

**Expansion of the 2023 Hanford Reach fall Chinook Salmon Juvenile
Coded Wire Tagging and PIT Tagging Project**

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Abstract

The Hanford Reach Upriver Bright Fall Chinook tagging study is a field project designed to capture and tag 200,000 juvenile natural origin fall Chinook Salmon. From June 1 through June 12, 2023, a total of 204,177 juvenile upriver bright (URB) fall Chinook were coded wire tagged. After accounting for mortalities and shed tags, the net number of coded wire tagged fish released was 191,967. The project was hampered by low wild smolt abundance and high hatchery fish abundance, especially in usual fishing areas upstream of the tagging trailer location. This required more extensive fishing downstream in Richland resulting in high mortality. Another negative impact throughout the project was the large number of Priest Rapids Hatchery (PRDH) juvenile Chinook present which were estimated to total more than 25% of the URB biomass captured by the project. In 2023, PRDH released three of their five raceways of fish prior to the end of the Hanford project, rather than waiting until the Hanford project ended as had been the case prior to 2017.

A total of 9,996 PIT-tagged Hanford Reach juvenile fall Chinook released by this project between June 7 and 10, 2023. Detections from fish PIT tagged by this study estimated a survival rate of 0.144 (se=0.068) from release to McNary Dam. By comparison, PRDH-released URBs had a survival to McNary of 0.490 (se=0.069). Mean travel times in 2023 were 26.9 days (se=0.9) to McNary Dam for Hanford URBs compared to 18.7 days (se=0.2) days for PRDH URBs.

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Introduction

Hanford Reach upriver bright fall Chinook Salmon (hereafter referred to as URBs) are a significant contributor to ocean fisheries off the coast of Alaska, British Columbia, and Washington, as well as Columbia River harvests (Anglin et al. 2006). This stock has produced large escapements in recent years and is used as an indicator stock by the Chinook Technical Committee (CTC). Therefore, since 1987, the U.S. Section of the Pacific Salmon Commission (PSC) has supported a Columbia River Inter-Tribal Fish Commission (CRITFC) coordinated project which seeks to capture and coded wire tag (CWT) 200,000 wild juvenile URBs in the Hanford Reach. Recoveries from these tagged fish are used to estimate exploitation and interception rates on this stock in ocean and in-river fisheries. Participants in this project include the Washington Department of Fish and Wildlife (WDFW), the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), and the Yakama Nation (YN).

Prior to 2014, the project had met its goal of 200,000 juvenile URBs coded wire tagged in 14 out of 27 years. However, the project had been level-funded since 2007 while inflation has increased costs. Therefore, in 2012, the project cut one of three capture crews and reduced the number of days funded from 12 days to 11 days, resulting in only 168,310 fish CWT-tagged in 2012 and 178,426 in 2013. Beginning in 2014, additional funding was provided by the CTC Letter of Agreement Funds (LOA) to restore the additional day and capture crew to the project. In 2014 this resulted in a CWT tag output of 192,739 despite high flows and low smolt abundance making it among the most challenging years for this project (Fryer 2015). In 2015, a project record 264,162 juvenile URBs were tagged as the project was aided by lower flows and higher smolt abundance (Fryer 2016) and this record was exceeded in 2016 with 264,460 juveniles URBs tagged (Fryer 2017). Since 2016, tag output has continued high with 263,071 fish CWT tagged in 2017 (Fryer 2018), 256,294 in 2018 (Fryer 2019), 233,446 in 2019 (Fryer 2020), 218,059 in 2021 (Fryer 2022), and 208,991 in 2022 (Fryer 2023).

The PSC CTC provided increased funding for a third capture crew, extra day, and PIT tagging through 2022. This funding ended when base Hanford project funding was increased for 2023 to maintain the expanded project. This report provides results from the 2023 project.

Methodology and Project Design

Study Area

The Hanford Reach is in Washington State between Columbia River rkm 557 and 639 and is home to the largest natural spawning population of Chinook Salmon in the Columbia Basin (Figure 1). Most spawning occurs upstream of the old Hanford townsite (Langshaw and Hoffarth, 2012).

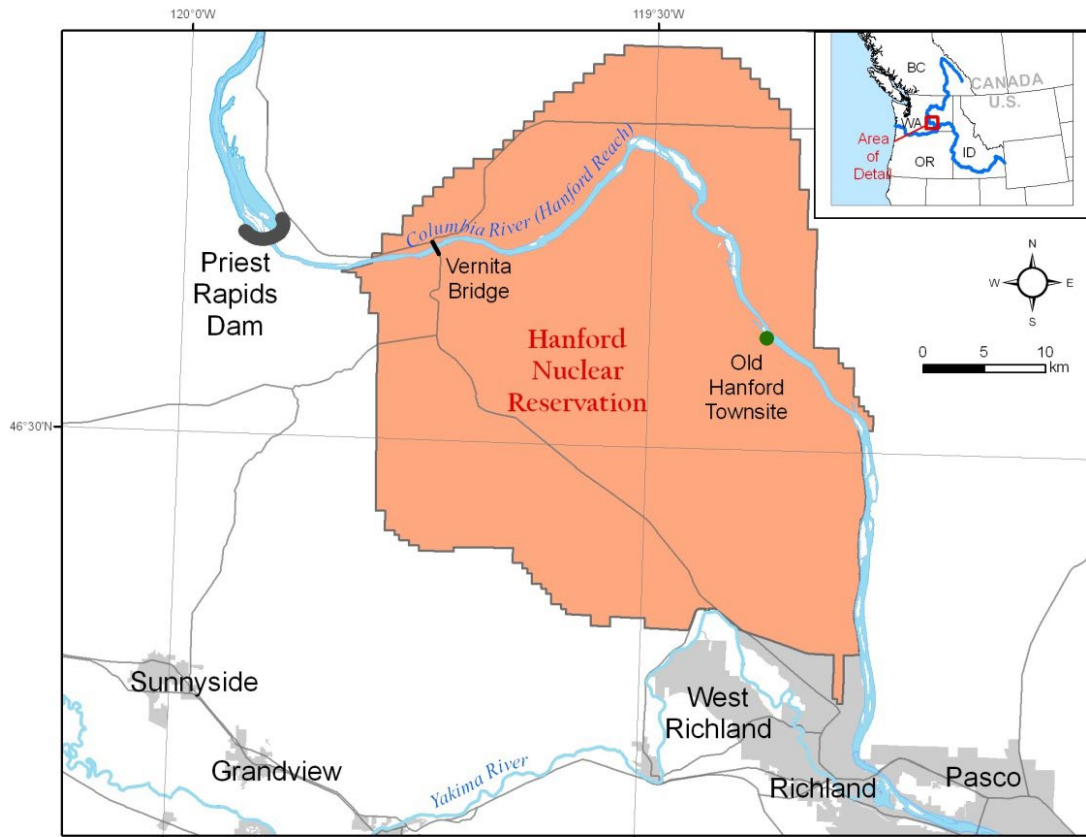


Figure 1. Map of Hanford Reach showing the old Hanford townsite where the tagging trailer was based for the 2023 tagging project.

Collection of Juvenile Hanford Reach URBs

Juvenile URBs were collected by three crews of four persons each working out of three 5.8 to 6.4 m jet sleds. Capture of URBs for this project in recent years has typically been conducted throughout the Hanford Reach from rkm 545 in Richland, WA, to near Priest Rapids Dam at rkm 639. We prefer to focus capture upstream of our tagging site at the old Hanford

townsite ramp at rkm 576 to avoid added stress on fish resulting from longer transport times to the tagging site as well as avoiding recaptures of previously tagged fish.

Fish were captured using both stick seines and beach seines. Stick seines approximately 11.0 m in length by 1.8 m deep with a mesh size of 6.5 mm are used in sections of the river with moderate velocity and 0.3 to 1.4 m of depth. The capture technique was to parallel the riverbank with two technicians pulling the net along the shore with the current for distances of 50 to 200 m before it is pursed. Shorter sets are made when large numbers of juveniles are encountered or to avoid obstacles.

Beach seines approximately 36.6 m long and 3.0 m deep with a mesh size of 6.4 mm were also used. One end of the beach seine was attached to the bow of the boat while the other end was handled by one or two persons walking through water approximately 1.0 m deep. The net was moved with the current for distances of 100 to 300 m before the net is pursed.

The captured juvenile URBs were poured or dipped out of the net into 19-liter plastic buckets and then transferred to the insulated and covered holding tanks located on each capture boat. These tanks were equipped with oxygen aerating systems and water in the tanks was changed periodically. The location and estimated catch were recorded for each set. When crews had a full load of fish (up to 12,000 fish per holding tank, depending on fish size) or about three hours had passed since fishing commenced, the fish were transported to the tagging area at the old Hanford townsite (Figure 1). At this site, they were transferred by net from the holding tank into 19-liter buckets, and then carried and poured into one of three 5.4x1.3x1.3 m troughs located on shore adjacent to the tagging trailer. These troughs were partitioned using mesh screens, allowing better management of fish groups. River water was continuously pumped through the troughs using a 1000 liter per minute electric pump powered by a 25 KW generator generating three-phase power. A second generator was required to power the tagging trailer which ran off two-phase power.

Coded wire Tagging

Juvenile URBs were processed in a WDFW manual tagging trailer with a screened electric-powered pump supplying river water to the trailer. The tagging trailer crew consisted of 10 technicians and one supervisor¹.

Fish for coded wire tagging were netted from a section of a 5.4x1.3x1.3 m trough, placed in a 19-liter bucket, and transferred to the tagging trailer holding trough. When an entire trough was emptied, it was drained, cleaned, and refilled by the fish subsequently brought back by the capture crews.

¹ The tagging supervisor in 2023, was Paul Graham of Biologix LLC who retired in 2017 from the Washington Department of Fish and Wildlife but has continued to run the tagging trailer at the Hanford Reach since 2018 for Biologix LLC.

In the tagging trailer, technicians netted fish out of the holding trough and placed them in a recirculating solution of MS-222 anesthetic. As we have done since 2015, we used a water conditioner (VidaLife by Western Chemical) in the anesthetic at a concentration of 25 ml per 400 liters to protect fish from abrasions by preserving the fish's natural mucous layer as well as a pH buffer. We used a JBC 1/3HP Arctica Aquarium Chiller to reduce fluctuations in the temperature of the anesthetic solution.

After the URBs were anesthetized, technicians visually sorted the juvenile URBs for tagging into two size groups, 48-60 mm and >60 to 80 mm fork length fish. A minimum size of 48 mm has long been used by this project as the minimum size for tagging without significantly impacting fish survival². An upper size cutoff on the larger group of 80 mm has been used since the project's inception to reduce the chance of tagging a downstream migrating spring or summer juvenile Chinook Salmon or, beginning in 2017, early Priest Rapids fall Chinook releases³. URBs less than 48 mm, URBs greater than 80 mm, and those with injuries were transferred by 10 cm PVC pipe into a 4.9x0.8x0.6 m round bottom recovery trough outside the trailer. This recovery trough was continuously supplied with fresh river water. These fish were released prior to the start of the tagging the subsequent day. Technicians counted all sorted URBs on hand tally counters with one click per 10 "sorts".

