Memorandum

To: *U.S. v. Oregon* Technical Advisory Committee

From: Jon Hess and Stuart Ellis, CRITFC

Date: May 06, 2019

Subject: Proposal for Research Project to Assess Temperature Effects on Steelhead Sampled at the Bonneville Dam AFF During Temperature Restricted Periods

**Proposal Overview**:

•NMFS imposes trapping restrictions at the AFF when temperatures increase above 72℉, and these restrictions hinder the ability to collect data during a critical steelhead passage time.

•NMFS’s justification for these restrictions is that handling will cause additional mortality.

•CRITFC has designed a study to test this assumption which is outlined in this proposal, has been reviewed by TAC, and requires guidance from the *U.S. v. Oregon* Policy Committee. Implementation of the proposal would require relaxing of the current standards in place that are imposed by NMFS for the current year of research activities at the AFF.

**•**CRITFC conducts research and monitoring activities at the AFF to support fishery management decisions by the *U.S. v. Oregon* parties.

•Under the Biological Opinion for the *U.S. v. Oregon* Management Agreement, there are from 0.1% to 0.3% impacts permitted on natural-origin A-Index and natural-origin B-Index steelhead for research and monitoring. The ongoing research and monitoring activities include the normal AFF sampling, sturgeon stock assessment work, and spring season mainstem test fishing.

•This proposal would utilize a portion of the allowed impacts to operate the AFF during periods of high water temperatures that under normal operating guidelines would cause sampling activities at the AFF to shut down.

**Introduction**:

*U.S. v OR* Technical Advisory Committee (TAC) uses data collected at the AFF to estimate the stock and age composition of steelhead during two management periods as defined in the *U.S. v. Oregon* Management Agreement: the Skamania management period from April 1 to June 30 and the A/B-Index summer management period from July 1 to October 31. TAC uses AFF data for A-/B-Index steelhead to directly manage fisheries affecting these groups. Run-reconstruction, run-forecasting, and in-season analysis of the steelhead return is conducted by TAC. These analyses primarily rely on stock (based on length), adipose-fin clip status, and the dorsal fin condition of fish sampled at the AFF.

The TAC has summarized the types of data that are used, how these data are used, and the limitations of data obtained from the AFF as related to the work TAC conducts. TAC has identified potential data issues related to the AFF and categorized them into those that have been a source of bias, or that are potentially contributing bias to the data that TAC utilizes, and those which are not. This information is summarized in a report “TAC Bonneville Dam Adult Fish Facility Sample Bias Report” (dated 4/02/2018) which examined the data collected from the AFF on four salmonid runs: spring Chinook salmon, summer Chinook salmon, sockeye salmon, and summer steelhead. Questions have been raised about how well sampled fish represent the runs at large because the trap is connected to only one of the fish ladders, fish must voluntarily choose to be sampled, the trap does not operate all days and times during the week, and sample rates are low. TAC described resolutions to some of the issues with steelhead sampling at the AFF with the following recommendations:

“Increase the biological sampling and the representativeness of the sampling of steelhead, particularly from mid-August through October. Low levels of precision and accuracy of the wild/hatchery composition and abundance of A-Index and B-Index steelhead can only be resolved by increased sample sizes and modifications to the trapping facility that allow fish to be randomly sampled. To help achieve this, density and temperature-based sampling restrictions at the AFF should be re-evaluated. Although steelhead are the highest priority, larger sample sizes that are randomly obtained would improve the precision and accuracy for all stocks and runs.”

Generally, there has been some form of trapping restrictions occurring when river temperatures (as measured at the Bonneville Dam forebay, http://pweb.crohms.org/tmt/documents/ops/temp/ ) rise above 70.0° F which last until the daily average is ≤ 69.9° F (**Table 2**). Current guidelines include a complete shutdown of sampling that is triggered at ≥72.0° F, and sampling resumes when the daily average is ≤ 71.9° F. The AFF trapping restrictions on steelhead have been due to both temperature restrictions and density restrictions. From 2011 to 2018 (total sample days = 703), there were a total of 223 days (32% of all sample days) in which sampling during the A-/B-Index summer steelhead management period was restricted due to temperature or both temperature and density restrictions. There were 103 days (15% of sample days) in which sampling was completely shut down. In total, 351 days (50% of sample days) of some form of sampling restriction affected data collection of A-/B-Index summer steelhead from 2011 to 2018. Most of the weeks that had a 0% sample rate due to temperature shutdowns occurred at the peak of the run when a large abundance of steelhead was counted at Bonneville Dam. It is typical that the peak counts of steelhead occur when the river temperatures are high and sampling at the AFF has been restricted or shutdown. In a 13-year period (2006-2018), these 0% sample rates have resulted in up to 22.9% of the total clipped passage and up to 27.0% of the total unclipped passage to be unsampled in a given year. These maximum unsampled percentages of clipped and unclipped passage occurred in 2018. In 2018, 25% of the total A-/B-Index steelhead passage occurred during shutdown periods.

