Chinook Salmon in Putah Creek, Spring, 2004

Report to Lower Putah Creek Coordinating Committee

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Introduction:

During the summer and fall months, fall run Chinook salmon adults migrate through San Francisco Bay and into Central Valley river systems (Moyle 2002). Most of the salmon move into the Sacramento River and its tributaries, including Putah Creek. Lower Putah Creek has adequate water and flow to support a small run of salmon but presence of salmon has been intermittent over the past six years. Adult salmon migrated into Putah Creek in 1998, 1999, and 2000, but none were seen in 2001, or 2002 (P. Moyle, pers. obs.). Visual surveys conducted by the authors in December of 2003 revealed approximately 35 redds in Lower Putah Creek indicating that about 70 adult salmon had spawned.

During the majority of the year, Lower Putah Creek is dammed within the Yolo Bypass, about 38 km downstream of the Diversion Dam, by a flash board dam to divert water for agriculture and to flood ponds for the Yolo Bypass Wildlife Area. While in place, the dam inhibits the inward and outward movement of migrating fish but it is removed each Fall to coincide with the 5 day mandated attraction flow release and remains open throughout the winter and early spring months. The attraction flow is a release of water from the Diversion Dam resulting in 50 cfs flows at the bypass, with the timing determined by the Putah Creek Coordinating Committee. This year 66-85 cfs of water was released at the Solano Diversion dam for six days with flows returning to baseline (25 cfs) a few days afterward (Fig 1.) The dam is removed and the attraction flow started "when they [DWR] are catching a substantial number of salmon in the toe drain" (D. Feliz, CDFG, pers. comm.) This Spring (2004), the wood planks in the dam were inserted on April 1 (D. Feliz, CDFG, pers. comm.). The exact timing of the insertion of the planks of this dam is different each year and depends on the needs of agriculture and the wildlife refuge.

The mandated attraction flows have been in place since the Fall of 2000, but in 2001 and 2002 the salmon did not return. The attraction flows are timed to coincide with the appearance of the adult Chinook in the toe drain, as well as to have the timing consistent with past runs (which have been in late November or early December).

The purpose of the current survey was to determine if the Chinook salmon adults that migrated into the Lower Putah Creek in the Fall of 2003 had spawned successfully and to determine if the young were able to migrate out of the Creek. In addition, we wanted to gather data to indicate other fish species to which Chinook young of the year (YOY) were being exposed.

Methods:

Ten sites were sampled spanning Lower Putah Creek to within 4 km of its termination. The sites were chosen by a combination of accessibility and suitability for our sampling methods. The sites were identified by position downstream relative to the Solano Diversion Dam, starting right below the dam at 0.0 km and ending 4.0 km above the toe drain at 38.0 km. The sites included and were labeled as, 0.0 km, 6.0 km, 15.0 km, 17.0 km, 21.0 km, 23.0 km, 24.5 km, 31.0 km, 36.0 km, 38.0 km. Each site was sampled one to three times, although most sites were sampled just once (sites 0.0 km, 15.0 km, 23.0 km, 24.5 km, 31.0 km, and 38.0 km). Three sites were re-sampled to increase effort

at areas where YOY salmon were expected to be found, but were not present the first time they were sampled (sites 6.0 km, 17.0 km, and 21.0 km). Sites 21.0 km and 36.0 km were re-sampled after finding YOY to determine if any were present in the same area at a later date. Sites ranged in length from about 20 to 300 m, though were often not continuous because of various barriers such as fast riffles, deep pools, or debris.

The main piece of equipment used for fish capture was a 30 ft beach seine equipped with a 4 ft by 4 ft bag, but at times additional equipment was used. Other equipment included a smaller 5 ft seine, a backpack electrofisher, dip nets, and a cast net (Table 1.). The large seine was chosen as a primary tool of capture over the electrofisher because it is more time efficient, can often span the whole stream width at once, and is less likely to be harmful to the YOY salmon.

All fish caught were transferred to a bucket of water, measured to the nearest mm standard length (SL) and released. Care was taken to release fish in areas where they would not be recaptured (usually downstream of our sampling area).