The 48-60 mm and >60-80 mm URBs were adipose fin clipped and placed in channels with a water flow taking them to two holding troughs (one for each size group) separated by a screen in the back of the tagging trailer. Since 2016, we have also set up a sorting station outside the tagging trailer, allowing capture crews, supervisory personnel, and occasional volunteers to effectively sort and adipose clip URBs when not busy with other activities. Fish from this sorting were transported by 19-liter bucket into the trailer holding tanks.

The tagging technicians netted the sorted fish of taggable size from the holding troughs, placed them in an anesthetic solution, and, after fish were anesthetized, they were implanted with a full length CWT using a Northwest Marine Technology MKIV tag injector (<http://www.nmt.us/products/cwt/cwt.shtml?tab=1#mkiv>), which automatically tracks the number of fish tagged. These machines can be equipped with different sized head molds for different species or sizes of fish. We used two different head mold sizes, one for smaller URBs and the other for larger URBs. These different URB size groups were given coded wire tags with different tag codes. After tagging, the fish were dropped through a quality control device (QCD) that diverted fish missing a coded wire tag into a 19-liter bucket. Any fish in these buckets were periodically checked for tags and, if necessary, retagged and this second tag tallied to be later removed from the total tag output. Fish that were not diverted by the QCD were automatically transported through a 10 cm PVC pipe to a 4.9x0.8x0.6 m round bottom recovery trough identical to that used

² Based on past annual Hanford Reach reports, the minimum size has been 47 mm in 1987-1992 and 2000-2002, 49 mm in 1993, 50 mm in 1994-1996 and 1998, and 48 mm in all other years.

³ The sole exceptions have been 1987 and 1992 when 90 mm was used as an upper threshold for coded wire tagging, in 1991 the upper threshold is unknown.

for the sorted fish. It too was continuously supplied with fresh water. Fish were released prior to the commencement of tagging the following day unless high fish densities necessitated a release of morning-tagged URBs at the lunch break. Mortalities were counted prior to release as well as after the end of tagging for the day to estimate tag mortality.

A sample of at least 200 tagged fish was collected one or two times per day to assess tag retention in the tagged group. At least 100 of these fish were also measured, as were at least 100 sorted fish to check sorting accuracy as well as to estimate daily mean fish length.

All mortalities that occurred prior to tagging or among sorted fish were enumerated and recorded.

Non-target species (e.g. shiners, Northern Pikeminnow, and sculpins) encountered in the tagging trailer were sorted out and placed in 19-liter buckets with a constant source of river water. At breaks, these were placed in garbage cans with holes drilled in them and placed in a holding tank. At the end of the day, the non-target species were sampled and enumerated prior to release.

Coded wire tag data was analyzed using tools provided by the Regional Mark Processing Center and available at www.rmcs.org.

PIT Tagging

Initially, fish for PIT tagging were netted from the same 5.4x1.3x1.3 m troughs holding fish for coded wire tagging and placed in a 5.6 mm (14/64") grader box floating on top of an empty holding trough section. This resulted in most of the fish too small to PIT tag dropping back into the holding trough where they were subsequently processed in the coded wire tagging trailer. The graded fish were then poured into a 19-liter bucket and brought to the PIT tagging holding trough. Unlike many years prior to 2017, the group of fish to be PIT tagged was not supplemented with >80 mm Chinook sorted from the coded wire tagging project due to the presence of unclipped juvenile Chinook from early Priest Rapids Hatchery releases in the river and in our collected fish.

Juvenile URBs were netted out of the PIT tagging holding trough, anesthetized in a recirculating anesthetic system (using MS-222 as an anesthetic), and scanned for PIT tags using an HPR Plus PIT tag reader (<https://www.biomark.com/hpr-plus>). If not previously PIT-tagged, judged too small, too big, or in too poor of condition for tagging, the fish were PIT-tagged by Biomark personnel using procedures developed by the PIT Tag Steering Committee (<http://www.ptagis.org/docs/default-source/ptagis-program-documents/2014-mark-procedures-manual.pdf?sfvrsn=2>). Fish judged too small were held for coded wire tagging, while injured fish, non-target species, and previously PIT tagged fish were placed in a 19.1 liter bucket, allowed to recover, and released. Following PIT tagging, the fish was scanned to ensure the tag

was present and tag and length recorded using P4 (<https://www.ptagis.org/software/p4>). Tagged fish were then placed in a 1.3x1.3x1 m holding tank and held overnight. Prior to release, mortalities and any shed tags were collected and recorded and shed tags were reused. PIT tagged juvenile URB fall Chinook Salmon were released from the holding tank via pipe directly into the river the morning after tagging.

PIT tag data was analyzed using two tools provided by the University of Washington School of Aquatic and Fishery Science Columbia Basin Research (Columbia River DART 2017) using the methods of Cormack (1964), Jolly (1965) and Seber (1965) to estimate survival and travel time to McNary, John Day, and Bonneville dams. The first tool was an online tool(http://www.cbr.washington.edu/dart/query/pit_sum_tagfiles) while the second was the program PitPro ([PitPro | Columbia Basin Research \(washington.edu\)](http://www.cbr.washington.edu/dart/query/pit_sum_tagfiles)). The online tool was used for overall survival and travel time estimates by date and time while PitPro was used for analyses of differences in survival and migration time by length. In addition, an analysis of travel times and survival by the Fish Passage Center was requested.

Results

Collection of Juvenile Hanford Reach URBs

Fish capture for the 2023 Hanford project started on June 1 and ran through June 14, with an estimated 415,019 juvenile URBs⁴ captured (Table 1). The mean catch per set in the 2023 project was 1330 (Table 1) which ranked 3rd among the 8 years the project has run since 2015 which have met the goal of 200,000 juvenile URBs coded wire tagged (Table 2).

Table 1. Estimated number of fish captured daily by CRITFC, CTUIR, and YN capture crews at the 2023 Hanford project.

Date	Capture Crew			Total	Mean Catch per Set	Mean Flow at Priest Rapids Dam (cfs)
	CRITFC	CTUIR	YN			
5/31/2023		7800	14000	21800	1211	108,500
6/1/2023	1300	16500	16000	33800	1166	127,900
6/2/2023	13350	13801	20300	47451	1636	107,100
6/3/2023	4450	10001	10200	24651	1450	103,200
6/4/2023	8050	14750	14500	37300	1166	124,100
6/5/2023	3500	8800	14597	26897	897	118,400
6/6/2023	19450	5600	9800	34850	1089	121,100
6/7/2023	21000	21200	11455	53655	1578	116,000
6/8/2023	7500	19100	8300	34900	2685	97,100
6/9/2023	3965	12500	13900	30365	1320	81,200
6/10/2023	16000	7150	17900	41050	1140	81,900
6/11/2023	11200	5300	11800	28300	1489	100,400
Total	109,765	142,502	162752	415019	1330	107,242
Percentage	26.4%	34.3%	39.2%	100.0%		

⁴ The estimated total catch of 415,019 was an overestimate of 40.1% as only 282,226 fish were processed by this project. This includes those fish going through the CWT and PIT tagging portions of the project in addition to non-Chinook processed plus approximately 2000 fish released at the project end.

Table 2. Number of net sets by day for the CRITFC, CTUIR, and YN capture crews at the 2023 Hanford project with a summary of catch per set by year by crew for 2014-2023.

Date	Number of Sets by Capture Crew			Total
	CRITFC	CTUIR	YN	
5/31/2023	No Fishing	8	10	18
6/1/2023	7	13	9	29
6/2/2023	10	12	7	29
6/3/2023	4	7	6	17
6/4/2023	10	9	13	32
6/5/2023	4	15	11	30
6/6/2023	7	9	16	32
6/7/2023	8	9	17	34
6/8/2023	5	5	3	13
6/9/2023	5	7	11	23
6/10/2023	7	14	15	36
6/11/2023	2	7	10	19
Total	69	115	128	312
% of Sets	22.1%	36.9%	41.0%	
Catch per Set by Crew by Year				
Year	CRITFC	CTUIR	YN	All Crews
2023	1,591	1,239	1,272	1,330
2022	1,502	788	831	966
2021	1,190	977	868	994
2019	801	589	804	718
2018	741	608	338	545
2017	1,312	1,669	1,063	1,311
2016	1,999	1,562	2,524	2,002
2015	982	1,180	754	943
2014⁵	738	881	514	672

In 2023, fish capture was early in the project was exclusively in areas upstream of the tagging site. However, lower capture on June 3-5 resulted in turning to Richland sites which was where capture focused for the rest of the project. Total daily catch peaked on June 7. There was considerable variation in daily flow in 2023 which maximum flow of 5/31 and a minimum of 81.2 kcfs on June 10. There was no significant linear relationship between flow and daily catch per set (Figure 2) . The highest catch per set was at Richland (Figures 3 and 4, Table 3).

⁵ The goal of 200,000 coded wire tagged URBs released was not reached in 2014.

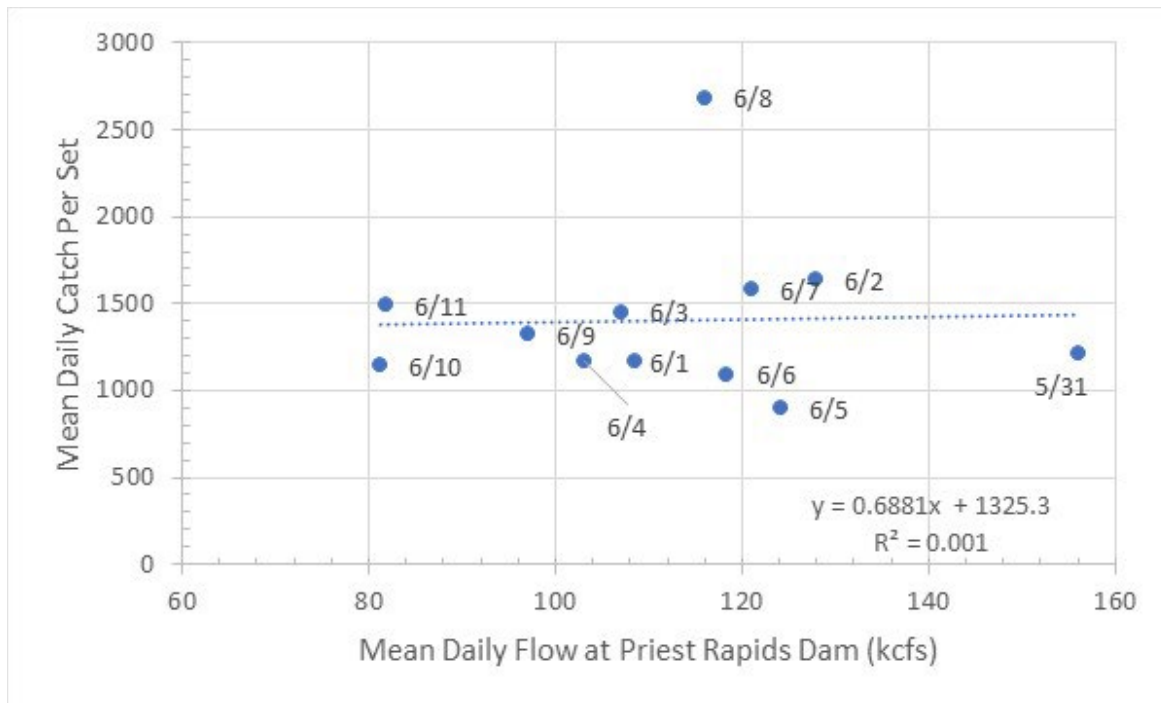


Figure 2. Relationship between mean daily flow at Priest Rapids Dam and catch per set for the 2022 Hanford project.

