bridge
Woodson Bridge to Hamilton City Br.	n/a	n/a	n/s	n/s	n/s	n/s	0	0.0%	0	0.0%	Woodson Bridge to Hamilton City Br.
Hamilton City Bridge to Ord Ferry Br.	n/a	n/a	n/s	n/s	n/s	n/s	0	0.0%	0	0.0%	Hamilton City Bridge to Ord Ferry Br.
Ord Ferry Br. To Princeton Ferry.	n/a	n/a	n/s	n/s	n/s	n/s	0	0.0%	0	0.0%	Ord Ferry Br. To Princeton Ferry.
TOTALS	125	100.0%	64	15.8%	1	100.0%	64	100.0%	254	30.7%	

Split refers to the section the survey ended in

This data from raw data binders at Red Bluff

2023 CARCASS SURVEY CALCULATIONS

	Within %	Downstream	#Redds Above	# Redds Below	Split Above	Split Below
Late fall carcass survey ended at Balls F	89.6%	10.4%	112	13	0	0
Winter run carcass survey end at Balls Ferry	100.0%	0.0%	64	0	0	0
Fall Run carcass survey ends at Balls Ferry	50.8%	49.2%	33	32	0	0

2023 Summary of Aerial Redd Survey Data*

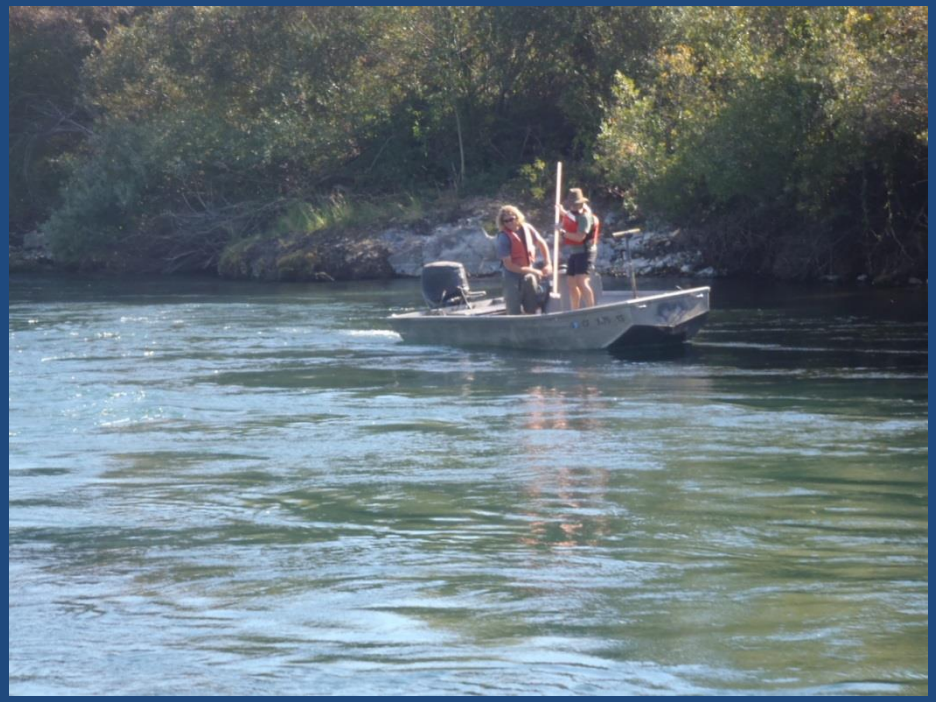
Late-Fall	% Dist.	Winter	% Dist.	Spring	% Dist.	Fall	% Dist	ALL	% Dist.	RIVER SECTIONS
93	74%	17	27%	0	0%	21	14%	131	39%	**Keswick to A.C.I.D. Dam.**
11	9%	32	50%	0	0%	12	8%	55	16%	**A.C.I.D. Dam to Highway 44 Bridge**
8	6%	15	23%	1	100%	29	19%	53	16%	**Highway 44 Br. to Airport Rd. Br.**
0	0%	0	0%	0	0%	13	9%	13	4%	**Airport Rd. Br. to Balls Ferry Br.**
1	1%	0	0%	0	0%	19	13%	20	6%	**Balls Ferry Br. to Battle Creek.**
2	2%	0	0%	0	0%	8	5%	10	3%	**Battle Creek to Jellys Ferry Br.**
0	0%	0	0%	n/s	n/s	6	4%	6	2%	**Jellys Ferry Br. to Bend Bridge**
2	2%	0	0%	n/s	n/s	7	5%	9	3%	**Bend Bridge to RBDD**
8	6%	n/s	n/s	n/s	n/s	17	11%	25	7%	**RBDD to Tehama Br.**
0	0%	n/s	n/s	n/s	n/s	5	3%	5	1%	**Tehama Br. To Woodson Bridge**
n/a	n/a	n/s	n/s	n/s	n/s	2	1%	2	1%	**Woodson Bridge to Hamilton City Br.**
n/a	n/a	n/s	n/s	n/s	n/s	9	6%	9	3%	**Hamilton City Bridge to Ord Ferry Br.**
n/a	n/a	n/s	n/s	n/s	n/s	2	1%	2	1%	**Ord Ferry Br. To Princeton Ferry.**
125	**100%**	**64**	**100%**	**1**	**100%**	**150**	**100%**	**340**	**100%**	

* Summary of: 1 late-fall-run, 13 winter-run, 1 spring-run, and 3 fall-run Chinook Salmon redd counting flights.

In 2023, there were 64 winter-run redds observed over 13 helicopter flights

Carcass Surveys: are used to develop the annual population estimate for four runs of salmon each year in the Sacramento River. The winter-run survey occurs from May to September, using two boats, seven days per week. It is a collaborative effort between the CDFW, USFWS and PSMFC staff.

Crews spear salmon carcasses with long poles and collect samples and data from each fish and return many of them to the river with a numbered jaw tag. Subsequent recaptures of the tagged fish form the basis of the "mark-recapture" methodology used to estimate how many winter-run salmon were in the population. Other data is simultaneously collected on the carcasses such as sex, length, pre-spawn mortality, scales, otoliths, tissues, cwt tags, and other information as needed.



