

## Technical Advisory Committee – Background Materials

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The following document provides background information on the federal Endangered Species Act (ESA) and descriptions of the various modeling tools that will be used in the development of the Salinas River Operations Habitat Conservation Plan (HCP) to inform the HCP Technical Advisory Committee discussions (HCP-TAC). The HCP-TAC's purpose is to assist in the development and evaluation of water management scenarios considered for the Salinas River Operations HCP by providing a forum for soliciting feedback and recommendations from the public via relevant technical experts during the water management evaluation process. The HCP-TAC is focused specifically on technical issues related to Monterey County Water Resources Agency's (MCWRA) water management responsibilities in the Salinas River basin.

MCWRA is the primary local agency managing water and minimizing flood risk along the Salinas River. One of MCWRA's highest priorities is water conservation,<sup>1</sup> implemented primarily through managed reservoir releases. Releases from the Nacimiento and San Antonio Dams provide groundwater recharge for the Salinas Valley Basin aquifers and surface diversion at the Salinas River Diversion Facility (SRDF), reducing reliance on groundwater pumping at the northern end of the Salinas Valley. Due to the many and growing challenges facing the Salinas River,<sup>2</sup> it is critical that MCWRA successfully manages the water resources for urban and agricultural users while minimizing flood risk and addressing the needs of species listed under the ESA, including federally threatened South-Central California Coast steelhead (*Oncorhynchus mykiss*) and federally endangered tidewater goby (*Eucyclogobius newberryi*). To address these challenges, MCWRA has initiated development of the Salinas River Operations HCP, a multi-species regional HCP compliant with Section 10 of the ESA that will, at a minimum, identify and evaluate the effects associated with reservoir operations and subsequently identify conservation measures by which impacts may be avoided, minimized, and mitigated such that the overall impacts of reservoir operation on covered species are fully offset.

A key milestone in developing an HCP is establishing the methods to evaluate impacts of all covered activities on each covered species. Development-based HCPs often quantify impacts by using land cover or habitat models overlain with land conversion areas. This approach is well accepted and straightforward for terrestrial species whose habitat changes little from year to year, can be mapped using a Geographic Information System (GIS), and where impacts are a permanent loss of existing habitat to developed lands. In contrast, HCPs covering on-going operational impacts of water systems, such as reservoir operations, require a more tailored approach to the effects analysis. An added layer of complexity in evaluating operational impacts is that these types of impacts have often been on-going prior to the HCP. To evaluate the effects of on-going operations, one must first define the reference points against which those on-going operations are measured.

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<sup>1</sup> In this context, "water conservation" primarily refers to conserving water in above- or below-ground reservoirs for the purpose of providing a more reliable supply to urban and agricultural users.

<sup>2</sup> The Salinas River Long-Term Management Plan (2019), Chapter 4, *Management Challenges*, provides an overview of the management issues affecting the Salinas River.

# Regulatory Guidance on Evaluating Impacts

Before U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS; collectively, *Services*) may issue incidental take permits under ESA Section 10(a)(1)(B) for the Salinas River Operations HCP, each Service is required to comply with ESA Section 7(a)(2) because issuing a Section 10 permit triggers an internal as well as intra-Service Section 7 consultation. As such, we must consider the regulatory standards for evaluating take under both Section 10 and Section 7. This section first identifies the terms defined by the regulations that are relevant to evaluating take and then describes the regulations and policies informing how take analyses are framed under ESA Section 10 and Section 7.

## Glossary

Select ESA terminology for Section 10 and Section 7 are provided for context on describing the effects determination process.

### General ESA Terms

**Take** means “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.” Harm is further defined as “any act that kills or injures the species, including significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering” (50 CFR 17.3).

**Incidental take** refers to takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the federal agency or applicant. (50 CFR 402.02)

### Section 10 Terms

**Authorized take** means take that is formally permitted under section 10 of the ESA (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016).

**Baseline conditions** means, within the context of HCPs or Safe Harbor Agreements, species population estimates and distribution and/or habitat characteristics determined to be present within the area of an enrolled property that sustains seasonal or permanent use by the covered species at the time an agreement is executed between the Services and the property owner.

**Conservation measure** means the avoidance, minimization, or mitigation actions taken to meet the goals and objectives of an HCP (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016). Conservation measures are, collectively, all avoidance measures, minimization measures, and mitigation measures.

**Conservation plan** means the plan required by section 10(a)(2)(B) of the ESA that an applicant must submit when applying for an incidental take permit. Conservation plans also are known as “habitat conservation plans” or “HCPs.” Incidental take is authorized through a section 10(a)(1)(B) permit (50 CFR 17.3 for USFWS; 50 CFR 222.102 for NMFS).

**Conservation strategy** means an established, consistent approach for guiding conservation actions. Should be founded on recovery plan actions if available, or other formal intra-Service planning, agreements, or procedures. Ideally, these take the form of directives issued by appropriate

management level governing the affected Service field stations (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016).

**Covered activities** means those projects or ongoing activities that receive incidental take authorization under the incidental take permits (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016).

**Covered species** means species for which incidental take is authorized in an ITP and is adequately covered in an HCP. Could also include unlisted species that have been adequately addressed in an HCP as though they were listed and are therefore included on the ITP (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016).

**Existing conditions** means environmental conditions present in the HCP Plan Area at the time of HCP development.

**Habitat conservation plan (HCP)** means a planning document that supports an application for an incidental take permit issued under Section 10 of the federal Endangered Species Act. See *conservation plan*.

**Incidental take permit (ITP)** means the federal incidental take permit issued by the U.S. Fish and Wildlife Service or National Marine Fisheries Service pursuant to Section 10(a)(1)(B) of the Endangered Species Act.

**Fully offset** means completely mitigating any impacts expected to remain after avoidance and minimization measures are implemented. Other terminology meaning the same thing are that conservation measures are commensurate with the level and type of impacts of the taking or that they will compensate for the impacts of the taking. Fully offset means the biological value that would be lost (from covered activities) will be replaced (through implementation of conservation measures) with equivalent biological value (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016).

**Permit area** means “the geographic area where the impacts of the activity(ies) occur for which an incidental take permit coverage is requested (i.e., the covered activities)” (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016).

**Proposed action** in the context of Section 10 means “issuance of an ESA incidental take permit for the purpose of authorizing incidental take for covered activities” (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016).

## Section 7 Terms

**Action area** means “all areas that will be affected directly or indirectly by the federal action, and not merely the immediate area involved in the action.” (50 CFR 402.02)

**Biological opinion** means the document that states the opinion of the Service as to whether or not the federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. (50 CFR 402.02)

**Critical habitat** means “(i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of the ESA, on which are found those physical or biological features and (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the

provisions of section 4 of the Act, upon a determination by the Secretary that such areas are essential for the conservation of the species.” (16 USC 1532)

**Cumulative effects** means “those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation.” (50 CFR 402.02)

**Effects of the action** means “all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action.” (50 CFR 402.02)

**Environmental baseline** means “the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. 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. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency’s discretion to modify are part of the environmental baseline.” (50 CFR 402.02)

**Incidental take statement** means a section after the conclusion of a biological opinion that “...(i) specifies the impact of such incidental taking on the species, (ii) specifies those reasonable and prudent measures that the Secretary considers necessary or appropriate to minimize such impact, (iii) in the case of marine mammals, specifies those measures that are necessary to comply with section 1371(a)(5) of this title with regard to such taking, and (iv) sets forth the terms and conditions (including, but not limited to, reporting requirements) that must be complied with by the federal agency or applicant (if any), or both, to implement the measures specified under clauses (ii) and (iii).”

**Jeopardy, jeopardize, jeopardize the continued existence of** means “...[T]o engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species.” (50 CFR 402.02)

## Endangered Species Act Section 10

To receive a Section 10(a)(1)(B) permit for take “that is incidental to, but not the purpose of, otherwise lawful activities” of federally listed species, the applicant is required to prepare an HCP that, among other things, specifies the “impact that will likely result from such taking” (50 CFR 17.22(b)(1)(iii)(A), 50 CFR 17.32(b)(1)(iii)(C)(1), and 50 CFR 222.307(b)(5)(i)). The *Habitat Conservation Planning and Incidental Take Permit Processing Handbook* (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016; HCP Handbook), provides guidance on how this take analysis should be structured. In its most simplified form, the analysis of the impact of the taking should occur through a three-step process: 1) describing how the impact occurs, 2) quantifying the take, and 3) evaluating the effect of the take on the covered species. While the outcomes of the third step in this process are the focus of the regulation, the first two steps are necessary to accurately and thoroughly assess the impact of the taking. This stepwise process also provides the basis for a logical, transparent, and science-based rationale to identify appropriate

conservation measures to avoid and minimize the effects of the taking (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016: 8-2). The HCP Handbook provides guidance on each of these three steps as summarized below.

### **Step 1: Describe how the Impact Occurs**

The HCP must describe the impact that will likely result from incidental taking (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016: 7-4). The initial step in describing the impact of the taking is to “deconstruct” and qualitatively describe how implementation of the covered activities may result in any effects to a covered species or its habitat, including effects that may not or do not rise to the level of take (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016: 5-2). The HCP Handbook recommends using USFWS’s “Effects Pathway Model” to deconstruct a covered activity into components, each of which may have a different effect on the covered species. Application of this model helps identify all “direct interactions” (effects on the individual organism) as well as “stressors” (any agent capable of causing an adverse or beneficial change to a resource upon which an organism depends) associated with covered activity implementation. Identifying and describing each impact mechanism in this manner helps determine the source of the impact. For example, a draft effects pathway model for steelhead as related to the covered activity of winter releases from the reservoirs could look, in part, as shown in Figure 1.

At this step it is important to begin to “identify and document the chain of logic needed for the development of the HCP’s conservation program” (e.g., avoidance, minimization, and mitigation measures) because the conservation measures will be considered as part of the suite of covered activities in the next step of quantifying the take to be covered by the HCP (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016: 8-1–8-2).

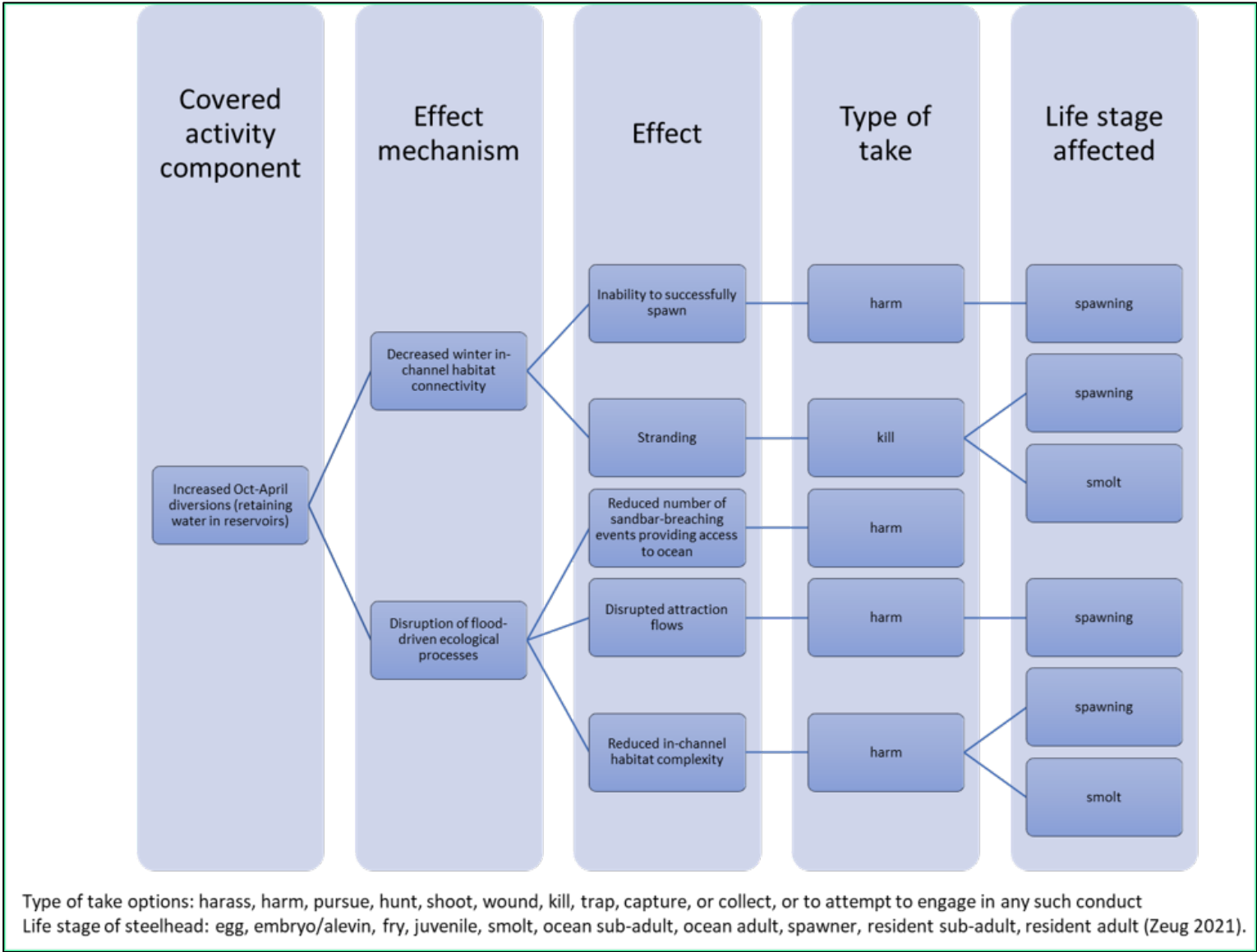


Figure 1. Example Effect Pathway Model for Steelhead (Incomplete)