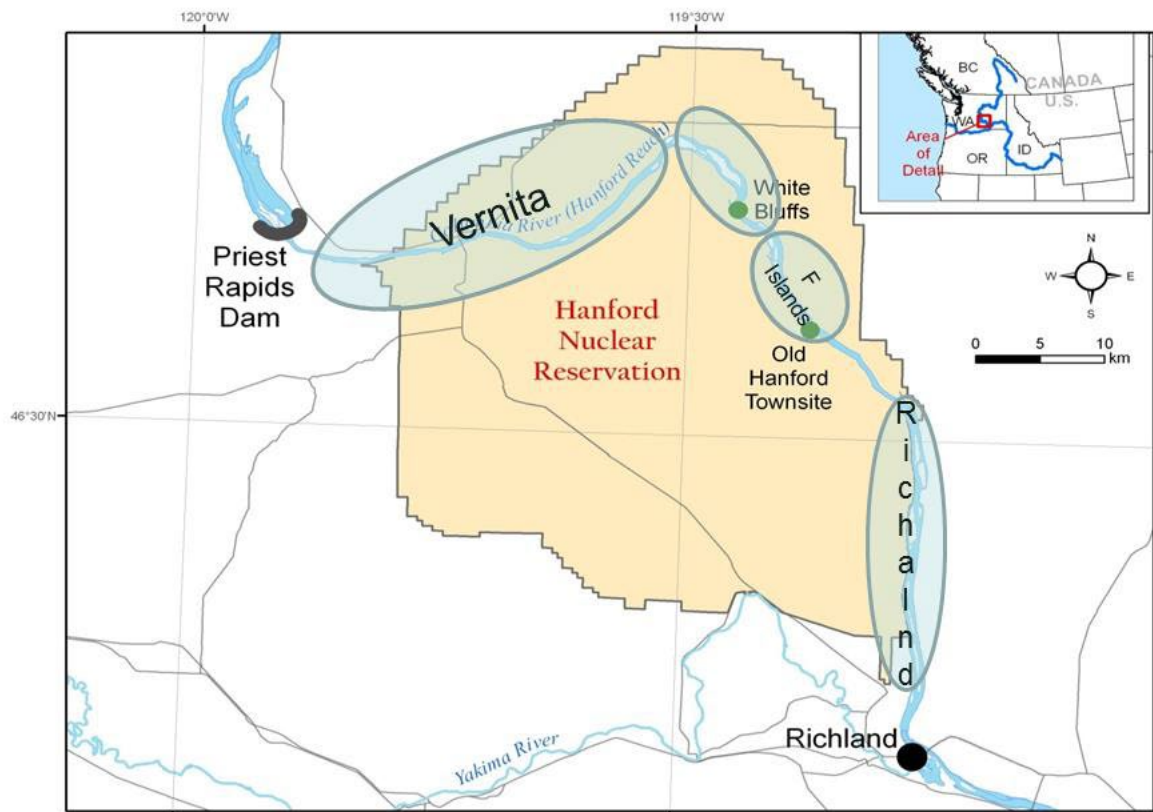


Figure 3. Map of the Hanford Reach showing the two boat ramps used on the reach (Hanford Town Site and White Bluffs) and the four areas (Vernita, White Bluffs, F Islands, and Richland) fished during the Hanford tagging project.

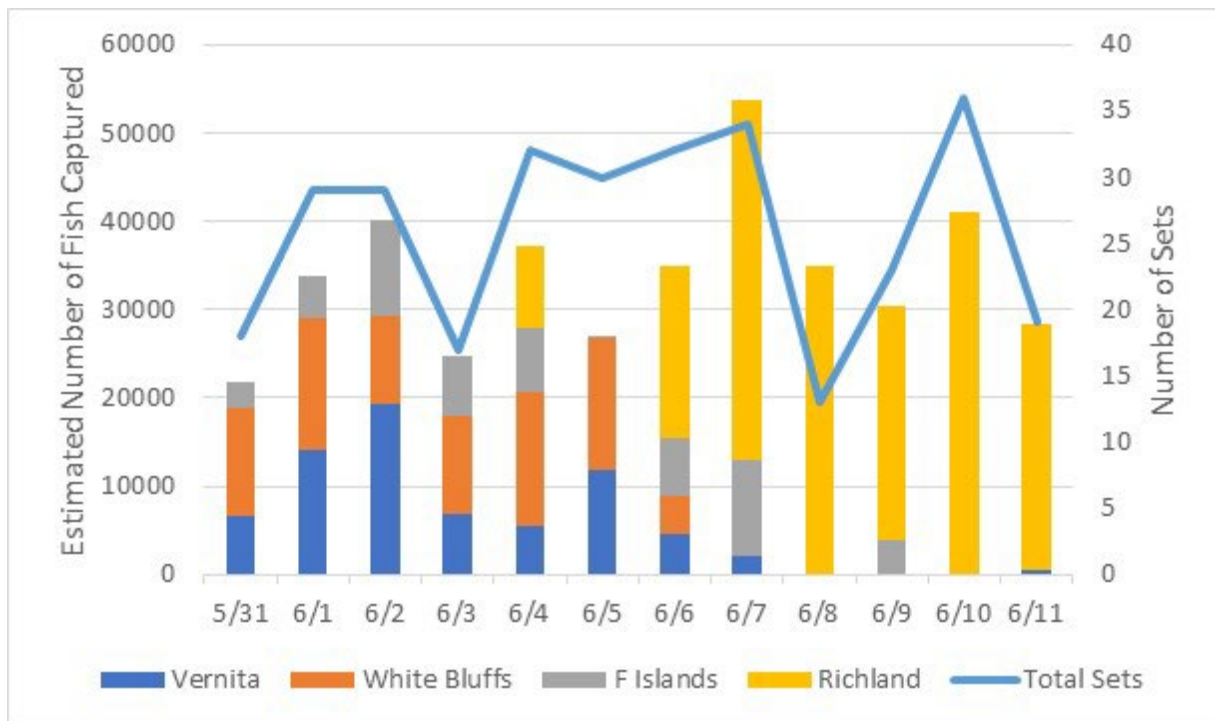


Figure 4. Distribution of juvenile URB fall Chinook catch by area in 2023 Hanford project with total fishing sets.

Table 3. Number of net sets and total capture by fishing region by day for the 2023 Hanford project.

Date	Vernita		White Bluffs		F Islands		Richland		Total		
	Sets	Catch	Sets	Catch	Sets	Catch	Sets	Catch	Sets	Catch	Catch/Set
5/31	5	6700	11	12250	2	2850	0	0	18	21800	1211
6/1	11	14000	11	15050	7	4750	0	0	29	33800	1166
6/2	6	19200	12	10151	11	10821	0	0	29	47451	1636
6/3	5	6900	6	11100	6	6651	0	0	17	24651	1450
6/4	4	5550	10	15000	9	7250	9	9500	32	37300	1166
6/5	13	11800	11	14997	6	100	0	0	30	26897	897
6/6	6	4550	9	4350	10	6500	7	19450	32	34850	1089
6/7	3	2050	0	0	4	10800	27	40805	34	53655	1578
6/8	0	0	0	0	0	0	13	34900	13	34900	2685
6/9	0	0	0	0	5	3965	18	26400	23	30365	1320
6/10	0	0	0	0	0	0	36	41050	36	41050	1140
6/11	2	500	2	0	0	0	15	27800	19	28300	1489
Total	50	42,050	115	122,757	90	93,355	164	125,388	419	383,550	1330
Pct.	17.6%	17.2%	23.1%	20.0%	19.2%	12.9%	40.1%	48.2%	100.0%	100.0%	
Catch per Set		1295		1151		895		1599		1330	

Coded Wire Tagging

The 2023 Hanford tagging project coded wire tagged 204,177 juvenile URB Chinook Salmon (Table 4). The project, as is always the case, started off slowly due to time lost for Hanford security training as well as training new crew members and reacquainting the returning crew members with CWT trailer procedures. Daily tag output peaked on June 7 at 24,229, after which crew member absences after 6/8 and running out of fish on 6/10 reduced tag output to below 20,000 for the rest of the project. The total output of 208,991 fish tagged was the lowest output since 2014.

Table 4. Summary statistics of daily sorting and tagging rates, mean fish size, CWT recapture, CWT retention, and river flow for the 2023 Hanford tagging project. 2014-2022 summary data is provided for comparison.

Date	Total Fish Processed	Fish Sorted	Fish Tagged	% Taggable	Mean Fork Length Tagged Fish (cm)	Ad Clipped "Recaps" ⁶	CWT Sample for Tag Loss Rate	CWT Loss Rate	Flow at Priest Rapids Dam (kcfs)
6/1	13,400	2,920	10,480	78.2%	56.6		198	2.5%	108.5
6/2	21,542	7,310	14,232	66.1%	55.4	0	690	0.1%	127.9
6/3	25,386	9,600	15,786	62.2%	60.1	0	727	1.9%	107.1
6/4	31,477	8,990	22,487	71.4%	56.3	0	721	0.0%	103.2
6/5	26,199	7,830	18,369	70.1%	54.1	5	478	0.2%	124.1
6/6	27,858	8,210	19,648	70.5%	58.7	0	527	0.0%	118.4
6/7	31,239	7,010	24,229	77.6%	59.8	0	414	0.2%	121.1
6/8	23,213	4,430	18,783	80.9%	58.2	10	638	0.2%	116.0
6/9	23,585	4,480	19,105	81.0%	61.5	13	500	0.2%	97.1
6/10	15,562	2,440	13,122	84.3%	62.1	18	616	0.0%	81.2
6/11	18,645	3,090	15,555	83.4%	NA	14	200	0.0%	81.9
6/12	16,411	4,030	12,381	75.4%	NA	17	200	0.0%	100.4
Total	274,517	70,340	204,177	74.4%	59.1	77	5909	0.4%	107.2
Year									
2014	318,349	125,610	192,739	60.5%	55.5	203	5,037	1.2%	204.1
2015	324,402	60,240	264,162	81.4%	58.1	18	3,293	0.4%	129.1
2016	281,870	17,410	264,460	93.8%	61.1	0	3,363	0.1%	140.6
2017	286,170	23,199	263,071	91.9%	60.3	2870	2,815	0.2%	260.3
2018	296,154	30,500	265,654	89.7%	56.4	98	5,065	0.7%	226.8
2019	293,768	60,322	233,446	79.4%	55.5	2,879	4,762	1.4%	192.0
2020	No Hanford Project due to COVID								
2021	249,509	31,450	218,059	87.4%	58.2	287	4780	0.7%	169.2
2022	263,351	54,360	208,991	79.4%	59.6	287	4128	0.12%	220.4

In 2023, an estimated 74.4% of juvenile Chinook captured were of taggable size with a mean fork length 59.1 mm (Table 4). There were 77 recaptures of previously adipose clipped fish less than 80 mm fork length. These could have been from smaller fish released from Priest Rapids Hatchery or Hanford releases recaptured at downstream fishing sites. Five tag code groups were used in 2023, 3 for 48-60 mm fish and 2 for >60-80 mm fish (Table 5). Release data reported to www.rmis.org can be found in Appendix A.

