ANALYTICAL APPROACH FOR THE CENTRAL VALLEY PROJECT AND STATE WATER PROJECT OPERATIONS CRITERIA AND PLAN BIOLOGICAL OPINION

NMFS JULY 21, 2008

1.0 Introduction

This document describes the analytical approach that will be used by NOAA's National Marine Fisheries Service (NMFS) in its formal consultation under section 7 of the Endangered Species Act (ESA) regarding the Central Valley Project and State Water Project Operations Criteria and Plan (OCAP), herein referred to as the proposed project. The purpose of the document is to serve as a source of information for independent expert peer review to help ensure that this consultation is transparent, objective, replicable, and evidence-based. In addition, NMFS has developed this document for peer review to help produce a consultation that complies with the ESA, the Administrative Procedure Act (APA), and the Data Quality Act (DQA).

The following analytical approach is organized into several sections, with the first section describing the legal and policy framework as it relates to the ESA, APA, and the DQA. Next, a general overview of how NMFS conducts its section 7 analyses is described, which is followed by a section that provides information on the analytic approach that is specific to this consultation. Then, because the proposed project is expected to primarily affect species' habitat, the analytical approach for evaluating the risk to designated critical habitat is described and followed by a section describing the approach for evaluating the risk to the species. The last section describes key aspects and tools that will be used to conduct these evaluations.

2.0 Legal and Policy Framework

2.1 Endangered Species Act

The purposes of the ESA, "…*are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section*." To help achieve these purposes, the ESA requires that, "*Each Federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat*…" Formal consultations to insure Federal agencies fulfill these purposes are concluded with the issuance of a biological opinion or a concurrence letter. Section 7 of the ESA and the implementing regulations (50 CFR 402), and associated guidance documents (*e.g.*, USFWS and NMFS 1998) require biological opinions to present: (1) a description of the proposed Federal action; (2) a summary of the status of the affected species and its critical habitat; (3) a summary of the environmental baseline within the action area; (4) a

detailed analysis of the effects of the proposed action on the affected species and critical habitat; (5) a description of cumulative effects; and (6) a conclusion as to whether it is reasonable to expect the proposed action is not likely to appreciably reduce the species' likelihood of both surviving and recovering in the wild by reducing its numbers, reproduction, or distribution or result in the destruction or adverse modification of the species designated critical habitat. By regulation (50 CFR 402.02), the "effects of the action" include the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action that will be added to the environmental baseline. To evaluate whether an action is not likely to result in jeopardy to a listed species or result in the destruction or adverse modification of designated critical habitat, NMFS considers the combination of the status of the species and critical habitat, the "effects of the action," and the cumulative effects of reasonably certain to occur future non-Federal actions.

Recent court cases have reinforced the requirements provided in section 7 regulations that NMFS must evaluate the effects of a proposed action within the context of the current condition of the species and critical habitat, including other factors affecting the survival and recovery of the species and the functions and value of critical habitat. In addition, the Courts have directed that our risk assessments consider the effects of climate change on the species and critical habitat and our prediction of the impacts of a proposed action. Finally, for this consultation, NMFS does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the analysis with respect to critical habitat described below.

2.2 Administrative Procedure Act

The Federal Administrative Procedure Act (APA) of 1946 governs the way in which administrative agencies of the United States Federal government may propose and establish regulations. The APA allows Federal courts to hold unlawful and set aside agency actions, findings, and conclusions that are determined to be: (1) arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law; (2) contrary to constitutional right, power, privilege, or immunity; (3) in excess of statutory jurisdiction, authority, or limitations, or short of statutory right; or (4) without observance of procedure required by law. In general, under the APA, a biological opinion could be considered arbitrary and capricious if: (1) it relied on factors (*e.g*., economics) which Congress did not intend NMFS to consider when conducting section 7 consultations; (2) it entirely failed to consider an important aspect involved in the consultation; (3) it offered an explanation for a conclusion that was not supported by the evidence, or was so implausible that it could not be ascribed to a difference in view or the product of expertise; or (4) it failed to articulate a satisfactory explanation for a conclusion.

2.3 Data Quality Act

Section 515 of the DQA directs the Office of Management and Budget (OMB) to issue government-wide guidelines that "*…provide policy and procedural guidance to Federal agencies for ensuring and maximizing the quality, objectivity, utility, and integrity of information disseminated by Federal agencie*s." These guidelines identify three elements of quality – utility, integrity, and objectivity. Utility represents the usefulness of the information to its intended

users, including the public. Integrity is described as the protection and security of information from unauthorized access or revision to prevent corruption or falsification. Objectivity as the term relates to the DQA is the presentation of accurate, reliable, unbiased information in an accurate, clear, complete, and unbiased manner within the proper context. The OMB suggests that to be objective, information should be produced by methods that are "transparent" and reproducible by others. NMFS strives to meet the OMB guidelines for all information the agency produces.

