July 1, 2019

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Columbia River Inter-Tribal Fish Commission
700 NE Multnomah St., Suite 1200
Portland, OR 97232

RE: In-season Report for the end of the Skamania Steelhead Management Period (June 30, 2019)

Dear Jon Hess, Jeff Fryer and John Whiteaker,

The Whooshh/CRITFC scanning project is well underway and yielding positive, informative results. This report is the first installation in fulfillment of **Task 3: Reporting.** The overall objective as expressed in the Statement of Work (SOW) was to "Install and utilize the scanning system to collect high quality images enabling fish species identification and to measure biological characteristics of individual fish including fork length, adipose fin status (clipped or unclipped), dorsal fin condition (eroded fin or intact), and other quantifiable traits. The results of the analysis of the images collected from the scanner may be used to supplement data that is required by the U.S. v OR Technical Advisory Committee (TAC) to manage the mainstem fisheries of steelhead and salmon."

Task 1 : Installation of scanning system in the Bonneville Dam AFF

Task 1, installation of the Whooshh FishL™ Recognition system, at the end of one of the two bypass flumes at the Adult Fish Facility (AFF) at Bonneville dam, prior AFF water-up was achieved. Prior to water-up there was no way to evaluate the water flow and fish velocity moving through the scanning system. They system had been optimized with a small flow passing over the scanning bed at ~2 meters/second. As the first fish moved down the flume and through the FishL™ Recognition system installation, it was clear via visual inspection of the scanned images that 1) the volume of water passing through was considerably more than the system was optimized with, 2) the resolution of the images required optimization and 3) the system sensors recorded fish slide speeds through the system at 2.5-5 meters/second with the average around 4 meters/second. The system was recalibrated prior to the second week of sampling. The exposure time was reduced which yielded better resolution images, however, they were uniformly darker requiring post-imaging manual adjustments to "lighten-up" the images for manual image evaluation.

The FishL™ Recognition system utilizes six synchronized, high speed, high resolution, machine vision cameras, positioned at three set angles, to capture 18 total images of each individual fish as it slides through the scanning bed over a distance of ~1.5 meters. The exposure times and shutter speeds are such that three images are taken per camera in well under the ~0.25 seconds it take the average fish to slide, unencumbered, through the system. As a fish enters the scanner a sensor logs the count and assigns a consecutive file name designation. If a second fish enters the scanner before the sensors detect the exit of the first fish, the second fish may not be recorded in the count. A database has been developed to transfer and assimilate all of the scanner recorded information. Data entry is a large, on-going process, which will require double-check cleaning and screening once all the data has been entered after the AFF waters-down for the winter.

Task 2: Remotely monitor the automated scanning system to collect fish counts and images for subsequent fish species identification and biological characteristics of individual fish

1) General characterization of species passing through the system:

   a. Abundance of fish: Given the caveats that a) in recalibrating the system there were some scan images taken that did not contain fish, b) there were some scan images that contain images of two fish, and c) no attempts have been made to date to reconcile theses counts inconsistencies, the scan file count of 5112 by June 30, 2019 is an accurate number of scan files created and a close approximation, but likely not the exact number, of fish that have passed through the Whooshh FishL™ Recognition system bypass path at the Bonneville AFF from water-up in April through June 30, 2019.

   b. Species of fish: Multiple species have been identified via their distinctive traits visualized in the set of 18 images recorded per fish/scan. 5112 x 18 = 92,016 images.

Chinook	Peamouth Chub
Steelhead	Lamprey
Sockeye	Small Mouth Bass
Coho**	American Shad
Juvenile Salmonids	Large Scale Sucker

   **CRITFC has agreed to view a selection of images to provide their expertise on distinguishing between several species of salmonids – in particular Coho and Chinook.

   c. Scan index data: Each scan is a set of 18 images. The set is assigned a consecutive file name/number. The date and time the scan was performed are logged. Thus the date and time that an individual fish passed through the FishL™ Recognition system bypass in the Bonneville AFF is associated with the image file that was subsequently manually view and speciation assigned.

2) Biological characteristics of each steelhead identified:
   a. What is the total fork length?
   b. What is the adipose fin status of each individual steelhead (clipped or unclipped)?
   c. What is the dorsal fin condition of the individual steelhead (eroded or "stubby" dorsal fin versus intact dorsal fin)?
   d. What other individual traits can be quantified from the image data?

a). The FishL™ Recognition system uses the multiple images from the three different camera angles, together with a proprietary algorithm, to rapidly calculate the fork length of an individual fish to 1/10 mm. Provided a single fish is captured in the images, fork length data is automatically calculated and was later uploaded and associated with the scan index and manual classification data in the database. For the period of April through June 30, 2019 the results of the identified Steelhead are captured here in Table 1.