Carcass survey results create a female in-river estimate, additional information from LSNFH and aerial redd surveys are utilized to expand the carcass mark-recapture effort. Once combined, all sources of winter-run data are then used to characterize the population for various management and research needs.

TOTAL POPULATION ESTIMATE			ESTIMATE	Adjustments	
Cormack Jolly Seber Calculation for Females from R [CJS v2.5.0]			1,070	1,070.0	See Image of R summary calculations imbedded in this file below for details:
Total FEMALES in-river after the Downstream Redd expansion			1,070	1.0000	No redds below carcass survey location. (64 redds observed during 13 WR surveys)
Number large Males (> 609 mm) in-river from Keswick Trap Data			823	0.7687	^ Based on the ratio of large WR males (>609) to total females at Keswick Trap: (N= 780, that includes 339 lg males to 441 females or 43.5% to 56.5%) vs. survey results for lg fresh males of 60, fresh females were 2
Number of small males (<609 mm) in-river from carcass survey data			27	0.0333	Based on number of total males to large males (>609 mm) from carcass survey fresh fish sample (62 total fresh: 2 small to 60 large or 3.2% to 96.8%). Includes no 0.5555 and 3- 9999's fresh males and no mini-jack.
Total MALES in-river adding in Jacks from Carcass survey data (Jills in			850		Sum of large and small males
Number of Fish Removed from Population by LSNFH			507	507	Updated-10-26-23 USFWS Data from LSNFH Broodstock Collections 2023 = total of 818 WR: of these 311 released back into Sac, leaving 507 REMOVED from Sac include: 382 spawned, 124 prespawn morts (19 fer
Final MAINSTEM Estimate is	**2,427**	=	2,427		This is expanded Mainstem Sacramento Spawner Escapement Estimate
Other Mainstem Winter-run Observed on other Survey Efforts (late fall, fall run,			2,427	0	0 WR carcasses found during LF carcass survey or in other creeks. This number will be updated by any WR determined to have spawned in other tribs when this number is available
				54	Battle Creek Jumpstart count as of 11-21-23 = 54 Draft per CS. Note in 2023 the 5th year of adult Jumpstart Battle Creek WR, there were 42 trucked to LSNFH (31 f's and 11m's), 0 that were videoed moving upstream

NOTE TABLES BELOW CONTAIN INFORMATION USED TO DETERMINE THE FINAL ESTIMATE: DO NOT MOVE OR DELETE

In-River totals	1,920	PERCENTS	In-River			PERCENT HATCHERY
Adult Females >2 yrs	1,065	55.5%	Total Adults	1,888	98.3%	OVERALL
Adult Males >2 yrs	823	42.8%	Total Grilse	32	1.7%	29.1%
Female Grilse-2yr Old	5	0.2466%	Females and Jills based on 580 mm cut-off from length-frequency carcass survey fresh female measured carcasses [1 females <580 mm ea. 225> 579 mm] of 225 total females measured] as [0.5555] and 2- 9999's included] Male 1 non-fresh hatchery 2 yr. old's under 580 mm this year. Kronick data supports			
Male Grilse-1 and 2yr Old's	27	1.4%	Males and Jacks based on 610 mm cut-off from length-frequency carcass survey fresh male measured carcasses [1 males <610 mm ea 61 >580mm] of 62 total fresh males] as: 0.5555 male inc. and 3 -9999's inc.]			
	1,920	100.0%	Note unmeasured fish originally measured as 0.5555 or 9999 for large and small purposes of mark re-capture study may be included in Length Frequency proportions depending on final cut off chosen, but not in deciding cut off.			

Carcass Population Component Breakdo	HATCHERY FISH			NATURAL FISH			OVERALL											
CATEGORY	In -River	LSNFH	Total	In -River	LSNFH	Total	Total	%										
Number of Adult Females [>579 mm]	353	85	438	1,147	114	1,261	1,699	70.0%	Number of Adult Females (>579 mm)									
Number of Adult Males [>609 mm]	67	162	229	333	119	452	681	28.1%	Number of Adult Males (>609 mm)									
Number of Grilse Females (Jills)	7	0	7	0	0	0	7	0.3%	Number of Grilse Females (Jills <580 mm)									
Number of Grilse Males (Jacks >400 and <610mm	7	27	34	7	0	7	40	1.7%	Number of Grilse Males (Jacks) (From 400 to 609 mm...no micro's)									
See Females in Fresh Fish table Inclusive 2-run 22-23]	433	274	707.3	1,487	233	1,720	2,427	100%										
			433			1,487												

