



2015 Summary Assessment of Larval/Juvenile Lamprey Entrainment in Irrigation Diversions within the Yakima Subbasin



**Cover Photo: Larval lampreys trapped on the dry bank
after dewatering at Wapatox Diversion, Naches River.**

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ABSTRACT

A total of 12 irrigation diversions were surveyed in the Yakima Subbasin (6, 2, 1 and 3 in the Yakima River, Ahtanum Creek, Taneum Creek and Naches River, respectively). Irrigation diversions provide preferred, yet in effect misleading, refuge habitat to hundreds of thousands of larval/juvenile lampreys moving downstream. When the diversions are dewatered after the irrigation season, the entrained lampreys are left to desiccate in or on top of dried fine sediment unless salvage occurs. Larval lamprey salvage surveys were conducted with the following objectives; 1) efficiently salvage as many larval/juvenile lampreys as possible and return them to their respective stream downstream of the diversion, 2) check dried banks closely for desiccated lampreys, and 3) understand lamprey distribution and densities upstream and downstream of the fish screens. In addition, we evaluated the ratio of entrained Pacific Lamprey versus Western Brook Lamprey within each of the surveyed irrigation diversion facilities.

In total, 15275 larval/juvenile lampreys were captured and returned to their respective stream (10731, 3252, 1221, and 71 from irrigation diversions in Ahtanum, Yakima, Naches, and Taneum watersheds, respectively). Missed lampreys that we could not capture constituted 76.4% of all observed lampreys (79.0% upstream and 39.8% downstream of fish screens). Surveys were conducted in almost equal ratio upstream and downstream of the fish screens (711 m² upstream and 703 m² downstream). Surveys upstream of the fish screens accounted for 83.3% of the total number of captured lampreys – however, this was primarily driven by the high counts at Bachelor-Hatton Diversion. In facilities where we surveyed both upstream and downstream of the fish screens (n=7), the average ratio of lampreys observed upstream of the fish screens was only 55.3% and densities of lampreys were on average 1.54 times higher compared to those observed downstream of the fish screens. Average density for all sites were 16.0 lamprey/m². A total of 2596 dead or nearly dead lampreys (3.8% of total lampreys observed) were found on dewatered banks or on top of partially wetted fine sediment (4.0% and 1.3% upstream and downstream of the fish screens, respectfully).

Pacific Lamprey were present at 7 of the 12 surveyed diversions and on average (by facility) constituted approximately 47% of lampreys identified. The ratio of Pacific Lamprey (vs. Western Brook Lamprey) was high at Bachelor-Hatton Diversion (97.7%) in Ahtanum Creek (river km 31.8), and Naches-Selah (66.7%) and Wapatox (51.2%) diversions in the Naches River (river km 30.6 and 29.0, respectfully). In the Yakima River, the ratio of Pacific Lamprey ranged from 5.9% (Union Gap Diversion, river km 188.7) to 15.7% (Wapato Diversion, river km 176.3); the ratio at Sunnyside Diversion (river km 171.4) was similar at 14.2%. The ratio of Pacific Lamprey has been increasing steadily since 2011 at Sunnyside and Wapato diversions from approximately 0% in 2012-2013 and 2013-2014, 7.0% in 2014-2015, to 15% in 2015-2016. This indicates that Pacific Lamprey began to appear in large numbers approximately 2.5 years after translocation began in Ahtanum Creek in 2013.