Environmental measurements taken at the time of sampling included water temperature (ºC) and flow, measured in cubic feet per second (cfs). Temperatures were taken every few hours on each trip and flow was measured on four trips over the course of the survey.

Results:

A total of 63 YOY Chinook salmon were captured equaling 4% of the total fish captured. Seven of the fifteen trips and five of the ten sites produced salmon captures (Table1.)

The YOY captured averaged in size at 68 mm SL and ranged in size from 47 to 94 mm SL (Fig. 2.). During the first half of April salmon averaged 65mm SL and during the second half of April they reached an average length of 80 mm SL and remained that size throughout the rest of the study (Fig. 3.).

1419 individuals and 23 species of non-salmon fish were captured (not counting larval and post-larval fish). Species that were captured in greater numbers than salmon were: red shiner (393 individuals), inland silverside (368), threespine stickleback (218), bluegill (154) and Sacramento pikeminnow (94). The other 18 non-salmon species were captured in smaller numbers than salmon (Table. 1).

Environmental parameters varied during the course of the present survey. Temperatures ranged from 13.5 ºC at the Solano Diversion Dam (site 0.0 km) to 22.1 ºC just below Road 106A (site 36.0 km) (Fig. 1). Flows ranged between 88 cfs and 10 cfs depending on date and site. Flows were typically higher earlier in the season and at sites closer to the Diversion Dam. (Table 1.)

Conclusions:

The capture of juvenile salmon in Putah Creek of varying sizes indicates that spawning was successful in 2003-2004. The relatively small number (63) of salmon captured presumably reflects a combination of low sampling efficiency, early emigration, and possibly poor survival in redds.

Sampling efficiency. While we sampled a variety of sites over a two month period within the rearing stage and focused on habitats where prior experience indicated that salmon were most likely to be, our ability to sample effectively was limited. The high flows and clear water (desirable from the perspective of juvenile salmon!), reduced sampling efficiency, despite efforts to use gear most likely to be effective in different situations. However, our ability to capture large numbers of other kinds of fish suggests that if high densities of salmon had been present, we would have had higher capture success, especially in areas where our seining was particularly effective (e.g site 31.0 km).

Timing of emigration. It is possible that most of the juvenile salmon had left the creek before we were able to begin sampling. We were unable to sample effectively until after April 1 (sampling began March 24), which is about when Lake Berryessa stopped spilling and flows had dropped considerably (Fig. 1.). Our sampling thus began after the usual peak of outmigration for the Fall-run Chinook, which is in March (Yoshiyama et al. 1998). This is also reflected in the capture data from a screw trap set in the toe drain, several miles below the point where Putah Creek enters it (Fig. 4) (T. Sommer, DWR, unpub. data, 2004). The screw trap captures show YOY salmon migrating down as early as Feb 18, peaking about March 22, then tapering off in April and May. These fish may have come down from many streams above Putah Creek, including overflow from the Sacramento River, and may or may not include Putah Creek fish. However we can assume many of the YOY in Putah likely would have left the system at a similar time, taking advantage of the high flows. If this assumption is true, then most of the Putah Creek YOY would have moved out before our sampling began.

Poor survival of embryos. It is likely that survival of embryos from the time they were buried in the gravel to emergence was low in most redds. Gravel is a limiting resource in Putah Creek for salmon; it occurs in only small patches and is often only a thin veneer over the underlying clay. In 2004, virtually every available patch of gravel was used by spawning salmon, even those with low suitability. During our December redd survey, we noted that in some cases, salmon had created redds that had the clay layer exposed on the bottom. Because the salmon came up and began spawning almost instantly after the attraction flows were initiated, many redds were constructed in places that became significantly shallower after flows were reduced. In a few cases redds were partially out of the water. Spawners on such redds would be exposed to increased mortality from predation and fishing. Following spawning, heavy rains resulted in Lake Berryessa spilling, initiating high flows down the creek, resulting in substantial bed load movement in some areas (P. Moyle, pers. obs. 2004). Thus some redds may have been scoured by the high flows and the embryos killed.