3.0 General Overview

3.1 Designated Critical Habitat Analyses

NMFS conducts its section 7 analyses for designated critical habitat using a sequence of steps. The first step identifies those aspects of the proposed project that are likely to have direct and indirect effects on the physical, chemical, or biotic environment of an action area. As part of this step, we identify the spatial extent of these direct and indirect effects, including changes in that spatial extent over time. The results of this step represent the action area for the consultation. The second step of our analyses identifies the areas of designated critical habitat that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our *exposure analyses*). In this step of our analyses, we try to identify the primary constituent elements (PCE) [1] that are likely to be exposed to the proposed project's effects. These PCEs are the sites which are essential to support one or more life stages of the species, including: (1) freshwater spawning, (2) freshwater rearing, (3) freshwater migration, (4) estuarine areas, (5) nearshore marine areas, and (6) offshore marine areas. These sites, in turn, contain physical or biological features essential to the conservation of the species, including adequate (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, (10) safe passage conditions, and (11) salinity conditions. The basis of the analysis is to evaluate the function and role of the critical habitat in the conservation of the species. As a result, NMFS bases the critical habitat analysis on the affected areas and functions of critical habitat essential to the conservation of the species, and not on how individuals of the species will respond to changes in habitat quantity and quality. For each PCE of each species, we will evaluate the effects of the action on individual physical, chemical, or biological features that comprise the PCE.

Once we identify which PCEs are likely to be exposed to the proposed project's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether the quantity, quality, or availability of one or more PCEs of critical habitat are likely to be reduced upon exposure (these represent our *response analyses*). The final steps of our analyses are to establish the risks those responses pose to critical habitat (these represent our *risk analyses*). Our adverse modification to critical habitat determinations must be based on whether the proposed project's effects are likely to reduce the conservation value of the critical habitat designation. The reasoning and decision making for the steps taken to determine whether the

[1] The critical habitat designation for Sacramento River Winter-Run Chinook salmon uses the term 'essential habitat.' For the purposes of this document, the term "PCE" includes essential habitat.

proposed project's effects are likely to result in the adverse modification of designated critical habitat are presented in **Table 1**.

Table 1. Reasoning and Decision Making Steps for Analyzing the Proposed Project's Effects on Designated Critical Habitat. Acronyms and Abbreviations in the Action Column Refer to Not Likely to Adversely Affect (NLAA) and Adverse Modification of Critical Habitat (AD MOD).

Step	Apply the Available Evidence to Determine if…	True/False	Action
A	The proposed project is not likely to produce stressors that have direct of indirect adverse consequences on the environment	True	End
		False	Go to B
B	Areas of designated critical habitat are not likely to be exposed to one or more of those stressors or one or more of the direct or indirect consequences of the proposed project	True	NLAA
		False	Go to C
C	The quantity, quality, or availability of one or more constituent elements of critical habitat are not likely to be reduced upon being exposed to one or more of the stressors produced by the proposed project	True	NLAA
		False	Go to D
D	Any reductions in the quantity, quality, or availability of one or more constituent elements of critical habitat are not likely to reduce the conservation value of the exposed area	True	-
		False	Go to E
E	Any reductions in the conservation value of the exposed area of critical habitat are not likely to reduce the conservation value of the critical habitat designation	True	No AD MOD
		False	AD MOD

3.2 Listed Species Analyses

NMFS conducts its section 7 analyses for listed species using a sequence of steps similar to the designated critical habitat analyses. The first step identifies those aspects of the proposed project that are likely to have direct and indirect effect on the physical, chemical, or biotic environment of an action area. As part of this step, we identify the spatial extent of these direct and indirect effects, including changes in that spatial extent over time. The results of this step represent the action area for the consultation. The second step of our analyses identifies the listed resources that are likely to co-occur with these effects in space and time and the nature of that co-occurrence (these represent our *exposure analyses*). In this step of our analyses, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to the proposed project's effects and the populations or subpopulations those individuals represent. Once we identify which listed resources are likely to be exposed to the proposed project's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure (these represent our *response analyses*).

The final steps of our analyses involve establishing the risks those responses pose to listed resources (these represent our *risk analyses*). Our jeopardy determinations must be based on the proposed project's effects on the continued existence of threatened or endangered species as those "species[2]" have been listed, which can include true biological species, subspecies, or distinct population segments of vertebrate species. Because the continued existence of listed

[2] For purposes of conservation under the Endangered Species Act, an Evolutionarily Significant Unit (ESU) or Distinct Population Segment (DPS) is a distinct population segment that is substantially reproductively isolated from other conspecific population units and represents an important component in the evolutionary legacy of the species (Waples 1991).

species depends on the fate of the populations that comprise them, the viability of listed species depends on the viability of the populations that comprise the species. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them; populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

Our risk analyses reflect these relationships between listed species and the populations that comprise them, and the individuals that comprise those populations. Our risk analyses begin by identifying the probable risks the proposed project poses to listed individuals that are likely to be exposed to the proposed project's effects. Our analyses then integrate those individuals risks to identify consequences to the populations those individuals represent. Our analyses conclude by determining the consequences of those population-level risks to the species those populations comprise.