INTRODUCTION

Pacific Lamprey (*Entosphenus tridentatus*), a species of high cultural and ecological value, is declining in population abundance and distribution throughout the Columbia River Basin. One of the major threats facing Pacific Lamprey are irrigation diversions, many of which provide preferred, yet in effect misleading, refuge habitat to hundreds of thousands of larval/juvenile lampreys moving downstream. When the diversions are dewatered after the irrigation season, the entrained lampreys (which are buried in the fine sediment) are left to dry up unless salvage efforts are put in place to rescue them. Larval lamprey salvage surveys were conducted in the Yakima Subbasin with the following objectives; 1) efficiently salvage as many larval/juvenile lampreys as possible and return them to their respective stream, 2) check dried banks closely for desiccated lampreys, and 3) understand lamprey distribution and numbers upstream and downstream of the fish screens. In addition, we evaluated the ratio of entrained Pacific Lamprey versus Western Brook Lamprey within each of the surveyed irrigation diversion facilities. By understanding the ratio of Pacific lamprey in these diversions, we can start to assess the overall impact of irrigation diversions on Pacific Lamprey at the larval/juvenile life stages. Monitoring this impact will be crucial to improving future Pacific Lamprey management and restoration efforts.

METHODS

The Yakama Nation Pacific Lamprey Project surveyed 12 dewatered irrigation diversions within the Yakima Subbasin for larval/juvenile lampreys primarily from October 16, 2015 to December 14, 2015. Additional surveys were conducted in early 2016 at select irrigation diversions, some with notably large numbers of entrained lampreys. Diversions were surveyed as close as possible to the initial dewatering date to limit additional loss of lampreys from desiccation and/or predation (with the exception of some diversions that require multiple days of dewatering to access optimal lamprey habitat). Diversions which have had relatively high entrainment from past surveys were given priority. As in previous years, we focused salvage efforts at two major Yakima River irrigation diversions with known high densities of lampreys; Wapato Diversion (upstream of the fish screens) and Sunnyside Diversion (downstream of the fish screens). In addition to these two diversions, salvage efforts were also focused at Bachelor Hatton Diversion (both upstream and downstream of the fish screens) due to a large and unexpected number of entrained Pacific Lamprey. Additional diversions were surveyed based on dewatering schedule and available time.

An AbP-2 Backpack Electrofisher (ETS Electrofishing Systems Inc., Madison, WI), specially designed for the sampling of larval lampreys, was used to survey available (wetted) larval habitat, using standard survey methods (slow tickle pulse of 3 pulses/sec and fast stunning pulse

of 30 pulses/sec, 25% duty cycle, 3:1 burst pulse train, and 125 volts). When water temperature was below 10°C, the voltage was increased to a maximum of 200 volts. Another person with a net was also present to help capture any electrofished larvae. Type I / II larval lampreys habitat (preferred and acceptable, respectively) was surveyed at each diversion, with Type I habitat given priority (Type II was surveyed if Type I was limited). Specific survey locations in each diversion (including upstream or downstream of the fish screens) were determined based on the presence or absence of available Type I / II habitat.

Captured lampreys were tallied by life stage and identified to species (if of identifiable length > 50 mm). Missed larvae were also quantified to determine the total number of electrofished lampreys per surveyed site. Desiccated larval lampreys (either on wetted or dried habitat) and any other lamprey mortalities (such as those found in water pumps) were separated and quantified by site and location and, if of identifiable length and decomposition condition, were identified to species. Desiccated larvae were enumerated with electrofished lampreys to get the total number of lampreys observed by survey location (totaled for all survey dates).

RESULTS

A total of 12 irrigation diversions were surveyed in the Yakima Subbasin (6, 3, 2, and 1 in the Yakima River, Naches River, Ahtanum Creek, and Taneum Creek, respectively). In total, 15275 larval/juvenile lampreys were captured and returned to their respective stream (10731, 3252, 1221, and 71 from irrigation diversions in Ahtanum, Yakima, Naches, and Taneum watersheds, respectively) (Table 1). The ratio of missed lampreys was 45.9% and 36.7% upstream and downstream of the fish screens, respectfully. However, in some diversions the ratio of missed lampreys constituted a large portion (such as Bachelor-Hatton and Wapatox diversions with 81.1% and 65.8%, respectfully). Surveys upstream of the fish screens covered slightly more area than downstream (711 m² upstream and 703 m² downstream). Surveys upstream of the fish screens accounted for 83.3% of the total number of captured lampreys; however, this was heavily influenced by the high counts at Bachelor-Hatton Diversion. In facilities where we surveyed both upstream and downstream of the fish screens (n=7), the average ratio of lampreys observed upstream of the fish screens (compared to those observed downstream) was only 55.3%. Average density for all sites were 16.0 lamprey/m² (23.7 and 3.8 lamprey/m² upstream and downstream of the fish screens, respectfully) – again this average is influenced significantly by the Bachelor Hatton Diversion with a density of 199.3 lamprey/m² upstream of the fish screens. In facilities where we surveyed both upstream and downstream of the fish screens (n=7), densities of observed lampreys were on average 1.54 times higher upstream of the fish screens compared to downstream of the fish screens. A total of 2596 dead or nearly dead lampreys (3.8% of total lampreys observed) were found on dewatered banks or on top of partially wetted fine sediment (4.0% and 1.3% upstream and downstream of the fish screens, respectfully). Total number of