## **Step 2: Quantify Take**

The HCP Handbook notes that, “quantifying the amount of take provides a key basis for evaluating project impacts.” While the first step identifies the nature of the take, this step provides scale. Take can be quantified in various ways, such as numbers of affected individuals, nesting groups, or a surrogate measure like acres of habitat or stream miles (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016: 8-1). Whatever approach is used, it must include defined units to quantify impacts in terms of taking within the plan area. These same units are included in the permit to specify the quantity of authorized take (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016: 8-3). These units of take will also be used to track and monitor the level of take occurring during permit implementation, so it is critical to use a unit of take that is feasible to track in the field. The loss of individuals of a species is often infeasible to monitor or track during implementation, so a surrogate measure is often used instead. If a surrogate measure such as the amount of habitat is used, the reasoning for using a surrogate must be clearly described and a causal link for the appropriateness of the surrogate explained. The critical focus of this analysis is that the incidental take ultimately defined must be expressed in terms that are measurable and enforceable in the HCP and in the permit (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016: 8-4).

In some cases, the Services will also require that the form of take be specified and quantified separately. For example, where the number of individuals taken can be reasonably estimated, it may also be possible to separate how many individuals are taken through injury (harm) versus mortality (kill). How take is quantified for impacts associated with reservoir operations in the Salinas River Operations HCP will be the focus of a second, future memo.

## **Step 3: Evaluate the Impact of the Taking on the Covered Species**

Finally, the HCP must evaluate the impact of the taking on the covered species, which is the effect on the species’ range or population resulting from the take (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016). The impact of the taking may have population or species-level effects substantially greater than just the number of individuals or acres of species habitat affected by the covered activities. Therefore, to understand the effects to the population, and to ensure that the taking does not appreciably reduce the likelihood of survival and recovery of the species, the area analyzed to determine the impact of the taking may include the entire range of the covered species (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016: 6-4). In other cases, the effects of the taking may be evaluated on a smaller scale such as a recovery unit or evolutionarily significant unit of an anadromous fish. The evaluation must be conducted for each covered species and often varies by species depending on the nature of effects.

A component of this analysis is accounting for changes that may occur to species habitat over the period in which the covered take will occur (i.e., over the permit term) that could compromise the success of the HCP’s conservation strategy (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016: 7-1). Climate change is a primary concern, but other changes may be anticipated as well such as species range shifts and deterioration of habitat due to causes partially or fully outside the control of the HCP permittee, such as stressors related to increased populations of invasive species (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016: 7-4). How the impacts of the taking are evaluated depends on the scale of the effects relative to the scale of the affected population. Projects with substantial effects on a local population may need to build

quantitative models to estimate population size over time both with and without the requested taking.

Ultimately the impacts of the taking must be minimized and mitigated to the maximum extent practicable, and ideally be fully offset. Therefore, the impact of the taking cannot be fully articulated without current information about the presence and status of the species in the plan area, a logical explanation of potential impacts based on the first two steps in the analysis described above (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016: 7-4), and a complete conservation strategy.

## Endangered Species Act Section 7

Section 7(a)(2) of the ESA requires federal agencies to ensure that discretionary actions they fund, authorize, or carry out are not likely to result in the jeopardy of a listed species or result in the destruction or adverse modification of its designated critical habitat. Issuance of an ITP for an approved HCP is a federal action. If a proposed federal action is likely to adversely affect listed species or designated critical habitat, the Service with authority over the potentially affected species “must develop and issue a [biological opinion] that reaches a jeopardy or no jeopardy (or adverse modification or no adverse modification) finding” (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016: 14-24). During this process, called *consultation*, the Service with authority over a given species analyzes the “effects of the action” (issuing the permit and enabling HCP implementation), together with “cumulative effects,” “to determine whether that permit action is likely to jeopardize the continued existence of the listed species or to destroy or adversely modify designated critical habitat” (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016: 1-9). There must be a defined “action area” to bound the geography of the analysis. The HCP Handbook notes that the action area should include “the farthest extent of all areas likely to be affected directly or indirectly by the covered activities” (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016: 6-4).<sup>3</sup>

Regulations guiding the consultation process (50 CFR 402.14(g)(3)) require that an “environmental baseline” be used to compare the current condition of the species and the designated critical habitat in the action area with and without the effects of the proposed action. In other words, the Services assesses the condition of listed species and critical habitat in the action area (the environmental baseline), and then assesses the additive effects of the proposed action to the environmental baseline. The Services are also required to consider cumulative effects in this analysis. The totality of the past, present, and anticipated future impacts on the species helps formulate the Services’ opinions as to whether the proposed action (issuing a permit that enables implementation of the HCP) is likely to jeopardize the continued existence of the listed species or result in the destruction or adverse modification of critical habitat.

In 2019, USFWS and NMFS issued a *Final Rule for Endangered and Threatened Wildlife and Plants; Regulations for Interagency Cooperation* (2019 Final Rule; 84 FR 44976- 45018). The January 2022 *Memorandum between the Department of the Army (Civil Works) and the National Oceanic and Atmospheric Administration* confirmed that no policies since 2019 have resulted in changes to the 2019 Final Rule. A key outcome of the 2019 Final Rule is that the Services declined to limit the “effects of the action” to the component(s) of the discretionary action that was funded, authorized,

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<sup>3</sup> The HCP Handbook does not provide clear guidance on the distinction between the “action area” of the Section 7 consultation and the “permit area” or “plan area” of the HCP. ICF anticipates working with the Services to determine these boundaries as HCP development advances.

or carried out by a federal agency. “Once in consultation, all consequences caused by the proposed action, including the consequences of activities caused by the proposed action, must be considered...provided those activities would not occur but for the proposed action under consultation, and both the activities and the consequences to the listed species or designated critical habitat are reasonably certain to occur” (84 FR 44990).

Ultimately, each Service must be able to conclude in a biological opinion that issuing an ITP and enabling implementation of the proposed HCP (including the covered activities driving the need for the HCP along with the conservation measures) does not appreciably reduce the likelihood of both the survival and recovery of the listed species.

## The Jeopardy Analysis

The HCP Handbook summarizes the jeopardy analysis for a biological opinion addressing the Services’ proposed issuance of ITP (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016: 14-24). The process relies on the following four components:

- “the *Status of the Species*, which evaluates the range-wide condition, the factors responsible for that condition, and the survival and recovery needs of the affected species;
- the *Environmental Baseline*, which evaluates the past and present factors influencing the current condition of the species, its habitat, and ecosystem within the area likely to be affected by the proposed action (i.e., the action area), the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species;
- the *Effects of the Action*, which assesses the direct and indirect impacts of the proposed federal action and the effects of any interrelated or interdependent activities on the species; and
- *Cumulative Effects*, which evaluates the effects of future, non-federal activities reasonably certain to occur within the action area on the species.”

In summary, the Services must evaluate if the proposed action is likely to result in jeopardy of the covered species, taking into consideration all past, current, and future impacts to the species across the species population and range.

## Discussion

The Section 7 regulations are clear that “effects of the action” are analyzed on the environmental baseline: the past, present, and proposed impacts of all federal, state, or private actions and other human activities in an action area, and anticipated impacts of state or private actions that are contemporaneous with the consultation. The Section 10 regulations, however, simply say that the HCP must specify the “impact that will likely result from such taking.” Section 10 regulations focus on the quantity and resulting effects of any take associated with HCP implementation, regardless of the take being more or less than the environmental baseline used in the Section 7 analysis (a foundational assumption for the Salinas River Operations HCP is that take of steelhead will be reduced when compared against baseline). Therefore, to meet the Section 10 standards in the Salinas River Operations HCP for evaluating the effects of the taking on covered species associated with the covered activity of reservoir re-operation, we must isolate the effects of reservoir re-operation from other effects that are related to, but not inherent in, the activity of re-operating the reservoirs. For example, impacts to steelhead caused by the presence of the dams (i.e., their physical

barrier to passage upstream or downstream) are part of the environmental baseline and will be evaluated in the Section 7 analysis, but are not inherently integral to the Section 10 effects analysis of reservoir operation.

We also anticipate that the eventual re-operation protocols will be developed—as they were for the 2007 Biological Opinion and the 2022 Interim Operating Protocols—to integrate impact avoidance and minimization measures. For example, to ensure minimal instream impacts, interim releases are ramped down gradually, over multiple days if needed, to minimize the risk of fish stranding. These measures are a required component of the HCP (16 USC 1539(a)(2)(A)(ii)) and, as such, should be identified discretely from the operation protocol that MCWRA would employ if it were only operating the reservoirs to meet its objectives of water conservation (providing water to its stakeholders when needed) and flood management. Once we understand the effects on covered species resulting from operating the reservoirs to meet MCWRA's objectives, we will subsequently work to quantify the avoidance and minimization component of the ultimate re-operation protocols to demonstrate compliance with impact minimization requirements.

Evaluation of effects associated with reservoir operations requires a comparison point. Of the relatively few completed HCPs that cover reservoir operations, ICF was not able to locate an example of a permitted HCP that utilized an effects analysis consistent with the guidance described above in this memo. While not a completed HCP, NMFS has provided guidance to United Water Conservation District (United Water) regarding United Water's current effort to develop an HCP related to operation of the Freeman Diversion Dam. In a letter dated March 1, 2017, providing United Water with comments on its October 2016 draft multi species HCP, NMFS wrote, "[t]he effects analysis should be confined to a comparison of the no-diversion scenario against the proposed action...[t]his comparison is the only comparison of interest, and relevance, to the permit issuance criteria and matters pertaining to development of the conservation program. This analytical approach would conceivably adequately predict the hydrologic-related effects that would be perpetuated under the proposed action." This comparison point would be one that evaluates a proposed operation schedule against flow conditions if the reservoirs were not operated and all flows into the reservoirs were bypassed (not retained in the reservoir and allowed to continue flowing downstream). This approach would approximate current<sup>4</sup> "natural" flows based on current climate conditions.

While this analysis is intended to comply with the HCP regulations, it will also support the Services' analysis of effects in their respective Section 7 biological opinions, the National Environmental Policy Act (NEPA) document, and other findings documents (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2016: 5-2). None of these analyses "supersedes" another as each is necessary to comply with relevant regulations governing the different laws and implementing regulations.

## **Proposal for Salinas River Operations HCP**

The primary tool that will be used to conduct the effects analysis for the HCP is the Salinas Valley Operational Model (SVOM) developed by the U.S. Bureau of Reclamation, U.S. Geological Survey (USGS), and MCWRA. Due to time and cost considerations in running the SVOM model, a limited

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<sup>4</sup> MCWRA and NMFS will need to discuss and agree upon what a "current" hydrologic period should be for this analysis.

number of model runs will be possible for HCP development. This limitation underscores the need for thoughtful consideration of how the effects analyses will be conducted for the HCP to define the comparison point from which impacts will be evaluated under Section 10, as well as the analyses supporting the Services' internal Section 7 consultations and for the ultimate re-operation protocols that will be covered under the HCP. ICF proposes the following three initial scenarios be run in the SVOM as comparison points (see Appendix A for model parameters).