It is worth noting that any fry which survived the adverse conditions in redds may have had fairly high subsequent survival rates. They were either flushed directly into the toe drain and into the estuary by the high flows or, if they stayed behind, found abundant food and habitat. The juveniles we did collect (except on May 13) were in good condition, suggesting that environmental factors in the creek were favorable for growth. Average length of juvenile salmon from the DWR trap in the toe drain was 72 mm FL

(67 SL) and ranged from 41 to 174 mm FL (38 - 167 mm SL). The average length of YOY in our survey was 68 mm SL and ranged from 47 - 94 mm SL. Putah Creek YOY were thus comparable in size to those from other sources.

Other Limiting factors:

The following is a brief discussion of factors that might be limiting survival of juvenile salmon in Putah Creek. The problems with spawning gravels and flows are discussed above, so here we cover (1) temperature, (2) predation and competition from alien fishes and (3) the effects of early closure of the Putah Creek flash board dam.

Temperature. For most of Putah Creek, temperatures were too warm for survival past mid-May. Salmon in the creek during the end of our study were being faced with temperatures of 22 ^{0}C at the lower sites. High mortality happens between 22 and 23 ^{o}C (Moyle 2002). The two fish captured at site 36.0 km on May 13 seemed slightly emaciated and did not survive being captured. There is some possibility for juvenile salmon to remain in the creek through the summer in the cool water below the Putah Creek Diversion Dam, although we did not find any this year. In some previous years, one or two juvenile salmon have been found in this area in late summer, suggesting survival through the summer (Moyle unpub. data).

Predation and competition. Other fishes, including alien species, are abundant in Putah Creek where there are juvenile salmon, as demonstrated by our sampling. The large size and good condition of most of the juveniles captured suggests that competition for food is not a problem under the flow and temperature conditions in which they were living. In fact, juvenile salmon may have an advantage in feeding in cool fast water compared to most of the other fishes collected with them. In addition, the larvae of suckers and other fishes can be an important food source for juvenile salmon for limited periods (Merz 1998).

Of greater concern is the substantial population of alien largemouth bass present in the pools of the lowermost reaches of the creek. They are potentially a major source of mortality for emigrating salmon that must pass through the pools, especially the long pool by the UCD Picnic Ground (site 23.0 km), as they are elsewhere (Moyle 2002). Efforts to collect large bass by angling for dietary analysis during the Spring months were largely unsuccessful and the few that were collected either had empty stomachs or were feeding on crayfish (B. Campos, UCD unpub. data). It is likely that predation by bass is mainly a problem for salmon when flows are low and temperatures warm, late in the spring. At this time any of theYOY salmon remaining in the system would be vulnerable to predation because they would be physically compromised by the high temperatures and thus unable to continue migration effectively.

Yolo Bypass Diversion Dam. The flash board dam that is present on Putah Creek in the Yolo Bypass (38.0 km) may be a hazard to emigrating salmon. This year the boards that raise the level of the dam were placed on April 1, a week after the beginning of our study. When we sampled the site on May 6 we found no salmon below this dam; however, we did collect two salmon of very poor condition just above the dam on May 13 (site 36.0

km). It would have been unlikely for the YOY to get past the dam at the time we sampled because there was only 10 cfs flow spilling over the dam and about fifteen feet drop below it. These salmon remained in the system because they were trapped there. Higher flows earlier in April presumably would have allowed the salmon to survive spilling over the top of the dam but under low flows, the dam represents a significant barrier to outmigration.

Recommendations:

Juvenile sampling. While our sampling at least demonstrates the presence of juvenile Chinook salmon, it does not provide a very good indication of numbers produced. In particular, we do not have a good idea if most juveniles spawned in the creek emigrate early or remain in the creek until April or May. During high flow periods, the best method for indicating emigration rates would be setting a screw trap in the lower creek, near or in the Yolo Bypass. A cooperative study with Ted Sommer of DWR would be a good way to accomplish this, given his experience in using traps in the Bypass. We recommend a screw trap study (which would be expensive) if knowledge of emigration timing is a high priority for management.