observed lampreys was 67749 from all 12 diversions surveyed; however, Bachelor-Hatton accounted for 86.2% of these lampreys. Because surveys were repeated in some diversion sites (such as Sunnyside, Wapato, Bachelor-Hatton, and Wapatox diversions), some of the missed lampreys may have been observed more than once, potentially inflating the total number of observed lampreys higher than the actual number of lampreys present, particularly at Bachelor-Hatton Diversion. For more information on the estimated number of lampreys in these repeatedly surveyed diversion sites, see Appendix Report G2 (2015 Intensive Monitoring of Larval-Juvenile Lamprey Entrainment in the Yakima River Subbasin).

Table 1. Overview of 2015-2016 dewatered irrigation diversion surveys in the Yakima Subbasin. “L” stands for lamprey in the table header.

Watershed	Stream	Diversion Name	River km	Survey Location	# of Survey Days	Survey Area (m ²)	Shock Time (min)	# of L. Captured (E-Fish)	# of L. Missed (E-Fish)	# of L. Observed (E-Fish)	Survey Density (#/m ²)	# of L. Dead	# of L. Observed (Total)
Lower Yakima	Yakima	Chandler	73.4	Upstream	1	24	21	0	0	0	-	0	0
Lower Yakima	Yakima	Chandler	73.4	Downstream	-	-	-	-	-	-	-	-	-
Lower Yakima	Yakima	Sunnyside	171.4	Upstream	1	11	8	40	7	47	4.3	0	47
Lower Yakima	Yakima	Sunnyside	171.4	Downstream	5	472	403	1954	470	2424	5.1	49	2473
Lower Yakima	Yakima	Wapato	176.3	Upstream	3	181	159	992	524	1516	8.4	378	1894
Lower Yakima	Yakima	Wapato	176.3	Downstream	1	50	40	194	110	304	6.1	0	304
Lower Yakima	Yakima	Union Gap	188.7	Upstream	1	24	38	18	10	28	1.2	0	28
Lower Yakima	Yakima	Union Gap	188.7	Downstream	-	-	-	-	-	-	-	-	-
Upper Yakima	Yakima	Roza	210.6	Upstream	1	12	8	5	3	8	0.7	0	8
Upper Yakima	Yakima	Roza	210.6	Downstream	1	50	38	40	14	54	1.1	0	54
Upper Yakima	Yakima	Town	264.7	Upstream	1	23	19	9	12	21	0.9	0	21
Upper Yakima	Yakima	Town	264.7	Downstream	-	-	-	-	-	-	-	-	-
Lower Yakima	Ahtanum	Diversion 14	24.8	Upstream	1	15	15	33	4	37	2.5	0	37
Lower Yakima	Ahtanum	Diversion 14	24.8	Downstream	1	5	5	0	1	1	0.2	0	1
Lower Yakima	Ahtanum	Bachelor-Hatton	31.8	Upstream	8	281	283	10343	44859	55202	196.4	1510	57132
Lower Yakima	Ahtanum	Bachelor-Hatton	31.8	Downstream	4	106	98	355	1091	1446	13.6	8	1454
Upper Yakima	Taneum	Taneum	3.7	Upstream	1	19	26	71	15	86	4.5	0	86
Upper Yakima	Taneum	Taneum	3.7	Downstream	-	-	-	-	-	-	-	-	-
Naches	Naches	Congdon	14.1	Upstream	1	4	8	2	2	4	1.1	0	4
Naches	Naches	Congdon	14.1	Downstream	1	10	8	1	0	1	0.1	0	1
Naches	Naches	Wapatox	29.0	Upstream	2	87	101	1212	2335	3547	40.8	651	4198
Naches	Naches	Wapatox	29.0	Downstream	-	-	-	-	-	-	-	-	-
Naches	Naches	Naches-Selah	30.6	Upstream	1	30	16	0	1	1	0.03	0	1
Naches	Naches	Naches-Selah	30.6	Downstream	1	10	12	6	0	6	0.6	0	6
Total	-	-	-	Upstream	22	711	702	12725	47772	60497	23.7	2539	63456
				Downstream	14	703	605	2550	1686	4236	3.8	57	4293
				Total	36	1414	1307	15275	49458	64733	16.0	2596	67749