Under the Biological Opinion for the *U.S. v. Oregon* Management Agreement, there are from 0.1% to 0.3% impacts permitted on natural-origin A-Index and natural-origin B-Index steelhead for research and monitoring (**Table 1**). Despite the fact that the research and monitoring activities have not exceeded these impacts to date, there is an assumption that handling at the AFF may increase mortality and possibly exceed these impacts when water temperatures are high. Therefore, data that is critical for management may be hindered by an untested assumption related to handling mortality.

**Table 1. 2019 TAC Pre-Season Unclipped Steelhead Forecasts and Total Research Impacts**

|  |  |  |
| --- | --- | --- |
|  |  | Impact Limit |
| Stock | **Forecast Run Size to Bonneville** | 0.30% |
| **A Index** |  |  |
| *Total Unclipped* | 38,400 | 115 |
| *Unclip Hatchery* | 4,500 | 14 |
| Wild | 33,900 | 102 |
| **B Index** |  |  |
| *Total Unclipped* | 2,050 | 6 |
| *Unclip Hatchery* | 1,100 | 3 |
| *Wild* | 950 | 3 |
| **Total A/B Index** |  |  |
| *Total Unclipped* | 40,400 | 121 |
| *Unclip Hatchery* | 5,600 | 17 |
| *Wild* | 34,800 | 104 |

**Objective**:

Test the assumption that temperature-based sampling restrictions that have been imposed on the AFF prevent increased mortality due to handling when water temperatures are high. Specifically, we will examine any differences in survival between steelhead handled at the Bonneville Dam Adult Fish Facility (AFF) at temperatures warmer than 72℉ compared to steelhead passing Bonneville Dam in the same time periods that are not handled. We anticipate that any differences in survival would be attributable to handling in the AFF. There is evidence that survival generally decreases as temperature increases. This study is designed to test if there is any additional reduction in survival associated with handling fish at higher temperatures. Because the AFF is a relatively unique sampling facility, we would not anticipate that any results from this study would necessarily apply to other sampling of fish at higher temperatures in other places.

**Materials and Methods:**

Our study design for this proposal is the same one that was outlined in the AFF sample bias report. We would use a dataset of two PIT-tag groups: (control group) adult A-/B-Index summer steelhead that were PIT-tagged as juveniles and (test group) adults handled and PIT-tagged at the AFF. We would track PIT-tag detections of these fish during the typical ≥72° F temperature-shutdown-period of the A-/B-Index summer steelhead as they migrated upstream. We would only use steelhead from the Snake River in this analysis because limiting the analysis to one stock would remove some uncertainty from stock-specific behavioral differences. For adults that are tagged at the AFF we would determine Snake River origin using Parentage-based tagging (PBT) and Genetic Stock Identification (GSI) data. Unclipped steelhead that assign to a hatchery stock with PBT would be assigned as hatchery origin. Unclipped steelhead that do not assign to a hatchery stock using PBT and have no evidence of an eroded dorsal fin and no other fin clips will be assigned as wild origin. We would determine Snake River origin of the adults tagged as juveniles from their release location. A proxy for survivorship would be estimated using the proportion of PIT-tags that were detected at both Bonneville Dam and The Dalles Dam or further upstream.

Travel time of the previously PIT-tagged steelhead would be measured in days using the time of first detection at Bonneville Dam and the first detection at The Dalles Dam. Travel time of the AFF PIT-tagged steelhead would be measured in days using the time of their release from the AFF and the first detection at The Dalles Dam. We cannot calculate harvest rates, so we would use the same time strata in both PIT-tag treatment groups to compare our survival estimates.