As the fish passed through the system of their own volition, assisted only by the water flow in the flume and gravity, the fish passed through the scanner in a fraction of a second and exhibited

a wide host of positions and orientations, at times, quite clearly visualized and at others specific identifying features were obstructed either by fish position or the water passing through the scanner bed along with the fish. To convey the wealth of the information collected and the challenges of identification, for this first report, a composite image of every Steelhead identified has been constructed with an inset of the set of 18 images at the top and 1-2 enlarged images of the specific steelhead, showcasing features that facilitated in the steelhead species determination which included some of the following:

Anal fin $\leq$ 12 rays	Distinctive, radiating, uniform spots on tail
White mouth and jaw	Spots on dorsal fin
Torpedo-like shaped body	Uniform spot size across body (often very small)
Red gill plate	Spots both above and below lateral line
Red stripe down lateral line	Flat, straight tail edge
Wide, thick caudal	

b). The adipose presence or absence (clipped) has been recorded in Table 1 for each steelhead. Experience in adipose identification via scanned images and utilization of near-infrared images to confirm adipose presence was employed.

c). As the fish assumed a wide host of positions and orientations as they traveled down the scanner bed and interacted with the water streaming down as well, the dorsal fin was not always in view or extended. A partially extended dorsal fin can roll up on itself out of the water and thus a conservative approach to defining "stubby dorsal" was adopted. Notes as to a potential altered state of the dorsal fin are recorded in Table 1. If there is no entry, it is assumed the dorsal fin is likely full and healthy. A question mark (?) indicates that the dorsal fin viewing has not been idea. Observations of split dorsal fins are noted. One, W21, appears to be all but absent – this was given a "stubby" descriptor.

d). As indicated above the date and time a given steelhead passed through was captured and that information is also recorded in Table 1. There were a handful of cases in which substantial damage, possibly associated with pinniped injury occurred. Injury descriptions were noted in Table 1 and image angles that enabled injury viewing were selected as the enlarged images in the composite for that particular fish. One fish had a bright yellow marking near the anal fin which was noted.

Results: Thirty-eight steelhead were conclusively identified via various features. One additional fish was considered as a possible 39th steelhead. On reviewing and having a second set of eyes viewing, this one remains inconclusive. The W39 data have been provided at the end of the Table 1 as entry W39, inconclusive. It is a possible steelhead and an image composite was also made for W39. The radiating tail spots are quite distinctive for steelhead and typically radiate down the tail in rows following the rays spanning the full width of the tail, however, Chinook can exhibit a similar pattern although typically not across the full tail. Spots radiating down the tail rays was observed although not across the full width of the tail which could suggest either not a steelhead or an imaging resolution challenge. The jaw and mouth are white. Other species have similar white mouth and jaw, but Chinook, which can have the radiating tail spots, have a black mouth and jaw. The anal fin appears sail-shaped and likely under 12 rays which is

a steelhead identifier although the anal fin is not well resolved and present in many of the images. No red gill plate or stripe, however most did not exhibit this. No spots along the body were convincingly seen which means they are either difficult to see due to imaging exposure or not present. The dorsal fin is not well decorated in spots and the tail does generally appear to have a flat, straight edge. The body shape is somewhat as expected but not conclusively torpedo-like. Given the others salmonid possibilities the reduced presence of spots and white mouth and jaw rule out Chinook and the presence of any spots and the flat, straight shape of the tail rules out sockeye. Coho generally have a silvery tail with few spots focused on the upper portion of the tail not specifically radiating and generally has a wider body shape, so this is generally ruled out as well. The wide caudal area is indicative of a steelhead. We can't rule out steelhead but do appear to be able to rule out the other possibilities and thus W39 remains an inconclusive possible steelhead.

The above description is an example of how the various features were considered to enable a steelhead species identification decision or not for all 39 fish described.

There are two instances in the steelhead population in which 2 fish were imaged together, W34 and W38. The steelhead slid through along with a sockeye in both cases. A steelhead forklength is not available for these steelhead. Of the 36 remaining, two were larger than 780 mm (W2 was 788 mm and W7 was 781mm). The 34 steelhead smaller than 780 mm were mostly in the 600-700 mm range, although W26 was 774 mm. In terms of wild verse hatchery origin, determined by the presence or absence of the adipose fin, of the 38 steelhead, 37 presented views for adipose fin determination. W3 did not present a view of the adipose fin region. Twenty-one steelhead had an adipose fin (wild) and sixteen had clipped adipose fins (hatchery).