If more efficient sampling is desired during periods of lower flows, we recommend both experimental seining at night in a few locations and using the barge electrofisher, such as the one used in the fall sampling of the creek by Tom Payne and Associates, for daytime sampling. The sampling program described in this report is adequate for determining whether or not spawning was successful and for demonstrating high growth rates of the juveniles. Additional sampling, as suggested above, would mainly provide more quantitative estimates of numbers and the importance of instream-rearing to the salmon population.

Predation. We recommend a protracted effort to collect largemouth bass during the salmon emigration period. This study would provide good information as to whether predation is a limiting factor during periods of low to moderate flows. This could be done through a combination of electrofishing, seining, and angling (using volunteers).

Gravel studies. We recommend a quick resurvey of gravel beds in the creek this summer to see how the high flows of 2004 have changed its distribution and availability to salmon. If Monticello Dam is not spilling, then the importance of gravel beds in different areas, including areas where gravel has been added to the creek, could be evaluated using emergence traps. This is a suggestion, not a recommendation, because emergence trap studies are a great deal of work for a relatively small amount of information.

Putah Creek flash board dam. A short-term solution to reducing the apparent (but unproven) impact of the dam on juvenile salmon would be to postpone the placement of the wooden planks until the middle of May. A longer-term solution would be to build a bypass for the salmon around it. The Putah Creek Coordinating Committee is currently working on a plan to build this by-pass (R. Marovich, PCCC, pers. com. 2004). We do

recommend that if salmon spawn in the creek next year that a bigger effort be made to evaluate the impact of this dam on emigrating fish.

References:

Merz, J. E. 1998. Juvenile Chinook salmon feeding habits in the Lower Mokelumne River. California. Unbubl. Rpt., E. Bay Muni.Utility Dist., Lodi, California. 13pp.

Moyle, P. B. 2002. Inland Fishes of California, Revised and Expanded. Berkeley, California. University of California Press.

Yoshiyama, R. M., F. W. Fisher and P. B. Moyle. 1998. Historical abundance and decline of Chinook salmon in the Central Valley region of California. N. Am. J. Fish. Mgmt. 18:487-521.

		bigscale logperch (E) Percina macrolepida	black cappie (E) Pomoxis nigromaculatus	bluegill sunfish (E) Lepomis macrochirus	Chinook salmon (N) Oncorhynchus tshawytscha	common carp (E) Cyprinus carpio	fathead minnow (E) Pimephales promelas	goldfish (E) Carassius auratus	green sunfish (E) Lepomis cyanellus	hitch (N) Lavinia exilicauda	inland silverside (E) Menidia beryllina	large mouth bass (E) Micropterus salmoides	pacific lamprey (N) Lamperta tridentata	prickly sculpin (N) Cottus asper	rainbow trout (N) Oncorhynchus mykiss	red shiner (E) Cyprinella lutrensis	redear sunfish (E) Lepomis microlophus	sacramento blackfish (N) Orthodon microlepidotus	sacramento pikeminnow (N) Ptychocheilus grandis	sacramneto splittail (N) Pogonichthys macrolepidotus	sacramento sucker (N) Catostomus occidentalis	threadfin shad (E) Dorosoma petenense	threespine stickleback (N) Gasterosteus aculeatus	tule perch (N) Hysterocarpus traski	western mosquito fish (E) Gambusia affinis			
km	**date**	**BLP**	**BCR**	**BGS**	**CHN**	**CRP**	**FHM**	**GLF**	**GSF**	**HTC**	**ISS**	**LMB**	**PLR**	**PSC**	**RBT**	**RSH**	**RES**	**SBF**	**PKM**	**SST**	**SKR**	**TFS**	**SBK**	**TUP**	**MSQ**	**°C**	**cfs**	**30 ft seine +**
0.0	5/27/04													2	1						1		161			13.5	32	cast net
6.0	4/1/04			1			3			1		1	1	2		1			36		12		13	17				
6.0	5/13/04																		5		1		5	4		17.5		
15.0	4/15/04				1											1			8							15.7		e-fisher
17.0	4/15/04								4										21		2		1			16.4		e-fisher
17.0	5/18/04															17			5		*					19.0		
21.0	3/24/04										11	1				4					*		3			14.8		
21.0	4/8/04				35						5					32			8		*		27		5	19.3		5 ft seine
21.0	4/14/04				6						2					1										16.4		
23.0	4/16/04			2								1									*					16.4		
24.5	4/8/04				1											2			1				7		2	18.1	88	5 ft seine
31.0	4/22/04			71	5	1					19	17				272	7	1	1		*		1		18	17.3		5 ft seine
36.0	4/29/04	33		47	13		1		1		80					40			6		1*			1	3	20.6	48	
36.0	5/13/04	2		15	2			1			66	1				23			3	2	19*	1			2	22.1		
38.0	5/6/04		2	18				1	2		185	1		5						22	*			1	29	22.0	10	dip net
total per species		35	2	154	63	1	4	2	7	1	368	22	1	9	1	393	7	1	94	24	16	1	218	23	59			
% of grand total		2	0	10	4	0	0	0	0	0	25	1	0	1	0	27	0	0	6	2	1	0	15	2	4			

