Appendix J

Concept for an Adaptive Management Plan Related to the Optional Segregation Weir

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The following concept for an Adaptive Management Plan (AMP) is designed to assist the resource agencies (National Marine Fisheries Service [NMFS], U.S. Fish and Wildlife Service [USFWS], and California Department of Fish and Game [DFG]) in determining the need for installation and management of a seasonal segregation weir to support development of an independent, self-sustaining population of spring-run Chinook salmon in the Lower Yuba River.

The Lower Yuba River Actions recommended in the Final HEP consist of three individual actions. Collectively, these actions expand habitat and support development of a new population of spring-run Chinook salmon. As discussed in Section 4.3.11 of the Final Habitat Expansion Plan (HEP), these actions also contribute to a larger integrated plan for management of spring-run Chinook salmon in the Lower Yuba River.

The Lower Yuba River Actions recommended in the Final HEP are as follows:

- Sinoro Bar spawning habitat expansion – expand spawning habitat in the Sinoro Bar geomorphic unit of the Englebright Dam Reach of the Lower Yuba River (described in Section 3.3.1 of the Final HEP);
- Narrows Gateway spawning habitat expansion – expand spawning habitat in the Narrows Gateway geomorphic unit of the Narrows Reach of the Lower Yuba River (described in Section 3.3.2 of the Final HEP); and
- segregation weir (optional) – plan for, and if deemed necessary by the resource agencies (NMFS, USFWS, and DFG), install a seasonally operated segregation weir at a location downstream of the Narrows Pool (described in Section 3.4 of the Final HEP).

The recommended habitat expansion actions at Sinoro Bar and Narrows Gateway (referred to as the *HEP action sites*) would provide habitat that supports development of a self-sustaining population. However, the Lower Yuba River also supports fall-run Chinook salmon that may use the expanded habitat. In other watersheds without barriers to migration, spring-run and fall-run Chinook salmon often are separated geographically, with spring-run fish ascending to upper watershed areas and fall-run fish spawning in the lower stream reaches. Upper stream reaches that are used by spring-run fish often are steeper, with cooler water temperatures relative to lower stream reaches used by fall-run fish. In some cases, seasonal hydraulic barriers that block fall-run fish from entering

during low-flow periods reinforce genetic separation of the two runs. In the Yuba River, however, Englebright Dam and other upstream dams block access to areas that historically supported spring-run Chinook salmon (Yoshiyama et al. 1998). At the same time, deep reservoir projects like New Bullards Bar provide water to the Lower Yuba River that is colder than occurred historically, providing conditions that are amenable to spring-run Chinook production.

The lack of geographic or physical separation between fall-run and spring-run Chinook salmon in the Lower Yuba River introduces the risk that the incursion of fall-run Chinook into the HEA action area could inhibit development of a new population of spring-run Chinook. To enhance the separation of fall-run and spring-run Chinook salmon and preserve genetic integrity, the Licensees recommend the use of a seasonally operated weir to be located below the Narrows Pool. The weir would ensure that sufficient separation of the two runs occurs, so that a viable population of spring-run Chinook salmon can develop using the expanded habitat. Segregation, in this case, refers to the presence of habitat to meet the numeric abundance criteria for an independent population (Lindley et al. 2007) and conditions that enhance genetic separation between the two runs to create a viable spring-run Chinook population. It is quite possible that the needed segregation of the two runs will occur naturally due to differences in habitat preferences between the two runs, or that the two runs will be able to maintain genetic separation due to behavioral differences between the runs. For example, Banks et al. (2000) found that spring-run and fall-run Chinook in the Central Valley have maintained genetic integrity despite considerable physical overlap in habitat and spawning. However, in the event that natural segregation is not sufficient, a weir could be implemented as a fisheries management tool at the discretion of the resource agencies. The resource agencies could elect to use the weir on an annual basis, or decide whether the weir is needed at all. To make these decisions, the Licensees suggest that the resource agencies develop and implement a structured decision making process. This appendix provides an example of an Adaptive Management Plan (AMP) for the proposed seasonally operated weir on the Lower Yuba River.

