CENWP-OD 19 October 2018

MEMORANDUM FOR THE RECORD

TITLE – 18FOS04 MFR Holding Unmarked Chinook Salmon at Foster Fish Facility (and other outplanting strategies)
DATE – 19 October
PROJECT – Foster Dam, Foster Fish Facility

Description of the problem

Only 65 unmarked spring Chinook salmon (*Oncorhynchus tshawytscha*) have been collected at Foster Fish Facility on the South Santiam River as of August 15, 2018 (personal communication, Brett Boyd, ODFW). Moreover, the Foster Facility continues to have issues with the collection of salmon and steelhead due to water temperature differentials between the cool ladder entrance and warmer tailrace, causing delays in fish entering the trap (Keefer et al. 2018).

Episodic high pre-spawn mortality (PSM) events occur in some Willamette spring Chinook populations, and high temperatures are a known contributor (Keefer et al. 2010; Bowerman et al. 2016; DeWeber et al. 2017). Stressful water temperatures occur annually in the South Santiam, however PSM is not always high, and it is difficult to predict if water temperatures at the beginning of the spring Chinook salmon run will become exceedingly high later in the summer. Typically stream temperatures decline in the middle of September just prior to the onset of spring Chinook spawning.

Estimated annual spring Chinook pre-spawn mortality rates have been between 11% and 40% in recent years for fish released above Foster Reservoir (Sharpe and others 2015, 2016, and 2018), with the highest rate occurring in the hottest summer of 2015 (Table 1). The extreme differences in water temperature in the Foster Fish Facility and upstream in the South Santiam River would result in outplanted salmon being shocked and stressed if not sufficiently acclimated prior to release.

Table 1. Estimated annual spring Chinook pre-spawn mortality rates (with 95% CI where available) for fish released above Foster Reservoir. Data compiled from Sharpe and others (2015, 2016, and 2018).

	2013	2014	2015	2016
PSM	22% (17-28)	31%	40% (28-53)	11% (2-19)

The combination of high water temperatures and low adult returns in the South Santiam this year are cause for concern. Managers discussed this situation and wish to employ all actions available to ensure the maximum survival of salmon and their spawning success. Potential options identified that could reduce exposure to high water temperatures or extreme differences in temperatures between the trap and point of release include the following, however there are risks associated with each (Table 2):

1. Hold spring Chinook salmon at the Foster Fish Facility until temperatures decrease to acceptable levels.
2. Release fish into upper Foster Reservoir.
3. Release to alternative stream location with cooler temperatures.

Table 2. Options to maximize survival (minimize pre-spawn mortality; PSM) of adult spring Chinook collected for release above Foster Dam.

Options	**Benefits**	**Risks**	**Notes**
1. Hold at AFF	Controlled cool water facility	Increased risk of disease transmission and stress associated with holding. Uncertain PSM for late outplants.	Difficult to estimate PSM late in season as flows increase
2. Release to reservoir	Cool water available - thermal regulatory benefits	Fallback rates estimates of 6-22%. Reservoir surface temperatures may be too high	Need to assess fish origin to refine fallback estimates
3. Release at alternative stream site with cooler water temperatures	Cooler water (if site available)	Stream temperatures vary seasonally, and go above 20^{o}C annually	

OPTION 1. HOLD AT FOSTER ADULT FISH FACILITY

Although best management practices and protocols included in the Willamette Fish Operations Plan (WFOP 2018) are to transport adults upstream of the dam quickly consistent with their run timing, Foster Fish Facility was designed to allow the holding of adult spring Chinook salmon for an extended period of time as an adaptive management option. The purpose of this design feature was to be able to outplant salmon above the dam later in the season to help maximize their survival and spawning success (Foster Fish Facility 90% DDR pages 2-3 and 2-4).

It is anticipated unmarked salmon would be outplanted in September prior to spawning, when conditions are more suitable for salmon survival. Spring Chinook salmon have been outplanted above the dams just prior to spawning with apparent low pre-spawn mortality (Sharpe presentations to Willamette Fisheries Science Reviews in February, 2015 and 2016). However Sharpe and eight others (2018) point out that "late-season carcasses can be difficult to recover after flows begin to increase, and since these fish are more likely to be successful spawners, there is the potential for systematic bias". Also, holding adults at Foster AFF increases risk of disease transmission since fish are in an artificial, high-density environment (Harmon 2009). Additional assessment is needed to

confirm pre-spawn mortality in late outplants and if spawner effectiveness is affected by late-season outplants.