Harvest rates vary across the run of steelhead and are affected by guidelines in the 2018-2027 *US vs. Oregon* Management Agreement (MA) to which the treaty and non-treaty fisheries adhere. We assume that fish passing Bonneville Dam in the same time strata will experience equal harvest rates.

Temperature, travel time, and harvest rates all vary through time. We can minimize this potential bias by utilizing strata that have sufficient sample sizes (N>40) in both PIT-tag treatment groups. Strata will be independently defined for the A-Index and B-Index groups. A general linearized model (GLM) executed in the statistical software R will be used to examine the response of survivorship to the variables of tagging treatment, temperature, travel time, week, day, and two-way interactions of these variables. All model iterations of the various combinations of these variables (i.e. including and excluding variable terms, and consideration of all combinations of two-way interaction terms) will be evaluated. A set of model iterations of combinations of variables will also be considered while not allowing “tagging treatment” to be dropped from the model. “Tagging treatment” will always be included in the best fit model regardless of whether we allow the iterations of the model to drop this variable or not. The model with the best fit according to AIC will be chosen to describe survivorship as a function. See Figure 1 (below) for an example of the relationship we found previously for temperature ranges that fall below 72° F.

**ESA Impact Proposal:**

In the Biological Assessment for the *U.S. v. Oregon* Management Agreement, TAC estimated that AFF monitoring from 2006 to 2017 used < 0.001% of the allowable impacts on natural-origin A-Index or B-Index steelhead. Two other research activities related to test fishing and sturgeon monitoring had 0% impacts on these steelhead groups but there were higher impacts for the pound net research conducted in 2017. CRITFC estimates that most of the available impacts could be used with additional research in 2019. We estimate that the standard research and monitoring activities will have no measurable impact on natural-origin A-Index or B-Index steelhead. However, we propose allocating a small portion for these activities in the unlikely event a steelhead is killed.

This proposed 2019 sampling project at the Bonneville Dam Adult Fish Facility (AFF) will utilize up to 5 unclipped B-Index steelhead impacts (2 natural origin) and 110 unclipped A-Index steelhead (95 natural origin) impacts of the available impacts allowed for research activities. The impacts will be used during the period(s) of a complete shutdown of the sampling facility when river temperatures reach 72° F during the A-/B-Index management period from July 1 to October 31. We propose that every unclipped B-Index and A-Index steelhead handled at the AFF during the ≥72° F period will be treated as mortalities, and the AFF will be allowed to conduct their normal sampling operations free of any ACOE sampling restrictions until the impact limit is attained. All salmonids other than steelhead that enter the AFF during this period will be passed without handling. All steelhead will be handled using established standard protocols which include PIT-tagging each individual. Any PIT-tagged unclipped A-Index or B-Index individual that is later detected at a PIT-tag array or mainstem dam upstream of Bonneville Dam will be considered as surviving its AFF handling and the assumed impact incurred will be removed from the appropriate group.

A key to our proposal is the in-season recovery of used impacts on handled natural-origin steelhead. Since we will be placing PIT-tags in all of these fish, any natural-origin A-Index or B-Index fish that is detected at The Dalles Dam or upstream of The Dalles Dam would be assumed to survive handling at the AFF and their assessed impact removed. Any fish that is unclipped and determined by PBT analysis to be hatchery-origin will be re-classified as hatchery origin. We will use the total handle of unclipped fish to determine our preliminary estimated impacts on A- and B-Index steelhead, however we will refine these estimated impacts using in-season run updates, upstream detections of PIT-tagged adults handled at the AFF, and genetic results. This will allow us to continue operations of the AFF until our impact limits are attained.

This proposed use of research impacts for the AFF would provide immediate relief from the steelhead sampling restrictions that were referred to in the recent TAC report (TAC Bonneville Dam Adult Fish Facility Sample Bias Report, April 02, 2018) as one of the issues affecting the quality of data for fisheries management of steelhead. This use of research impacts at the AFF would allow an evaluation of handle mortality at temperatures ≥72° F. In addition to this request for removal of sampling restrictions on steelhead during the ≥72° F period, we would also request a waiver of all sampling restrictions for a minimum of half the sampling days each week. This would allow an evaluation of handling mortality rates under all scenarios that typically trigger some form of restrictions (e.g. ≥70° F restrictions that limit hours and fish density restrictions that can limit hours and numbers of picket leads). Comparisons of fish that were handled at the AFF and unhandled fish that were PIT-tagged as juveniles would be made to assess the relative survivorship of these AFF-handled versus AFF-unhandled steelhead. Any conclusions made from this research on handle mortality would apply exclusively to the handle at the Bonneville Dam AFF on steelhead.