The following concept for an AMP illustrates the notion of an adaptive plan for operation of a seasonal segregation weir and serves as an example for discussion purposes. The Licensees stand ready to assist the resource agencies in developing a final AMP for operation of the weir as part of a larger integrated plan for management of spring-run Chinook salmon in the Lower Yuba River. An important aspect of this integrated plan is DFG's expressed support for management of the Lower Yuba River between Englebright Dam and the outlet of the Narrows Pool for spring-run Chinook salmon (Hill pers. comm.).

The concept of adaptive management calls for management actions to be implemented based on an experimental design that tests key assumptions (Walters and Hilborn 1976). An adaptive experimental design requires explicit statement of testable hypotheses, criteria for testing these hypotheses, and management responses to outcomes of the tests. The following sections provide an outline for an experimental AMP design.

J.1 Management Hypotheses

J.1.1 Hypothesis 1

Channel form and substrate in the Sinoro Bar and Narrows Gateway areas can be modified to produce stream channel characteristics that are consistent with the habitat needs of Central Valley spring-run Chinook salmon.

The HEA calls for creation of habitat capable of supporting 2,000–3,000 spring-run Chinook salmon. Pasternack (2010a, 2010c) describes features that could be constructed at Sinoro Bar and Narrows Gateway that are consistent with the spawning habitat needs of spring-run Chinook salmon and could be maintained by the existing geomorphic processes, gravel augmentation by the U.S. Army Corps of Engineers (Corps), and additional maintenance by the Licensees provided under the HEA. Construction of these features requires completion of a number of logistical and regulatory steps.

Hypothesis test: Test of this hypothesis is that the logistical and regulatory steps are completed and that the spawning habitat expansion features are constructed. Project steps include:

1. Secure access to the required sites for construction and maintenance.
2. Acquire all in-water work permits.
3. Complete the California Environmental Quality Act process and public stakeholder review.
4. Construct and maintain required features.

J.1.2 Hypothesis 2

Spring-run and fall-run Chinook salmon have habitat preferences and spawning fidelity that results in sufficient genetic separation of the two races to create a viable population of spring-run Chinook salmon in the HEA action area.

The potential of the expanded spawning habitat in the Sinoro Bar and Narrows Gateway areas to support a population of spring-run Chinook salmon depends on the preferential selection of the habitat above the Narrows Pool by spring-run fish and, conversely, the avoidance of the area by fall-run fish.

The second hypothesis is that the created habitat in the Sinoro Bar and Narrows Gateway areas will be preferentially used by spring-run fish such that the expanded habitat will support development of a viable spring-run Chinook salmon population. Facts supporting this hypothesis are: (1) the location of the

action in the upper reaches of the Lower Yuba River below Englebright Dam; (2) the steeper gradient of the area relative to lower river areas; (3) the temperature of water released from upstream reservoirs that is consistent with the needs of spring-run fish; and (4) observations that early spawning Chinook in the Lower Yuba River presently migrate to this area and attempt to spawn (Pasternack 2010b).

This hypothesis could be tested through field observations of spawn-timing on the new habitat relative to explicit criteria. Should Hypothesis 2 be rejected (i.e., if movement of fall-run Chinook salmon into the expanded habitat likely precludes development of a viable spring-run Chinook salmon population), then the AMP would move to Hypothesis 3 that calls for construction and operation of a seasonal weir to mechanically ensure adequate genetic segregation of the two runs.

Hypothesis test: Following completion of the habitat expansion actions in the Sinoro Bar and Narrows Gateway areas, Hypothesis 2 would be tested through field observations over a set time period. Criteria defining success should be developed by the resource agencies. For example, the actions could be considered successful if: (1) Chinook salmon expressing a spring-run phenotype preferentially select habitat above the Narrows Pool; and (2) sufficient numbers of spring-run Chinook spawn above the Narrows Pool such that a viable population of spring-run Chinook salmon is created. This leads to two test criteria: (1) the acceptable degree of habitat selection by spring-run Chinook; and (2) the number of spring-run Chinook salmon required to create a viable population of spring-run Chinook salmon. A test of this hypothesis also requires a definition of what constitutes a spring-run Chinook salmon—a surprisingly non-straightforward question. The following are examples of test criteria for this hypothesis:

Run segregation criterion. At least 65 percent of spring-run Chinook salmon spawning in the Lower Yuba River needs to occur above the Narrows Pool in more than half the years during the test period.