Pacific Lamprey were present at 7 of the 12 surveyed diversions and on average (by facility) constituted approximately 47% of lampreys identified (Table 2). The ratio of Pacific Lamprey (vs. Western Brook Lamprey) was high at Bachelor-Hatton Diversion (97.7%) in Ahtanum Creek (river km 31.8), and Naches-Selah (66.7%) and Wapatox (51.2%) diversions in the Naches River (river km 30.6 and 29.0, respectfully). In the Yakima River, the ratio of Pacific Lamprey ranged from 5.9% (Union Gap Diversion, river km 188.7) to 15.7% (Wapato Diversion, river km 176.3); the ratio at Sunnyside Diversion (river km 171.4) was similar at 14.2%.

Table 2. Overview of species composition from the 2015-2016 dewatered irrigation diversion surveys in the Yakima Subbasin. “L” stands for lamprey in the table header.

Watershed	Stream	Diversion Name	River km	Survey Location	# of Survey Days	# WB L.	# PA L.	% PA L.
Lower Yakima	Yakima	Chandler	73.4	Upstream	1	-	-	-
Lower Yakima	Yakima	Chandler	73.4	Downstream	-	-	-	-
Lower Yakima	Yakima	Sunnyside	171.4	Upstream	1	-	-	-
Lower Yakima	Yakima	Sunnyside	171.4	Downstream	5	399	66	14.2%
Lower Yakima	Yakima	Wapato	176.3	Upstream	3	269	50	15.7%
Lower Yakima	Yakima	Wapato	176.3	Downstream	1	-	-	-
Lower Yakima	Yakima	Union Gap	0	Upstream	1	16	1	5.9%
Lower Yakima	Yakima	Union Gap	188.7	Downstream	-	-	-	-
Upper Yakima	Yakima	Roza	210.6	Upstream	1	4	0	0.0%
Upper Yakima	Yakima	Roza	210.6	Downstream	1	36	0	0.0%
Upper Yakima	Yakima	Town	264.7	Upstream	1	7	0	0.0%
Upper Yakima	Yakima	Town	264.7	Downstream	-	-	-	-
Lower Yakima	Ahtanum	Diversion 14	24.8	Upstream	1	26	0	0.0%
Lower Yakima	Ahtanum	Diversion 14	24.8	Downstream	1	-	-	-
Lower Yakima	Ahtanum	Bachelor-Hatton	31.8	Upstream	8	5	402	98.8%
Lower Yakima	Ahtanum	Bachelor-Hatton	31.8	Downstream	4	8	149	94.9%
Upper Yakima	Taneum	Taneum	3.7	Upstream	1	2	0	0.0%
Upper Yakima	Taneum	Taneum	3.7	Downstream	-	-	-	-
Naches	Naches	Congdon	14.1	Upstream	1	1	0	0.0%
Naches	Naches	Congdon	14.1	Downstream	1	0	1	100.0%
Naches	Naches	Wapatox	29.0	Upstream	2	137	144	51.2%
Naches	Naches	Wapatox	29.0	Downstream	-	-	-	-
Naches	Naches	Naches-Selah	30.6	Upstream	1	-	-	-
Naches	Naches	Naches-Selah	30.6	Downstream	1	2	4	66.7%
Total	-	-	-	Upstream	22	467	597	56.1%
				Downstream	14	445	220	33.1%
				Total	36	912	817	47.3%