**Table 2. Days in which river temperatures at Bonneville Dam would trigger sampling restrictions at the AFF if 2016 guidelines were applied and average weekly proportions of runs passing Bonneville Dam.**

|  | Number of days in which temperature restrictions are in effect | | | | | | | | | | |  |  |  | Chinook | | | Steelhead |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1st Day | Statweek | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Spring | Summer | Fall | Summer | Sockeye |
| 5-Jun | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9% | 2% | - | 0% | 7% |
| 12-Jun | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2% | 22% | - | 1% | 23% |
| 19-Jun | 26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | 24% | - | 1% | 33% |
| 26-Jun | 27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | - | 19% | - | 2% | 21% |
| 3-Jul | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | - | 13% | - | 4% | 10% |
| 10-Jul | 29 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | - | 10% | - | 6% | 3% |
| 17-Jul | 30 | 2 | 7 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 7 | 0 | 3 | 1 | - | 6% | - | 8% | 1% |
| 24-Jul | 31 | 7 | 7 | 0 | 4 | 3 | 0 | 0 | 7 | 0 | 7 | 6 | 7 | 7 | - | 4% | 0% | 10% | 0% |
| 31-Jul | 32 | 7 | 7 | 0 | 7 | 7 | 0 | 0 | 7 | 6 | 7 | 6 | 7 | 7 | - | 0% | 1% | 10% | 0% |
| 7-Aug | 33 | 7 | 7 | 0 | 7 | 7 | 0 | 7 | 7 | 7 | 7 | 6 | 7 | 7 | - | - | 2% | 11% | 0% |
| 14-Aug | 34 | 7 | 7 | 5 | 7 | 7 | 0 | 7 | 7 | 7 | 7 | 6 | 7 | 7 | - | - | 4% | 9% | 0% |
| 21-Aug | 35 | 7 | 7 | 7 | 7 | 3 | 4 | 7 | 7 | 7 | 7 | 7 | 6 | 4 | - | - | 13% | 8% | 0% |
| 28-Aug | 36 | 5 | 7 | 4 | 7 | 0 | 5 | 5 | 7 | 7 | 7 | 6 | 7 | 0 | - | - | 20% | 7% | 0% |
| 4-Sep | 37 | 0 | 6 | 0 | 7 | 0 | 2 | 0 | 7 | 7 | 1 | 0 | 6 | 0 | - | - | 24% | 7% | 0% |
| 11-Sep | 38 | 0 | 0 | 0 | 7 | 0 | 5 | 0 | 7 | 0 | 0 | 0 | 3 | 0 | - | - | 16% | 6% | 0% |
| 18-Sep | 39 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | - | - | 9% | 4% | 0% |
| 25-Sep | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | 4% | 2% | 0% |
|  | **shutdown** | **5** | **0** | **0** | **10** | **3** | **0** | **4** | **35** | **12** | **23** | **3** | **16** | **16** |  |  |  |  |  |
|  | **Total** | **42** | **56** | **16** | **56** | **27** | **16** | **26** | **62** | **44** | **69** | **37** | **53** | **33** |  |  |  |  |  |

Note: The percent of each species and run are shown during these weeks as the average across years in this time period. This measure is a hypothetical restriction if the protocols that were in place in 2016 were applied consistently across years. In this case, duration of restrictions lasts until the average daily temperature falls below 69.9 after a daily temperature reading reaches 70.0 F. The period in which a complete shutdown of sampling would occur (shutdown at > 72.0 F which remains until < 71.9 F) is indicated in black shading, and the actual days of shutdown are summed below the table.