Table. 1. Lower Putah Creek YOY salmon survey: sites and dates of sampling, species and numbers caught, temperatures, flow and extra equipment used. Sites are named by position of the site downstream from the Solano Diversion Dam in km. Species abbreviation codes are below the species common name and scientific name with E indicating exotic and N indicating native. Column "ºC" is the average temperature at the site and date of sampling, "cfs" is the flow in cubic feet per second at the site and date of sampling, and "30 ft seine +" is the equipment used in addition to the 30 ft seine at each site and date. A "*" in the SKR column means larval/post larval suckers were present but not included in the total per species or in the % of grand tot

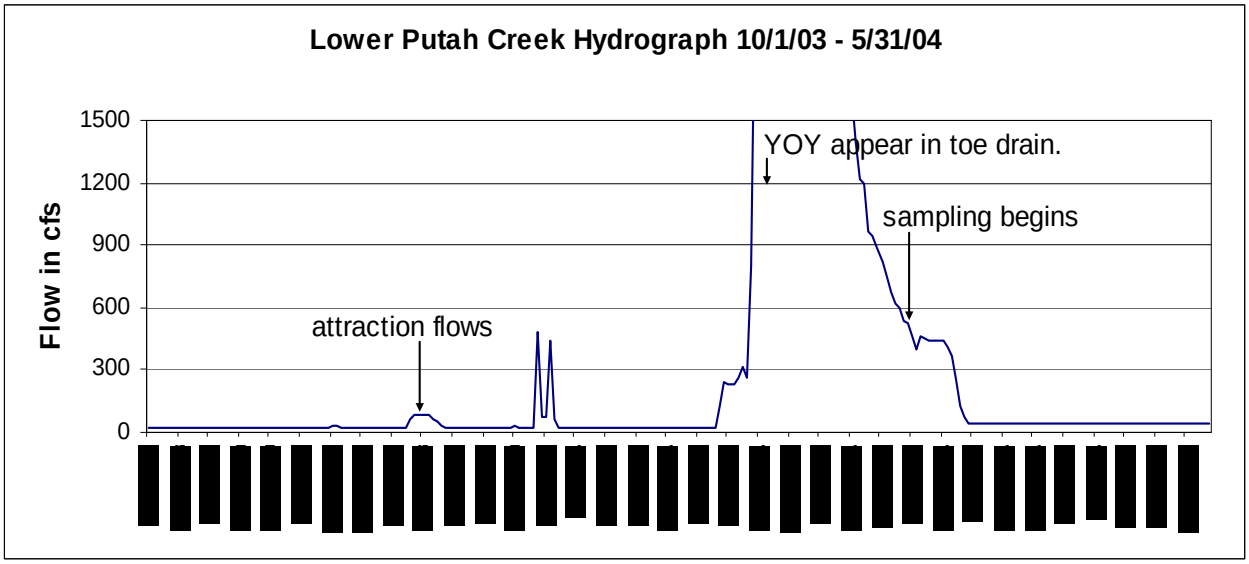

Figure 1. Flows in cfs released from the Solano Diversion Dam into Lower Putah Creek from the start of the 2004 water year beginning in Oct 2003. Attraction flows started on Dec 31. The first DWR salmon capture happened on Feb. 2 (7,723 cfs) and peaked on March 22 (537 cfs). Our survey began on March 24 (465 cfs). Flows at sites of sampling were significantly less.