We measure risks to listed individuals using the individual's "fitness," which are changes in an individual's growth, survival, annual reproductive success, or lifetime reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable responses to the proposed project's effects on the environment (which we identify during our response analyses) are likely to have consequences for the individual's fitness.

When individual, listed plants or animals are expected to experience reductions in fitness, we would expect those reductions to also reduce the abundance, reproduction rates, or growth rates (or increase variance in one or more of these rates) of the populations those individuals represent (see Stearns 1992). Reductions in one or more of these variables (or one of the variables we derive from them) is a *necessary* condition for reductions in a population's viability, which is itself a *necessary* condition for reductions in a species' viability. On the other hand, when listed plants or animals exposed to the proposed project's effects are *not* expected to experience reductions in fitness, we would not expect the proposed project to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (for example, see Anderson 2000 and Stearns 1992). If we conclude that listed plants or animals are *not* likely to experience reductions in their fitness, we would conclude our assessment.

If, however, we conclude that listed plants or animals are likely to experience reductions in their fitness, our assessment tries to determine if those fitness reductions are likely to be sufficient to reduce the viability of the populations those individuals represent (measured using changes in the populations' abundance, growth rate, spatial structure, and diversity or variance in these measures to make inferences about the population's extinction risks). In this step of our analyses, we use the population's base condition, represented by the environmental baseline, as our point of reference. Finally, our assessment tries to determine if changes in population viability are not likely to be sufficient to reduce the viability of the species those populations comprise. In this step of our analyses, we use the species' status as our point of reference. The general conceptual model of this assessment approach is shown in **Figure 1**. The reasoning and decision making for the steps taken to determine whether the proposed project's effects are not likely to jeopardize the continued existence of listed species are presented in **Tables 2 and 3**.

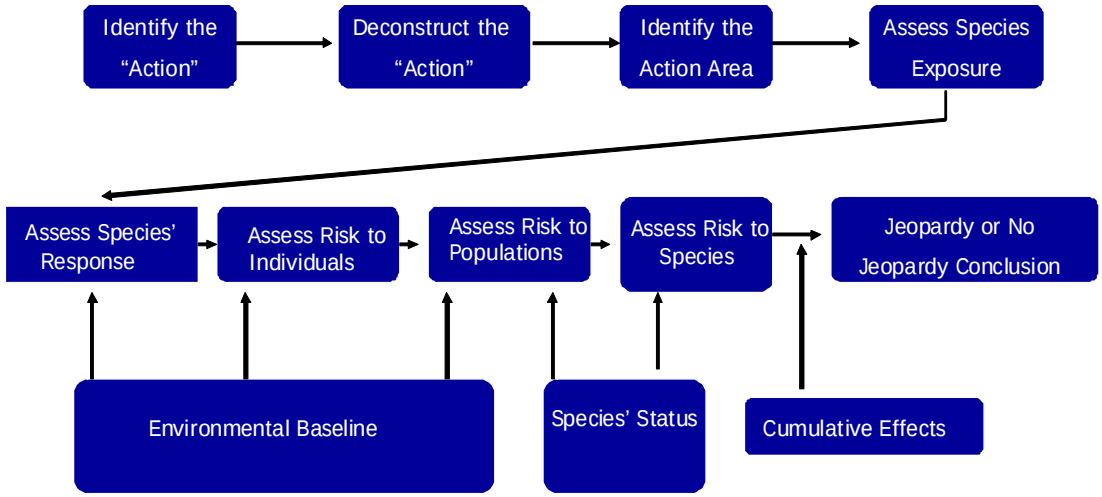

Figure 1. General Conceptual Model for Conducting Section 7 Analyses for Listed Species.

4.0 Specific Analytical Approach

Pursuant to section 7(a)(2) of the ESA, Federal agencies are directed to insure that their activities are not likely to result in the destruction or adverse modification of critical habitat or jeopardize the continued existence of any listed species. The following sections outline the specific conceptual framework and key steps and assumptions utilized in the critical habitat destruction or adverse modification risk assessment and the listed species jeopardy risk assessment. Wherever possible, these sections were written to apply to all seven listed species occurring in the action area, which include:

- Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*);
- Central Valley spring-run Chinook salmon (*O. tshawytscha*);
- Central Valley steelhead (*O. mykiss*);
- Central California Coast steelhead (*O. mykiss*);
- Southern Oregon/Northern California Coast coho salmon (*O. tshawytscha*);
- Southern Distinct Population Segment of North American green sturgeon (*Acipenser medirostris*); and
- Southern Resident killer whales (*Orcinus orca*).

However, the analytical approach for evaluating the potential effects of the proposed project on these species, in many cases, required genus-specific information. For example, because of varying life history strategies and habitat needs among the species, the Ecological Conceptual Framework was divided into three sections: one for salmonids, one for green sturgeon, and one for killer whales.

Table 2. Propositions that are used to organize this assessment of whether the proposed project is likely to jeopardize the continued existence of endangered or threatened species.