OPTION 2. RELEASE TO RESERVOIR

Naughton et al. (2018) assessed the potential benefits of releasing transported adult Chinook salmon into Foster Reservoir compared to upstream in the South Santiam River. They estimated over 5 years of study that the cumulative exposure of reservoir-released fish was reduced by 64 degree days, on average, relative to river-released fish. However 14% of all reservoir-released fish fell back. This fallback rate may be lower for fish originating from upstream of the dam, since up to 35% of transported adults have been known to be unmarked hatchery origin spring Chinook which were not produced above Foster Reservoir (Evans et al. 2016) and therefore may be more likely to move downstream. Additional assessment is needed to determine fallback rates for spring Chinook originating from above Foster Dam.

OPTION 3. RELEASE AT ALTERNATIVE STREAM SITE

Temperature differential between the Foster Fish Facility and the upstream release point in the South Santiam River can be greater than the maximum identified in the WFOP. When temperature difference is great, it becomes impractical to acclimate transported fish because it would require holding fish in a truck for long periods. Currently only one release site is used in the South Santiam above Foster Dam, and it is not clear if other sites are available.

TEMPERATURE TRIGGERS FOR EMPLOYING ADAPTIVE MANAGEMENT OF ADULT OUTPLANTS TO MINIMIZE PRE-SPAWN MORTALITY

Acute Temperatures

Stress on salmonids increases rapidly from handling if the water temperature exceeds 18^{o}C, with increased disease risks above 18 ^{o}C, and blockage of migration occurring at 21 ^{o}C, and lethal conditions when temperature exposure is >21 ^{o}C for a week or more (NMFS 2008 Biop Table 4.1-1).

Temperature Differential

The Willamette Fish Operations Plan (US Army Corps of Engineers. 2018) identifies that If the temperature difference between the receiving water and tank water is > 7°F, the water will be tempered to a difference of < 5°F at a rate of 1°F/6 minutes

Recommended Triggers for employing adaptive management actions to minimize PSM

- Do not use a release site when 7-Day ADM water temperatures are above 20 ^{o}C.
- If the temperature difference between the receiving water and tank water is > 7°F, the water will be tempered to a difference of < 5°F at a rate of 1°F/6 minutes (US Army Corps of Engineers 2018).

- If water cannot be tempered to within 5°F of the release site temperature in less than y time:
    - Outplant at alternative location that meets habitat and temperature criteria

Type of outage/change required
See Option 1 above.

Impact on facility operation
Limited. Unmarked salmon will be sorted and held in long-term holding pond.

Dates of impacts/repairs
July 12, 2018 through August 12, 2018

Length of time for repairs
About 1 month

Expected impacts on fish
There are potential risks and benefits for nonmarked salmon maximizing their survival by holding or utilizing some other release strategy (Table 2). Holding non-marked spring Chinook salmon allows temperature exposure to be controlled, however exposes adults to stress and disease, delays upstream migration, and PSM and spawner effectiveness is uncertain. Regarding employing a reservoir release strategy, Naughton et al. (2018) concluded that releasing fish into Foster Reservoir would reduce temperature accumulation, however fall back rates were 14% and spawner effectiveness was also not evaluated. An alternative and accessible stream release site with cooler water temperatures has not been identified.

Comments from agencies
Comments from NMFS in Attachment 1.
Comments from ODFW in Attachment 2.

NMFS and ODFW are in full support of implementing this action immediately (Option 1).

Edits were made by the U.S. Army Corps of Engineers, Portland District.

U.S. Army Corps of Engineers Biologists (PME) comments:
Given the current situation with very low numbers of unmarked salmon returning to Foster trap, extreme water temperatures currently in the outplant areas above Foster dam, uncertainty in the fallback rate, and no additional stream release sites currently identified providing access to cool water, it is desirable to hold any remaining unmarked salmon that may enter Foster trap in the long-term holding pools until the 7-day average of the daily maximum are less than 20 ^{o}C near the release site. In future years, options should be further investigated with triggers on when to employ adaptive management to minimize PSM for outplanted spring Chinook salmon. These triggers and adaptive

management options should be incorporated into the WFOP. Additional RM&E should be considered to further assess the best options and triggers for deviations from the WFOP protocols. Specifically:

- What is the fallback rate for spring Chinook originating above Foster Dam that are released into Foster Reservoir?
- What temperature triggers should be used to employ adaptive management options to minimize PSM?
- What is the PSM rate of adult spring Chinook outplanted late in the season?
- What is the spawner effectiveness of adults under different ouplanting protocols (extended holding, reservoir resease, and stream release)?
- Are there alternative stream release locations with better water temperature conditions available?