**Estimated ESA Impacts for the AFF during Temperature Shutdown**:

If we apply the highest past observed impact rates in the standard research and monitoring activities to this year’s forecasted abundance, we expect to kill less than 1 natural-origin steelhead in 2019. If this same level of impact occurred in research and monitoring activities in 2019, we would have remaining impacts to use for additional research and monitoring at the AFF.

The AFF rarely has incurred steelhead mortalities during the recent years of sampling operations (**Table 3**). We propose in 2019 that up to 5 and 110 of the available research impacts for natural-origin B-Index and A-Index steelhead, respectively, be allocated for this AFF project. These impacts would be incurred as "mortalities" for every unclipped B-Index and A-index steelhead that we handle during a period when the AFF would normally be shutdown due to high temperatures (>72° F). The temperature shutdowns can last several weeks, but we estimate that we would not exceed the proposed research impacts in 2019 due to a relatively low forecast in 2019 and given observed average handle rates from previous years. The average AFF handle rate per year under consistent 72° F restrictions from 2006 to 2016 was 0.152% and 0.068% for A-Index and B-Index steelhead, respectively (**Table 4**). Based on this year’s A-Index unclipped forecast (38,400) and the average A-Index handle rate, we expect to handle 59 unclipped A-Index steelhead. An allocation of up to 110 natural-origin A-Index impacts will likely be more than adequate for any shutdown periods in 2019. Based on this year’s B-Index unclipped forecast (1,100) and the average B-Index handle rate, we expect to handle 1 unclipped B-Index steelhead.

At the bottom of each of the following tables (Tables 5-7), we have listed the "remaining impacts" given what our research activities (i.e., Bonneville AFF sampling, Lower River test fishery, Sturgeon Monitoring, and Research Gear Testing) have managed to sum up as a maximum value in any given year. In 2017, the pound net study was responsible for all the steelhead impacts. This should act as a conservative value since it is based on the maximum impact we have observed in any given year. The total impact limits are listed below each table in blue. We used forecasts (when available) for all the ESA-listed stocks and calculated what the total number of fish ("Remaining morts"), we could kill from each stock, remaining after the maximum observed impacts had been accounted for. The only species that is negative was Chum (These impacts are intended to come out of Non-Treaty fishing impacts as stated in the BA; “Any impacts to chum will be covered under the Non-Treaty impact limits”). We do not expect to handle any chum at the AFF. In the recent five years, the average Bonneville Dam total Chum passage and Chum passage as of October 31 was 109 and 12 fish, respectively. All other species have not exceeded their allowable research and monitoring impact limit.

**Additional Benefits of this CRITFC Proposal:**

This year would be a timely year to implement this research because the company Whooshh is also in the process of assembling an image scanner on one of the flumes at the AFF. The plan is to use these 3D images and demonstrate the utility of an imaging algorithm that could measure fork length size and identify adipose clips on steelhead (Figure 2). Whooshh would have to manually identify the steelhead prior to being able to implement this technology in a more automated fashion. However, a demonstration of this technology may be provided to TAC using steelhead during the Skamania management period (April 1 – Jun 30). The intent is for the image scanner to be in operation for the whole year including the A-/B-Index period. However, the equipment can only be used when the AFF is operating. If we continue AFF sampling during a 72° F shutdown period, the scanning equipment would also be simultaneously be collecting imaging data. The goal for the Whooshh data is to increase the sample size that TAC uses to make abundance estimates of A- and B-Index clipped and unclipped steelhead during this management period.

**Table 3. Number of fish handled, number killed, and mortality rate of Chinook, Sockeye, and steelhead sampled at the AFF from 2008 to 2018.**