1. **Bypassing all flows under current physical and flood management constraints.** This scenario would demonstrate the condition of flows in the Salinas River if all Nacimiento and San Antonio reservoir inflows were bypassed (i.e., reservoir inflow is allowed to pass downstream) to the extent feasible given the physical limitations of the dams (e.g., reservoir outlet capacity is limited, no bypass mechanism exists below deadpool) and while upholding flood management responsibilities. This scenario would be compared against Scenario #3 (below) to reveal the impacts (based on a yet-to-be-determined unit of take) associated with operating the reservoirs without consideration to covered species impact minimization. This scenario would also be compared to the final re-operation protocol covered in the HCP to demonstrate that impacts are minimized (as required by 16 U.S.C. 1539 (a)(2)(B)(ii)) and if any impacts remain that require additional mitigation.
2. **Current operating procedures including the 2007 Biological Opinion flow requirements** as currently included in MCWRA's water right. This scenario would provide the environmental baseline for the Section 7 analysis. This scenario would also be used to inform the re-operation protocol based on current best available data.
3. **Current operating procedures excluding the 2007 Biological Opinion flow requirements.** This scenario would represent the "core"<sup>5</sup> covered activity for the HCP, representing the status quo in reservoir operation, including April–October SRDF operation, but not considering covered species habitat needs.

Once the above three analyses are conducted, MCWRA will work with the Wildlife Agencies, modeling consultants, and an extensive group of stakeholders to develop up to three additional SVOM scenarios that could become the final proposed re-operation protocols to be covered in the HCP. The final re-operation protocols will address flood management, water conservation, and steelhead and tidewater goby conservation.

## Core Covered Activities

MCWRA operates flood control, water supply, groundwater augmentation, and hydroelectric facilities throughout the Salinas River basin. These include the Nacimiento and San Antonio Dams and Reservoirs, the Nacimiento Dam hydroelectric project, the SRDF, the Castroville Seawater Intrusion Project (CSIP), and the Salinas Valley Recycling Project. As related to water supply operations, MCWRA has the authority to:

- Store water in surface or underground reservoirs;
- Appropriate, conserve, or reclaim water;

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<sup>5</sup> The concept of a "core" covered activity is established to differentiate the main purpose of why MCWRA is pursuing an HCP (its need to permit reservoir operations for the purpose of water conservation and flood management) as opposed to all HCP covered activities, which will include conservation measures intended to minimize and mitigate the impacts of the "core" covered activities.

- Prevent degradation of water quality;
- Control flood and stormwater; and

For the purposes of this document the core covered activities include the operation of Nacimiento and San Antonio Dams and Reservoirs.

One aspect of MCWRA's operation is water conservation, implemented primarily by maximizing the amount of groundwater recharge into the Salinas Valley Groundwater Basin aquifers. This is largely achieved through the regulated release of water from Nacimiento and San Antonio Reservoirs to:

- maintain Salinas River streamflow to increase groundwater recharge through the streambed, and
- operate the SRDF and augment the water supply available to the CSIP to allow a reduction in groundwater pumping from, primarily, the 180/400 Foot Aquifer subbasin which—in turn—minimizes seawater intrusion.

Following installation of the Nacimiento Hydroelectric plant in 1987, MCWRA was required by California Fish and Game Code Section 5937 to maintain a release of at least 25 cubic feet per second (cfs) from the reservoir when elevation is greater than 687.8 feet ft to keep conditions below the dam suitable for fish (Monterey County Water Resources Agency 2018). Since the 2007 issuance of a biological opinion for Phase I of the Salinas Valley Water Project (SVWP), MCWRA has also managed reservoir releases to provide flows for federally listed SCCC steelhead; minimum flows below Nacimiento Dam are maintained at 60 cfs per the 2007 Biological Opinion. In a letter dated February 19, 2019, NMFS determined that all non-discretionary terms and conditions of the 2007 biological opinion had been met. Soon thereafter, the U.S. Army Corps of Engineers (Corps) provided a letter to MCWRA concluding that the Clean Water Act Section 404 permit issued for construction of Phase I of the SVWP was complete. The Corps has also declined to take jurisdiction over sandbar management activities undertaken by MCWRA as part of its flood management responsibilities. As a result of these regulatory conclusions, MCWRA has no federal nexus under which to conduct an ESA Section 7 consultation. As a result, MCWRA is now undertaking development of the Salinas River Operations HCP, a multi-species regional conservation plan. HCPs and their incidental take permits are a durable mechanism to provide take coverage to non-federal entities for the incidental take of federally listed species. An HCP can be developed in a comprehensive and flexible manner to address long-term regulatory needs. HCPs may also streamline permitting for projects with a federal nexus that require a Section 7 consultation. Therefore, MCWRA is preparing a comprehensive, programmatic HCP to cover impacts to species associated with reservoir and SRDF operations.

## Salinas Valley Hydrologic Models

A comprehensive hydrologic model for the Salinas Basin was developed by USGS and can simulate surface water, ground water, and water operation dynamics. The modeling framework consists of the Salinas Valley Watershed Model (SVWM), Salinas Valley Integrated Hydrologic Model (SVIHM), Salinas Valley Operational Model (SVOM), and Basin Characterization Model (BCM).

### Salinas Valley Watershed Model

The purpose of the SVWM is to simulate runoff within the Salinas River watershed. The SVWM was used to develop time series of streamflow to feed into the SVIHM and SVOM along the boundary of

these models, so that those models do not have to simulate the entire watershed. The locations where the SVWM supplies streamflow time series are termed pour points and are shown on Figure 2. These pour points are located at the edge of the SVIHM/SVOM domain, which represents the edge of the major alluvial aquifers. Inherent to the relationship between this model and the SVIHM and SVOM is the assumption that conditions within the SVIHM or SVOM do not impact the generation of runoff from the upland areas simulated with the SVWM. Therefore, the communication between the SVWM and the SVIHM or SVOM is unidirectional.

The SVWM utilizes the Hydrologic Simulation Program – FORTRAN (HSPF) modeling software developed by the U.S. Environmental Protection Agency. The SVWM covers the entire watershed of the Salinas River and tributaries from its headwaters to Monterey Bay, as well as watersheds that drain to Monterey Bay from Monterey in the southwest to Elkhorn Slough in the north (Figure 2). The model divides the watershed into ten major subareas and 574 stream segments.

The SVWM takes various climate (precipitation, temperature, potential evapotranspiration) and land surface (soil parameters, land use) data to partition rainfall into runoff, recharge, and evapotranspiration. This model is discretized into hourly timesteps covering the period from October 1947 to December 2018. It is fed downscaled climate data developed by the USGS for the BCM.

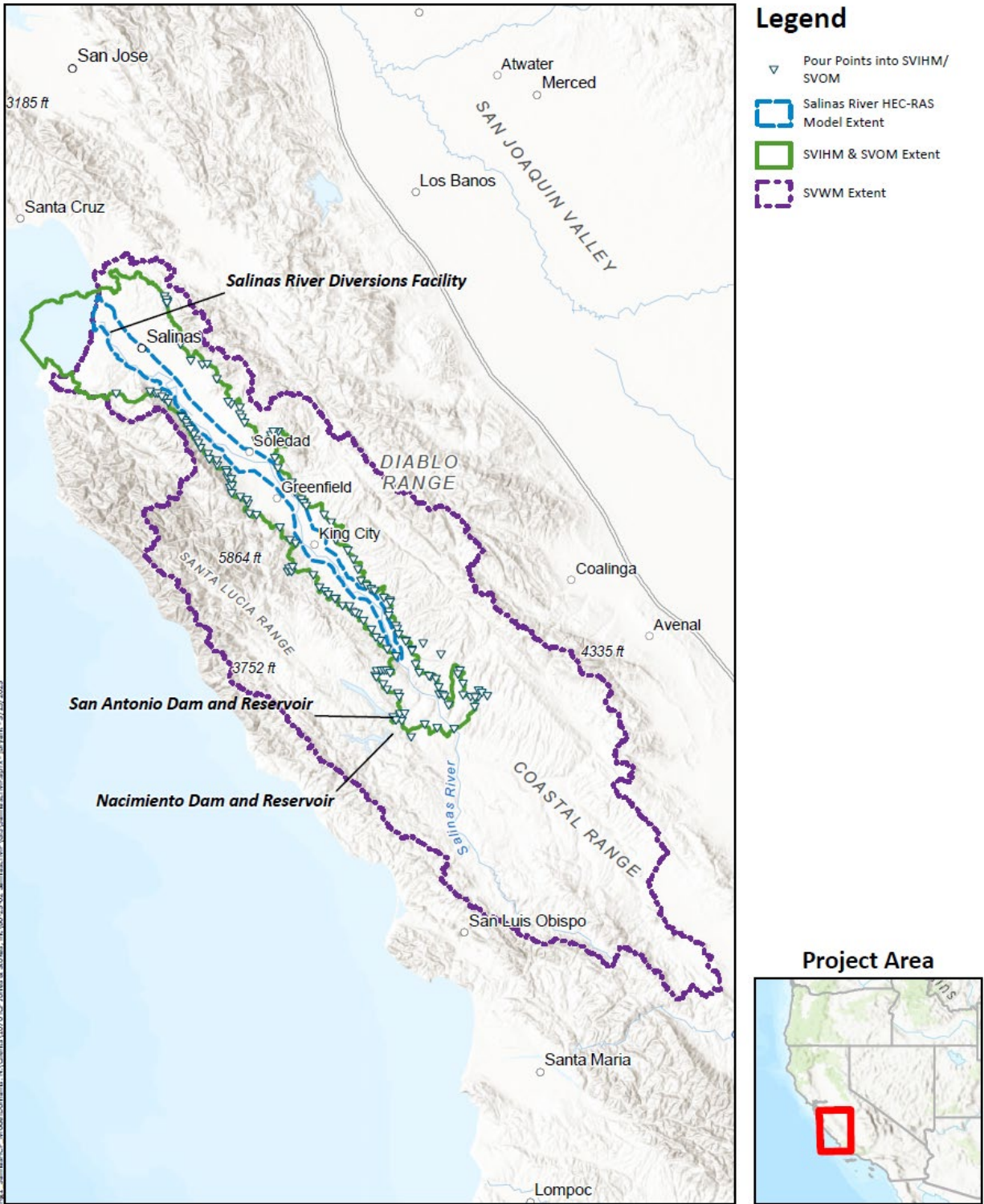
## **Salinas Valley Integrated Hydrologic Model**

The purpose of the SVIHM is to simulate historical conditions within the alluvial aquifers of the Salinas Valley. The SVIHM uses the MODFLOW-OWHM software code, which is a version of the industry standard MODFLOW code that focuses on conjunctive use of surface water and groundwater and land surface/agricultural processes. This model is configured to simulate groundwater flow, streamflow routing, groundwater-surface water interaction, agricultural supply and demand, land surface processes, riparian evapotranspiration, agricultural drains, municipal and industrial well pumping, and seawater intrusion (note that the model does not simulate dual-density flow or solute transport, but instead uses approximations to quantify seawater intrusion at the interfaces between the freshwater aquifers and the Pacific Ocean).

The model extent is shown on Figure 2; it covers the entire area of saturated alluvium within the Salinas Valley from just south of the Monterey-San Luis Obispo County line to Monterey Bay, including the offshore extent of the freshwater aquifers to where they outcrop beneath Monterey Bay. The model has a rectilinear grid consisting of 976 rows, 272 columns, and 9 layers of cells, each measuring 529' by 529' in the horizontal (the thickness of each layer varies). The model has 673,319 active cells, with the rest representing areas outside of the regional groundwater flow system. The model consists of 615 monthly stress periods covering the period from October 1967 (when San Antonio Dam became operational) to December 2018, each of which consists of 2 timesteps (see Section 3.3.2 below for definitions of these terms).

Some inputs to the model (climate data, reservoir releases, municipal and industrial pumping, land use) are derived from historical measurements or estimates. Streamflow inputs at the edges of the model are provided by the SVWM, as described in Section 3.1.2. Agricultural pumping is calculated by the SVIHM based on crop demand and available supplies.

The SVIHM simulates historical conditions within the alluvial aquifers of the Salinas Valley. It is calibrated to a wide array of measured data collected by various entities throughout the historical period, including MCWRA, the USGS, and others. These observed data include groundwater levels,



streamflow, and agricultural well pumping. The purpose of the SVIHM is to reproduce (to the extent possible) the conditions that were observed to occur in the historical period using the best available data so that users can be confident in the ability of the model to simulate other potential sets of conditions; this can be achieved by using the SVIHM as a framework for another tool (the SVOM) that can use other sets of inputs to simulate the system under different conditions from those observed historically. The SVIHM provides the physical structure to the SVOM, including model layers, cell sizes, number of rows and columns, facilities, stream networks, and more.