Final results

Adult (nonmarked) spring Chinook salmon were held at the Foster Fish Facility while temperatures were high at upriver release sites. Unmarked spring Chinook salmon were held at Foster starting July 12th and continuing until August 9th in an effort to reduce stress caused by the 20° temperature differential and reduce pre-spawning mortality. There were 38 adults held during this period. On August 13th, temperatures at the outplanting release site dropped to 63°F and direct outplanting resumed with the 38 previously held adults released.

As of 30 September, 87 non-marked spring Chinook salmon were transported to adult release sites above Foster Dam. The desired future operation will need to be incorporated into the WFOP.

References:

Bowerman, T., Keefer, M. L., and Caudill, C. C. (2016). Pacific salmon prespawn mortality: patterns, methods, and study design considerations. Fisheries 41, 738–749. doi:10.1080/03632415.2016.1245993.

Evans, M. L., Jonson, M. A., Jacobson, D., Wang, J., Hogansen, M., and O'Malley, K. G. (2016). Evaluating a multi-generational reintroduction program for threatened salmon using genetic parentage analysis. Canadian Journal of Fisheries and Aquatic Sciences 73, 844–852. doi:10.1139/CJFAS-2015-0317.

DeWeber, J. T., Peterson, J. T., Sharpe, C., Kent, M. L., Colvin, M. E., and Schreck, C. B. (2017). A hidden-process model for estimating prespawn mortality using carcass survey data. North American Journal of Fisheries Management 37, 162–175. doi:10.1080/02755947.2016. 351245223.

Harmon, T. S. (2009). Methods for reducing stressors and maintaining water quality associated with live fish transport in tanks: a review of the basics. Reviews in Aquaculture 1, 58–66. doi:10.1111/J.1753-5131.2008. 01003.X

Keefer, M.L., T.S. Clabough, M.A. Jepson, T. Blubaugh, G. Brink, G.P. Naughton, C.T. Boggs, and C.C. Caudill. 2018. Evaluation of Adult Chinook Salmon Behavior at the Foster Dam Adult Fish Facility and in Foster Dam Reservoir on the South Santiam River, 2017. Prepared by the Department of Fish and Wildlife Sciences, University of Idaho, Moscow, Idaho for the U.S. Army Corps of Engineers Portland District. Technical Report 2018-3-FINAL.

Keefer, M. L., Taylor, G. A., Garletts, D. F., Gauthier, G. A., Pierce, T. M., and Caudill, C. C. 2010. Prespawn mortality in adult spring Chinook salmon outplanted above barrier dams. Ecology Freshwater Fish 19, 361–372. doi:10.1111/J.1600-0633.2010.00418.X.

Naughton, G.P., and six others. 2018. Reservoir provides cool-water refuge for adult Chinook salmon in a trap-and-haul reintroduction program. Marine and Freshwater Research, 2018, 69, 1–13; https://doi.org/10.1071/MF18124.

Kock and five others. 2018. Responses of Hatchery- and Natural-Origin Adult Spring Chinook Salmon to a Trap-and-Haul Reintroduction Program. North American Journal of Fisheries Management 1-13.
Naughton and six others. 2018 (in press). Reservoir provides cool-water refuge for adult Chinook salmon in a trap-and-haul reintroduction program.

Sharpe and eight others. 2018. Abundance, Distribution, Diversity and Survival of Adult Spring Chinook Salmon in the Upper Willamette River: 2015 and 2016. Oregon Department of Fish and Wildlife Willamette Salmonid Research, Monitoring, and Evaluation Program, Corvallis Research Lab, Corvallis, Oregon 97333. Prepared for the U.S. Army Corps of Engineers, Portland District Task Orders: W9127N-12-2-0004-4009 and W9127N-10-2-0008-0036. October 2017.

Sharpe and eight others. 2016. 2014 hatchery baseline monitoring. Oregon Department of Fish and Wildlife Willamette Salmonid Research, Monitoring, and Evaluation, Corvallis Research Lab, Corvallis, Oregon. Prepared for the U.S. Army Corps of Engineers, Portland District. Task Orders: W9127N-12-2-0004-1009 and W9127N-10-2-0008-0031. June 2016.

Sharpe and eight others. 2015. 2013 hatchery baseline monitoring. Oregon Department of Fish and Wildlife Willamette Salmonid Research, Monitoring, and Evaluation, Corvallis Research Lab, Corvallis, Oregon. Prepared for the U.S. Army Corps of Engineers, Portland District. Task Orders: W9127N-12-2-0004-1009 and W9127N-10-2-0008-0031. May 2015.

US Army Corps of Engineers. 2018. Willamette Fish Operations Plan. URL: http://pweb.crohms.org/tmt/documents/FPOM/2010/Willamette_Coordination/WFOP/2018/index.html [Accessed: September 2018].