| Fish handled and killed | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Chinook salmon, January 1 to June 15 | | |  |  |  |  |  |  |  |  |  |
| Total handled | 1,105 | 974 | 1,172 | 1,110 | 1,301 | 917 | 1,764 | 1,499 | 1,359 | 1,072 | 1,464 |
| Total direct mortalities | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| Mortality rate | 0.00% | 0.10% | 0.00% | 0.00% | 0.00% | 0.00% | 0.06% | 0.00% | 0.07% | 0.00% | 0.00% |
| Chinook salmon, June 16 to July 31 | | | |  |  |  |  |  |  |  |  |
| Total handled | 772 | 359 | 243 | 278 | 209 | 466 | 377 | 221 | 537 | 516 | 328 |
| Total direct mortalities | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 3 | 1 | 0 |
| Mortality rate | 0.13% | 0.28% | 0.41% | 0.00% | 0.00% | 0.00% | 0.27% | 0.45% | 0.56% | 0.19% | 0.00% |
| Chinook salmon, August 1 to December 31 | | | | |  |  |  |  |  |  |  |
| Total handled | 1,133 | 890 | 1,023 | 1,128 | 1,324 | 1,365 | 1,270 | 1,626 | 1,154 | 901 | 1,284 |
| Total direct mortalities | 2 | 2 | 5 | 5 | 2 | 1 | 1 | 1 | 2 | 3 | 1 |
| Mortality rate | 0.18% | 0.22% | 0.49% | 0.44% | 0.15% | 0.07% | 0.08% | 0.06% | 0.17% | 0.33% | 0.08% |
| Sockeye salmon |  |  |  |  |  |  |  |  |  |  |  |
| Total handled | 1,162 | 850 | 918 | 767 | 1,637 | 799 | 1,420 | 917 | 1,706 | 1,095 | 1,873 |
| Total direct mortalities | 0 | 0 | 0 | 2 | 0 | 3 | 5 | 2 | 1 | 3 | 1 |
| Mortality rate | 0.00% | 0.00% | 0.00% | 0.26% | 0.00% | 0.38% | 0.35% | 0.22% | 0.06% | 0.27% | 0.05% |
| Steelhead, April 1 - June 30 | | |  |  |  |  |  |  |  |  |  |
| Total handled | 207 | 240 | 260 | 77 | 87 | 83 | 144 | 66 | 140 | 52 | 87 |
| Total direct mortalities | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mortality rate | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Steelhead, July 1 - October 31 | | | |  |  |  |  |  |  |  |  |
| Total handled | 2,432 | 2,233 | 1,501 | 1,314 | 1,399 | 1,197 | 1,584 | 838 | 1,470 | 785 | 812 |
| Total direct mortalities | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Mortality rate | 0.00% | 0.00% | 0.07% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.07% | 0.00% | 0.00% |
| Note: All Chinook reported mortalities were limited to adult-sized fish defined by fork length > 56 cm. It is assumed that mortality rates on jack-sized fish (defined by fork length =< 56 cm) would be similar to those of adult-sized Chinook. | | | | | | | | | | | |

**Table 4. Total expected Bonneville Dam AFF handles per year under consistent 72 F restrictions applied across years (2006 – 2018).**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Handled during restricted period | | | | | | | | | |
|  |  | A-Index | | | | | B-Index | | | | |
| **Year** | **Weeks of restrictions** | **Wild** | **Hat Unclipped** | **Total Unclipped** | **Unclipped run Size** | **% of unclipped run handled** | **Wild** | **Hat Unclipped** | **Total Unclipped** | **Unclipped run Size** | **% of unclipped run handled** |
| 2006 | 1 | 35 | 2 | 37 | 63,735 | 0.058% | 0 | 0 | 0 | 8,466 | 0.000% |
| 2007 | 0 | 0 | 0 | 0 | 77,268 | 0.000% | 0 | 0 | 0 | 9,015 | 0.000% |
| 2008 | 0 | 0 | 0 | 0 | 80,075 | 0.000% | 0 | 0 | 0 | 20,103 | 0.000% |
| 2009 | 3 | 462 | 66 | 529 | 152,624 | 0.346% | 23 | 0 | 23 | 15,148 | 0.154% |
| 2010 | 2 | 50 | 8 | 58 | 120,328 | 0.048% | 16 | 2 | 18 | 22,552 | 0.080% |
| 2011 | 0 | 0 | 0 | 0 | 116,755 | 0.000% | 0 | 0 | 0 | 7,400 | 0.000% |
| 2012 | 2 | 54 | 10 | 63 | 70,412 | 0.090% | 12 | 0 | 13 | 10,004 | 0.126% |
| 2013 | 6 | 110 | 31 | 142 | 93,281 | 0.152% | 2 | 5 | 7 | 3,260 | 0.213% |
| 2014 | 3 | 122 | 10 | 132 | 110,951 | 0.119% | 7 | 0 | 7 | 12,904 | 0.051% |
| 2015 | 4 | 171 | 4 | 175 | 85,158 | 0.206% | 1 | 0 | 1 | 5,580 | 0.016% |
| 2016 | 2 | 26 | 8 | 34 | 36,665 | 0.094% | 3 | 0 | 3 | 9,077 | 0.037% |
| 2017 | 4 | 145 | 10 | 154 | 31,496 | 0.490% | 1 | 0 | 1 | 1,145 | 0.059% |
| 2018 | 5 | 88 | 3 | 90 | 23,908 | 0.377% | 6 | 2 | 9 | 5,606 | 0.153% |
| Avg | 2.5 | 97 | 12 | 109 | 81,743 | 0.152% | 5 | 1 | 6 | 10,020 | 0.068% |