For GRAND	Total	A
INTO LSNFH	507	
ABOVE RBD	1,920	
BELOW RBD	0	
TOTALS	2,427	

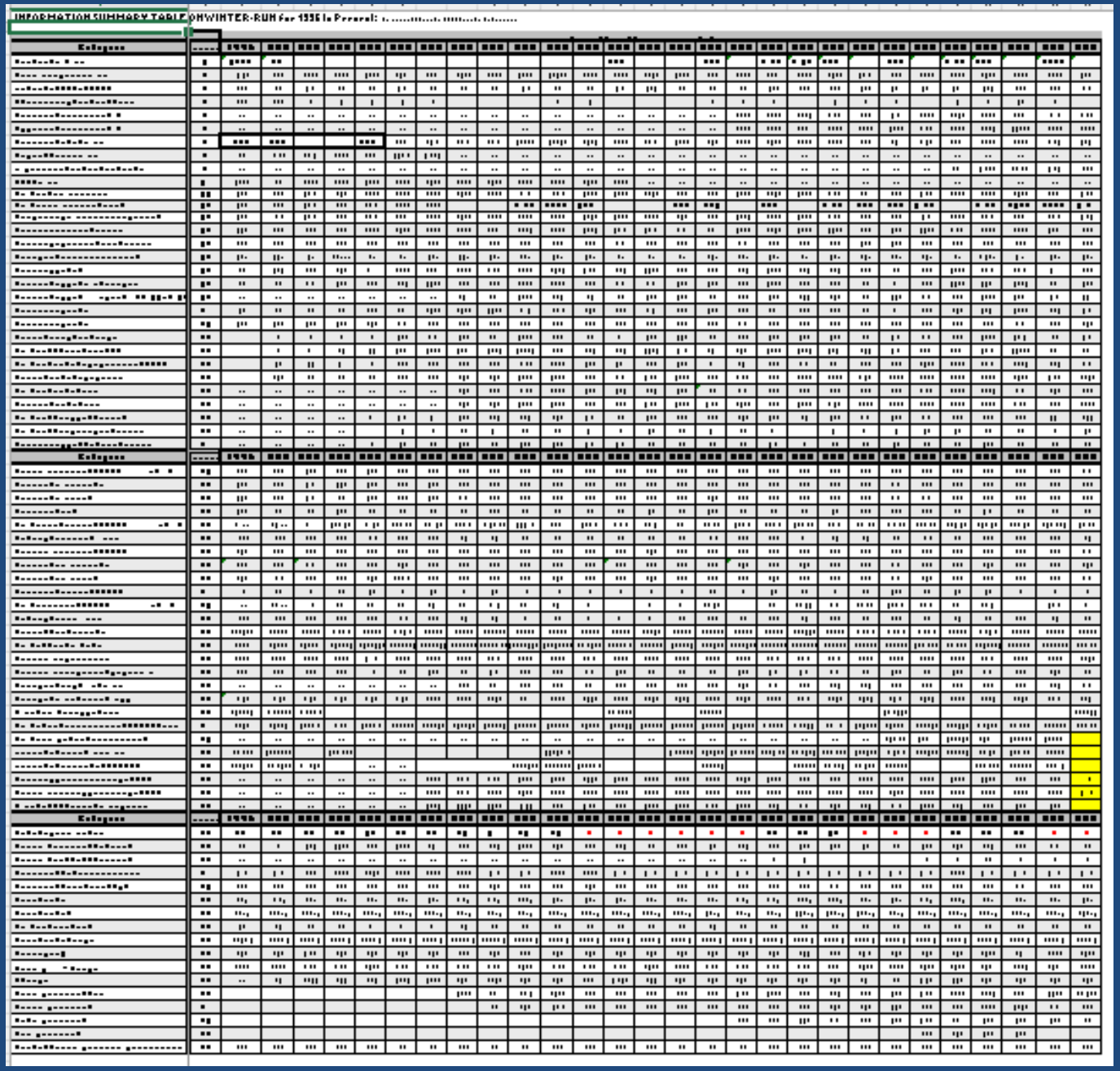
Note: The this table's purpose is to calculate the number of hatchery origin winter-run fish that were present in the overall population. Calculations can be found in USFWS report and at bottom of this worksheet

Hatchery Fish Estimate Calculation (USFWS)			Based on coded-wire tag results and the total WR population (in-river + LSNFH) calculated above
Count of hatchery fresh carcass recoveries	65	65.0	Based on sum of all fresh clipped and those calculated to be clipped (from ovt recoveries) of fresh carcasses (final ad-fin >0.9)