	Proposition
P1.	The proposed project does not represent an attempt to engage in any form of 'take' of endangered species or threatened species (as term 'species' is defined in section 3 of the Endangered Species Act of 1973, as amended, and applicable regulations) or does the proposed project represent an intentional act that would otherwise constitute a violation of section 9 of the Act.
P2.	If the proposed project does not represent an attempt to engage in any form of 'take,' the proposed project and any activities that are interrelated or interdependent with the proposed project *are not likely* to produce potential stressors or subsidies that would reasonably be expected to act directly on listed individuals or have direct or indirect consequence (positive or negative) on the environment of those listed individuals or constituent elements of designated critical habitat.
P3.	If the proposed project and any activities that are interrelated or interdependent with the proposed project *are likely to produce potential stressors*, endangered or threatened individuals or units of designated critical habitat *are not likely to be exposed* to one or more of those potential stressors or subsidies or one or more of the direct or indirect consequences of the proposed project (or any activities that are interrelated or interdependent with the proposed project) on the environment.
P4.	If *listed individuals are likely to be exposed* to one or more of the direct or indirect consequences of the proposed project on the natural environment, those listed individuals *are not likely to respond*, positively or negatively, to that exposure.
P5.	If *listed individuals are likely to respond*, those responses *are not likely to be sufficient to reduce their individual performance* or are they likely to constitute an incidental 'take' of endangered species or threatened species.
P6.	If *the responses of listed individuals are likely to reduce their individual performance*, those fitness reductions *are not likely* to be sufficient to appreciably reduce the performance of the population(s) those individuals represent.
P7.	If *populations of listed individuals are likely to experience reductions in their performance*, those reductions in population performance *are not likely* to be sufficient to appreciably increase the extinction probability of the species those population(s) constitute (that is, reduce their likelihood of both surviving and recovering in the wild).

Table 3. Decision outcomes that result from accepting or rejecting the seven propositions associated with endangered or threatened species. "A" means that we accept a proposition as true given the evidence available, "R" means that we reject a proposition as false given the evidence available; "-" means that a proposition is not applicable

Outcomes Associated with Propositions		P1	P2	P3	P4	P5	P6	P7
01	No effect because action is not likely to produce potential stressors	A	A	-	-	-	-	-
02	No effect because listed resources are not likely to be exposed to stressors	A	R	A	-	-	-	-
03	May affect, not likely to adversely affect because probability of exposure is "discountable"	A	R	A	-	-	-	-
04	May affect, not likely to adversely affect because responses are not likely to be measurably different from no response	A	R	R	A	-	-	-
05	May affect, not likely to adversely affect because responses are entirely beneficial	A	R	R	A	-	-	-
06	May affect, not likely to adversely affect because responses are not likely to have fitness consequences	A/R	R	R	R	A	-	-
07	Not likely to jeopardize because reduction in population performance is not likely	A/R	R	R	R	R	A	-
08	Not likely to jeopardize because reduction in species viability is not likely	A/R	R	R	R	R	R	A

4.1 Ecological Conceptual Framework

4.1.1 Anadromous Salmonids

In order to assess the survival and recovery of any species, a guiding framework that includes the most appropriate biological and demographic parameters is required. McElhany *et al*. (2000) defines a viable salmonid population (VSP) as an independent population that has a negligible probability of extinction over a 100-year time frame. The VSP concept provides specific guidance for estimating the viability of populations and larger-scale groupings of Pacific salmonids such as Evolutionarily Significant Units (ESU) or Distinct Population Segments (DPS). Four VSP parameters form the key to evaluating population and ESU/DPS viability: (1) abundance; (2) productivity (*i.e*., population growth rate); (3) population spatial structure; and (4) diversity (McElhany *et al.* 2000). These four parameters and their associated attributes are presented in **Figure 2**.

As presented in Good *et al*. (2005), criteria for VSP are based upon measures of the VSP parameters that reasonably predict extinction risk and reflect processes important to populations. Abundance is critical, because small populations are generally at greater risk of extinction than large populations. Stage-specific or lifetime productivity (*i.e*., population growth rate) provides information on important demographic processes. Genotypic and phenotypic diversity are important in that they allow species to use a wide array of environments, respond to short-term changes in the environment, and survive long-term environmental change. Spatial structure reflects how abundance is distributed among available or potentially available habitats, and can

affect overall extinction risk and evolutionary processes that may alter a population's ability to respond to environmental change.

The VSP concept also identifies guidelines describing a viable ESU/DPS. The viability of an ESU or DPS depends on the number of populations within the ESU or DPS, their individual status, their spatial arrangement with respect to each other and to sources of catastrophes, and diversity of the populations and their habitat (Lindley *et al*. 2007). Guidelines describing what constitutes a viable ESU are presented in detail in McElhany *et al*. (2000).