Note: We used the observed average annual sample rate applied to the weeks when 72 F restrictions would have affected the BONAFF in each year to estimate the number of A-Index and B-Index wild steelhead that may have been handled if the BONAFF had continued to operate without restrictions. The wild steelhead were calculated from observed proportions of A-Index and B-Index wild steelhead that TAC had estimated each week. In particular years in which weeks had not been sampled there were no observed proportions available for A-Index and B-Index wild steelhead, and so in those cases we averaged the observed proportions that were available from the two nearest neighboring weeks occurring before and after the period of no data.

Figure 1 (Figure 35d.in AFF uncertainty report) Comparison of PIT-tag treatment groups (PIT-tag-as-juvenile versus Bonneville Dam AFF) across 2014-2016 for survivorship as a function of temperature (figure from BONAFF sample bias report).



Figure 2. An image from the type of scanning equipment Whooshh will be adapting to the flumes at the BONAFF in 2019.

**Table 5. Actual impact rates across all RM&E activities on listed Chinook (2006-2017)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Chinook |  | Snake River spring/summer chinook | Upper Columbia River spring chinook | Upper Willamette River spring chinook | Lower Columbia River Chinook | | | Snake River fall Chinook |  |
| Type | Year | Spring | Fall Tule | Fall Bright |  |
|  | 2006 | 0.004% | 0.004% | 0.012% | 0.012% | 0.000% | 0.000% | 0.000% |  |
|  | 2007 | 0.002% | 0.002% | 0.007% | 0.007% | 0.000% | 0.000% | 0.000% |  |
|  | 2008 | 0.019% | 0.019% | 0.009% | 0.009% | 0.000% | 0.000% | 0.001% |  |
|  | 2009 | 0.017% | 0.017% | 0.012% | 0.012% | 0.001% | 0.001% | 0.001% |  |
|  | 2010 | 0.020% | 0.020% | 0.022% | 0.022% | 0.000% | 0.000% | 0.001% |  |
|  | 2011 | 0.033% | 0.033% | 0.042% | 0.042% | 0.000% | 0.000% | 0.001% |  |
|  | 2012 | 0.020% | 0.020% | 0.036% | 0.036% | 0.000% | 0.000% | 0.001% |  |
|  | 2013 | 0.008% | 0.008% | 0.009% | 0.009% | 0.000% | 0.000% | 0.000% |  |
|  | 2014 | 0.010% | 0.010% | 0.025% | 0.025% | 0.000% | 0.000% | 0.000% |  |
|  | 2015 | 0.008% | 0.008% | 0.010% | 0.010% | 0.000% | 0.000% | 0.000% |  |
|  | 2016 | 0.012% | 0.012% | 0.013% | 0.013% | 0.000% | 0.000% | 0.000% |  |
|  | 2017 | 0.040% | 0.040% | 0.031% | 0.031% | 0.069% | 0.104% | 0.103% |  |
|  | Min | 0.002% | 0.002% | 0.007% | 0.007% | 0.000% | 0.000% | 0.000% |  |
|  | Max | 0.040% | 0.040% | 0.042% | 0.042% | 0.069% | 0.104% | 0.103% |  |
|  | Average | 0.016% | 0.016% | 0.019% | 0.019% | 0.006% | 0.009% | 0.009% |  |
|  | Impact Limit | 0.500% | 0.500% | 0.500% | 0.500% | 0.500% | 0.500% | 0.500% |  |
| Average Remaining | Impacts | 0.460% | 0.460% | 0.458% | 0.458% | 0.431% | 0.396% | 0.397% |  |
|  |  |  |  |  |  |  |  |  |  |