Estimate of hatchery non-fresh carcass recoveries	54	54.2	Based on ratio of fresh hat carcass recovery rate (= 65 fresh hatchery *240 total non-fresh recoveries / 288 fresh recoveries) (note 39 actual NF hat fish observed on survey)

In 2023 there were an estimated 2,427 winter-run salmon in the Sacramento River

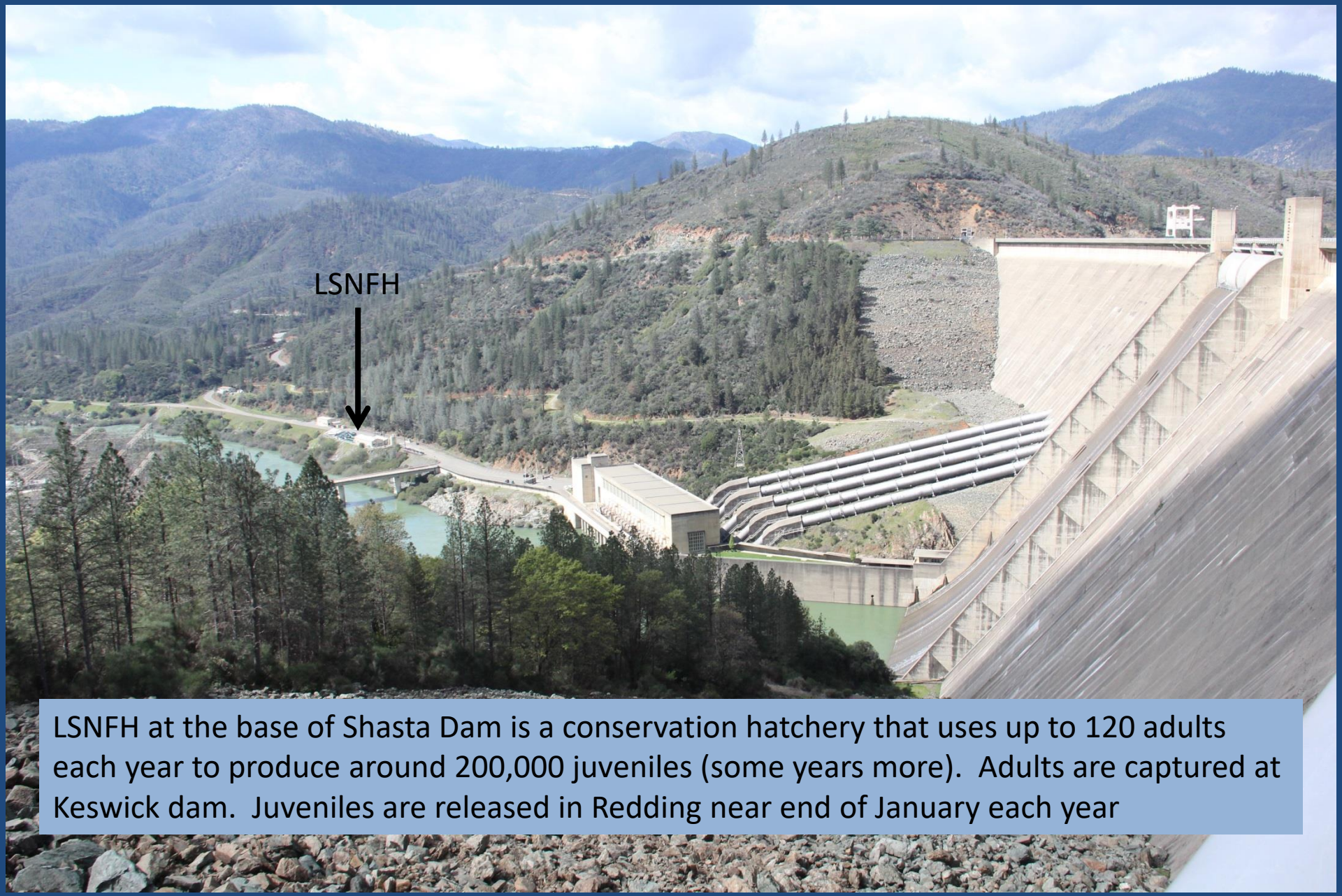
Following the creation of the annual population estimate the annual data is available in a summary table providing winter-run data for categories of interest for various users.