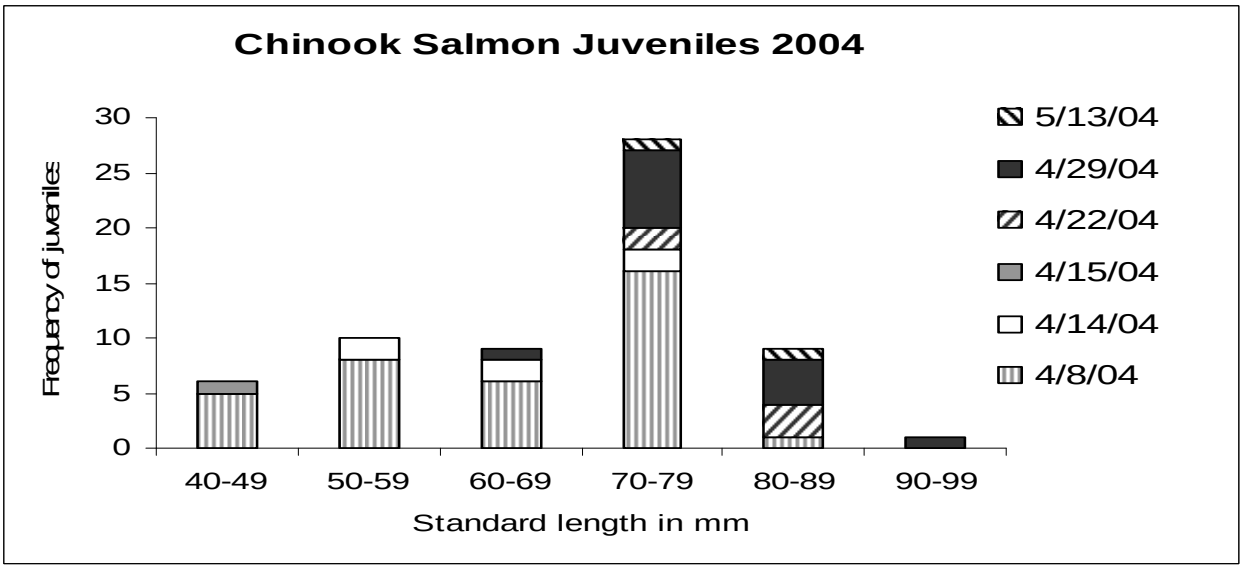

Figure 2. Length vs. frequency (number captured) of juvenile salmon in Lower Putah Creek. Different patterns refer to dates the individuals were measured. Average length was 68 mm SL and ranged from 47 – 94 mm SL.