## Salinas Valley Operational Model

The SVOM is used to simulate conditions within the Salinas Valley under various sets of non-historical inputs. It is identical to the SVIHM except with the additional capability for simulating the operation of the reservoirs (using SWO) and associated projects (i.e., SVWP), land use conditions, plus other scenario-specific modifications that are made. It can be used to simulate the effect of projects and management actions under a representative set of climatic and hydrologic conditions.

The SVOM is built from the SVIHM and uses the same model grid, boundary condition locations, climate inputs (precipitation and potential evapotranspiration), and stream inflows along the model edges. It follows a slightly different temporal discretization, with 615 monthly timesteps each made up of 5 to 6 timesteps, depending on the length of the month. Although it uses hydrologic information from the historical period (October 1967 to December 2018), it is not meant to represent historical conditions. It also is not a representation of future conditions, considering that future hydrology cannot be predicted accurately nor can the evolution of the land use conditions. Instead, it provides a reasonable simulation of long-term basin conditions under a set of realistic climate inputs and current operations. The SVOM is best used as a comparative tool, with scenarios run with and without changes of interest (such as specific changes to the reservoir operations) and the differences between scenarios analyzed to understand the effects of the changes on the system.

As noted above, there are two major changes that differentiate the SVOM from the SVIHM. The SVIHM uses land use conditions (especially crop types) that are representative of historical conditions, based on various datasets that include areas of the basin. The SVOM uses the 2014 land use configuration developed for the SVIHM as the static condition throughout the model duration. As with the SVIHM, the SVOM uses a six-month crop rotation to approximate the seasonal growing conditions in the basin, with one set of land use conditions in effect from January to June each year and a different set in effect from July to December.

The other substantive change from the SVIHM is the incorporation of SWO into the SVOM, a module that can integrate reservoir operations into a MODFLOW model. Whereas the SVIHM is able to utilize the historical time series of reservoir releases as an input, the time series of releases is unknown a priori for the SVOM and must instead be estimated based on conditions both at the reservoirs and downstream within the model. SWO communicates with the MODFLOW model iteratively to estimate reservoir releases based on conditions at the reservoirs and within the stream system in the MODFLOW model, relying on a user-supplied suite of operational rules consisting of logical statements (e.g., if-then statements), calculations, and rating curves. Various changes to the reservoir operations, reflecting projects (including changes to the physical configuration of the dams) and management actions, can be simulated using SWO. SWO also incorporates operation of the SVWP facilities (especially the SRDF) into the reservoir operations.

## Limitations and Assumptions

Any model used to approximate conditions within a natural system is reliant on a large number of assumptions and simplifications to simulate processes within that system. The purpose of this section is not to provide an exhaustive catalog of the assumptions inherent to the MODFLOW modeling code, but rather to highlight certain assumptions, limitations, and simplifications within the SVOM that have potential bearing on how the results of model simulations should be understood and interpreted. The topics discussed in this section relate to the model discretization (both spatial and temporal), representation of the stream network, and representation of the reservoirs, including operations there and at the SRDF).

As noted above, the SVOM has not yet been released to the public by the USGS and is considered a preliminary model. However, we believe that it is the best available tool for understanding the groundwater-surface water-reservoir system as a whole. The following disclaimer accompanies the SVOM:

*SVOM Model: Unofficial Collaborator Development Version of Preliminary Model. Access to this repository and use of its data is limited to those who are collaborating on the model development. Once the model is published and receives full USGS approval it will be archived and released to the public. This preliminary data (model and/or model results) are preliminary or provisional and are subject to revision. This model and model results are being provided specifically to collaborate with agencies who are contributing to the model development and meet the need for timely best science. The model has not received final approval by the U.S. Geological Survey (USGS). No warranty, expressed or implied, is made by the USGS or the U.S. Government as to the functionality of the model and related material nor shall the fact of release constitute any such warranty. The model is provided on the condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the model.*

## Model Discretization

MODFLOW discretizes time into two basic categories: stress periods and timesteps (timesteps are subdivisions of stress periods). A stress period is an interval within the model during which all stresses applied at the model boundaries (the model inputs; e.g., well pumping, climate data, and stream inflow along the edges of the model) are uniform. In the case of the SVOM, stress periods are all one month long and therefore of variable length (from 28 to 31 days). The stress period length was chosen to correspond to the most common way that data are available (e.g., monthly pumping data provided by MCWRA).

A timestep is a computational unit within the stress period, with all of the equations in the model solved once per timestep. Although a model can have equal timestep and stress period lengths (i.e., all model equations are solved once per stress period), having multiple timesteps per stress period allows for better temporal resolution of changes within the system. Timestep lengths in the SVOM vary between 5 and 6 days and are set with consideration of the stress period length in mind. Each February in the model includes 5 timesteps (with 4 timesteps of length 5.5 days and one timestep of 6 days during non-leap years, and 4 timesteps of length 5.75 days and one timestep of 6 days during leap years), and all other months include 6 timesteps (with 6 timesteps of length 5 days for months with 30 days, and 5 timesteps of length 5 days plus one timestep of length 6 days for months with 31 days). The timestep length was chosen to be as close as possible to 5 days because: 1) many of the block flows required by the Flow Prescription (Monterey County Water Resources Agency 2005)

last for multiples of 5 days (e.g., 15 or 20 days); and 2) because this is similar to the time scale of flow from the reservoirs to Monterey Bay (E. Jachens, personal communication, March 8, 2023).

Conditions within each timestep are invariant with time. In other words, head (or streamflow, or groundwater flux between cells, or reservoir release) throughout the model is only calculated once per timestep and is assumed to be in effect throughout the timestep. This means that the model cannot provide output on a time discretization shorter than the length of the timestep.

## **Stream Network**

MODFLOW is fundamentally a groundwater modeling code, although it is capable of simulating streamflow and groundwater-surface water interaction and other processes in a simplified manner (e.g., Prudic et al., 2004). The simplifications involved allow MODFLOW to simulate the effect of conditions within the surface water system on groundwater (where processes typically happen on a substantially longer timescale) but can make MODFLOW a tool that is limited in its ability to represent certain processes within the surface water system.

Streamflow routing in the SVOM relies on the SFR2 Package (Niswonger and Prudic, 2005). The SFR2 Package uses a simple continuity approach to routing water through a stream system, with the outflow from each stream reach equal to the inflow at the upstream end of the reach plus any inflows (precipitation, runoff from the land surface, and gains from groundwater) and minus any outflows (evaporation and losses to groundwater). The physical movement of water through the stream system is not directly simulated. Storage within the stream network is not simulated; in effect, the stream network starts each timestep empty, and is filled from the upstream end to the downstream end based on the simplified routing.

Because of the continuity approach to streamflow routing, MODFLOW does not estimate streamflow velocity. SFR2 can incorporate fairly detailed spatial geometry of the streambed to relate streamflow to stream depth and width (based on user-defined rating curves or equations). However, it is not designed to simulate inundation of the floodplain during high flows.

The nature of the temporal discretization of MODFLOW (described above) means that routing from the upstream end of the system to the downstream end is instantaneous. This means that there is no delay between the reservoirs and the SRDF or Monterey Bay, and the impact of reservoir releases is felt downstream immediately (note that interactions between the surface water and groundwater systems are simulated, so water is still lost along the Salinas River).

The Salinas River Lagoon is not simulated as part of the stream network in the SVOM. At all times, the Salinas River ends at its outlet south of Monterey Dunes. Certain rules of the Flow Prescription (Monterey County Water Resources Agency 2005) require reservoir operation decisions to be made based on the status of the Salinas River Lagoon; in the SVOM, a simplification is made whereby the Lagoon is assumed to be open if streamflow at the Salinas River at Spreckels gauge location is at least 80 cfs.

Considering the simplifications, limitations, and assumptions listed above, care must be taken when interpreting the results of the SVOM in terms of streamflow. The simplifications inherent to MODFLOW and those used by the USGS to represent the natural system of the Salinas River mean that the SVOM cannot be used directly to understand such things as: the movement of peak flows through the stream network; stream velocity or its variation over space and time; or the extent and development of inundation during floods.

## Reservoir and Salinas Valley Water Project Operations

Much effort has been applied to ensuring that the SVOM represents, as closely as possible, MCWRA's current operational approach for the Nacimiento and San Antonio Reservoirs. This includes supplying the SRDF, adhering to the requirements of the Flow Prescription, providing flood protection, and maintaining the habitat for fish and wildlife below the dams, all while operating under the limitations imposed by the water rights that MCWRA holds on the reservoirs. However, the representation of reservoir operations is not exact because of the assumptions and limitations inherent in the model.

The reservoirs are not explicitly represented within the three-dimensional grid of the SVOM; that is, they are not simulated as physical entities within the system that interact with their surroundings, with equations describing fluxes between the reservoirs and adjacent areas incorporated into the equation matrix solved by MODFLOW. Instead, the reservoirs are simulated as being outside the model grid (not in any particular physical place) and connected to the model through the reservoir releases that become inflow to the model at select locations. To arrive at a solution where the reservoirs are releasing an appropriate amount of water to fulfill requirements at the reservoirs and all downstream demands, MODFLOW must iterate between a solution of the model equations (groundwater levels and fluxes) and a solution of the reservoir equations (reservoir releases). This method of representing the reservoirs leads to the following simplifications:

- The reservoirs do not interact with the surrounding bedrock
- The reservoirs are simulated conceptually as buckets with instantaneous and complete mixing (i.e., the movement of water through the reservoir from upstream to downstream is ignored, and residence time of water within the reservoir is not considered)
- Rainfall into and evaporation from the reservoirs is based on the areal extent of each reservoir and prescribed time series of climate variables, and inflow to the reservoirs is also prescribed; if model scenarios result in a smaller areal extent of the reservoirs compared to the Baseline, there is no treatment of rainfall that falls on areas that were beneath the surface of the reservoir under the Baseline (i.e., this rainfall does not become runoff to the reservoir).

Because the reservoirs are operated in the model based on a set of logic-based rules, there is no ad-hoc decision-making possible within the model. The model cannot rely on the decades of experience and knowledge that MCWRA reservoir operators have to make decisions. The reservoir operations in the model also do not in any way rely on forecasting; the simulated reservoirs cannot release water in advance of a severe storm, for example, but must only react during and after the storm.

The release capacity of the reservoirs is based on the storage in each reservoir and the physical limitations of the various outlet works, as described in various SWO rule files. The model determines the release capacity of each reservoir at the beginning of each timestep based on reservoir storage at that time (i.e., after completion of the previous timestep). In some situations, this can lead to unrealistic changes in reservoir storage during individual timesteps. As an example, if a given timestep represents a historical time when a very large storm passed through the system, the inflow to the reservoirs can be substantial. This can increase reservoir storage greatly during the timestep, potentially well above the flood rule curve. The release capacity of the reservoirs would increase as reservoir storage increases during the storm. But because the release capacity is determined at the start of the timestep (i.e., before the impact of the storm on reservoir storage is felt), the model releases water only at the rate representing storage conditions at the beginning of the timestep. This

effect is especially pronounced when the reservoir starts a timestep just below the spillway crest elevation because the release capacity changes dramatically when stage rises above the spillway crest. The impact of this simplification is generally short-lived, as one or two subsequent timesteps are typically sufficient to bring reservoir storage back down to the flood rule curve.

SVOM operates the reservoirs with the assumption that releases can be made to exactly target the amount of downstream demand as if the losses in transit can be known prior to the releases being made. It takes several days for water to move from the reservoir outlets to downstream demand locations (e.g., the SRDF), meaning that reservoir operators must conservatively estimate those transit losses to ensure that the system can deliver at least as much water as is demanded. SWO incorporates a certain amount of approximation in this process so that there is typically some amount of over-delivery.

Diversion from the Salinas River occurs in the model at the location of the SRDF. The SRDF can take up to about 36 cfs from the Salinas River, but the actual amount of diversion depends on demand at any given time. Typically, the growers supplied by the SRDF irrigate during daylight hours only, meaning that diversion generally less than 36 cfs averaged over the course of the day. The SVOM assumes that the SRDF diverts at its maximum rate of 36 cfs whenever the SVWP is operating, whether or not there is agricultural demand within the CSIP area for that water; the model returns any diversion beyond the agricultural demand to the Salinas River downstream of the SRDF. Although this treatment does not reflect the SRDF diversion rate that has been observed to date, it is faithful to how MCWRA must release water to supply the SRDF, since they cannot release water from the reservoirs tailored to the time series of agricultural demand (because of the timescale of water movement from the reservoirs to the SRDF) and must instead assume that the SRDF will divert 36 cfs when they make release decisions.