Winter-Run Chinook Salmon Data Table available for various categories for 1996-2023



Category	Note*	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Official Total System Estimate	1	1,337	880	2,998	3,289	1,353	8,223	7,459	8,218	7,869	15,839	17,297	2,543	2,830	4,537	1,596	827	2,673	6,086	3,015	3,440	1,548	977	2,638	8,033	6,390	10,269	5,927	2,427
In-river spawner estimate	2	1,012	836	2,889	3,264	1,263	8,120	7,360	8,133	7,784	15,730	17,197	2,487	2,725	4,416	1,533	738	2,578	5,920	2,627	3,182	1,409	795	2,458	7,852	6,195	9,956	5,437	1,920
Into Hatchery (CNFH or LSNFH)	3	325	44	103	24	89	102	96	85	85	109	94	55	105	121	63	86	93	164	388	257	137	180	180	180	191	298	484	507
Other Winter-run (e.g. -Battle, LF survey)	4	237	226	6	1	1	1	3	0	0	0	6	1	0	0	0	3	2	2	0	1	2	2	0	1	4	15	6	0
Lower confidence interval (90%)	5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2,449	5,343	2,741	3,042	329	109	2,235	7,213	5,958	9,280	5,009	2,084
Upper confidence interval (90%)	6	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2,894	6,732	3,290	3,836	2,763	1,888	3,029	8,852	6,821	11,258	6,889	2,767
Peterson standardized estimate	7	273	564	2,162	1,136	4,290	6,760	6,106	6,602	6,205	13,549	13,919	2,161	2,448	3,307	1,338	712	2,246	5,198	2,475	2,454	829	610	2,017	5,380	5,494	7,896	4,031	1,610
Reported Peterson estimate	8	820	2,053	5,501	2,262	6,670	11,502	10,541	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Jumpstart returns into Battle Creek (into Sac Riv)	9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	95 (0)	1038 (8)	240 (24)	109 (1)	54 (2)
RBDD estimate	10	1,337	880	2,992	3,288	1,352	5,523	9,169	9,757	7,192	5,299	7,436	6,144	3,635	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Number adult females in-river- (no jills)	11	193	395	1,908	817	3,483	5,262	5,682	5,179	3,252	9,005	8,807	1,542	1,462	2,717	822	424	1,498	3,613	1,698	2,058	560	236	1,024	4,888	3,978	6,199	2,650	1,065
Number total females in-river	12	193	422	1,908	849	3,508	5,295	5,733	5,218	3,292	9,047	8,858	1,550	1,462	2,722	824	491	1,498	3,680	1,744	2,063	658	373	1,088	4,947	4,023	6,199	2,663	1,070
Total spawning females in-river (no unspawned)	13	182	407	1809	827	3508	5260	5654	5189	3258	8849	8664	1519	1439	2699	817	488	1481	3645	1727	2022	653	367	1080	4884	3904	5860	2607	1061
Carcasses encountered on survey	14	118	239	785	475	2,482	5,145	4,959	4,549	3,280	8,771	7,698	1,581	1,409	1,904	908	430	1,348	3,219	1,389	1,194	297	143	1,126	3,026	3,678	4,847	1,650	528
Percent of population observed on survey	15	43%	42%	36%	42%	58%	63%	66%	55%	42%	55%	45%	62%	50%	42%	57%	52%	50%	53%	46%	35%	19%	15%	43%	38%	58%	47%	28%	22%
Date of peak carcasses encountered	16	15-July	11-July	01-July	22-June	02-July	08-July	15-July	11-July	15-July	23-July	14-July	14-July	5-July	5-July	4-July	21-July	22-July	19-July	6-July	17-July	21-July	29-July	31-July	9-July	8 + 17 July	10-July	12-July	17-July
Carcasses tagged (all fish)	17	86	191	575	313	2,000	4,364	3,770	3,457	2,072	4,758	4,121	1,063	841	1,146	582	253	881	1,734	731	721	223	93	857	1,883	2,508	2,906	1,000	329
Carcasses chopped (all-mark-recapture)	18	32	48	208	162	482	781	1,189	882	958	2,448	2,656	427	502	606	189	134	467	1,485	658	473	74	50	269	1,143	1,170	1,941	650	199
Carcasses chopped (clips years 2003-2011)	19	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	210	250	1,565	921	91	66	152	137	43	388	183	211	213	83	112	906	954	1,527	1,220	109	110
Carcasses recaptured (all)	20	13	22	75	57	829	2,200	2,159	2,175	1,128	3,001	2,206	716	475	401	384	124	533	990	335	252	59	20	457	713	1,610	1,463	361	103
Percent recaptured (all)	21	15%	12%	13%	18%	41%	50%	57%	63%	54%	63%	54%	67%	56%	35%	66%	49%	60%	57%	46%	35%	26%	22%	53%	38%	64%	50%	36%	31%
Carcasses showing hatchery origin	22	0	5	4	4	4	155	208	179	250	1,565	885	83	60	137	112	32	362	158	196	195	76	109	903	948	1,474	1,201	94	104
Number of CWT's found (x) = non-winter CWT	23	0	5 (0)	2 (0)	2 (1)	1 (1)	124 (0)	148 (8)	134 (0)	168 (1)	1269 (1)	776 (0)	66 (1)	46 (1)	116 (1)	100 (4)	21 (0)	312 (0)	133 (3)	168 (1)	161 (0)	71 (1)	106 (0)	879 (0)	888 (0)	1,404 (0)	1,135 (2)	74 (0)	95 (0)
Number of hatchery fish in population	24	0	12	11	10	7	429	566	423	636	3,056	2,386	143	170	467	199	80	810	399	705	770	466	824	2,177	2,989	2,907	3,271	641	707
Percent hatchery fish in population	25	0.0%	2.1%	0.5%	0.8%	0.2%	5.2%	7.6%	5.1%	8.1%	19.3%	13.8%	5.6%	6.0%	10.3%	12.5%	9.7%	30.3%	6.6%	23.4%	22.4%	30.1%	84.3%	82.5%	37.2%	45.5%	31.9%	10.8%	29.1%