Figure 2. Viable Salmonid Population (VSP) Parameters and Their Attributes

Along with the VSP concept, NMFS uses a conceptual model of the species and its critical habitat to evaluate the potential impact of proposed actions. For the species, the conceptual model is based on a bottom-up hierarchical organization of individual fish at the life stage scale, population, diversity group, and ESU/DPS (**Figure 3**). The guiding principle behind this conceptual model is that the viability of a species (*e.g.*, ESU) is dependent on the viability of the diversity groups that compose that species and the spatial distribution of those groups; the viability of a diversity group is dependent on the viability of the populations that compose that group and the spatial distribution of those populations; and the viability of the population is dependent on the four VSP parameters, and on the fitness and survival of individuals at the life stage scale. The anadromous salmonid life cycle includes the following life stages and behaviors, which will be evaluated for potential effects resulting from the proposed project: adult immigration and holding, spawning, embryo incubation, juvenile rearing and downstream movement[3], and smolt outmigration.

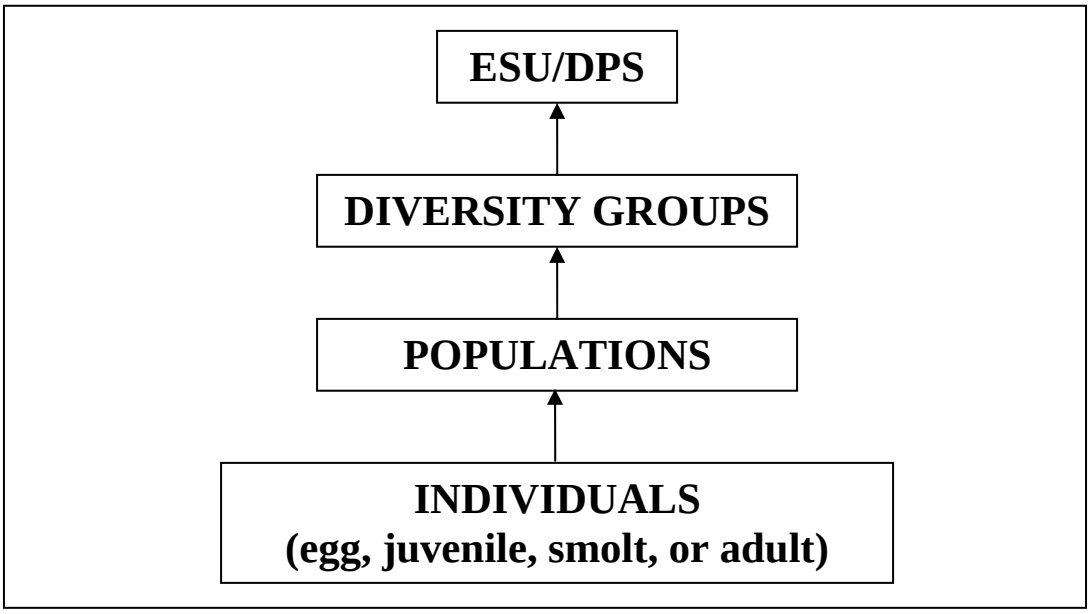

Figure 3. Conceptual Model of the Hierarchical Structure that is used to Organize the Jeopardy Risk Assessment for Anadromous Salmonids.

NMFS equates a species' viability (or extinction risk) with the likelihood of both the survival and recovery of the species in the wild for purposes of conducting jeopardy analyses under section 7(a)(2) of the ESA. Similar to a species with a low likelihood of both survival and recovery, a species with a low likelihood of viability does not equate to a species that does not have the potential to become viable. Instead, the designation of a low likelihood of viability indicates that the species faces significant risks from internal and external processes that can

[3] The juvenile rearing and downstream movement life stage is intended to include fry emergence, and fry and fingerling rearing, which occurs both in natal streams and as these fish are moving downstream through migratory corridors at a pre-smolt stage. The distinction between juveniles and smolts is made because smolts have colder thermal requirements than juveniles that are not undergoing osmoregulatory physiological transformations.

drive a species to extinction. The status assessment considers and diagnoses both the internal and external processes affecting a species' extinction risk.

The four VSP parameters are important to consider because they are predictors of extinction risk, and the parameters reflect general biological and ecological processes that are critical to the survival and recovery of the listed salmonid species (McElhany *et al*. 2000). The VSP parameters of productivity, abundance, and population spatial structure are consistent with the "reproduction, numbers, or distribution" criteria found within the regulatory definition of jeopardy (50 CFR 402.02) and are used as surrogates for "numbers, reproduction, and distribution." The VSP parameter of diversity relates to all three jeopardy criteria. For example, numbers, reproduction, and distribution are all affected when genetic or life history variability is lost or constrained, resulting in reduced population resilience to environmental variation at local or landscape-level scales.

4.1.2 Southern DPS of North America Green Sturgeon

We will use a conceptual model for green sturgeon similar to that of anadromous salmonids, in that: (1) a bottom-up model is also used to evaluate potential effects of the proposed project such that the analysis followed a life stage/individual-population/DPS hierarchical organization; and (2) the effects of the proposed project on green sturgeon abundance, productivity, spatial structure, and diversity are considered. The life cycle model for green sturgeon includes adult immigration and holding, spawning, embryo incubation, and juvenile rearing and outmigration.