⁶ These are juvenile URBs estimated to be of taggable size (48-80mm) that were noted by technicians doing fish sorting to have been missing an adipose fin. These are likely recaptures of URBs which have already been adipose clipped by this project and were recaptured in the Richland area after release. These could also be smaller fish from Priest Rapids Hatchery early releases.

Table 5. Tag codes used at Hanford coded wire tagging project in 2023⁷.

Tag Code	Tagging Dates	Length Group Tagged	Number Tagged
610003	6/1-6/6	48-60 mm	59,887
610004	6/4-6/10	48-60 mm	58,358
610008	6/1-6/12	>60-80 mm	60,710
610195	6/10-6/12	>60-80 mm	11,013
610212	6/9-6/12	48-60 mm	14,029
Total All Lengths			204,177
Total 48-60 mm			132,454
Total >60-80 mm			71,723

Pre-tag and immediate post tagging mortality rates were the highest estimated since 2014 (Table 6), while overnight mortality rates were tied for 5th highest in the high when compared to recent years (since 2014) with pre-tag mortality (6.8%) highest among those years, and tag mortality (2.1%) and post tag mortality (1.9%) third highest of the 8 years. If these mortality rates are summed, the 2023 rate of 19.2% was highest in years since 2014⁸.

⁷ Tag Code information uploaded to www.rmis.org is found in Appendix A.

⁸ Since these rates are all calculated with different denominators, the sum is not a true mortality rate, but can be considered an index of mortality for comparing daily or annual mortality.

Table 6. Daily and cumulative estimates of mortality at Hanford project in 2023.

Tagging Date	Mortality Prior to Tagging		Immediate Post-tagging Mortality ⁹		Number Held	Additional Mortality Prior to Release the Next Day		Sum of Mortality Rates ⁸
	Number	Rate	Number	Rate		Mortalities	Rate	
June 1	898	6.3%	188	1.8%	10,292	81	0.8%	8.9%
June 2	864	3.9%	241	1.7%	13,991	134	1.0%	6.5%
June 3	1,131	4.3%	169	1.1%	26,517	62	0.2%	5.6%
June 4	715	2.2%	118	0.5%	22,369	66	0.3%	3.0%
June 5	18,301	41.1%	197	1.1%	18,172	106	0.6%	42.8%
June 6	386	1.4%	97	0.5%	19,551	88	0.5%	2.3%
June 7	840	2.6%	166	0.7%	24,063	62	0.3%	3.6%
June 8	3,086	11.7%	692	3.7%	18,091	440	2.4%	17.9%
June 9	2,431	9.3%	1,159	6.1%	17,346	530	3.1%	18.5%
June 10	2,751	15.0%	887	6.8%	12,235	513	4.2%	26.0%
June 11	2,229	10.7%	3,379	21.7%	12,176	950	7.8%	40.2%
June 12	9,439	36.5%	1,102	8.9%	0	0	NA	45.4%
2023 Total	43,071	13.6%	8,395	4.1%	194,803	3032	1.4%	19.2%
Annual Project Mortality Rates								
Year		Rate		Rate			Rate	Sum of Mortality Rates ⁹
2022		6.8%		2.1%			1.9%	10.8%
2021		5.5%		3.5%			3.4%	12.4%
2020	No tagging at Hanford due to COVID							
2019		6.7%		1.2%			0.9%	8.8%
2018		2.4%		1.5%			1.4%	5.3%
2017		1.5%		0.3%			0.4%	2.2%
2016		3.5%		1.4%			1.5%	6.4%
2015		4.0%		0.9%			0.4%	5.3%
2014		2.6%		3.2%			3.1%	8.9%
Mean 1998-2022¹⁰		3.4%		1.6%			3.1%	6.9%

Bycatch of species other than Chinook in 2023 was again too high to completely enumerate given the personnel time available for the task, thus sampling was used to estimate bycatch. Typically, we collected and weighed all bycatch and held the bycatch during the four tagging sessions (two in the morning and two in the afternoon) in 77 liter garbage cans (drilled with holds for water exchange) placed in a fish holding trough. We then weighed scoops of

⁹ Immediate mortality is typically mortality which occurs between tagging and release.

¹⁰ Data on mortality prior to tagging was first recorded in 1998.

bycatch and counted them by species, and then expanded by the inverse of the proportion counted as estimated by weight. For the first time since we have started measuring bycatch in 2015, the stickleback species was the top bycatch at 54.5% (Table 7, Figure 5) of the total followed by shiners at 16.0%, pikeminnows at 7.7% and whitefish at 7.4%. The total bycatch was estimated at 20,404 compared to the 2015-2023 mean of 11,178 and the high of 20,432 in 2021 during this period. We again observed banded killifish for which this project made the first report of this fish in this portion of the Columbia River in 2022 (Fryer et al. 2023). These were likely from catches in the Richland area as we only observed these after capturing fish in Richland.

Table 7. Estimated bycatch by species observed at the coded wire tagging trailer at 2023 Hanford project with 2014 to 2022 data for comparison. Tagging did not occur in 2020 due to COVID-19.

Species	2023	2022	2021	2020	2019	2018	2017	2016	2015	Mean
Stickleback	54.5%	35.2%	28.5%	6.8%	8.8%	14.0%	5.4%	5.8%	12.4%	19.0%
Shiner	16.0%	7.9%	16.3%	17.2%	31.8%	7.1%	44.5%	26.3%	37.8%	22.8%
Pikeminnow	7.7%	45.4%	40.3%	24.2%	38.0%	49.6%	31.4%	44.4%	31.9%	34.8%
Whitefish	7.4%	2.7%	9.5%	36.8%	5.6%	1.0%	15.7%	3.6%	2.6%	9.4%
Largemouth Bass	3.6%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
Peamouth	3.5%	0.0%	0.1%	5.1%	5.5%	0.4%	0.5%	0.2%	0.4%	1.7%
Smallmouth bass	1.6%	1.1%	0.3%	1.1%	1.0%	0.0%	0.8%	0.3%	0.2%	0.7%
Sucker	1.4%	1.5%	3.1%	2.8%	0.3%	1.2%	0.0%	2.1%	0.0%	1.4%
Dace	1.3%	0.9%	0.2%	0.5%	1.7%	6.1%	0.0%	6.3%	0.5%	1.9%
Sculpin	0.9%	1.2%	0.3%	4.2%	6.6%	17.8%	1.4%	11.0%	13.9%	6.4%
Bluegill	0.5%	0.5%	0.2%	0.0%	0.3%	0.2%	0.0%	0.0%	0.0%	0.2%
Crayfish	0.5%	0.0%	0.0%	0.0%	0.1%	0.8%	0.0%	0.0%	0.0%	0.2%
Banded Killifish	0.4%	1.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
Crappie	0.3%	0.0%	0.2%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
Yellow Perch	0.2%	1.7%	0.1%	1.2%	0.1%	1.6%	0.0%	0.0%	0.1%	0.6%
Pumpkinseed	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Coho	<0.1%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Sockeye	<0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%
Tadpole	<0.1%	0.0%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
Chiselmouth	<0.1%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%
Sunfish	<0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	20,404	9,258	20,432	11,149	18,272	3,907	2,128	2,944	12,110	11,178

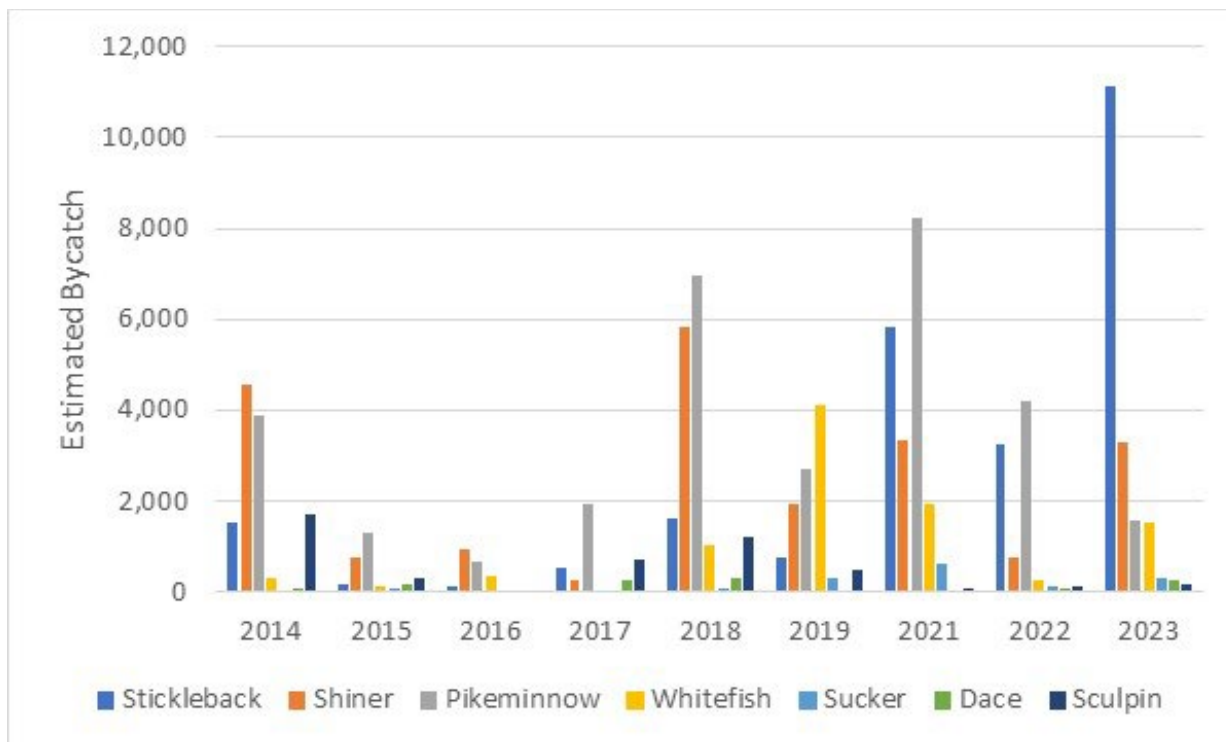


Figure 5. Estimated annual bycatch of non-target species by the Hanford URB tagging project for the years 2014-2019 and 2021-2023. Tagging did not occur in 2020 due to COVID-19.