Number of hatchery fish in-river	26	n/a	n/a	n/a	n/a	n/a	n/a	n/a	413	628	3,048	2,379	134	161	461	197	79	808	399	454	638	358	655	2,023	2,873	2,781	3,030	318	433
Percent of hatchery fish in-river	27	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5.1%	8.1%	19.4%	13.8%	5.4%	5.9%	10.4%	12.9%	10.7%	31.3%	6.7%	17.3%	20.1%	25.4%	82.4%	82.3%	36.6%	44.9%	30.4%	5.8%	22.6%
Number of WR floy tags released	28	n/a	n/a	n/a	n/a	20	106	100	152	261	281	219	103	93	157	359	293	714	197	41	177	303	194	403	293	357	646	110	311
Number of WR floy tags recaptured	29	n/a	n/a	n/a	n/a	0	1	5	26	10	34	33	10	9	12	24	10	44	20	0	10	20	1	13	13	48	26	9	13
Percent of floy tags observed	30	n/a	n/a	n/a	n/a	0%	1%	5%	17%	4%	12%	15%	10%	10%	8%	7%	3%	6%	10%	0%	6%	7%	1%	3%	4%	13%	4%	8%	4%
Percent males: survey and LSNFH (>2002)	31	29%	25%	12%	25%	18%	35%	22%	36%	58%	43%	48%	38%	46%	39%	46%	35%	42%	38%	35%	36%	54%	56%	57%	38%	36%	38%	52%	30%
Percent adult males to all adults:	32	13%	24%	10%	11%	17%	29%	18%	32%	43%	38%	48%	35%	42%	38%	45%	28%	39%	34%	29%	35%	37%	40%	54%	35%	29%	37%	48%	29%
Percent adult males to all fish:	33	11%	22%	10%	9%	16%	26%	17%	30%	32%	35%	47%	33%	39%	38%	44%	21%	37%	32%	26%	34%	22%	20%	30%	33%	26%	36%	44%	28%
Percent jacks to all fish:	34	18%	4%	2%	17%	2%	9%	5%	6%	26%	7%	2%	5%	7%	1%	2%	13%	5%	7%	9%	1%	32%	35%	26%	5%	10%	3%	8%	2%
Number of Jacks: survey and LSNFH (>2002)	35	50 + n/a	21 + n/a	40 + 0	189 + 12	90 + 17	738 + 22	360 + 15	496 + 8	2015 + 26	1110 + 4	327 + 0	129 + 2	203 + 4	48 + 1	39 + 0	87 + 22	142 + 2	393 + 2	183 + 88	43 + 6	420 + 67	302 + 44	665 + 23	391+14	613 + 12	245 + 15	315 + 531	14 + 27
Fork length cutoff for jacks (mm): survey	36	< 645	< 645	< 595	< 635	< 605	< 665	< 685	< 610	< 710	< 670	< 660	< 670	< 670	< 670	< 670	< 705	< 645	< 675	< 700	< 610	< 710	<720	<705	< 680	< 665	< 625	< 675	<610
Percent females: survey and LSNFH	37	71%	75%	88%	75%	82%	65%	78%	64%	42%	57%	52%	62%	54%	61%	54%	65%	58%	62%	65%	64%	46%	44%	44%	62%	64%	62%	48%	70%
Percent adult females to all adults:	38	87%	76%	90%	89%	83%	71%	82%	68%	57%	62%	52%	65%	58%	62%	55%	72%	61%	66%	71%	65%	63%	60%	57%	65%	71%	63%	52%	71%
Percent adult females to all fish:	39	71%	70%	88%	72%	81%	64.30%	77%	64%	42%	57%	51%	62%	54%	61%	53%	56%	58%	61%	63%	64%	38%	30%	41%	62%	64%	62%	48%	70%
Percent jills to all fish: survey and LSNFH	40	0%	5%	0%	3%	1%	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	9%	0%	1%	2%	0%	9%	14%	3%	1%	1%	0%	0%
Number of Jills: in-river and LSNFH (>2002)	41	0+n/a	27+n/a	0+3	32+0	25+0	33+0	51+0	39+0	40+1	42+0	51+0	8+0	0+0	5+0	2+0	66+12	0+0	67+0	46+11	5+2	98+37	137+3	64+2	59+0	45+1	0+0	13+7	7 + 0
Fork length cutoff for jills (mm): survey	42	< 645	< 645	< 595	< 595	< 585	< 605	< 545	< 610	< 610	< 600	< 590	< 600	< 600	< 600	< 580	< 645	< 540	< 626	< 610	< 575	< 630	<645	<620	< 610	< 590	<525	<610	<580
Percent Adults vs Percent Grilse	43	82% - 18%	92% - 8%	98% - 2%	80% - 20%	97% - 3%	90% - 10%	94% - 6%	93% - 7%	74% - 26%	93% - 7%	98% - 2%	95% - 5%	92% - 8%	99% - 1%	97% - 3%	77% - 23%	95% - 5%	92% - 8%	89% - 11%	98% - 2%	60% - 40%	50% - 50%	70% - 30%	94% - 6%	90% - 10%	97% - 3%	92% - 8%	98% - 2%
Number Adults vs Number Grilse	44	223 - 50	516 - 48	2122 - 40	915 - 221	4175- 115	7349- 771	6949 - 411	7675- 543	5786- 2083	14683-1156	16918-378	2402- 139	2622-207	4483-54	1555-41	637-187	2527-144	5576-462	2688-328	3383-56	924-622	357-438	1730-729	7403-450	5715-671	9,994 - 260	5,433 -488	2350 - 47
Percent female spawn success	45	94.5%	96.4%	94.8%	97.4%	100.0%	99.3%	98.6%	99.5%	99.0%	97.8%	97.8%	98.0%	98.4%	99.2%	99.2%	99.4%	98.8%	99.0%	99.0%	98.0%	99.2%	98.3%	99.3%	98.7%	97.0%	94.5%	97.9%	99.1%
Percent females unspawned (prespawn morts)	46	5.5%	3.6%	5.2%	2.6%	0.0%	0.7%	1.4%	0.5%	1.0%	2.2%	2.2%	2.0%	1.6%	0.8%	0.8%	0.6%	1.2%	1.0%	1.0%	2.0%	0.8%	1.7%	0.7%	1.3%	3.0%	5.5%	2.1%	0.00885
Average fork length (mm) fresh females	47	n/a	n/a	n/a	n/a	n/a	n/a	n/a	739	760	757	756	770	766	752	748	732	715	806	748	721	691	674	738	763	726	744	761	802
Average Female Fecundity (# eggs)	48	5,019	5019	5019	5019	5019	5019	4,923	4,854	5,515	5,500	5,484	5,112	5,424	5,519	5,161	4,832	4,518	4,596	5,308	4,819	4,131	4,109	5,141	5,424	4,991	5,312	5,505	5,510
Estimated number of eggs layed in-river	49	915,831	2,042,375	9,078,404	4,148,253	17,606,652	26,398,139	27,833,461	25,189,698	17,968,910	48,671,423	47,514,506	7,766,556	7,806,944	14,895,046	4,217,615	2,358,220	6,689,267	16,750,496	9,168,354	9,742,267	2,696,962	1,507,113	5,552,179	26,490,089	19,484,965	31,125,828	14,351,535	5,846,110