4.1.3 Southern Resident Killer Whales

The proposed project has the potential to affect Southern Resident killer whales in a more limited way relative to the anadromous species discussed above. For example, only prey availability (*i.e.*, salmon abundance) for killer whales could potentially be altered by the Project, and no direct mortality or habitat effects are expected. Because salmonids, and particularly Chinook salmon, are the primary prey for the Southern Resident DPS, any Project-related effects that would decrease the availability of salmon in the ocean could adversely affect Southern Resident killer whales (NMFS 2008). Considering that recent estimates of the percentage of Chinook salmon off the central California coast that are of wild origin range from four to 16 percent (Barnett-Johnson *et al*. 2007), the jeopardy risk assessment for killer whales is based on: (1) potential changes in the number of Chinook salmon produced in hatcheries as mitigation for the proposed project; and (2) the effects of the proposed project on the abundance of natural-origin Chinook salmon.

5.0 Destruction or Adverse Modification Risk Assessment Approach

To determine if the proposed project is likely to result in the destruction or adverse modification of designated critical habitat for each of the listed species under NMFS' jurisdiction that occur in the proposed project area, NMFS will analyze the effects of the action on the elements of critical habitat identified as essential to the conservation of each of the species. Our critical habitat destruction or adverse modification risk assessment will begin with a discussion of the biological

and physical features (*i.e.*, PCEs) in the entire designated critical habitat that are essential to the conservation of each ESU/DPS, the current conditions of such features, and the factors responsible for those current conditions. Next, to describe the environmental baseline, NMFS will discuss the current condition of critical habitat in the action area, the factors responsible for that condition, the conservation role of those specific areas, and the relationship of critical habitat designated in the action area to the entire designated critical habitat at the ESU/DPS scale to the conservation of the species. To evaluate the effects of the proposed project, NMFS will characterize the effects on critical habitat designated in the action area. This characterization represents the exposure analyses, described in section 3.1. Using the best scientific and commercial data available, we estimate the effect of the proposed project on water quantity/quality and instream habitat because these effects may influence substrate and sediment levels, water quality conditions, and other general conditions of watersheds that support the biological and ecological requirements of each of the species (response analyses). If the effects of the proposed project, when added to the environmental baseline and combined with cumulative effects, are not reasonably likely to destroy or adversely modify the value of constituent elements essential to the conservation of each of the listed species in the action area, then the proposed project is not likely to destroy or adversely modify designated critical habitat as a whole (risk analyses). Conversely, if the conservation value of the affected essential habitat features in the action area is likely to be destroyed or adversely modified, NMFS must then determine whether the impacts reduce the function of the overall critical habitat at the ESU/DPS scale for the conservation of the species or reduce the current ability of the critical habitat to establish essential habitat features and functions. Different areas and features of critical habitat will have varying roles in the recovery of natural, self-sustaining populations. For the final steps, NMFS evaluates whether, with implementation of the proposed project, critical habitat would remain functional to serve the intended conservation role for each ESU/DPS or retain its current ability to establish those features and functions essential to the conservation of the species.

6.0 Jeopardy Risk Assessment Approach

6.1 Anadromous Salmonids

The listed anadromous salmonids that occur in the action area include the Sacramento River winter-run Chinook salmon ESU, the Central Valley spring-run Chinook salmon ESU, the Central Valley steelhead DPS, the Southern Oregon/Northern California Coast (SONCC) coho salmon ESU, and the Central California Coast (CCC) steelhead DPS. Our jeopardy risk assessment for each of these species will begin with a diagnosis of the current status of each ESU/DPS throughout its geographic range. In other words, NMFS will evaluate the viability of each ESU/DPS given its exposure to human activities and natural phenomena throughout its geographic distribution. As discussed above, NMFS utilizes the VSP conceptual framework for this assessment. The diagnosis describes the species legal status, identifies existing threats, and details the distribution and trends of threats throughout the range of each ESU/DPS. We describe the species status in terms of the VSP characteristics of the ESU/DPS and the diversity groups and populations within the ESU/DPS that are affected by the proposed project. The species' status includes the effects of ongoing changes in climate conditions and the influence of ocean conditions on the species. In the species' status, we also consider the ecology of

population collapse and extinction, especially as it relates to the dynamics of small population size (see Abrams 2002 and Niwa 2007). Because NMFS' opinion as to whether an action is not likely to jeopardize a species is based on the species-as-listed scale (*e.g.*, ESU for Chinook salmon), the status of the species diagnoses provide points-of-reference that NMFS uses in its final steps in the jeopardy analysis.