DISCUSSION

As in previous years of monitoring, both observed and salvaged lampreys from Sunnyside and Wapato diversions in the Wapato Reach of the Yakima River were high during this monitoring season in 2015-2016. One major change we observed this year was the presence and abundance of lampreys in some of the other smaller diversions; namely, Bachelor-Hatton Diversion (Ahtanum Creek) and Wapatox Diversion (Naches River). Total number of observed lampreys was over 50,000 and 4,000 at Bachelor-Hatton and Wapatox diversions, respectfully, many of which were Pacific Lamprey. In previous survey years, we were not able to survey the Bachelor-Hatton Diversion immediately after dewatering in early July and it is possible that we have continuously missed the best timing for lamprey salvage at this diversion. However, it is more likely that lamprey entrainment increased significantly in 2015 based on the fact that lampreys were observed at this diversion continuously and long after the initial dewatering period in 2015 (which was not observed in previous years). At Wapatox Diversion, the area immediately

downstream of the headgate was never surveyed until 2015 due to uncondusive water level conditions at this area. However, in 2015, we were able to maintain the water levels conducive to electrofishing through the help of Bureau of Reclamation and this allowed us to observe a much higher number of lampreys, including Pacific Lamprey, at this site compared to past years.

Pacific Lamprey were present at 7 of the 12 surveyed diversions and on average (by facility) constituted approximately 47% of lamprey identified. In four of these diversions (Union Gap, Wapatox, Naches-Selah, and Bachelor Hatton diversions), Pacific Lamprey was found and identified for the first time since diversion monitoring began in 2011-2012. The ratio of Pacific Lamprey (vs. Western Brook Lamprey) was high at Bachelor-Hatton Diversion (97.7%) in Ahtanum Creek (river km 31.8), and Naches-Selah (66.7%) and Wapatox (51.2%) diversions in the Naches River (river km 30.6 and 29.0, respectfully). In the Yakima River, the ratio of Pacific Lamprey ranged from 5.9% (Union Gap Diversion, river km 188.7) to 15.7% (Wapato Diversion, river km 176.3); the ratio at Sunnyside Diversion (river km 171.4) was similar at 14.2%. The ratio of Pacific Lamprey has been increasing steadily since 2011 at Sunnyside and Wapato diversions from approximately 0% in 2012-2014, 7.0% in 2014-2015, and 15% in 2015-2016. This indicates that Pacific Lamprey began to appear in large numbers approximately 2.5 years after translocation began in Ahtanum Creek in 2013. Two Pacific Lamprey macrophthalmia (eyed Pacific Lamprey) were found at Sunnyside Diversion on November 17, 2015, and December 14, 2015. This is the first time that macrophthalmia have been found within the Yakima Subbasin during irrigation diversion surveys since monitoring began in 2011.

APPENDIX

DIVERSION MAPS AND SURVEY LOCATIONS

Mainstem Irrigation Diversions

Chandler Diversion; Lower Yakima River (River km: 73.4)



Map 1. An overview map of Chandler Diversion showing key locations (white arrows) and primary survey location (blue arrow).

Sunnyside Diversion; Lower Yakima River (River km: 171.4)



Map 2. An overview map of Sunnyside Diversion showing key locations (white arrows) and primary survey locations (blue arrows).