Number hatchery juveniles released in-river	50	4,718	21,271	153,909	30,840	166,206	252,684	233,613	218,617	168,261	173,344	196,288	71,883	146,211	198,582	123,859	194,264	181,857	205,224	609,311	420,006	141,388	217,270	223,817	249,119	302,166	520,285	732,324	
Number of Jumpstart (Battle Cr.) juvs released	51	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	215,047	185,000	182,415	214,000	137,358	174,550	
Juvenile Production Estimate (females)	52	550,872	1,386,346	4,676,143	1,490,249	4,946,418	5,643,635	6,964,626	6,181,925	2,786,832	12,109,474	11,818,006	1,864,521	1,952,614	3,728,444	1,049,385	512,192	1,809,584	4,431,054	2,409,171	2,630,547	166,189	201,409	433,176	854,941	330,130	125,038	49,924		
Juvenile Production Index (RST RBDD)	53	469,183	2,205,163	5,000,416	1,366,161	n/a	n/a	7,635,469	5,781,519	3,677,989	8,943,194	7,298,838	1,637,804	1,371,739	4,972,954	1,572,628	996,621	1,814,244	2,481,324	523,872	440,951	640,149	734,432	1,477,529	4,691,764	2,270,968	779,427	354,001	
Percent eggs to juvenile survival past RBDD	54	n/a	n/a	n/a	n/a	n/a	n/a	27.4%	23.0%	20.5%	18.4%	15.4%	21.1%	17.6%	33.4%	37.3%	42.3%	27.1%	14.8%	5.7%	4.5%	23.7%	48.7%	26.6%	17.7%	11.7%	2.5%	2.5%	0.0%
Percent mortality of total eggs to juveniles past RBDD	55	n/a	n/a	n/a	n/a	n/a	n/a	72.6%	77.0%	79.5%	81.6%	84.6%	78.9%	82.4%	66.6%	62.7%	57.7%	72.9%	85.2%	94.3%	95.5%	76.3%	51.3%	73.4%	82.3%	88.3%	97.5%	97.5%	1
Estimated fry at RBDD for each female spawner	56	n/a	n/a	n/a	n/a	n/a	n/a	1,351	1,114	1,129	1,011	842	1,078	953	1,843	1,924	2,042	1,225	681	303	218	981	2,002	1,368	961	582	133	136	0
Cohort Replacement Rate	57	3.5	4.7	2.3	2.5	1.5	2.7	2.3	6.1	1.0	2.1	2.1	0.3	0.2	0.3	0.6	0.3	0.6	3.8	3.6	1.3	0.3	0.3	0.8	5.2	6.5	3.9	0.7	0.4
Total number of winter redds observed	58	43	30	141	1,146	572	1,396	610	878	621	1,968	717	288	441	86	223	18	261	569	127	196	18	26	198	515	491	578	406	64
Total number of WR redds dewatered	59	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5	1	0	0	0	2	5	26	2	4	3
Percent of redds within carcass survey area	60	100%	100%	94%	92.5%	72.1%	89.5%	95.9%	99.3%	100%	100%	99.7%	96.2%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	99.8%	100.0%	100.0%	100.0%	100.0%
Percent of redds not observed by flights	61	76%	93%	92%	-39%	84%	73%	89%	83%	81%	78%	92%	81%	69%	97%	73%	96%	82%	84%	93%	90%	97%	93%	82%	89%	87%	90%	84%	94%
Survey Date Start	62	4-Apr	30-Apr	5-May	5-May	3-May	2-May	1-May	30-Apr	30-Apr	28-Apr	1-May	1-May	1-May	4-May	3-May	2-May	30-Apr	30-Apr	29-Apr	28-Apr	2-May	1-May	30-Apr	29-Apr	4-May	3-May	2-May	1-May
Survey Date End	63	5-Sep	29-Aug	28-Aug	27-Aug	29-Aug	29-Aug	27-Aug	4-Sep	3-Sep	2-Sep	25-Aug	24-Aug	22-Aug	28-Aug	27-Aug	1-Sep	2-Sep	5-Sep	11-Sep	17-Sep	15-Sep	6-Sep	26-Sep	26-Sep	24-Sep	23-Sep	22-Sep	21-Sep
Number of Survey Periods	64	19	41	39	38	40	40	40	41	43	43	39	39	38	39	39	41	42	43	43	45	45	43	47	48	45	45	45	45
Survey River Mile Range	65	271-301	288 -301	288 -301	288 -301	288 -301	288 -301	288 -301	288 -301	286.5 -301	273.5-301	273.5-301	276 - 301	276 - 301	276 - 301	276 - 301	276 - 301	276 - 301	276 - 301	276 - 301	276 - 301	276 - 301	276 - 301	276 - 301	276 - 301	276 - 301	276 - 301	276 - 301	276 - 301	276 - 301
Flow range (cfs x 1000)	66	7 - 16	8 - 15	10 - 23	9 - 13	8 - 16	8 - 15	7 - 15	8 - 29	8 - 16	4 - 37	6 - 15	8 - 15	8 - 13	7 - 13	7 - 15	6 - 19	6 - 14	7 - 14	4 - 11	7 - 7.5	5 - 10.7	5 - 13	7 - 13	5 - 13	7 - 12.8	7- 10	4.6- 3.3	7 - 13.4
Water temp (°F) range	67	52 - 59	49 - 52	50 - 54	50 - 54	51 - 54	50 - 55	50 - 56	50 - 54	50 - 57	51 - 59	50 - 56	50 - 58	50 - 58	51 -58	49 - 54	50 - 57	50 - 55	50 - 58	50 - 59	53 - 60	51 - 56	49 - 57	51 - 55	51 - 56	51 - 60	52 - 61	51 - 60	49 - 53
Visibility range (ft)	68	n/a	3 - 10	4.5 - 11	6 - 11	9 - 21	14 - 21	17 - 22	8 - 15+	8.5 - 16	2 - 16+	5 - 13	2.5 - 20+	10.5 - 16+	2 - 11	4 - 16+	5 - 14	6 - 15+	8 - 15+	7 - 15+	7 - 15	5 - 10	2 - 9	10 - 16	1 - 12	4 - 16+	8 - 15	7 - 14	2 - 13
Tissue samples collected	69	0	0	0	0	0	0	0	1,584	870	2,201	2,138	787	548	836	782	347	1,045	1,867	845	791	254	132	1,078	2,323	2,941	2,530	1,126	380 (179)
Scale samples collected	70	0	0	0	0	0	0	0	0	72	219	1,807	758	537	832	639	277	894	982	754	718	216	113	869	885	2,636	1,816	606	346
Otolith samples collected	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	594	789	112	402	253	129	1,062	970	158	163	134	54
Eye samples collected	72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	937	712	152	162	0	0
Sac Riv WR water temperature compliance location	73	BND	BND	BND	BND	BND	JLF	JLF	BND	JLF	JLF	BND	BSF	AND	AND	JLF	JLF	JLF	AND	CCR	CCR	BSF	BSF	BSF	BSF	CCR	SAC	SAC	CCR

