Preliminary Summary for Estimated Adult Pre-spawn Mortality for all 2021 Central Valley Chinook Salmon Runs Due to Excessive Temperatures in the Sacramento Basin.

California Department of Fish and Wildlife

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Please note that the information provided in this summary in not final and has been generated from several varying sources/agencies and state of analyses. Some results are preliminary and still being analyzed. As reports and data are finalized, CDFW will promptly make available through a public notification.

The California Advisory Committee on Salmon and Steelhead Trout requested that the California Department of Fish and Wildlife (CDFW) provide an estimate of the adult pre-spawn mortality for all 2021 Central Valley Chinook Salmon runs due to excessive temperatures throughout the Sacramento Basin. CDFW annually monitors the escapement of the returning adult Chinook Salmon runs in the Central Valley. Specific runs including Winter- and Spring-run Chinook Salmon enter the Central Valley during periods of colder water temperatures but hold and spawn during periods of the year that experience higher (potentially lethal) water temperatures, especially during years with minimal water availability and prolonged elevated air temperatures. These poor water conditions can impact the ability for an adult to survive long enough to spawn. If the adults do successfully spawn and water temperatures remain elevated, survival of the eggs can also be severely impacted confounding impacts to the population. Both Winter- and Spring-run Chinook Salmon are also limited in geographic range and habitat which additionally can confound the population success. Fall-run Chinook Salmon adults generally enter the basin when water temperatures are elevated and potentially lethal which can contribute to pre-spawn mortality, but in most years if able to spawn, the water temperatures start to lower and there is less associated egg mortality. The timing of Late Fall-run Chinook Salmon adults is generally during periods of adequate water conditions and tend to be the least impacted by pre-spawn mortality, however the population size in the Sacramento Basin is small and still could be impacted by environmental conditions.

Winter-run Chinook Salmon:

Pre-spawn mortality was higher than usual for Sacramento River Winter-run Chinook Salmon (WRSC), 5.5% compared to a historical average of 1.3% (CDFW data). It is unknown how much of the pre-spawn mortality was due to warm water temperatures during holding and how much was due to other causes or natural variability. However, almost all pre-spawn mortality was observed early in the season during warm water bypass releases being made in effort to conserve cold in Shasta Reservoir for later in the spawning season. A decrease in pre-spawn mortality similar to typical levels was observed when the bypass releases ceased, and the river cooled. Of the WRCS that survived to spawn, NOAA Fisheries estimates that approximately 75% of incubating eggs were lost due to temperature dependent mortality (SWFSC 2021). Based on juvenile

trapping data at Red Bluff, egg to fry survival of brood year 2021 WRSC was estimated at 2.5%. In addition to temperature dependent mortality, egg mortality due to Vitamin B1 (thiamine) deficiency is estimated at 44% (NOAA Fisheries 2022).

Spring-run Chinook Salmon:

Significant adult pre-spawn mortality was observed in Spring-run Chinook Salmon (SRCS) in Butte Creek during the summer holding period, and approximately 14,900 unspawned carcasses were processed by CDFW staff. Data from carcass surveys in currently being analyzed and expanded to estimate total losses to pre-spawn mortality. CDFW will be publishing a report in 2022.

Drought impacts to Feather River SRCS likely differed from other Spring-run populations in the Central Valley. While streamflow was low, approximately 650 cfs in the “low flow channel” spawning reach, temperatures were favorable for both summer holding and fall spawning. Low water levels in Lake Oroville required that water be released from the river outlet, which accesses the coolest water of the reservoir. Temperatures within the low flow channel remained in the high 40s to low 50s (deg F) throughout the summer and fall months. While temperatures supported successful spawning and egg incubation, low flows may have limited available spawning habitat and promoted redd superimposition, which could reduce juvenile production.

Drought impacts to SRCS in the Sacramento River mainstem were likely severe due to low streamflow and water temperatures exceeding 56°F which created unsuitable conditions throughout spawning and incubation, however estimates are not available. Juvenile trapping confirmed very poor survival of brood year 2021 SRCS in the mainstem and tributaries upstream of Red Bluff (i.e, Clear, Battle, Cow, and Cottonwood creeks) (USFWS 2022).

CDFW is unable to estimate pre-spawn mortality for SRCS populations in Mill and Deer Creeks, but it is potentially high based on water temperatures in lower elevation habitat during holding and spawning seasons. Temperature dependent mortality during incubation is also unknown, but likely to be lower than for WRCS, as stream temperatures progressively cooled in these tributaries during the incubation period.

Fall-run Chinook Salmon:

Due to the large geographic range of Fall-run Chinook Salmon (FRCS) populations in the Sacramento River basin and the variation of monitoring efforts in the tributaries it is currently not possible to estimate total losses for fall run due to high water temperatures in all Chinook Salmon runs combined efforts.

Throughout the Sacramento River Basin, water temperatures were unsuitably warm during at least part of the FRCS spawning and incubation period. FRCS in the mainstem Sacramento River returned to very poor conditions due to drought. Average daily water temperatures below Keswick Dam did not cool below 56 degrees until November 18, after peak spawning, which led to high temperature related mortality. Juvenile trapping also

showed very poor survival of brood year 2021 fall-run Chinook Salmon in the mainstem and tributaries upstream of Red Bluff (i.e, Clear, Battle, Cow, and Cottonwood creeks) (USFWS 2022).

Low flows in the American and Feather rivers reduced adult holding and spawning habitats, likely increasing redd superimposition, and lowering egg to fry survival. Conditions in the Lower American River during spawning included low flow and prolonged periods of water temperatures exceeding 56°F. Pre-spawn mortality of FRCS females was estimated at 15%, which is the lowest rate since 2015 (6%) and lower than the average rate of 21% for 2000-2021. The Lower American River escapement estimate of 11,232 FRCS is a 50% decrease compared to the previous year (22,456) and the lowest since 2017 (7,457).

Late Fall-run Chinook Salmon:

Late-fall-run salmon in the mainstem Sacramento River spawned under much better conditions than other runs in 2021, and temperature related mortality was not a factor in their egg to fry survival.

Thiamine Deficiency:

In addition to drought and temperature-related impacts, thiamine deficiency is anticipated to reduce egg and fry survival in all runs of adult Chinook Salmon returning to the Central Valley during 2021. Thiamine concentrations were sampled from ocean harvest and hatchery returns to evaluate the extent of deficiency and assess likely impacts to naturally spawning populations.

Reference:

Southwest Fisheries Science Center (SWFSC). 2021. Water year 2021 winter-run Chinook temperature-dependent mortality estimate. Prepared by the Southwest Fisheries Science Center. October 24.

NOAA Fisheries. 2022. River temperatures and survival of endangered California winter-run Chinook Salmon in the 2021 Drought. West Coast Regional Office. Accessed on 6 May, 2022 at: https://www.fisheries.noaa.gov/west-coast/climate/river-temperatures-and-survival-endangered-california-winter-run-chinook-salmon

U.S. Fish and Wildlife Service (USFWS). 2022. Red Bluff Juvenile Passage Estimates. Data accessed on SacPAS: Central Valley Prediction & Assessment of Salmon on 6 May 2022: https://www.cbr.washington.edu/sacramento/data/query_redbluff_daily.html