The above assumptions, simplifications, and limitations are variances from the actual operations of the reservoirs (and associated projects like the SVWP), but the SVOM remains the best predictive tool for simulating conditions within the complex groundwater-stream-reservoir system in the Salinas Basin. These facts must be kept in mind when interpreting the model results; in particular, the SVOM is best suited to simulating longer-term conditions rather than day-to-day fluctuations in system conditions.

## **Salinas River HEC-RAS Model**

The Salinas River HEC-RAS model was developed by FlowWest based on earlier models by Newfields and others (FlowWest, 2015). It covers the Salinas River channel and floodplain from near Bradley to the mouth of the Salinas River. It used a beta version of the HEC-RAS 2D software to simulate the impact of various projects and management actions on 5- and 10-year events in the system, focusing on the extent and depth of flooding and the velocity of flow. It utilizes a digital elevation model (DEM) with a variable resolution (10 feet in some areas and 10 meters in others) to define the surface elevations of the model. Tributary flows are defined where Arroyo Seco and San Lorenzo Creek enter the Salinas River, but only the Salinas River itself is simulated. HEC-RAS 2D is not capable of simulating groundwater-surface water interaction, so this model does not take this into consideration.

As noted above, the SVOM uses a simplified treatment of surface water flow that does not simulate various conditions related to peak flows, including the development of inundation in the floodplains of the stream network. This is due to the fact that the SVOM is a model that must be able to simulate groundwater conditions and is therefore focused on longer-term conditions and the more typical

streamflow regime (i.e., lower flows). It does not incorporate the floodplain into the stream geometry. It also uses a five- to six-day timestep length, typically longer than many high flow events and is not suited to simulating peak flows.

The Salinas River HEC-RAS model can be used in conjunction with the SVOM to expand the capabilities of the SVOM for simulating peak flow conditions. The SVOM estimates streamflow on the scale of individual timesteps; these modeled streamflow results can be used to drive conditions in the HEC-RAS model by transforming the simulated SVOM streamflow at Bradley into a realistic hydrograph with an estimated peak flow, then applying this peak flow at the upstream end of the HEC-RAS model.

A similar approach was used in modeling that was incorporated into the Interlake Tunnel Draft EIR (see Wood, 2022). In that study, a peak flow period was selected from the time series of simulated streamflow for each of the model scenarios and run through the Salinas River HEC-RAS model, then the model results for each of the scenario peak flows were compared to demonstrate the potential impact of the Interlake Tunnel and San Antonio Dam Spillway Raise on inundation and flow velocity in the system.

## Modeling Impacts to Steelhead Trout Habitat

Larger-scale and regional HCPs often use habitat models to quantify impacts. This is generally straight-forward for terrestrial species whose habitat changes little year to year and can be mapped using a GIS. Models are also used to quantify impacts to aquatic species but there is more variability in the application of such models given the difficulty in monitoring aquatic species and their habitats.

The operation of Nacimiento and San Antonio Dams and Reservoirs (collectively referred to as “the reservoirs” hereafter) are the core activities to be covered under the HCP that will have the most significant direct impact on steelhead habitat and individuals. The timing, frequency, and quantity of water released from the reservoirs has a direct impact on migration, reproductive and rearing success, as well as productivity, carrying capacity, and distribution. Specifically, operation of the reservoirs is expected to result in the following categorical effects to steelhead and their habitats:

- Modifications to physical habitat conditions including channel width and depth, velocity, substrate compositions, riparian vegetation abundance and composition, aquatic vegetation, and water quality (temperature, dissolved oxygen, suspended sediments, turbidity, and contaminants/toxins)
- Juvenile behavior, movement, and distribution
- Food availability and thermal refugia
- Availability and distribution of spawning habitats
- Upstream (adult) and downstream (smolt) migration opportunities

While this list is not exhaustive it provides the basis for developing an analytical approach to quantify the effects from operation of the reservoirs on steelhead and their habitat. The following section describes an approach for evaluating these impacts. Core covered activities will be further described as part of the HCP.

## Evaluating Impacts and Quantifying Take

Analyzing the effects of regulated river systems on aquatic ecosystems and species has been completed in many basins across the western US and therefore numerous methods and approaches exist to complete this type of analysis. A common approach is the Instream Flow Incremental Method (IFIM) which relies on a model referred to as PHABSIM (Physical Habitat Simulation) to model changes in life stage specific habitat conditions as a function of river flow. The IFIM/PHABSIM approach, first developed by Bovee (1982), utilizes a combination of hydraulic, hydrologic, and habitat data to model how habitat suitability changes as a function of river discharge and stage. Relying on habitat conditions as a proxy for impacts to fish is often preferable because it can be exceptionally difficult to quantify any potential take as a result of project operations in terms of number of individuals. In addition to flow and stage, key habitat metrics of this approach include water velocity, water depth, surface area, substrate composition, and availability of instream cover (e.g., large wood, boulders, undercut banks). The PHABSIM approach combines key habitat metrics into an index referred to as Weighted Useable Area (WUA).

WUA is calculated by relating modeled habitat characteristics, such as depth and velocity, to habitat suitability criteria derived from empirical fish observational studies that quantify the relationship between habitat features and fish presence. The IFIM/PHABSIM approach is often preferable because it is relatively easy to apply to new systems and does not require fish population demographic data such as abundance or density. While the IFIM/PHABSIM habitat-based approach has been widely used to evaluate impacts of water management in regulated river systems, there are several draw backs to this approach including (Railsback 2016):

- Habitat indices such as WUA lack clarity and biological meaning;
- Spatial scales are often ignored or inappropriately applied; and
- Depth, velocity, and substrate are not the only factors that influence fish behavior and life history expression.

However, IFIM type approaches are still widely used and are advantageous when time or funding is limited and developing a population or lifecycle model based on the characteristics of the local fish populations is not feasible.

In the context of ESA Sections 7 and 10, take of listed fish species is often evaluated via proxies such as habitat accessibility, availability, or quantity. For this purpose, an IFIM/PHABSIM type approach is often used because WUA is an indicator of habitat quantity and quality under different flows. For example, the Deschutes River Basin HCP<sup>6</sup> in Oregon quantified effects of various water management scenarios using habitat-based models to estimate habitat capacity and suitability for discrete salmon and steelhead life stages. The City of Santa Cruz's water rights project<sup>7</sup> utilized an IFIM/PHABSIM approach to model changes in useable area for steelhead and salmon life stages. And in the Lower Klamath River, the Bureau of Reclamation used the Stream, Salmonid Simulator (S3) to evaluate the effects of water operations at Iron Gate Dam<sup>8</sup> on coho and Chinook salmon. S3 is a dynamic simulation model that relies on daily flows and their influence on habitat availability for different

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<sup>6</sup> <https://www.fws.gov/project/deschutes-river-basin-habitat-conservation-plan>

<sup>7</sup> <https://www.cityofsantacruz.com/Home/Components/BusinessDirectory/BusinessDirectory/126/2089>

<sup>8</sup> <https://www.usbr.gov/mp/kbao/programs/ops-planning.html#:~:text=An%20electronic%20version%20of%20both%20the%20U.S.%20Fish,March%2031%2C%202024%2C%20can%20be%20provided%20upon%20request.>

salmonid life stages to model growth, movement, and survival of salmon populations in streams and rivers (Perry et al. 2019). These habitat-based approaches all rely on empirical indices that represent the quantity of suitable life stage specific habitat as a result of the given water management strategy.

Where habitat-based models often fall short is in providing important context for how covered activities may impact covered fish species over time and space. Moreover, habitat-based approaches fail to account for impacts of covered activities on seasonal availability of habitat quantity and quality that is important for the survival of covered fish species. For this reason, applying a population dynamics or lifecycle model that is spatially and temporally specific is desirable. This type of approach can provide a broader perspective on ecological, biological, and population dynamics of covered fish species over time. Additionally, a lifecycle approach provides useful context for assessing the influence of the covered activities on species recovery and viability. For salmonids, NMFS has established Viable Salmon Population (VSP) parameters<sup>9</sup> which are used to evaluate species recovery and viability over time.

Habitat-based models can be combined with specific estimates of life stage specific densities to demonstrate how, over time, the covered activities may affect population dynamics such as abundance or productivity. One such approach translates habitat availability to carrying capacity or production potential by applying observed or literature-based fish densities to modeled habitat area. In the Deschutes Basin HCP, effects of the covered activities on listed salmonids in the Crooked River were evaluated by predicting carrying capacities for juvenile steelhead and Chinook salmon using observed (steelhead) and literature-derived (Chinook) density data (Figure 3). Carrying capacity represents the maximum number of fish a system can support based on the quantity and quality of available habitat when habitat is most limiting, often the summer. For example, a river reach may have numerous pools that theoretically would support high densities of juvenile salmonids, but if the water temperature exceeds the species' thermal thresholds, carrying capacity of the reach would be zero. The relationship between quantity and quality of habitat is important in determining carrying capacities. While the carrying capacity approach provides a theoretical maximum population given changes in habitat quantity in response to different flows, it still does not provide data on how fish populations impacted by the covered activities will respond for the duration of the permit period.

Using a lifecycle model allows for the inclusion of life stage-specific survival parameters, density dependence, and stochasticity in the model, which can provide additional understanding and perspective on how effects of the covered activities may impact species over time and space. The Ecosystem Diagnosis and Treatment (EDT) model is a commonly used lifecycle habitat-based model that characterizes the aquatic environment "through the eyes of salmon" (Mobrand et al. 1997) (Figure 4). It provides results in terms of NMFS VSP parameters. EDT is a spatially explicit model (Blair et al. 2009), that uses three basic components to characterize a watershed: the system river network (geometry), the system conditions (habitat attributes), and species life histories (Figure 5). This model considers influential factors in a watershed such as time and location of spawning, timing of life stage transitions, and speed of migration upstream and downstream across different life stages. Variations of these factors are termed life history trajectories. EDT can be used to evaluate habitat along the many possible life history trajectories of the species being evaluated (Figure 6). The model generates thousands of possible life history trajectories to evaluate a range of

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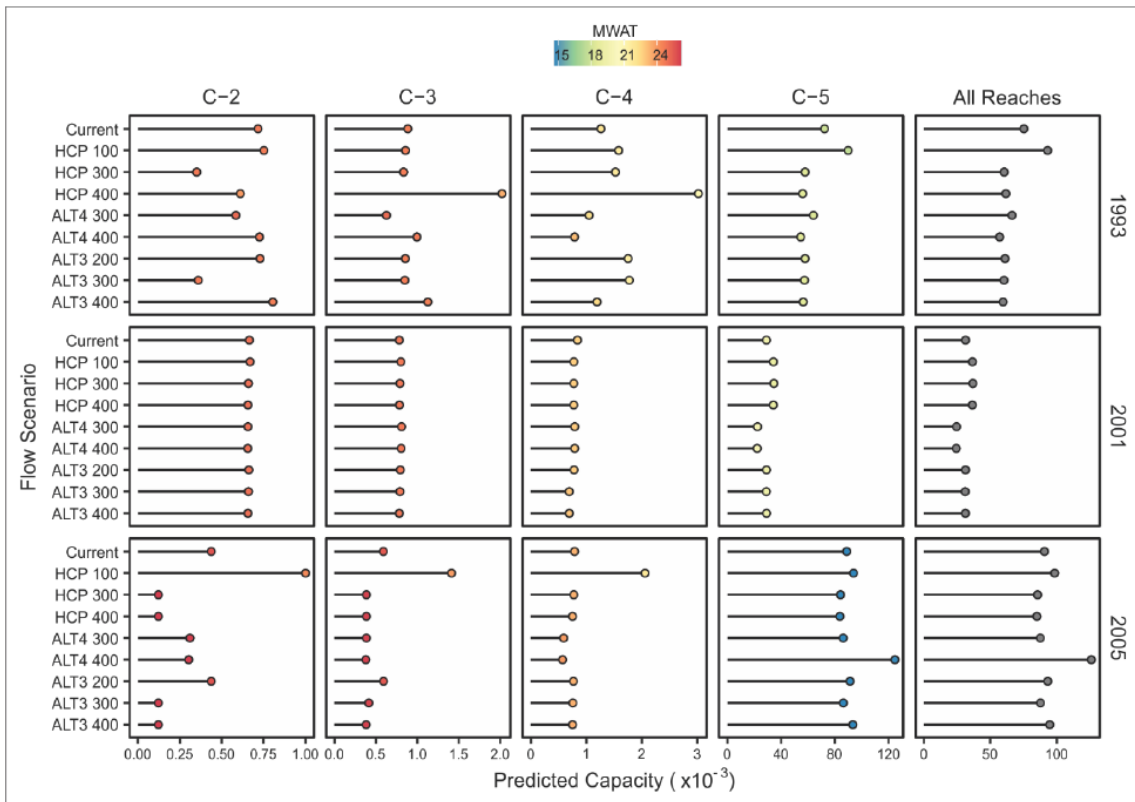
<sup>9</sup>NMFS identifies the four Viable Salmon Population parameters as: abundance (population size), population growth rate, population spatial structure, and diversity (McElhany et al. 2000).

habitat uses by the species and provides information on how the stream environment affects a range of fish life history permutations. Fish performance in the model is a reflection of the quality and quantity of habitat under given scenarios through population parameters. These population-level metrics can be compared across scenarios to weigh tradeoffs and optimize benefits.