PIT Tagging

A total of 10,144 juvenile URB Chinook were PIT tagged between June 6 and June 8, 2023, with 9,996 PIT tagged fish released (Table 8, Figure 6). It quickly became clear that it was not going to be possible to supply enough Chinook of taggable size for PIT tagging solely by grading out larger Chinook from the holding tanks without adversely affecting CWT tag output. Therefore, a tagging technician coded wire tagging 60-80 mm Chinook placed fish into a 19-liter bucket after coded wire tagging rather than sending them to the recovery trough. These buckets were then periodically emptied into the PIT tagging holding tank and the fish were then PIT tagged. This project has double-tagged (PIT+CWT) juvenile URBs in previous years when abundance of PIT taggable fish was low and in past years no significant difference was found between PIT+CWT and PIT-only survival to downstream sites (Fryer 2009).

Table 8. 2023 Hanford Reach juvenile fall Chinook Salmon PIT tagging summary. Note all fish were released the day following the date they were tagged.

Tag File	Tag Date	# Tagged	Post Tagging Mortality		Clipped Plus CWT	No Clip or CWT	Total PIT tagged Hanford URBs Released	>80mm unclipped	>80 mm Ad-clipped	Non Target by- Catch	Too Small	Total Handled
			N	Percent								
JKF--157-t01.xml ¹¹	6/6	792	17	2.15	0	775	775	272	208	55	79	1,389
JKF--157-t02.xml	6/6	1492	30	2.01	1462	0	1,462	0	0	0	0	1,462
JKF--158-w03.xml	6/7	1592	13	0.82	1579	0	1,579	0	0	0	0	1,579
JKF--158-w04.xml	6/7	1035	17	1.64	1018	0	1,018	0	0	0	0	1,018
JKF--158-w05.xml	6/7	1792	34	1.90	1758	0	1,758	0	0	0	0	1,758
JKF--159-th6.xml	6/8	617	2	0.32	615	0	615	0	0	0	0	615
JKF--159-th7.xml	6/8	2675	35	1.31	2640	0	2,640	0	0	0	0	2,640
JKF--159-mrt.xml	6/8	149	0	0.00	149	0	149	0	0	0	0	149
Total		10,144	148	1.46	9,221	775	9,996	272	208	55	79	10,610

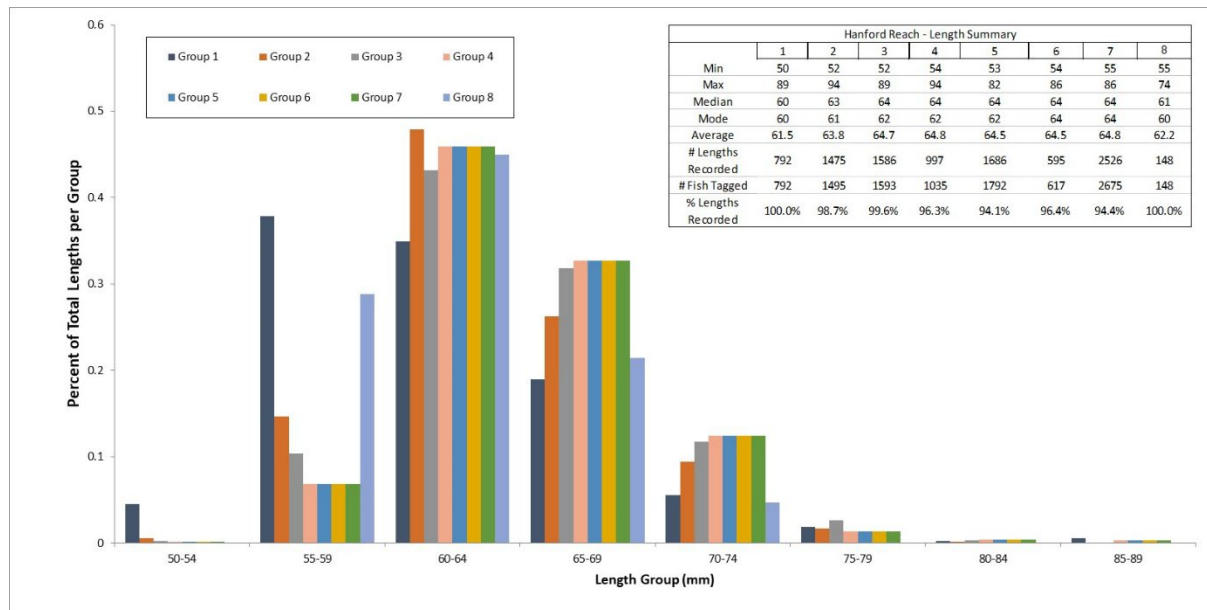


Figure 6. Length summary for juvenile URBs PIT tagged at Hanford Reach in 2023.

Mortality subsequent to PIT tagging ranged from 0.0% to 2.2% with a mean of 1.5%, an improvement from 2022 when it ranged from 1.3% to 14.6% with a mean rate of 4.3% (Fryer 2023). The estimated survival from release to McNary Dam by date (Table 9, Figure 7) ranged

¹¹ This was the only group of fish that was not pre-sorted coded wire tagged fish coming from the tagging trailer.

from 0.046 (se=0.028) for those fish tagged on June 6 to 0.282 (se=0.273) on June 8. Across all tag groups, survival from release to McNary was 0.242 (se=0.165) and to Bonneville Dam was 0.008 (se=0.003) (Table 9). Survival from release to McNary was the lowest in the past 10 years of tagging (Table 10). The survival rate of Priest Rapids Hatchery URBs from release to McNary of 0.490 (se=0.069) was the highest since 2018 (Table 10).

Table 9. Percentage of juvenile Chinook Salmon tagged at Hanford that were subsequently detected and downstream survival by date in 2023.

Date Released	Number Released (N)	Mortality prior to release	Detection Rate D/N	Survival Estimates							
				Release to McNary		McNary to John Day		John Day to Bon. Dam		Release to Bon. Dam	
				Mean	SE	Mean	SE	Mean	SE	Mean	SE
June 6	2,237	2.1%	1.4%	0.046	0.028	0.784	0.843	NA	NA	NA	NA
June 7	4,355	1.4%	1.4%	0.207	0.199	NA	NA	NA	NA	NA	NA
June 8	3,404	1.1%	1.9%	0.282	0.273	0.099	0.107	0.316	0.222	0.009	0.004
All Dates	9,996	1.5%	1.6%	0.144	0.068	0.255	0.166	0.237	0.151	0.009	0.004

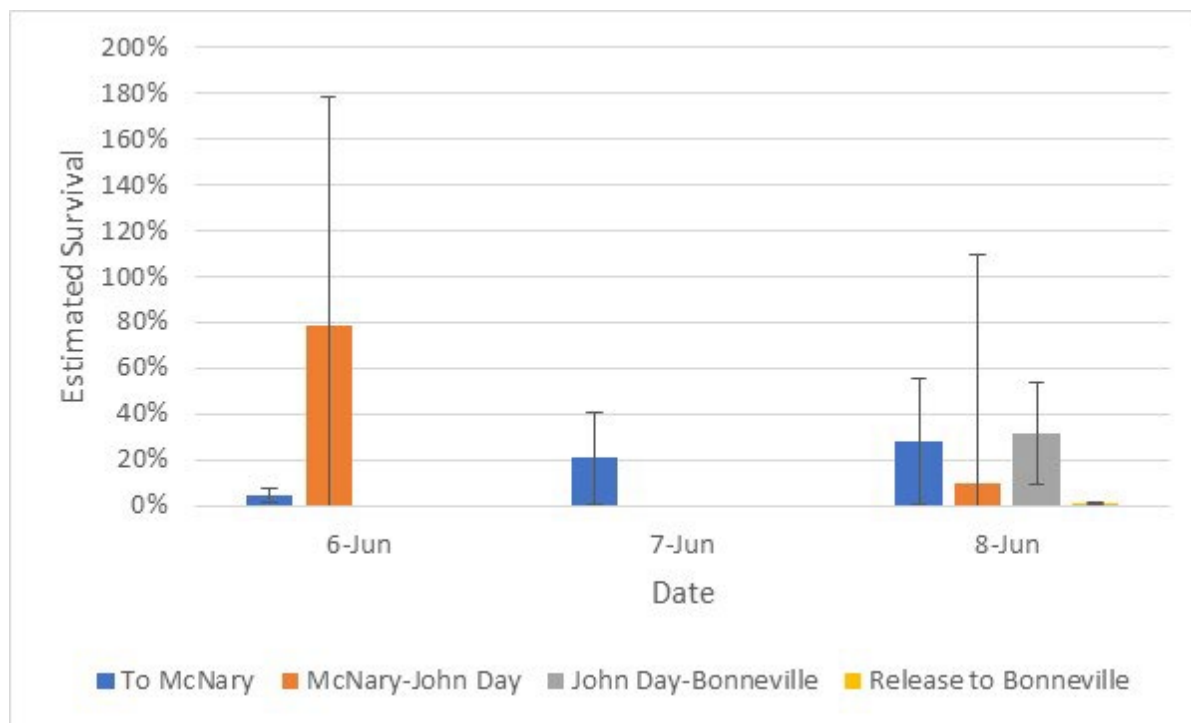


Figure 7. Survival from release to McNary, McNary to John Day, John Day to Bonneville and release to Bonneville Dam by tagging date for 2023 Hanford Reach PIT tagging with standard errors. No bars mean insufficient detections to estimate the survival in question.

Table 10. Downstream survival estimates for juvenile fall Chinook Salmon PIT tagged at the Hanford Reach and Priest Rapids Hatchery for 2014-2023. Tagging did not occur in 2020 due to COVID-19.