Population abundance criterion. Based on the conclusions of Lindley et al. (2007) a viable salmon population needs at least 500 successful spawners (effective population size) or at least 250 spring-run Chinook redds. Using the figure of Lindley et al. (2007) that effective population size is 20 percent of total fish abundance, this translates into a total abundance of spring-run Chinook salmon in the Lower Yuba River of at least 2,500 adult fish. The HEA recommended actions should provide more than enough habitat to meet this abundance criterion.

Definition of spring-run Chinook salmon. Spring-run Chinook salmon are those that return to the Yuba River between March 1 and June 15 and spawn between August 1 and October 15.

The question of what constitutes a spring-run Chinook salmon in the Central Valley is not simple due to overlap in timing between spring-run and fall-run, and mixing of hybridized fish, particularly those of hatchery origin. The two runs can be distinguished genetically (Banks et al. 2000, Garza et al. 2009); however, genetic tests remain difficult to implement in real-time during migration. The spring-run Chinook salmon definition provided here is intended to be a practical, operational definition that could be used for test purposes as part of the AMP. The dates proposed are similar to those used in the Feather River Hatchery Draft Genetic Management Plan to provide separation of fall-run and spring-run Chinook salmon.

Test period for Hypothesis 2. Testing of this hypothesis using the above criteria would occur for up to a 10-year period[1] following completion of the habitat features in the Sinoro Bar and Narrows Gateway areas.

The test period needs to be long enough to account for natural variation in abundance of the two runs from year to year, and to allow the population to build and take advantage of the expanded habitat.

J.1.3 Hypothesis 3

A seasonally operated weir can be constructed and operated below the Narrows Pool to provide sufficient genetic segregation of fall-run and spring-run Chinook salmon to allow development of a viable spring-run Chinook salmon population.

Hypothesis 3 is tested if Hypothesis 2 is rejected (i.e., if insufficient genetic segregation is naturally occurring between the two runs). The location of the weir is envisioned to be above Timbuctoo Bend, but below the Narrows Pool. This location would support use of the Narrows Pool for adult holding of spring-run Chinook and create minimal impact on fall-run Chinook salmon production in the Timbuctoo Bend reach. Timing of the weir installation and removal would depend on seasonal fish and river monitoring data.

Currently, there is a partial passage impediment for upstream migrating fish at Daguerre Point Dam that may be contributing to the observed distribution of spring-run Chinook salmon that currently hold in the pool immediately downstream of the dam. According to the 2007 biological opinion for operations at Englebright and Daguerre Point Dams, the Corps will be enhancing passage for both adult and juvenile fish at Daguerre Point Dam[2]. Once the migration impediment has been removed, adult spring-run Chinook salmon would be

[1] Actual period to be determined in consultation with the resource agencies.

[2] National Marine Fisheries Service. 2007. Biological Opinion for the Operation of Englebright and Daguerre Point Dams on the Yuba River, California. File Number 151422-SWR-2006-SA00071: MET (PCTS #2007/01232). Sacramento, CA.

expected to move upstream earlier in their migration and make greater use of the Narrows Pool for summer holding.

Hypothesis test: If Hypothesis 2 is rejected, then evaluation of Hypothesis 3 involves testing the following assumptions:

1. Resource agencies agree on the need for a segregation weir.
2. A suitable engineering design can be developed to accommodate site-specific factors and seasonal operational needs.
3. All necessary permits can be secured.
4. Spring-run Chinook salmon move upstream early enough for a segregation weir to be effective.
5. Success criteria for Hypothesis 2 would apply to Hypothesis 3 as well.

J.2 References

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