The EDT approach utilizes population performance metrics embodied in the NMFS VSP concept. Because the VSP concept is linked to recovery planning for fish, it is helpful to have these measures as direct outputs of the modeling process. In addition, EDT results include estimates of fish abundance. This output is intuitive and easily integrated into an HCP effects analysis. While results include numbers of fish, the model does not require fish demographic data as an input from a specific watershed. EDT has been used for projects where species do not currently exist, but plans were developed to re-introduce a species (e.g., Mid-Columbia River coho salmon, San Joaquin spring-run Chinook salmon, and the Alameda Creek Watershed HCP). Thus, the model is useful even when the system being evaluated does not currently have a population of the target fish species or when fish data are limited or absent. And finally, EDT allows for a quantified comparison of different scenarios and their associated tradeoffs.

- Variables considered. EDT focuses on a suite of parameters (stressors), all of which might strongly influence fish response. These include stream flow, water temperature, substrate, in-stream cover, and riparian vegetation. Integration across multiple variables—when overlaid with a life history component—allows for a heightened understanding of factors influencing fish life history and spatial diversity, productivity, and abundance.
- Widespread use of model. Common uses of EDT include watershed restoration planning, salmonid recovery plans, evaluation of managed flow and temperature regimes, and identifying limiting habitat factors in watersheds. It has also been used to support environmental impact statements at state and national levels, to support Salmon Safe certification processes, and to evaluate alternate passage scenarios in complex hydropower systems.
- Modularized. EDT relies on five modules (Figure 5):
  - system geometry and reach structure;
  - reach level environmental attributes such as water quality, water temperature, channel size, flow, channel morphology, substrate sedimentation, and macro invertebrate species richness, and abundance;
  - fish life history descriptions;
  - species-habitat relationships (generally developed by the modeler and refined for regional considerations with input from species biologists); and
  - a report module to analyze and compare multiple scenarios of real or hypothetical conditions.

The first two modules require reach-level data inputs which will need to be developed from available information before the model can be run. This may incorporate current or past field survey data, modeled data, and expert opinion/literature.



**Figure 3. Carrying capacity predictions for steelhead trout in the Crooked River, Oregon based on the proposed management actions in the Deschutes Basin Habitat Conservation Plan (Blackman 2019).**

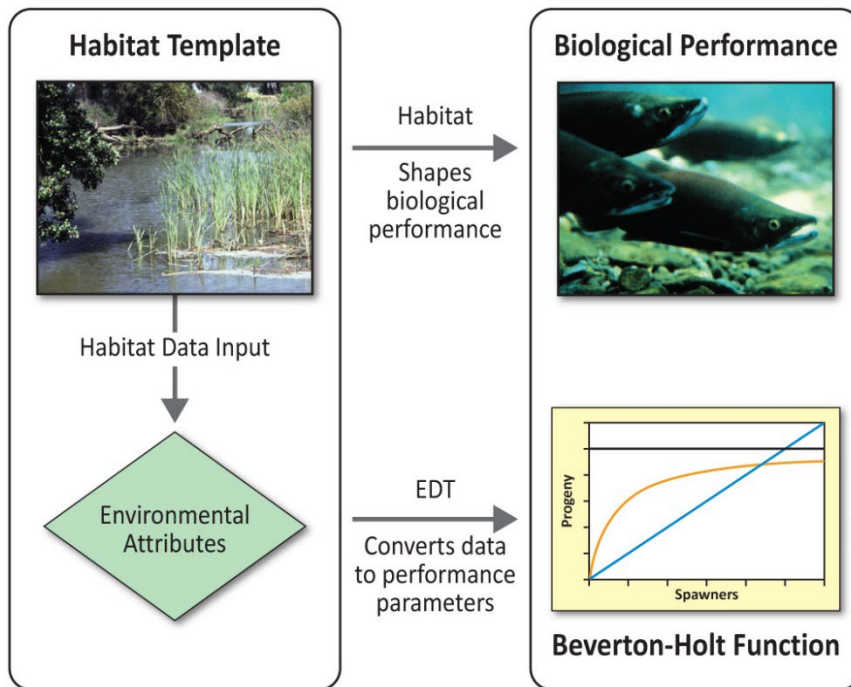


Figure 4. EDT conceptual model.

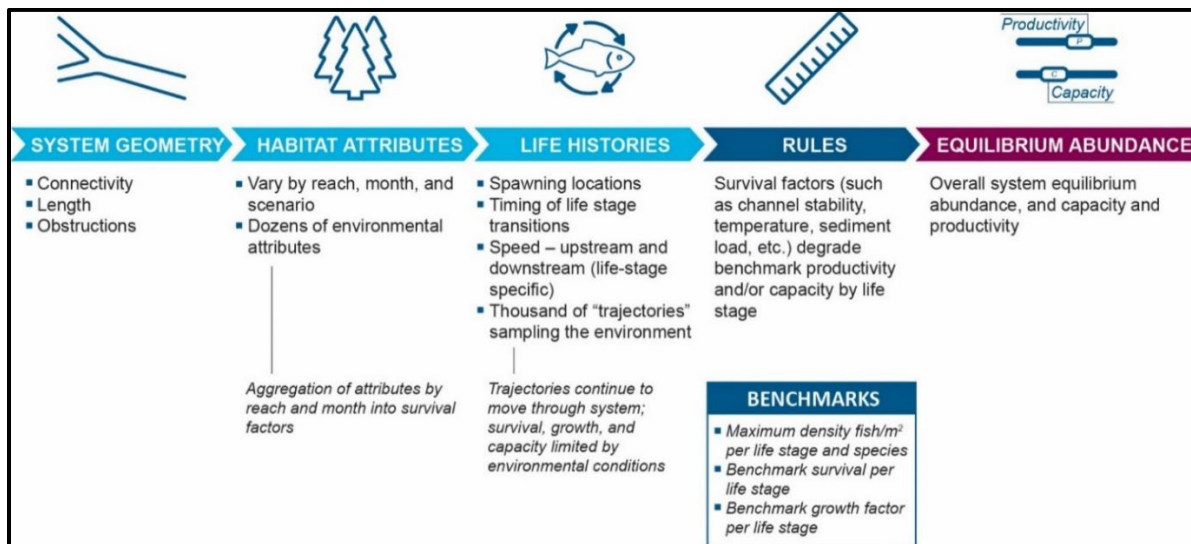


Figure 5. Ecosystem Diagnosis and Treatment Framework.

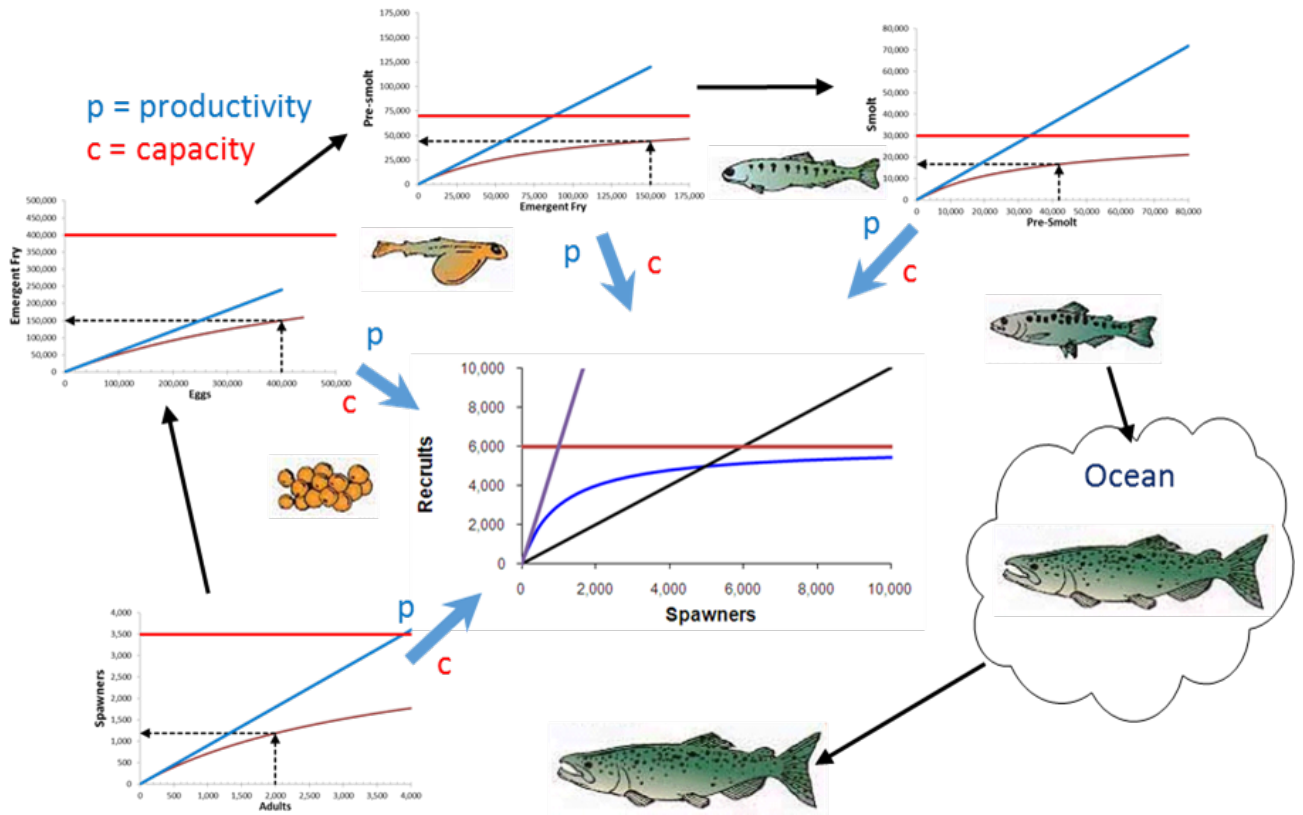


Figure 6. Depiction of the EDT lifecycle model involving a series of Beverton-Holt relationships.

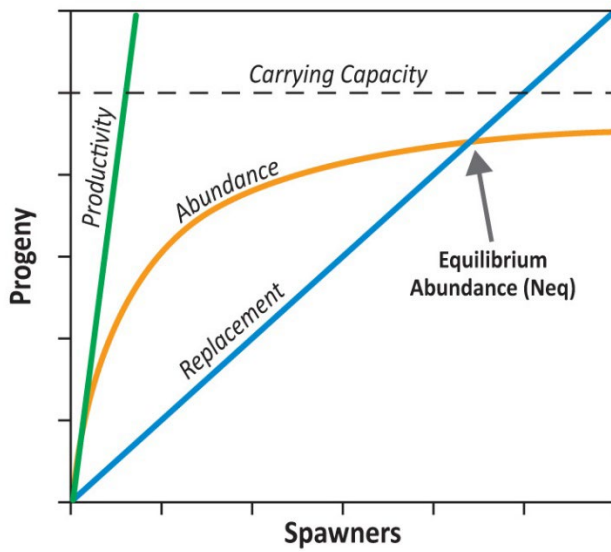


Figure 7. Features of the Beverton-Holt stock-recruitment relationship.

# Approach for the Salinas River Operations HCP

For the purposes of the Salinas River Operations HCP, we will utilize a combination of habitat-based modeling and lifecycle modeling to demonstrate how operation of the reservoirs will affect steelhead and their habitats over time and space. The approach includes the following.

- Model instream flow conditions at key locations using the SVOM.
- Develop a one-dimensional (1-D) hydraulic model (HEC-RAS) for the lower Nacimiento and San Antonio Rivers to model changes in river features by reach (e.g., depth, wetted area, velocity, etc.) resulting from the re-operations protocol.
- Evaluate changes in rearing and spawning habitat within the lower Nacimiento and San Antonio Rivers using a habitat suitability-based approach (IFIM/PHABSIM) based on literature derived habitat suitability criteria from systems with similar ecological, geomorphological, and hydrologic characteristics.
- Establish minimum adult and smolt migration flows in the mainstem Salinas River using the Critical Riffle Analysis (CRA) defined by Thompson (1972) and CDFW (2017).
- Apply modeled habitat data to the EDT model to evaluate how steelhead populations are likely to respond to proposed re-operations protocols and alternatives.