Wapato Diversion; Lower Yakima River (River km: 176.3)



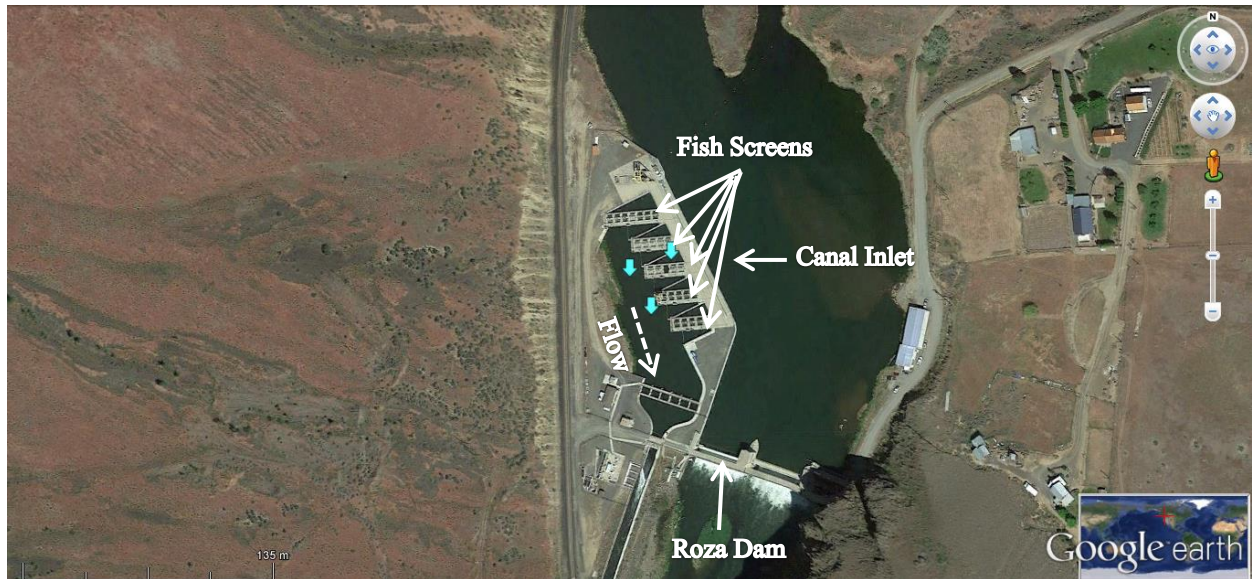
Map 3. An overview map of Wapato Diversion showing key locations (white arrows) and primary survey locations (blue arrows).

Union Gap Diversion; Lower Yakima River (River km: 188.7)



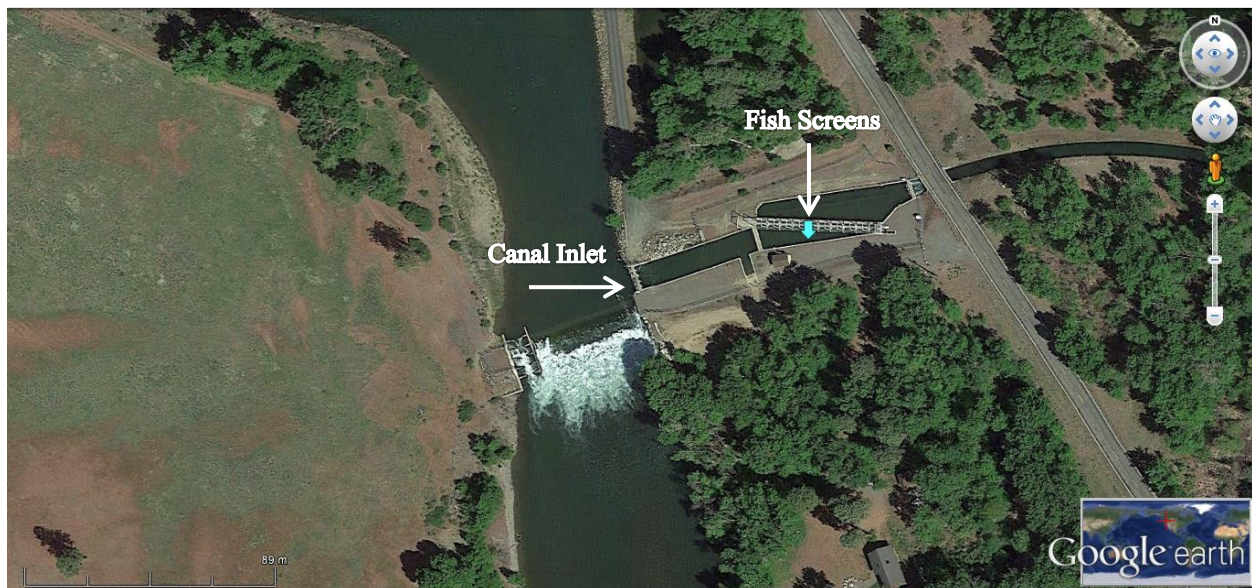
Map 4. An overview map of Union Gap Diversion showing key locations (white arrows) and primary survey locations (blue arrows).