Year	Location	Number Tagged (N)	Down-stream Detections (D)	Detection Rate D/N	Release-McNary Survival		McNary-John Day Survival		John Day Bonneville Survival	
					Mean	SE	Mean	SE	Mean	SE
2014	Hanford	9,940	1,705	17.2%	0.343	0.019	0.798	0.097	0.992	0.473
2015	Hanford	4,965	179	3.6%	0.777	0.537	0.239	0.230	NA	NA
2016	Hanford	9,926	636	6.4%	0.566	0.139	0.190	0.062	0.543	0.505
2017	Hanford	9,989	1,217	12.2%	0.301	0.024	0.615	0.081	NA	NA
2018	Hanford	9,987	643	6.3%	0.244	0.034	0.490	0.110	NA	NA
2019	Hanford	9,974	757	7.6%	0.231	0.061	0.703	0.256	0.321	0.026
2021	Hanford	9,878	391	4.0%	0.435	0.170	0.261	0.114	NA	NA
2022	Hanford	9,983	735	7.4%	0.213	0.027	0.417	0.079	0.393	0.324
2023	Hanford	9,996	157	1.6%	0.144	0.068	0.255	0.166	0.237	0.151
2014	Priest Rapids	2,988	863	28.9%	0.768	0.073	0.856	0.205	0.546	0.375
2015	Priest Rapids	42,621	5,425	12.7%	0.772	0.048	0.484	0.056	1.250	1.235
2016	Priest Rapids	42,955	8,256	19.2%	0.849	0.040	0.345	0.025	1.335	0.524
2017	Priest Rapids	42,840	8,022	18.7%	0.532	0.018	0.751	0.042	1.378	0.194
2018	Priest Rapids	42,895	6,038	14.1%	0.520	0.024	0.621	0.045	0.536	0.139
2019	Priest Rapids	42,850	3,527	8.2%	0.403	0.091	0.799	0.907	NA	NA
2021	Priest Rapids	42,873	2,303	5.4%	0.377	0.028	0.839	0.094	NA	NA
2022	Priest Rapids	42,971	3,762	8.8%	0.293	0.018	0.605	0.060	1.892	1.846
2023	Priest Rapids	42,978	4,328	10.0%	0.490	0.069	0.294	0.051	0.749	0.149

The 61-70 mm length group comprised 72.3% of the juvenile URBs for which length was measured (Table 11). Of the four length measured groups, only two groups (61-70 and 71-80 mm) had sufficient detections downstream to estimate survival (Table 11). Fish from the 61-70 mm group had the highest survival to McNary, however, the difference between the 61-70 mm and 71-80 mm groups was not significant ($t=0.45$, $p=0.75$). In 2023, the length distribution of detections at McNary Dam was skewed towards larger fish when compared to the length distribution of URBs tagged at Hanford but this was not statistically significant ($\alpha=0.05$) using a Kolmogorov-Smirnov test $\chi^2=5.0$, ($p=0.08$) (Figure 8). The mean length at tagging of Hanford-tagged URBs detected at McNary was 65.7 mm compared to 64.3 mm for the mean fork length of all URBs tagged at Hanford before release; this was significant at $\alpha=0.05$ using a t-test ($p=0.01$) (Figure 9).

Table 11. Survival from release to McNary and John Day dams and from McNary to John Day Dam by length group for juvenile URB Chinook Salmon PIT tagged and released at the Hanford Reach in 2023.

Length Group	N	Mean Length (mm)		Survival from Release-McNary		Survival from McNary to John Day	
		Mean	Std Dev	Mean	SE	Mean	SE
51-60mm	1,801	58.6	1.7	NA	NA	NA	NA
61-70mm	6,974	64.5	2.6	0.211	0.045	0.456	0.153
71-80 mm	861	73.2	2.2	0.113	0.069	0.369	0.303
81-94 mm	24	85.2	4.1	NA	NA	NA	NA
No length	336	NA	NA	0.209	0.073	NA	NA
All Fish Tagged	9,758	64.3	23.8	0.212	0.029	0.437	0.089

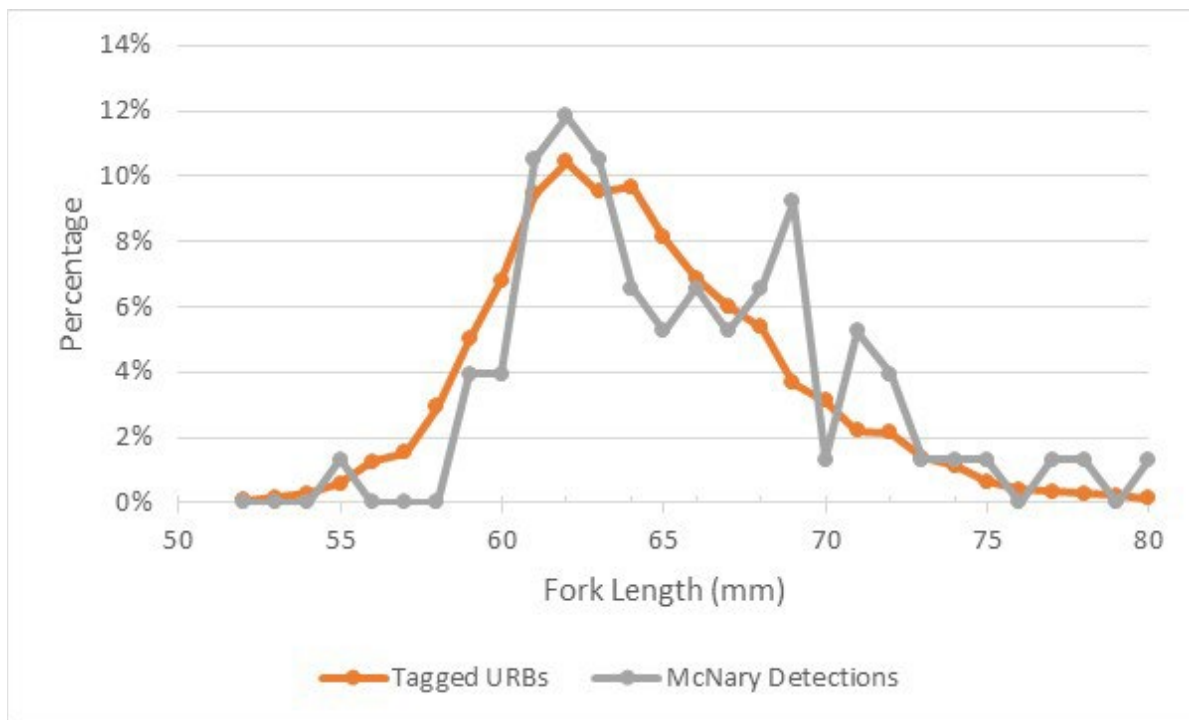


Figure 8. Comparison of the fork length distribution of PIT-tagged juvenile URB fall Chinook tagged at the Hanford Reach in 2023 with the length distribution of subsequent detections at the McNary Dam juvenile bypass from the same group.

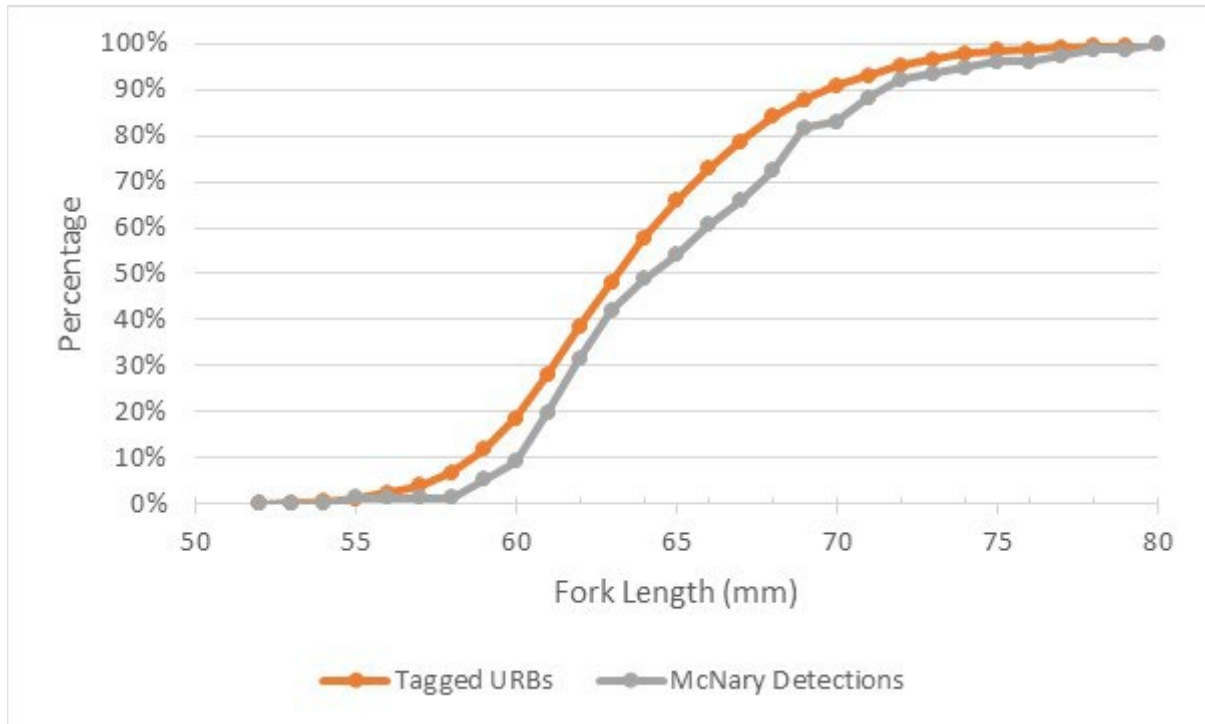


Figure 9. Comparison of the cumulative frequency distribution of fork lengths of PIT-tagged juvenile URB fall Chinook tagged at the Hanford Reach in 2023 with the distribution of URBs subsequently detected at the McNary Dam juvenile bypass (MCJ).

Mean travel time from release at the tagging site to McNary Dam in 2023 was 26.9 (se=0.9) days compared to 18.7 (se=0.2) days for the Priest Rapids Hatchery group (Table 12). When grouped by fork length, Hanford URBs in groups with greater mean fork lengths had shorter travel times to all McNary and John Day dams, but not to Bonneville Dam than did the groups with shorter fork lengths (Table 13).

Table 12. Downstream travel time estimates for juvenile URB Chinook Salmon PIT tagged at the Hanford Reach 2014-2023 with Priest Rapids Hatchery included for comparison.

Year	Location	Release-McNary Travel Time (d)		Release-John Day Travel Time (d)		Release-Bonneville Travel Time (d)	
		Mean	SE	Mean	SE	Mean	SE
2014	Hanford	26.5	0.3	30.6	0.3	32.9	0.4
2015	Hanford	23.4	1.1	27.7	0.7	30.5	1.6
2016	Hanford	13.1	0.4	17.8	0.5	19.0	0.5
2017	Hanford	21.9	0.3	26.2	0.4	28.1	0.3
2018	Hanford	30.9	0.4	35.3	0.4	34.2	0.6
2019	Hanford	23.1	1.2	32.5	0.7	29.7	1.0
2021	Hanford	17.8	0.6	23.3	0.4	25.2	0.4
2022	Hanford	18.5	0.8	31.2	0.7	32.6	0.8
2023	Hanford	26.9	0.9	33.8	1.4	33.8	0.9
2014	Priest Rapids	13.3	0.2	16.0	0.3	19.0	0.4
2015	Priest Rapids	12.5	0.1	16.8	0.1	18.7	0.2
2016	Priest Rapids	6.7	0.0	10.5	0.1	11.7	0.1
2017	Priest Rapids	16.0	0.1	18.8	0.2	20.5	0.4
2018	Priest Rapids	19.7	0.2	23.2	0.2	24.0	0.2
2019	Priest Rapids	19.6	0.3	24.0	0.2	25.5	0.3
2021	Priest Rapids	15.1	0.2	18.3	0.2	20.8	0.2
2022	Priest Rapids	22.4	0.3	27.2	0.3	29.2	0.3
2023	Priest Rapids	18.7	0.2	22.2	0.3	24.0	0.3

Table 13. Mean travel time in days by length group for juvenile URB Chinook tagged at the Hanford Reach in 2023.