Other Winter-Run Data: Carcass survey data is combined with data from Livingston Stone National Fish Hatchery (LSNFH) to create the annual population estimate.

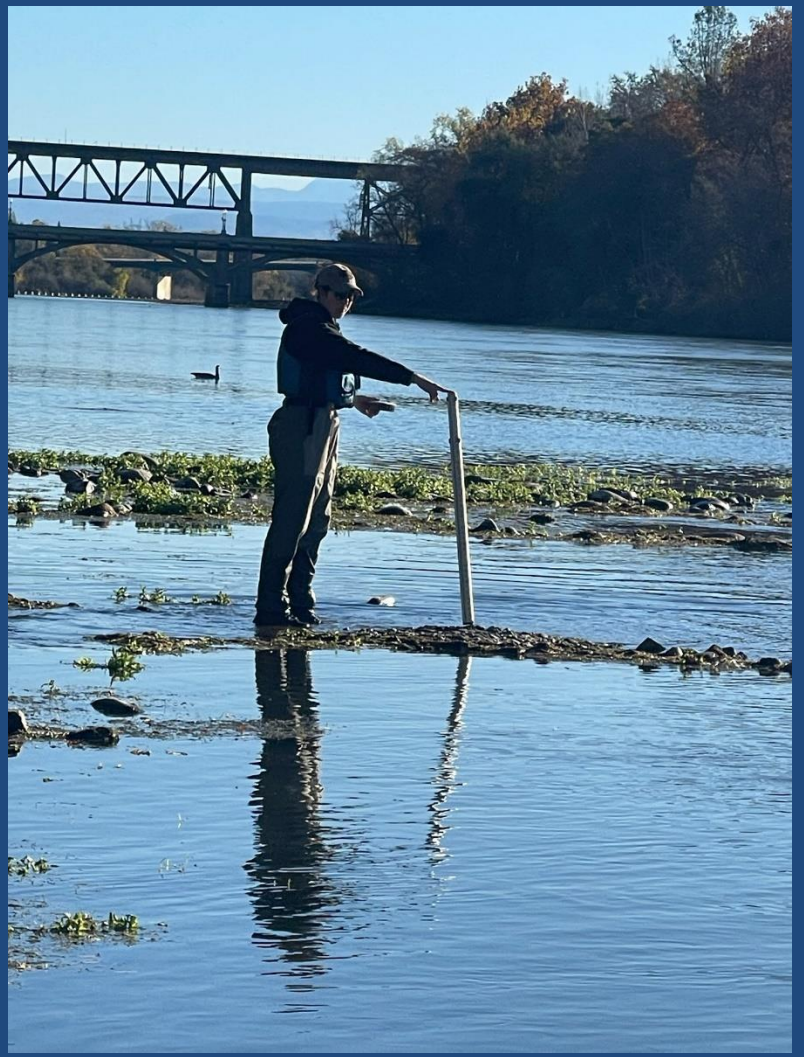


LSNFH at the base of Shasta Dam is a conservation hatchery that uses up to 120 adults each year to produce around 200,000 juveniles (some years more). Adults are captured at Keswick dam. Juveniles are released in Redding near end of January each year

Each year winter-run adults are collected by USFWS at the Keswick fish trap and trucked to the LSNFH where they are sorted and hatchery broodstock fish are selected and tanked until ready for spawning in the summer.

Shallow/Dewatered Redd Monitoring: In concert with the carcass surveys this effort monitors winter-run redd dewatering annually. Dewatered redd surveys begin in June for winter-run. They are designed to identify shallow water redds that may become dewatered if flows are lowered later in year. Depending on water temperatures Chinook redds can take between 70 and 100+ days for juvenile salmon to emerge from the gravel and start feeding.

- Shallow Winter-run redd monitoring initiated in 2013 season.
- Physical data collection: location, depth, photo, fish presence.



Data from the shallow/dewatered redd survey is used to inform flow management during and after the adult spawning takes place. In 2023, twenty-six shallow redds were monitored and three were dewatered before juveniles had opportunity to emerge from those redds. In total, there were an estimated 1,061 redds in the river and 0.28% of these (3) were dewatered.

ID	Redd Number	Born On Date	Estimated Date of Emergence	Born on depth	Status	Born on FLOW (KWK)	Born on Flow (KES)	*ACTUAL or ESTIMATED DEWATER FLOW (KES)*	Location
1	4001	13-Jun	17-Sep	15	EMERGED	9,227	9,095	*6,500*	Sec 2, RR Below Sundial
2	4002	13-Jun	17-Sep	37	EMERGED	9,227	9,095	*5,000*	Sec 2, RL Sewer Line
3	4003	22-Jun	26-Sep	18	EMERGED	9,514	9,011	*5,000*	Sec 2, RL Turtle Bay West
4	4004	22-Jun	26-Sep	19	EMERGED	11,062	10,365	*5,000*	Sec 2, RL Turtle Bay West
5	4005	22-Jun	26-Sep	17	EMERGED	9,484	8,974	*6,000*	Sec 2, TB Kayak Ramp
6	4006	5-Jul	9-Oct	15	EMERGED	11,095	10,383	*3,500*	Sec 2, RL Sewer Line
7	4007	12-Jul	20-Oct	54	EMERGED	10,705	10,627	*3,250*	Sec 1, Center Above Dentist House
8	4008	12-Jul	16-Oct	18	EMERGED	10,705	10,686	*5,000*	Sec 2, RR Below Sundial
9	4009	5-Jul	9-Oct	13	EMERGED	11,030	10,363	*5,000*	Sec 2, RR Market Street Gravel
10	4010	12-Jul	16-Oct	12	DEWATERED	10,673	10,664	*6,600*	Sec 2, TB Kayak Ramp
11	4011	12-Jul	16-Oct	11	EMERGED	10,673	10,664	*5,000*	Sec 2, TB Kayak Ramp
12	4012	12-Jul	16-Oct	17	EMERGED	10,673	10,664	*4,000*	Sec 2, TB Kayak Ramp
13	4013	12-Jul	16-Oct	17	EMERGED	10,673	10,664	*5,000*	Sec 2, TB Kayak Ramp
14	4014	12-Jul	16-Oct	24	EMERGED	10,721	10,682	*4,000*	Sec 2, TB Kayak Ramp
15	4015	19-Jul	27-Oct	49	EMERGED	11,095	10,985	*4,000*	Sec 1, RR Above Big Bend
16	4016	19-Jul	20-Oct	34	EMERGED	11,079	10,985	*4,000*	Sec 3, RL at Coppertop Riffle
17	4017	19-Jul	24-Oct	19	EMERGED	11,079	10,974	*4,000*	Sec 2, TB Kayak Ramp
18	4018	19-Jul	24-Oct	26	EMERGED	11,079	10,974	*4,000*	Sec 2, RL Sewer Line
19	4019	25-Jul	2-Nov	39	EMERGED	11,062	10,755	*4,000*	Sec 1, RR Above Big Bend
20	4020	25-Jul	27-Oct	35	EMERGED	11,062	10,730	*4,000*	Sec 2, Painter's Side Channel
21	4021	25-Jul	27-Oct	37	EMERGED	11,062	10,730	*4,000*	Sec 2, Painter's Side Channel
23	4022	25-Jul	27-Oct	32	EMERGED	11,062	10,755	*4,500*	Sec 2, Painter's Side Channel
24	4023	25-Jul	30-Oct	21	EMERGED	11,062	10,677	*4,500*	Sec 2, RR Market Street Gravel
25	4024	25-Jul	30-Oct	18	EMERGED	11,062	10,677	*5,800*	Sec 2, RR Market Street Gravel
26	4025	25-Jul	29-Oct	10	DEWATERED	11,128	10,677	*6,600*	Sec 2, RL Below Market Street
27	4026	27-Jul	31-Oct	13	DEWATERED	11,226	10,692	*6,400*	Sec 2, RL Below Market Street

Questions?

Further information on winter-run data can be found on the Calfish website at the following link:
https://www.calfish.org/ProgramsData/ConservationandManagement/CentralValleyMonitoring/CDFWUpperSacRiverBasinSalmonidMonitoring.aspx

Or by contacting doug.Killam@wildlife.ca.gov