Roza Diversion; Upper Yakima River (River km: 210.6)



Map 5. An overview map of Roza Diversion showing key locations (white arrows) and primary survey locations (blue arrows).

Town Diversion; Upper Yakima River (River km: 264.7)



Map 6. An overview map of Town Diversion showing key locations (white arrows) and primary survey location (blue arrow).

Ahtanum Creek (Lower Yakima Watershed)

Diversion 14; Ahtanum Creek (river km 24.8)



Map 7. An overview map of Diversion 14 showing key locations (white arrows) and primary survey locations (blue arrows).

Bachelor-Hatton Diversion; Ahtanum Creek (river km 31.8)



Map 8. An overview map of Bachelor-Hatton Diversion showing key locations (white arrows) and primary survey locations (blue arrows).Taneum Creek Diversions (Upper Yakima Watershed)

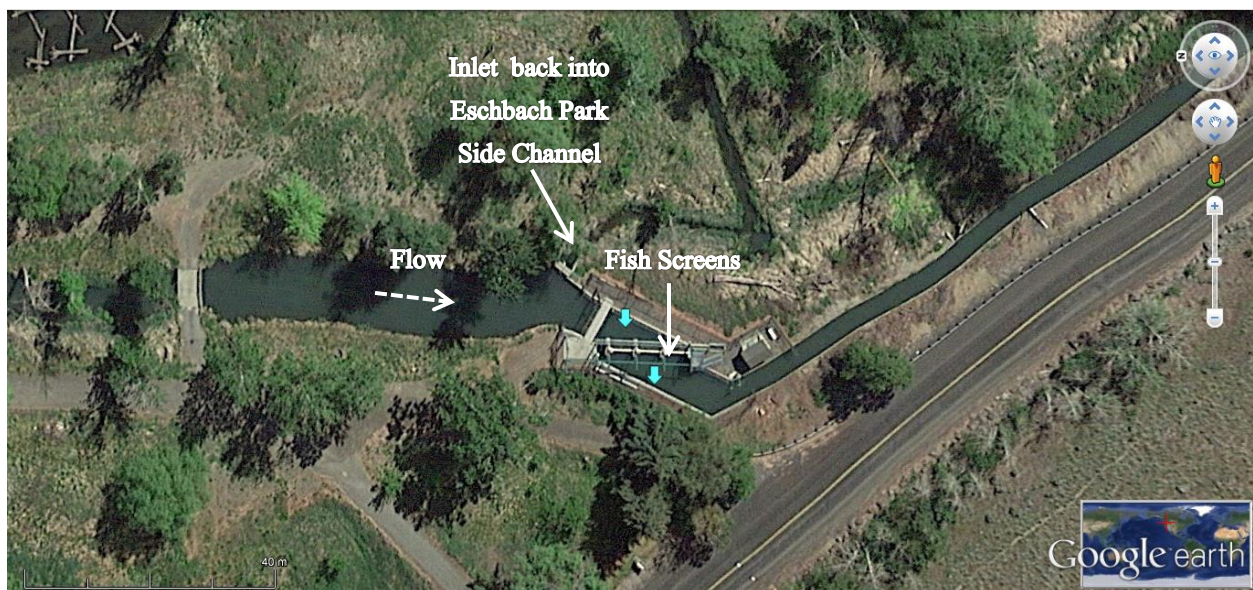
Taneum Diversion; Taneum Creek (river km 3.7)