Our jeopardy risk assessment continues with the environmental baseline, which is designed to assess the viability of populations at the scale of the action area given their exposure to both human activities and natural phenomena. The environmental baseline "*…includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process*" (50 CFR 402.02). The environmental baseline includes the conditions that likely have resulted from past and current operation of the proposed project, and their effects on individual listed salmonid at the life stage scale and the viability parameters of respective populations. Because our jeopardy analysis must consider the effects of the proposed project within the context of the other impacts experienced by the species, some information provided in the environmental baseline is also used to describe the conditions faced by the same individuals that will be affected by the future proposed operations of the proposed project. NMFS uses the analysis of how activities other than proposed project operations have impacted the fitness (growth, survival, or reproduction) of individual fish to provide the context or condition of the animals that the proposed project operations will impact over the life of the proposed project (*i.e.*, until 2030).

The environmental baseline is organized into several sequential parts. First, existing scientific information related to the seasonal periodicity and life history traits and biological requirements of listed salmon and steelhead within the Project area is presented. Understanding the spatial and temporal occurrence of these fish is a key step in evaluating how they are affected by current human activities and natural phenomena.

Second, NMFS summarizes past and current human activities and describes how these activities influence current habitat conditions within each of the listed salmonid populations in the action area. NMFS then describes how these habitat conditions influence the viability of each species.

NMFS evaluates the likely effects of the proposed project on listed salmonids within the action area. The first steps in evaluating the potential impacts a project may have on an individual fish would entail: (1) identifying the main variables that define riverine characteristics that may change as the result of project implementation; (2) determining the extent of change in each variable in terms of time, space, magnitude, duration, and frequency; (3) determining if individual listed species will be exposed to potential changes in these variables; and (4) then evaluating how the changed characteristic would affect the individual fish in terms of the fish's growth, survival, and/or reproductive success.

Riverine characteristics may include: flow, water quality, vegetation, channel morphology, hydrology, neighboring channel hydrodynamics, and connectivity among upstream and downstream processes. Each of these main habitat characteristics are defined by several

attributes (*i.e*., water quality includes water temperature, dissolved oxygen, ammonia concentrations, turbidity, *etc.*). The degree to which the proposed project may change attributes of each habitat characteristic will be evaluated quantitatively and/or qualitatively, in the context of its spatial and temporal relevance[4]. The changed nature of each attribute will then be compared to the attribute's known or estimated habitat requirements for each fish species and life stage. For example, if water temperature modeling results demonstrate that water temperatures during the winter-run Chinook salmon spawning season (mid-April through mid-August) would be warmer with implementation of the proposed project, then the extent of warming and associated impact, would be assessed in consideration of the water temperature ranges required for successful winter-run Chinook salmon spawning.

Next, NMFS evaluates the likely response of listed salmonids to such stressors based on the best available scientific and commercial information available, including observations of how similar exposures have affected these species as described in the environmental baseline. Since habitat modification by the proposed project represents the primary mechanism by which the proposed project has potential effects on individual listed salmonids, NMFS utilizes a habitat-based assessment to analyze effects. For example, NMFS first describes the hydrological modifications that result from the proposed project in the action area using modeled flows. NMFS then evaluates whether the resulting hydrological conditions support the biological and ecological needs of each listed salmonid species in the action area. NMFS assesses whether the conditions that result from the proposed project, in combination with conditions influenced by other past and ongoing activities and natural phenomena as described by the environmental baseline, will affect growth, survival, or reproductive success (*i.e.*, fitness) of individual listed salmonids at the life stage scale.

NMFS will then evaluate how the proposed project's effects on riverine characteristics may affect the growth, survival, and reproductive success of individual fish. For example, growth and survival and reproductive success of individual fish may all be affected if the proposed project results in increased water temperatures during multiple life stages. Individual fish growth also may be affected by reduced availability, quantity, and quality of habitats (*e.g*., floodplains, channel margins, intertidal marshes, *etc*.). Survival of an individual fish may be affected by suboptimal water quality, increased predation risk associated with non-native predatory habitats and physical structures (such as gates, weirs), impeded passage, and susceptibility to disease. Reproductive success of individual fish may be affected by impeded or delayed passage to natal streams, suboptimal water quality (*e.g*., temperature), which can increase susceptibility to disease, and reduced quantity and quality of spawning habitats. Instream flow studies (*e.g*., instream flow incremental methodology studies) available in the literature, which describe the relationship between spawning habitat availability and flow will be used to assess proposed project-related effects on reproductive success. All factors associated with the proposed project that affect individual fish growth, survival, or reproductive success will be identified during the exposure analyses.

[4] Not all of the riverine characteristics and associated attributes identified above may be affected by proposed project implementation to a degree where meaningful qualitative or quantitative evaluations can be conducted. That is, if differences in flow with and without the proposed project implementation are not sufficient to influence neighboring channel hydrodynamics, then these hydrodynamics will not be evaluated in detail, either quantitatively or qualitatively.

Once we have determined how the proposed action, when added to environmental baseline conditions, will affect the fitness of individual listed salmonids, the next steps in NMFS' jeopardy risk assessment are to evaluate whether these fitness consequences, in combination with cumulative effects, including future environmental variation, are reasonably likely to affect viability of each species at the population level. For example, lower survival resulting from loss or reduction of rearing habitat may reduce abundance. This same habitat reduction can reduce the productive capacity of the river system and impact the productivity of the population, or constrain the ability of individuals of the species to track environmental changes, affecting the diversity and spatial structure of the population.