**Table 6. Actual impact rates across all RM&E activities on listed steelhead (2006-2017)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | River Entry Year | Snake River Steelhead | | Upper Columbia River | Mid Columbia River Steelhead | | Lower Columbia River Steelhead | | Upper Willamette River |
| RunYear | A-Index | B-Index | Winter | Summer | Winter | Summer |
| 2006-07 | 2006 | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.028% | 0.000% | 0.028% |
| 2007-08 | 2007 | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.015% | 0.000% | 0.015% |
| 2008-09 | 2008 | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.019% | 0.000% | 0.019% |
| 2009-10 | 2009 | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.029% | 0.000% | 0.029% |
| 2010-11 | 2010 | 0.000% | 0.000% | 0.000% | 0.006% | 0.000% | 0.049% | 0.002% | 0.049% |
| 2011-12 | 2011 | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.117% | 0.002% | 0.117% |
| 2012-13 | 2012 | 0.001% | 0.001% | 0.001% | 0.000% | 0.001% | 0.028% | 0.004% | 0.028% |
| 2013-14 | 2013 | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.050% | 0.001% | 0.050% |
| 2014-15 | 2014 | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.038% | 0.000% | 0.038% |
| 2015-16 | 2015 | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.018% | 0.000% | 0.018% |
| 2016-17 | 2016 | 0.001% | 0.001% | 0.001% | 0.000% | 0.001% | 0.039% | 0.000% | 0.039% |
| 2017-18 | 2017 | 0.025% | 0.049% | 0.025% | - | 0.025% | - | 0.000% | - |
|  | Min | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.015% | 0.000% | 0.015% |
|  | Max | 0.025% | 0.049% | 0.025% | 0.006% | 0.025% | 0.117% | 0.004% | 0.117% |
|  | Average | 0.002% | 0.004% | 0.002% | 0.001% | 0.002% | 0.039% | 0.001% | 0.039% |
|  | Impact Limit | 0.300% | 0.300% | 0.300% | 0.300% | 0.300% | 0.300% | 0.300% | 0.300% |
| Average Remaining | Impacts | 0.275% | 0.251% | 0.275% | 0.294% | 0.275% | 0.183% | 0.296% | 0.183% |
|  |  |  |  |  |  |  |  |  |  |

**Table 7. Actual impact rates across all RM&E activities on listed coho, chum, sockeye, green sturgeon, and bull trout (2006-2017).**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Year | Lower Columbia River Coho | Columbia River Chum | Snake River Sockeye | Green Sturgeon | Bull Trout |
|  | 2006 | 0.002% | 0.000% | 0.000% | 0.0 | 0.0 |
|  | 2007 | 0.000% | 0.000% | 0.004% | 0.0 | 0.0 |
|  | 2008 | 0.001% | 0.000% | 0.000% | 0.1 | 0.0 |
|  | 2009 | 0.003% | 0.000% | 0.000% | 0.2 | 0.0 |
|  | 2010 | 0.008% | 0.009% | 0.000% | 1.1 | 0.0 |
|  | 2011 | 0.000% | 0.002% | 0.002% | 1.0 | 0.0 |
|  | 2012 | 0.000% | 0.008% | 0.000% | 0.7 | 0.0 |
|  | 2013 | 0.002% | 0.007% | 0.002% | 0.9 | 0.0 |
|  | 2014 | 0.001% | 0.000% | 0.001% | 0.5 | 0.0 |
|  | 2015 | 0.001% | 0.003% | 0.000% | 2.1 | 0.0 |
|  | 2016 | 0.000% | 0.007% | 0.000% | 2.5 | 0.0 |
|  | 2017 | 0.198% | 0.000% | 0.003% | 1.0 | 0.0 |
|  | Min | 0.000% | 0.000% | 0.000% | 0.0 | 0.0 |
|  | Max | 0.198% | 0.009% | 0.004% | 2.5 | 0.0 |
|  | Average | 0.018% | 0.003% | 0.001% | 0.8 | 0.0 |
|  | Impact Limit | 0.500% | 0.000% | 0.300% | 0.500% | - |
| Average Remaining | Impacts | 0.302% | -0.009% | 0.296% | - | - |
|  |  |  |  |  | - | - |