Length Group	Mean Travel Time in Days					
	Release-McNary		Release-John Day		Release-Bonneville	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
<= 60 mm	28.3	10.2	37.5	5.3	33.1	3.7
61-70 mm	28.0	7.0	34.5	10.5	34.8	3.8
71-80 mm	22.4	8.8	27.9	3.5	31.7	7.8
>=81 mm	NA	NA	NA	NA	NA	NA
All	26.9	0.9	33.8	1.4	33.8	0.9

Discussion

Although the 2023 Hanford coded wire tag output of 208,991 was less than that of the six years the project ran between 2015 and 2021, it did hit the goal of 200,000 URBs coded wire tagged¹². Prior to 2014, the project had never had more than three consecutive years of more than 200,000 URBs tagged, we are currently on a streak of eight straight years of exceeding that goal. Despite low flows which are normally beneficial to this project, there were several factors which reduced coded wire tag output in 2023 when compared to 2015-2022. Tagging crew performance was not as good as usual due to absences and very few outstanding performers among the crew personnel. This project has often benefitted by having a small number of key technicians who demonstrated high performance at tagging or clipping fish but have lost most of them over the years as they have retired or found higher paying jobs.

Another factor resulting in lower tag output was low abundance of Hanford URBs, likely a result of the 32nd lowest (out of 35 years) number of spawners in 2023 whose offspring we captured in 2024. Towards the end of the project's field work, we had two days in which we ran out of fish.¹³ Low fish abundance upstream of the tagging sight meant that our crews went downstream to fish the Richland area and as is often the case, the result was high mortality. This is likely a combination of trailering the boats with fish in the boat holding tanks from Richland back to the tagging location with no opportunity for water exchanges. This exacerbates temperature and oxygen issues that may be prevalent and the jostling during travel in crowded tanks results in descaling. Furthermore, we found out subsequent to this year's field work that Ringold Hatchery had completed an early release on June 5, because of high hatchery water temperatures meant fish condition in the hatchery was deteriorating. Mortalities from these fish, many of which were unclipped and thus unrecognizable from Hanford URBs, may have boosted our mortality number.

Another factor contributing to the difficulties encountered in 2023 were the large numbers of Priest Rapids Hatchery releases comingled with Hanford URBs. Prior to 2017, Priest Rapids Hatchery delayed URB hatchery releases until the Hanford project was concluded to avoid impacting the Hanford Project. However, to increase adult returns by increasing downstream migration survival to the ocean for Priest Rapids Hatchery releases, beginning in 2017, two ponds were released prior to the start of the Hanford project (Table 14) and a third was typically released towards the end of the project. The result has been an unprecedented number of larger URBs (75-120 mm) captured by this project. The PRDH releases are planned around sizes where fish have >80 mm fork length, however, up to 8.4% of releases in 2023 prior to the end of the Hanford tagging project were ≤80 mm fork length, meaning it is likely that there were unclipped PRDH releases that were coded wire tagged or PIT tagged by the Hanford tagging project (with Hanford tags).

¹² However, after excluding mortalities and tag loss, the net release of coded wire tagged fish was 192,398.

¹³ Output could have been increased on days the project ran out of fish by tagging fish immediately after capture, rather than holding them overnight prior to tagging. However, in past years, this has resulted in high mortality, so we chose not to do so.

Table 14. Year 2023 Priest Rapids Hatchery juvenile URB release groups, numbers PIT tagged, and percentage adipose clipped within each group. (Data from Steve Richards, WDFW)

Release Pond	Release Date	Total Released	% Ad Clipped	PIT Tagged Released	% Released <=80 mm Fork Length
E	5/16/2023	1,546,626	43.1%	8,594	6.8%
D	5/24/2023	1,461,388	55.6%	8,597	8.4%
C	6/9/2023	1,399,744	47.5%	8,599	1.3%
B	6/15/2023	1,396,789	47.6%	8,597	3.3%
A	6/20/2023	1,333,482	49.9%	8,591	8.6%
Total		7,138,029	48.7%	42,978	5.7%

Data from this project was used to estimate the percentage of the biomass handled by this project that was PRDH origin. The total weight of each of the three groups of fish (coded wire tagged, sorts <48mm, and sorts >80mm) was estimated based on a length-weight relationship ((Triton Environmental Consultants 2010). The percentage of the coded wire tag group and sorts <80 mm in length of PRDH origin was estimated as 0%, while differential adipose clip rates resulted in an estimate of 67% of the sorts >=80mm being of PRDH origin. This results in an estimated biomass of Hanford fish processed by this project as 69.6% of the total biomass compared to 30.4% that were PRDH fish (Table 15). By comparison, in 2023 it was estimated that 58.0% of the total biomass of URBs handled by this project was Hanford origin and 42.0% PRDH origin.

Table 15. Estimates of Hanford and Priest Rapids Hatchery biomass processed by the 2023 Hanford coded wire tagging project.

Statistic	Coded Wire Tagged Fish	Sorts <48 mm	Sorts >=80 mm	Percentage Biomass
Mean Length (mm)	56.3	42.8	93.4	
Grams/fish ¹⁴	1.63	0.64	8.98	
Total Captured	208991	48178	22,162	
Total kilograms	340	31	199	
Percent PRDH origin by Group	≈0%	≈0%	≈67%	
Hanford biomass (kg)	340	31	66	69.6%
PRDH biomass (kg)	≈0	≈0	133	30.4%

If 30.4% of the biomass captured by the Hanford tagging project is PRDH fish, this has numerous impacts on the project. First is cost. Given that the cost of running capture crews for Hanford is approximately \$190,000 and cost is roughly proportional to biomass captured (boat holding tank capacity is biomass-limited more so than numbers-limited), I estimate that this project spent about \$57,000 capturing PRDH URBs in 2023. Similarly, the capacity of our

¹⁴ Estimated using the equation $y=0.000002 \cdot x^{3.3763}$ where x is fork length and y is grams (Triton Environmental Consultants. 2010).

tagging trailer troughs are also biomass-limited rather than numbers-limited, thus having so much tank or trough capacity devoted to PRDH fish increases our chances of running out of fish for tagging or causing overcrowding mortality.

The very low estimated survival from release to McNary was even lower for Hanford PIT-tagged URBs than it was in 2022, which was the previous record low. The PRDH survival rate from release to MCN increased in 2023 from the low of 2022¹⁵ (Figure 10). Survival of Hanford-tagged URBs to McNary Dam was much lower for June 6 releases (4.6%, Table 9) than for those released on June 7 (20.7%) or June 8 (28.2%). The smaller size of the Group 1 and 2 releases on June 6 compared to those released on June 7 and June 8 may be a contributing factor for this difference (Figure 6).

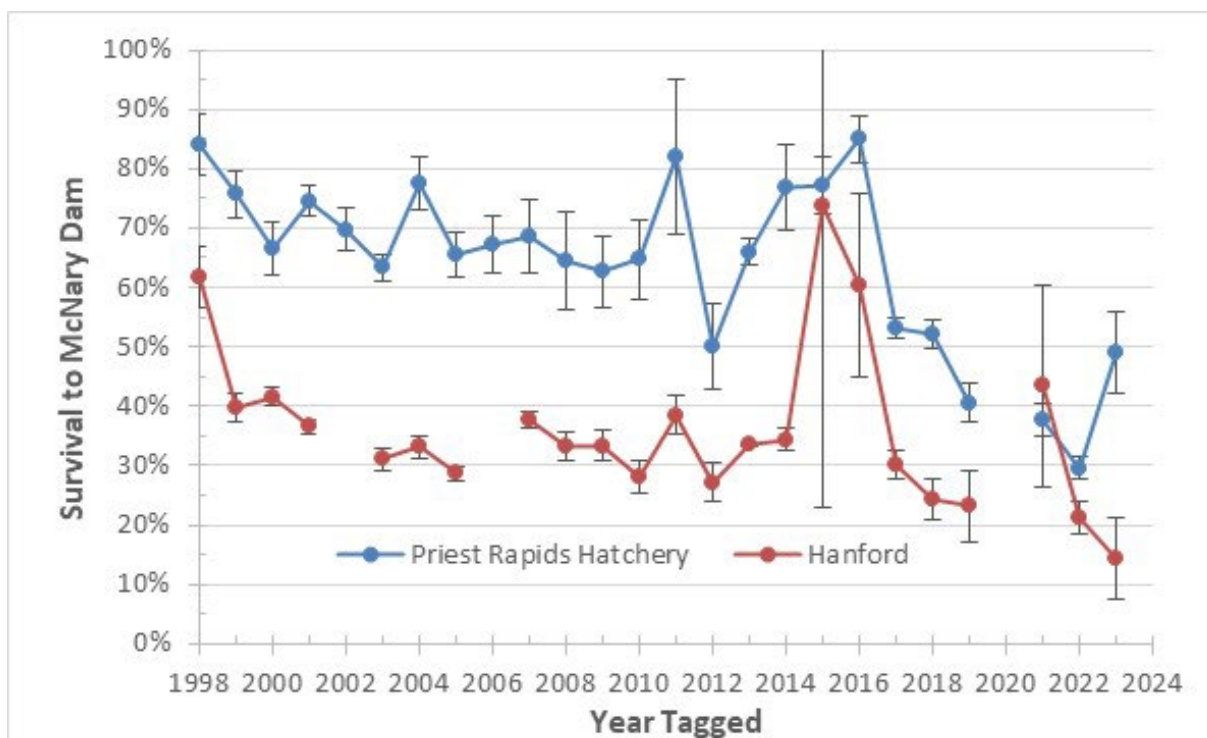


Figure 2. Estimated survival with standard errors from release to McNary Dam for juvenile URB Chinook PIT tagged at the Hanford Reach and Priest Rapids Hatchery 1998-2023.

After accounting for tagging mortality, overnight tagging mortality, and tag loss, the estimated number of live tagged fish released by this project in 2023 was 191,967 which was 8,479 fewer than 2022 and well under that of 2015-2019 (Table 16, Figure 11) years. Tag loss at 0.4% was slightly below the mean of 0.5% for years 2015 - 2023, while overnight mortality was slightly above the mean (1.6% versus 1.4%). However, immediate tagging mortality of 4.1% was over double the 1.9% mean, and among the 36 years of this project, 2023 had the highest

¹⁵ The decreased PRDH survivals are to be expected due to the smaller size at release and longer time these fish therefore spend in the Hanford Reach to grow. However, the assumption made is that higher survival downstream of MCN will outweigh the lower survival from release to MCN.

immediate tagging mortality. Year 2023, at 13.6%, also had the highest pre-tagging mortality of the 25 years this statistic has been collected (Figure 11).