Map 9. An overview map of Taneum Diversion showing key locations (white arrows) and primary survey location (blue arrow).

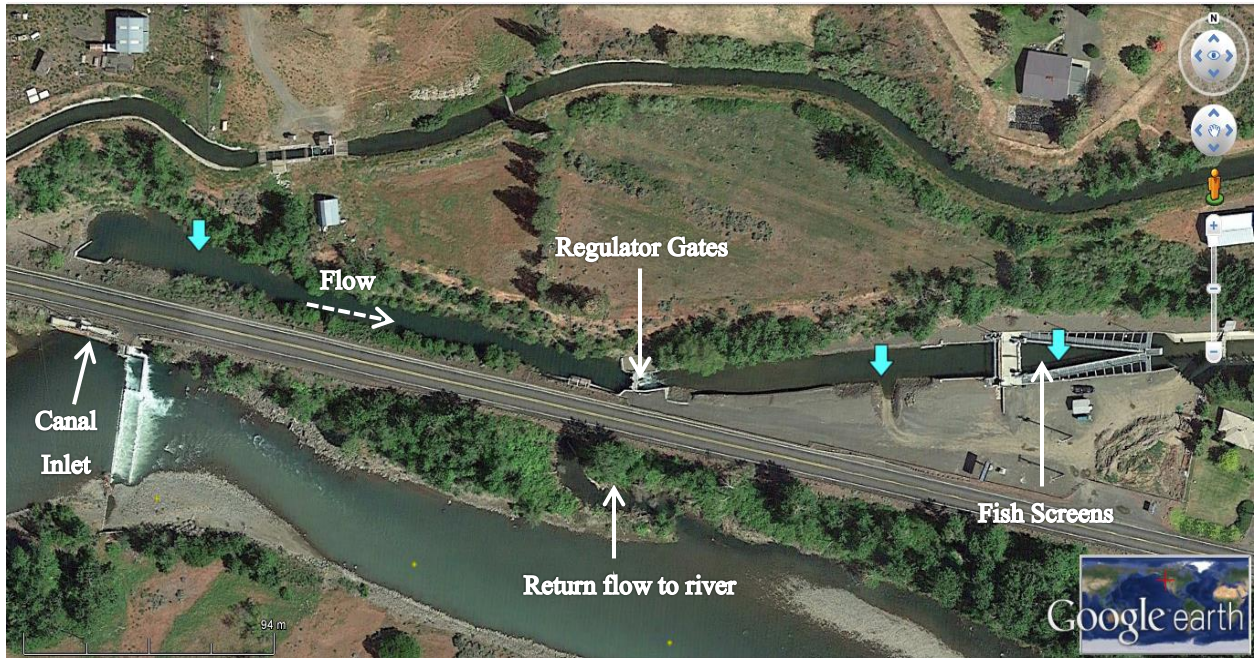
Naches River Irrigation Diversions (Upper Yakima Watershed)

Congdon Diversion; Naches River (River km 14.0)



Map 10. An overview map of Congdon Diversion showing key locations (white arrows) and primary survey locations (blue arrows).

Wapatox Diversion; Naches River (River km: 28.9)



Map 11. An overview map of Wapatox Diversion showing key locations (white arrows) and primary survey locations (blue arrows).

Naches-Selah Diversion; Naches River (river km 30.6)



Map 12. An overview map of Naches-Selah Diversion showing key locations (white arrows) and primary survey locations (blue arrows).