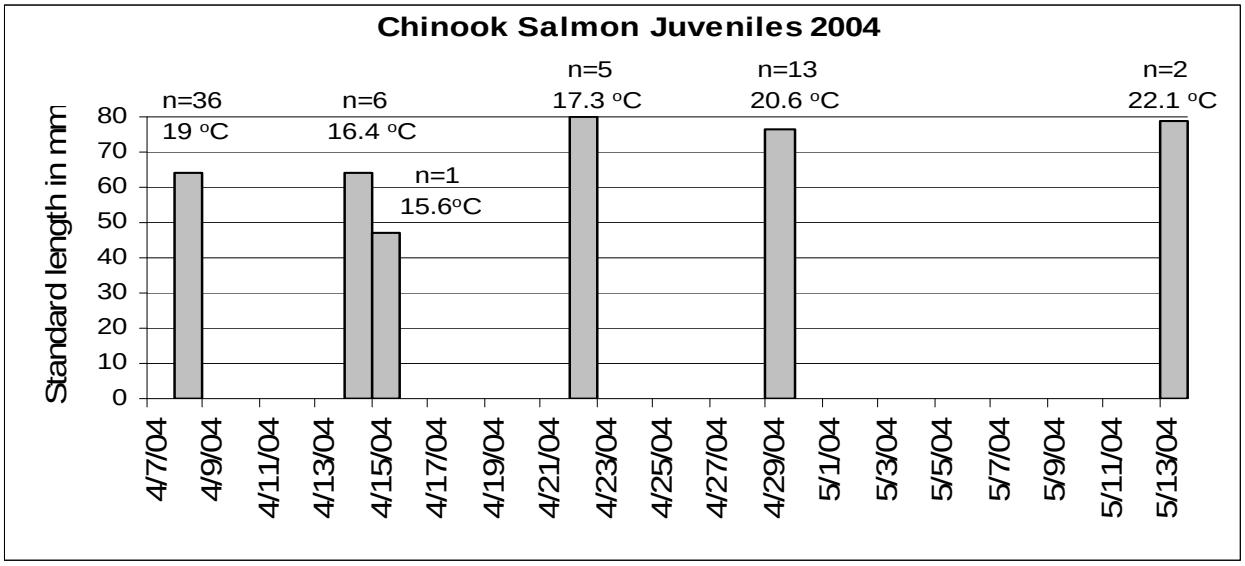

Figure 3. Standard length of YOY salmon over time in Lower Putah Creek. 63 total fish were measured. Average temperatures over the sampling period each date are posted in degrees Celsius and may include more than one site.

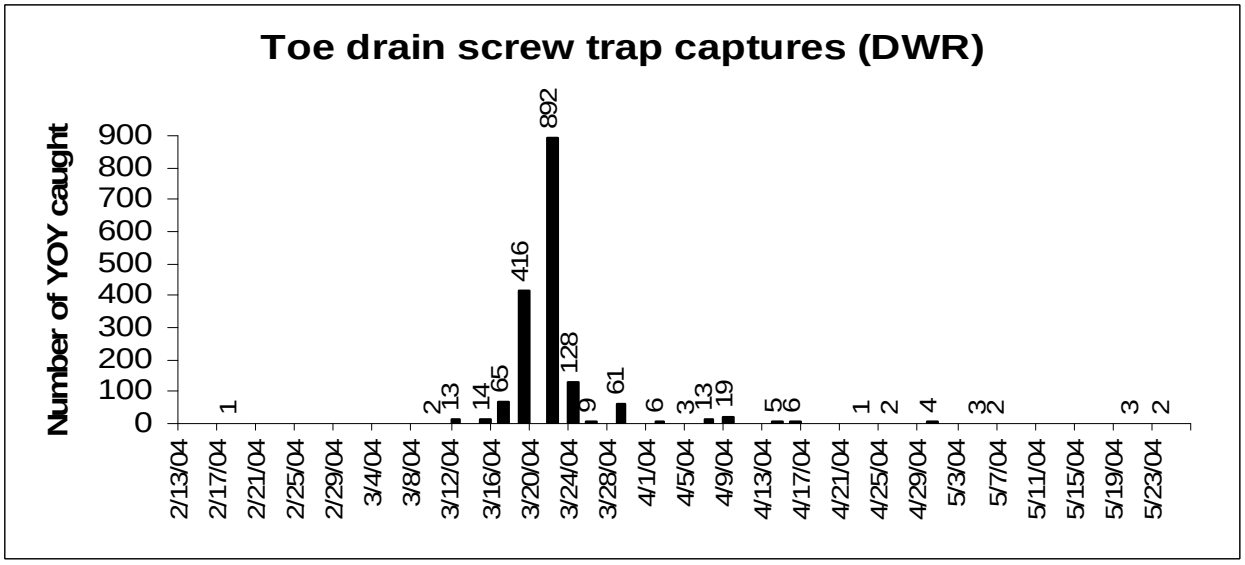

Figure 4. Department of Water Resources screw trap captures from the toe drain into