For a given species, if the effects of the action are likely to reduce the viability of one or more populations, we then assess whether this reduction is reasonably likely to appreciably reduce the viability of the diversity group to which the population belongs. If no reductions in a population's viability are expected, we conclude that the diversity group and, therefore, also the ESU/DPS are not appreciably affected by the proposed action. For the purposes of the jeopardy risk analysis, NMFS assesses whether the proposed project is not likely to reduce the viability of the diversity group based on how the viability of its member populations is affected by the proposed project.

The Central Valley Domain Technical Recovery Team (TRT) recommended that for the three species listed in that Domain, all extant populations should be secured and that, "…*every extant population be viewed as necessary for the recovery of the ESU*" (Lindley *et al*. 2007). Similarly, the SONCC Domain TRT recommended that all extant coho salmon populations be secured in order to achieve ESU recovery. Based on these recommendations, it was assumed that if appreciable reductions in any population's viability are expected to result from implementation of the Project, then this would be expected to appreciably reduce the likelihood of both the survival and recovery of the diversity group the population belongs to as well as the listed ESU/DPS. Although, NCCC Domain TRT recommendations for achieving steelhead recovery in that domain have not yet been developed, it was assumed reasonable to also apply the recommendations (i.e., secure all extant populations) developed for the Central Valley and SONCC domains in order to assess whether or not the proposed project would jeopardize the continued existence of CCC steelhead.

6.2 Green Sturgeon

Our jeopardy risk assessment for the Southern DPS of green sturgeon follows a similar approach to that which is described for anadromous salmonids. First, the status of the species describes the viability of the Southern DPS of green sturgeon given its exposure to human activities and natural phenomena throughout its geographic distribution. In addition, we consider the effects of ongoing changes in climate conditions, the influence of ocean conditions on the species, and the population dynamics of population with low abundance. Because NMFS' opinion as to whether an action is not likely to jeopardize a species is based on the species-as-listed scale (e.g., Southern DPS), the diagnoses presented in the status of the species provide points-of-reference that NMFS uses in its final steps in the jeopardy analysis.

Next, the environmental baseline section describes the past and present impacts on green sturgeon of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The environmental baseline identifies the antecedent conditions, including those that likely have resulted from past and current operation of the proposed project, and their effect on individual listed green sturgeon at the life stage scale as well as the abundance, productivity, spatial structure, and diversity of the DPS, which is solely composed of the Sacramento River population. The evaluation of the current status of this green sturgeon population within the proposed project area provides a reference condition at the population scale to which NMFS will add the effects of the proposed action in order to compare the potential effects of the proposed action to the environmental baseline.

Once the species' status and environmental baseline have been established, the effects of the proposed project on green sturgeon are analyzed using the exposure-response-risk framework described above for anadromous salmonids. Because the Southern DPS of green sturgeon is composed of only the Sacramento River population, any impacts to individuals at the life stage scale that would not likely be expected to reduce the viability of the population also would not likely be expected to not reduce appreciably the likelihood of both the survival and recovery of the DPS.

6.3 Southern Resident Killer Whales

Again the jeopardy risk assessment approach will build from the status of the species, to the environmental baseline, and finally to the analysis of effects section, with the general content of these sections following that which was described above for anadromous salmonids. As previously mentioned, the jeopardy risk assessment for killer whales was based on the number of Chinook salmon produced in hatcheries as mitigation for the proposed project and the abundance of natural-origin Chinook salmon. More details regarding how the exposure, response, and risk to killer whales will be analyzed are in development.

7.0 Key Aspects and Tools of NMFS' Analyses

7.1 Key Aspects of the Analyses

Key aspects of the consultation that will need to be defined and fully described include the following:

- Water temperature effects by species and life-stage (provide table w/references)
- Red Bluff Diversion Dam delays
- Predation
- Loss due to unscreened diversions
- Delta pumping entrainment salvage and loss assumptions

- Survival in-river, assumed fish split at Delta Cross Channel
- Survival through Delta
- Survival in ocean.

7.2 Modeling Tools

The effects analysis will rely on several modeling tools:

- Hydrologic Models: CALSIM II & DSM2 (Delta)
- CalLite Model (screening tool)
- Temperature Models, USBR and SRWQM
- Feather River Temperature Model, DWR
- Salmon Mortality Model, USBR
- Life Cycle Model, Interactive Object-Oriented Salmon Simulation (IOS) developed by Cramer & Associates for Winter-run Chinook only
- Population Models
- SALMOD Model, USBR
- Viable Salmonid Population (VSP) Framework, (Lindley *et al.* 2007)
- Climate Change Models, USBR and DWR
- Uncertainty estimates in models

To the greatest extent possible, this consultation will strive to include comments and recommendations developed by an expert panel that was organized for a water temperature management and modeling workshop help in support of the OCAP (Deas *et al*. 2008).

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