Table 16. Number of juvenile URBs tagged by the CWT portion of the Hanford project and the effective output after mortality and CWT loss is accounted for in the years 2015-2023. Tagging did not occur in 2020 due to COVID – 19.

Year	Initial Tag Output	Immediate Tag Mortality		Estimated Overnight mortality after tagging		Tag Loss		Net Tag Output
		Percentage	N	Percentage	N	Percentage	N	
2023	204,177	4.1%	8,395	1.6%	3,032	0.4%	783	191,967
2022	208,991	2.1%	4,352	1.9%	3,890	0.2%	304	200,446
2021	218,059	3.5%	7,592	3.4%	7,187	0.7%	1,320	201,960
2019	233,446	1.2%	2,733	0.9%	1,921	1.4%	3,812	224,980
2018	265,644	1.5%	3,865	1.4%	3,665	0.7%	1,830	256,294
2017	263,071	0.3%	789	0.4%	1,049	0.2%	522	260,710
2016	264,460	1.4%	3,702	1.5%	3,911	0.1%	257	256,589
2015	264,162	0.9%	2,377	0.4%	1,047	0.4%	1,043	259,694
Mean	240,251	1.9%	4,226	1.4%	3,213	0.5%	1,234	231,580

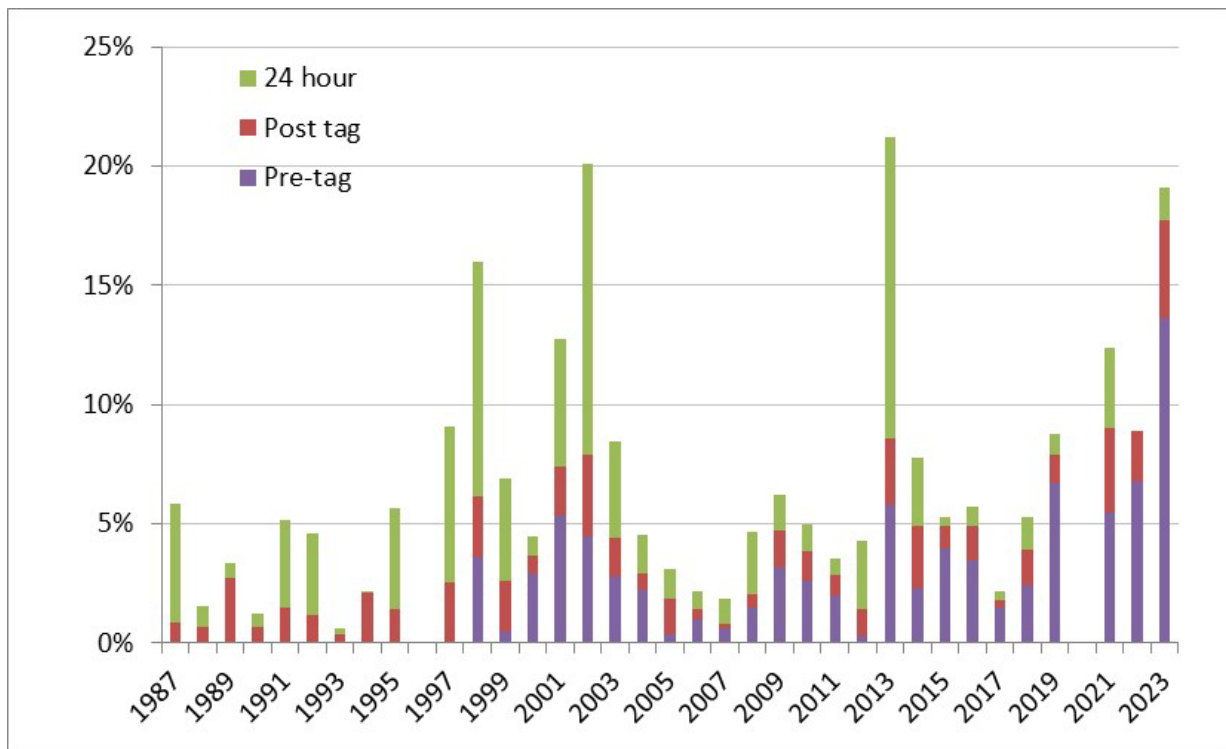


Figure 3. Pre-, post-, and 24 hour-tagging mortality at the Hanford tagging project, 1987-2023. Pre-tagging mortality data was not collected until 1998. No data was recorded in 1996 and the project did not occur in 2020.

The high mortality rates are primarily due to fishing in Richland. Over the first three days of the project, before fishing Richland, mortality rates were very low; pre-tagging mortality was 3.6%, tagging mortality 0.7%, and overnight mortality of coded wire tagged fish 0.3%.

PIT tags from URBs tagged by this project are recovered from avian colonies located along the Columbia River mostly downstream of the Hanford Reach. Significant predator species include Caspian Terns (*Hydroprogne caspia*), Double-crested Cormorants (*Phalacrocorax auratus*), and California Gulls (*Larus californicus*). The percentage of tagged juvenile Hanford Reach URBs released in 2023, where their tags were detected on avian islands was 8.4%, third only to 2021 (11.5%) and 2019 (9.9%) (Figure 12). Due to variable rates of deposition and detection by year, colony, and avian species, it is not possible to directly translate these detection rates into mortality rates. A CTC-funded project for Real Time Research and CRITFC to explore these factors was completed in 2020 and a final report included in Fryer 2022.

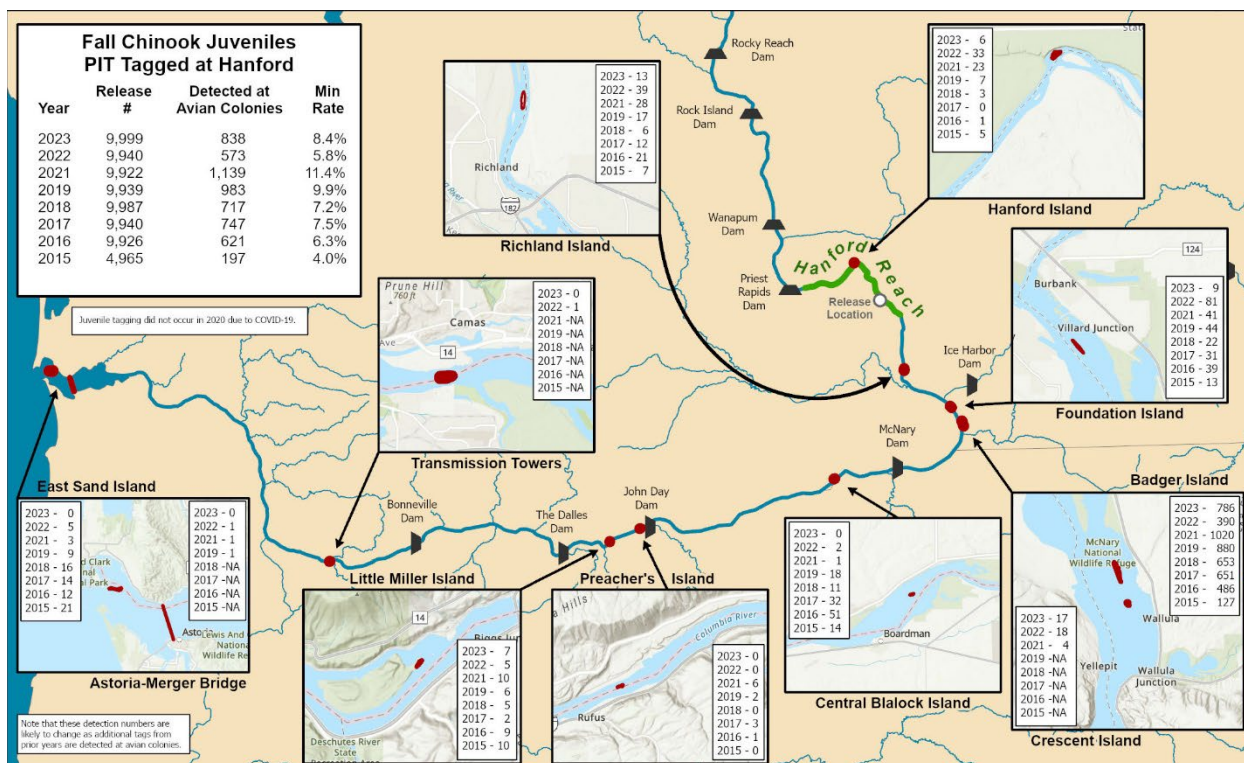


Figure 4. Recoveries of PIT tags from juvenile Hanford URBs PIT tagged by this project in years 2013-2019 and 2021-2023.

The Hanford Reach fall Chinook and coded wire tagging project will continue in 2024, and we are planning a two major changes. The first is to start the project a week early prior to Memorial Day. This will hopefully improve fish abundance as the inability to catch fish in the second week of the project in recent years has been the reason that capture crews have fished in Richland with resulting high mortality. Starting earlier may result in lower tag output as URBs will likely be smaller size resulting in more processing time for trailer technicians as smaller fish are smaller fish are sorted out. We also plan to allow no, or very limited, fishing in Richland to reduce mortality which may also adversely affect tag output.

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Appendix A. Release by 2023 Hanford tag code data for upload to Regional Mark Information System (RMIS), www.rmis.org

		Coded Wire Tag Code					
Tagging Date	Release Date	610003	610212	610004	61008	610195	Total
6/1	6/2	8549			1931		10480
6/2	6/3	11449			2783		14232
6/3	6/4	13152			2634		15786
6/4	6/5	16210		2041	4236		22487
6/5	6/6	8236		6320	3813		18369
6/6	6/7	2291		10683	6674		19648
6/7	6/8			16530	7699		24229
6/8	6/9			8725	10058		18783
6/9	6/10		1276	8605	9224		19105
6/10	6/11		898	5454	4892	1878	13122
6/11	6/12		6663		6025	2867	15555
6/12	6/12		5372		741	6268	12381
Total Tagged		59887	14209	58358	60710	11013	204177
Mean Length (mm)		52.0	55.9	53.1	66.1	67.8	57.6
Percentage taggable size (48-80 mm)		69.1%	80.2%	76.9%	76.9%	79.0%	74.4%
Total Fish Released¹⁶		86631	17706	75894	78947	13934	273113
CWT released		59887	14209	58358	60710	11013	204177
CWT releases after immediate and overnight mortality		58900	11549	56064	56481	9403	192398
Tag Retention Rate		99.2%	100.0%	99.9%	99.7%	100.0%	99.6%
CWT retained		58406	11547	55983	56328	9403	191667
CWT shed tag		495	2	81	153	0	730
Total CWT release		58406	11547	55983	56328	9403	191667
Non-CWT release¹⁷		28225	6160	19911	22619	4531	81446
2023 Release Dates		6/2-6/6	6/10-12	6/5-6/10	6/2-6/12	6/11-12	6/2-11

¹⁶ Number of coded wire tags divided by the percentage taggable.

¹⁷ Total fish released minus CWT releases.