The following sections provide brief descriptions on each component of the approach.

## Model Instream Flow Conditions

The SVOM will be used to model reservoir releases from Nacimiento and San Antonio Dams as well as instream flows in the mainstem Salinas River. This model is based on a historical model, the SVIHM, also developed by USGS. Both models are informed by a rainfall-runoff model of the Salinas River Watershed uplands, the USGS' SVWM. Although the SVIHM and SVWM will not be analyzed in detail for this project, the results of these models are central to the SVOM. The SVOM uses historical data from the SVIHM to model changes in water operational strategies. Within the SVOM, reservoir operations, flow prescriptions, and water rights can be modified, and model results can be compared across scenarios. Modeled instream flows will be produced for specific locations within the permit area identified through conversations with the technical team and based on model constraints. Modeled instream flow will then be used to estimate spawning and rearing habitat availability in the Nacimiento and San Antonio Rivers and to estimate migration opportunities in the mainstem Salinas River for each modeled water management scenario based on instream flow estimated produced by the model.

## Develop 1-D Hydraulic Model

Changes in flow influence the area and characteristics of steelhead habitat and have a direct impact on steelhead life history expression. Quantifying the effects of water releases from the reservoirs on steelhead trout spawning and rearing habitat will be completed using a combination of 1-D hydraulic and habitat-based modeling. This approach will rely on a river 1-D hydraulic model (HEC-RAS) calibrated using site specific channel geometry, channel roughness, water releases from the reservoirs, tributary inputs, and meteorological conditions. The hydraulic model will be used to estimate changes in water surface area, depth, and velocity in spawning and rearing habitat in the lower Nacimiento and San Antonio Rivers using detailed stream channel profile measurements. The

mainstem Salinas River is considered a migration corridor for adults and smolts and does not support rearing or spawning life stages (NMFS 2007).

Data will be collected using the California Department of Fish and Wildlife's (CDFW) *Standard Operating Procedures for Streambed and Water Surface Elevation Data Collection in California* (California Department of Fish and Wildlife 2013). The data collected as part of this process include water surface elevations, wetted streambed elevations, bankfull discharge elevations, mean water column velocities, and substrate and cover classifications (Holmes and Cowan 2014). The observed bankfull heights are good indicators of the 1.5-year high water line, an important benchmark for hydraulic model calculations. CDFW (2013) recommends collecting measurements during low and high flow conditions to accurately capture the relationship between channel hydraulics and discharge.

The U.S. Army Corps of Engineers Hydraulic Engineering Center's River Analysis System, also known as HEC-RAS<sup>10</sup> has the capability of simulating 1-dimensional or 2-D unsteady flows in river systems. For the purposes of the Salinas River Operations HCP, 1-D modeling will be used given the coarseness of the surrounding elevation data sources. The HEC-RAS model can provide estimates of water depth, water surface elevation, velocity, flow, and residence time. The hydraulic model will utilize a combination of digital elevation models (DEM), LiDAR<sup>11</sup>, and channel elevation, water depth, and velocity data recorded at strategically placed transects in each study river.

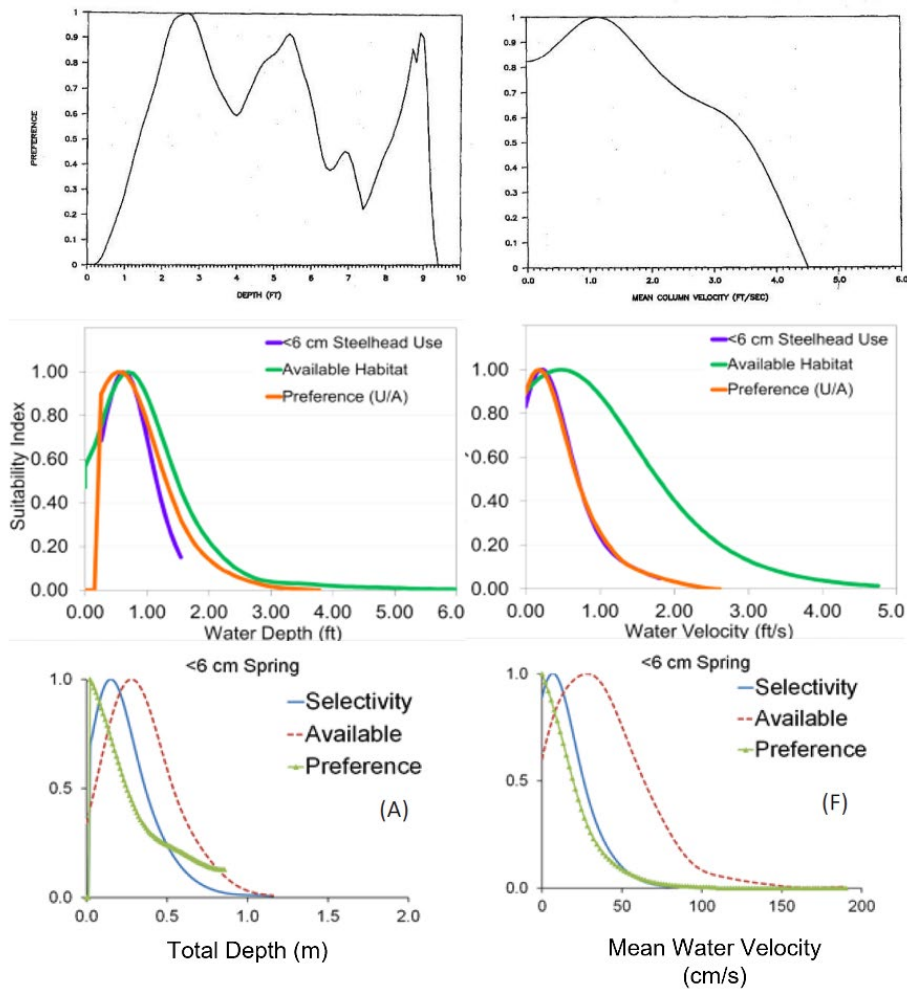
The hydraulic model will then be used to simulate hydraulic conditions for a range of simulated flows at transects that cover the range of channel unit types found in both rivers. Simulated hydraulic features will then be related to habitat suitability criteria curves derived from the relevant literature (Figures 8 and 9) to estimate WUA as a function of discharge (Figure 10). Once these relationships have been quantified, total WUA values by river or study reach can be calculated based on the specific modeled hydrologic scenario. WUA is typically summarized by location and water year type (dry, normal, wet) on a daily or monthly basis depending on modeling constraints or species biological characteristics. Modeling results will be summarized for each river and for dry, normal, and wet water year types.

Surveys to characterize river features that influence rearing juvenile steelhead behavior and distribution) in the Nacimiento and San Antonio Rivers are necessary to model changes in steelhead habitat based on the re-operations protocol and other operational scenarios. Rearing habitat features will be measured and mapped using methods described by CDFW (California Department of Fish and Wildlife 1998). Specifically, habitat unit types will be categorized using CDFW level III methods which classify units into pools, riffles, and glides. Rearing and spawning habitat features will be identified and measured using ground crews in both basins (Table 1). Four (4) one-mile reaches will be surveyed in the lower Nacimiento River and two (2) one-mile reaches will be surveyed in the lower San Antonio River.

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<sup>10</sup><https://www.hec.usace.army.mil/software/hecras/>

<sup>11</sup> <https://www.arcgis.com/apps/View/index.html?appid=9204adf2fd1546379b845d163ef2544a>



**Figure 8. Habitat preference criteria for depths and velocities selected by steelhead trout juveniles in the upper Trinity River, California (Hampton 1998) (top row), in the South Fork Eel River, California (CDFW 2019) (middle row), and the Big Sur River, Monterey County, California (Holmes and Cowan 2014) (bottom row).**

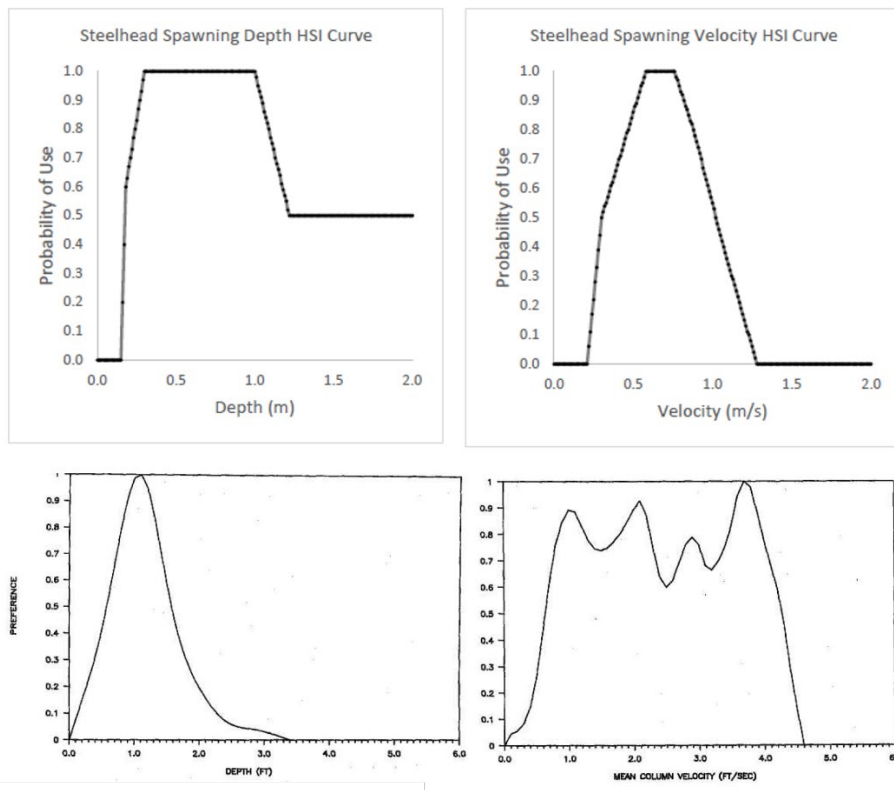


Figure 9. Habitat preference criteria for total depths and mean velocities selected by spawning steelhead trout in the Okanogan Basin, British Columbia (Okanagan Nation Alliance Fisheries Department 2020) (top row) and the upper Trinity River, California (Hampton 1998) (bottom row).

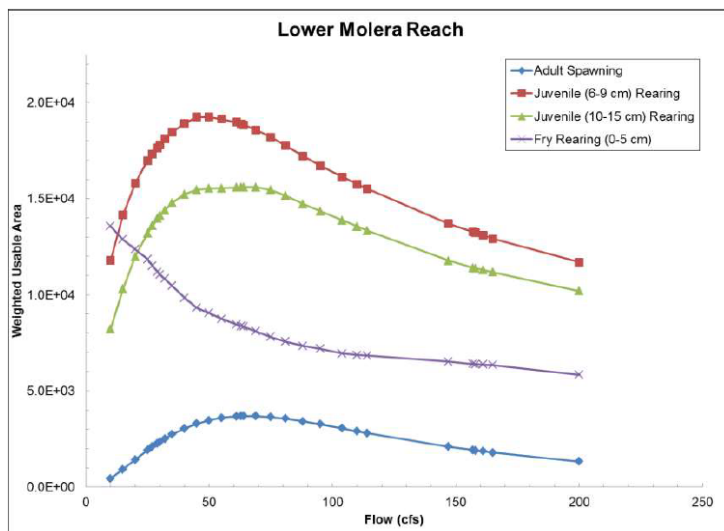


Figure 10. Steelhead habitat/streamflow relationship on the Big Sur River, Monterey County, California (CDFW 2014).