Conclusion: Between April and June 30, 2019 there were series of dates in which the Bonneville AFF was operational and fish that passed over the right-side false weir, and were not selected for sampling, slid through the right-side bypass and were imaged via the Whooshh FishL™ Recognition system before exiting into a calm channel connected to the fish ladder. Within this timeframe and under these conditions, 5112 scans were recorded and date and time of scan logged. Thirty-eight scans contained fish that were conclusively identified as steelhead. One additional possible steelhead is also described. The system is functioning well. Eight species have been definitely identified in the scans to date. The project is providing a wealth of images for algorithm development and additional data for fisheries management.

Composite images (example BV_1687_W1_Complete) of W1-W38 steelhead plus fish W39 will be posted in the Whooshh/CRITFC Dropbox with a link here:
https://www.dropbox.com/sh/lr6hmgj7f352jfn/AADpYTHjv34aKm0YE5P9cKQUa?dl=0

Table 1: Steelhead identified via the FishL™ Recognition system at Bonneville AFF between April and June 30, 2019. W# is steelhead number. Number is the scan number. Lightly shaded gray fork length boxes highlight >780 mm steelhead. W39 was a possible steelhead but inconclusive.

W#	Number	Adipose fin	ForkLength (mm)	Date	Time	Dorsal	Condition
1	1687	clipped	700.2	5/7/2019	12:05:31		descale 5-19%
2	1757	clipped	788.4	5/7/2019	12:34:12	?	scrape
3	2477	not visible	578.0	5/15/2019	12:12:02		
4	2648	clipped	522.1	5/22/2019	10:58:39		redband stripe
5	2796	clipped	717.5	5/30/2019	12:23:45	?	
6	3225	present	618.3	6/13/2019	11:58:08		descale >20%
7	3457	present	781.1	6/18/2019	11:41:47		
8	3473	clipped	629.6	6/18/2019	11:55:00	?	
9	3542	present	690.6	6/20/2019	9:59:50		
10	3571	present	583.2	6/20/2019	10:30:55		
11	3613	present	635.6	6/20/2019	11:18:19	?	
12	3619	present	560.5	6/20/2019	11:23:13		bright yellow marking near anal fin
13	3627	clipped	644.8	6/20/2019	11:29:44		
14	3783	present	631.8	6/21/2019	10:37:44		
15	4218	present	692.3	6/25/2019	9:32:30		
16	4283	clipped	674.7	6/25/2019	10:58:22	?	
17	4297	present	724.0	6/25/2019	11:06:06		
18	4401	present	727.2	6/25/2019	12:12:05	?	
19	4440	present	699.1	6/25/2019	12:47:24	split fin	
20	4515	present	642.0	6/26/2019	10:42:33	?	
21	4542	clipped	618.8	6/26/2019	11:06:20	stubby	
22	4625	clipped	601.0	6/26/2019	12:21:38		tail split
23	4628	present	616.8	6/26/2019	12:24:17		tail split
24	4697	clipped	719.1	6/27/2019	11:46:19	split fin	descale >20%
25	4755	present	676.5	6/27/2019	12:33:27	split fin	
26	4771	present	774.0	6/27/2019	12:51:57		
27	4798	clipped	638.9	6/27/2019	1:32:01	?	
28	4861	clipped	659.6	6/28/2019	9:02:11	?	
29	4882	clipped	651.1	6/28/2019	9:31:22		
30	4980	clipped	623.8	6/28/2019	10:39:35	?	
31	4984	present	614.0	6/28/2019	10:42:06	?	
32	4993	clipped	647.3	6/28/2019	10:47:17	?	curved scratch
33	4995	present	645.7	6/28/2019	10:48:13		
34	5002	present	2 fish - no FL	6/28/2019	10:56:12		open wound, steelhead + sockeye in the same scan view
35	5011	present	696.0	6/28/2019	11:01:34		open wound
36	5039	present	646.7	6/28/2019	11:15:55	split fin	open wound, split tail
37	5111	clipped	651.1	6/28/2019	11:57:13	?	
38	4513	present	2 fish - no FL	6/26/2019	10:39:53		Steelhead and sockeye in the same scan view - together plus water limited feature viewing
Inconclusive							
39	4519	present	618.1	6/26/2019	10:47:35	no or few spots	spot related features inconsistent but may be an imaging issue, white mouth and jaw, and anal fin suggestive of steelhead

Inquires as to the data or report please feel free to contact me.

Best regards,

Janine Bryan

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