**Table 1. Rearing habitat features to be measured in the lower Nacimiento and San Antonio Rivers.**

<b>Habitat Feature</b>	<b>Description</b>	<b>Nacimiento Methods</b>	<b>San Antonio Methods</b>
Channel Unit Types	Identification of level III channel unit types as defined by CDFW (1998) (pools, riffles, glides, etc.)	Field crews	Field Crews or UAV
Channel Unit Wetted Width	Distance across the individual unit perpendicular to the flow of water. Measured at 1-3 locations depending on unit type and width variability.	Field crews	Field Crews or UAV
Channel Unit Depth	Average water depth across the channel unit. Measured at three locations to capture variability in water depth.	Field crews	Field Crews or UAV
Bankfull Width	Width of the channel measured perpendicular to the stream from the bankfull flow line on each side of the channel. Bankfull is typically defined as the 1.5-year high water line.	Field crews	Field Crews or UAV
Flood-Prone Width	The stream width at a discharge level roughly twice the maximum bankfull depth.	Field crews	Field Crews or UAV
Instream Shelter Complexity	Rating of -0, 1, 2, or 3; based on the presence of wood, boulders, riparian vegetation, undercut banks, submerged aquatic vegetation, etc. See CDFW 1998 for addition details.	Field crews	Field Crews or UAV
Instream Shelter Percent Cover	Instream percent cover is a measurement of the total area of habitat occupied by instream shelter.	Field crews	Field Crews or UAV
Substrate composition	Proportion of each substrate type occupying the channel bottom. Substrate types include gravel, cobble, boulders, sand, silt, and bedrock	Field crews	Field Crews or UAV
Large Wood	Counts of large wood 1 foot in diameter or greater and between 6 and 20 feet or greater than 20 feet	Field crews	Field Crews or UAV
Canopy Cover	Percent of the channel unit area influence by tree canopy	Field crews	Field Crews or UAV
Percent of Vegetated Banks	Proportion of each bank that is covered by vegetation from bankfull discharge level to 20 feet upslope.	Field crews	Field Crews or UAV
Channel Unit Spatial Location	GPS coordinates or up and downstream locations of the channel	Field crews	Field Crews or UAV

## **Establish Minimum Migration Flows**

Migration opportunities for smolt and adult steelhead will be evaluated via hydrologic modeling by relating modeled flow conditions to critical riffle depths at key locations along the Salinas River. CRA will be used to identify minimum flows necessary to facilitate passage of adult and juvenile steelhead through critical riffles during migration windows. Standard operating procedures (SOP) for CRA in California involve locating a critical riffle, identifying a transect along the riffle’s shallowest point from bank to bank, measuring water depth at set intervals along the transect, and repeating this process over a range of flows (California Department of Fish and Wildlife 2017). Field measurements are then compared to water depth passage criteria for various life stages of steelhead, which are derived primarily from Thompson 1972. However, the CDFW CRA SOP states that the method is not applicable “to rivers or streams that do not have riffles, such as those dominated by silt and sand substrates with particle sizes less than 0.1 inches.” Given that the Salinas

River is dominated by sandy substrates, modifications to the CDFW SOP were made to better account for the streambed characteristics (FISHBIO 2022). Critical riffles will be identified using a UAV to create digital elevation models of the mainstem Salinas Riverbed. These data will then be used to estimate water depth at critical riffles across various levels of discharge and determine the flows at specific reaches that provide the minimum depths required for adult upstream and smolt downstream passage. To verify accuracy of results, model outputs will then be validated through comparison with empirical data collected in the field through the use of a Stadia rod and an Acoustic Doppler Current Profiler (ADCP) across a range of flows. Further, UAV surveys will be repeated following periods of high flow to evaluate the potential for riffle crest movement and the processes driving riffle formation in the highly mobile bed of the Salinas River. CDFW (2017) identifies minimum passage depths of 0.7 feet for adult steelhead and 0.3 feet for juvenile salmonids; final minimum passage depth criteria for steelhead adults and smolts in the Salinas River will be proposed based on the results of the CRA and will be confirmed with the Services.

## Apply Modeled Habitat Data to the Lifecycle Model

Hydrologic and habitat model results will then be applied to the EDT model to produce and compare VSP parameters across management scenarios. The EDT model will facilitate examination of changes in productivity, abundance, carrying capacity, and life history diversity (Figure 5) and provide insight into how effects from operation of the reservoirs could influence population growth over time and space. Figure 11 provides an example of EDT output for a project completed in the Willamette Valley, Oregon.

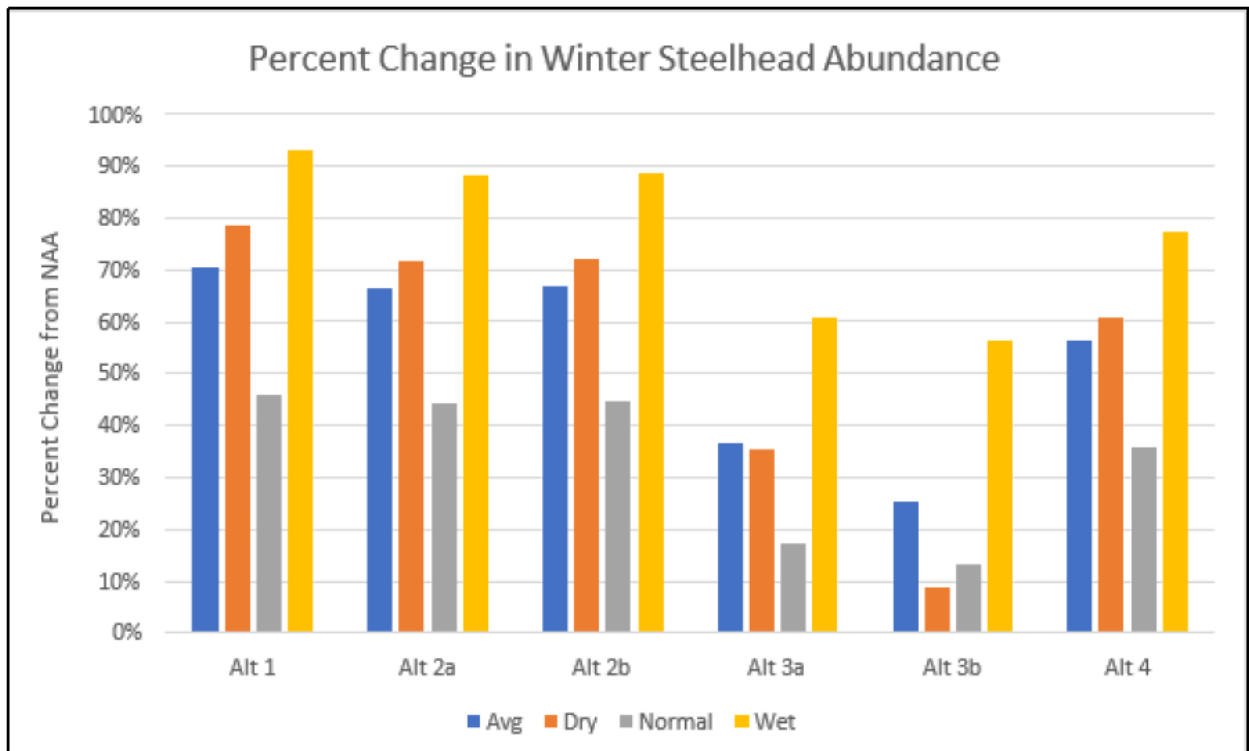


Figure 11. Example of EDT abundance estimates for various water management scenarios during average, dry, normal, and wet water years.

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## Appendix A – Comparison Point Hydrologic Scenarios to be Evaluated

	Current Operations with Flow Prescription Requirements	Current Operations without Flow Prescription Requirements	No Operations
Scenario Description	Scenario 2	Scenario 3	Scenario 1
<b>Flood Rule Curves</b>			
Nacimiento Reservoir	787.75' Dec 1 to Mar 1 800' Apr 1 to Nov 1 Linear change Mar 1 to Apr 1 and Nov 1 to Dec 1	No changes	<b>Removed</b>
San Antonio Reservoir	774.45' Jan 1 to Feb 1 780' Apr 1 to Aug 1 Linear change Feb 1 to Apr 1 and Aug 1 to Jan 1	No changes	<b>Removed</b>
<b>Release Capacity</b>			
<b>Nacimiento Reservoir</b>			
Low-Level Outlet Works	420 cfs at 687.8' to 425 cfs at 800'	No changes	No changes
High-Level Outlet Works	0 cfs at 755' to 5,568 cfs at 825'	No changes	No changes
Spillway	0 cfs at 787.75' to 74,941 cfs at 825'	No changes	No changes
All Available Gates Used	Yes	No changes	No changes
Hydro Gate	Not used	No changes	No changes
<b>San Antonio Reservoir</b>			
Outlet Works	858 cfs at 666' to 2,194 cfs at 800'	No changes	No changes
Spillway	0 cfs at 780' to 35,000 cfs at 800'	No changes	No changes
All Available Gates Used	Yes	No changes	No changes
<b>Release Balancing</b>	Always prioritize release from Nacimiento Reservoir	No changes	No changes
<b>Operational Pools</b>			

	Current Operations with Flow Prescription Requirements	Current Operations without Flow Prescription Requirements	No Operations		
Nacimiento Reservoir	Flood Pool: 787.75-801 ft msl Conservation Pool: 687.8-787.75 ft msl Minimum Pool: 670-687.8 ft msl Dead Pool: < 670 ft msl	No changes	No changes		
San Antonio Reservoir	Flood Pool: 774.45-780 ft msl Conservation Pool: 666-774.5 ft msl Minimum Pool: 645-666 ft msl Dead Pool: < 645 ft msl	No changes	No changes		
<b>Flood Control Releases</b>					
Nacimiento Reservoir	Controlled solely by Flood Rule Curve	No changes	<b>Removed</b>		
San Antonio Reservoir	Controlled solely by Flood Rule Curve	No changes			
<b>Fish Passage Requirements</b>					
<b>Adult Rules</b>					
Migration Period	Jan 1 to Apr 30	<b>Removed</b>	<b>Removed</b>		
Release Period	Feb 1 to Mar 31				
Storage Requirement	220,000 af of combined storage Feb 1 to Mar 31				
Year Type Requirement	None				
Natural Streamflow Requirement	340 ± 10% cfs at Arroyo Seco near Soledad AND 173 ± 10% cfs at Arroyo Seco below Reliz				
Streamflow Requirement	260 ± 10% cfs at Chualar for 5+ days				
<b>Smolt Rules</b>					
Migration Period	Mar 15 to Jun 15				
Release Period	Mar 15 to Jun 15				
Storage Requirement	150,000 af of combined storage on Mar 15				
Year Type Requirement	Normal Years only (checked on Mar 15 and again on Apr 1 if Mar 15 year type was dry or wet)				
Natural Streamflow Requirement	125 cfs at Sapaque OR 70 cfs at Arroyo Seco below Reliz				
Streamflow Requirement	700 cfs at Soledad for 5 days, then 300 cfs at Spreckels for 15 days, then 80 cfs at Spreckels flow at Reliz drops below 1 cfs				
<b>Juvenile Rules (+smolt and kelt)</b>					

	Current Operations with Flow Prescription Requirements	Current Operations without Flow Prescription Requirements	No Operations
Migration Period	Apr 1 to Jun 30		
Release Period	Apr 1 to Jun 30		
Storage Requirement	220,000 af of combined storage Apr 1 to Jun 30		
Year Type Requirement	Normal or Wet		
Lagoon Requirement	Open for smolt and kelt flows Closed for juvenile flows		
Streamflow Requirement	45 cfs to Lagoon for 10 days or until Lagoon closes, whichever happens first (smolt and kelt), then 15 cfs to Lagoon until Jun 30 (juvenile)		
<b>SRDF Operations</b>			
Channel Wetting Releases			<b>Removed</b>
Wetting Requirements	< 20 cfs at Soledad Mar 1 to Mar 31	No changes	
Storage Requirement	At least 145,000 af of combined storage AND At least 55,000 af in San Antonio Reservoir	No changes	
Wetting Period	Mar 15 to Apr 20	No changes	
Streamflow Requirement	1,200 cfs for 10 days (cut to 5 if Spreckels > 40 cfs), then 900 cfs for 5 days, then 600 cfs for 20 days or Spreckels > 40 cfs	No changes	
Operation Season	Apr 1 to Oct 31	No changes	
Storage Requirement	At least 145,000 af of combined storage AND At least 55,000 af in San Antonio Reservoir	No changes	
Year Type Requirement	None	No changes	
Natural Streamflow Requirement	None	No changes	
Streamflow Requirement	36 cfs at SRDF PLUS 2 cfs bypassing SRDF	Remove 2 cfs Bypass Flow	
<b>Fish and Wildlife Habitat Release</b>			
Nacimiento Reservoir	Target minimum release of 60 cfs at all times	Changed to 25 cfs	<b>Removed</b>
San Antonio Reservoir	Target minimum release of 10 cfs at all times	No changes	
Factoring into minimum storage?	Nacimiento Reservoir minimum storage target of 22,300 af on Oct 1	Changed table to reflect 25 cfs minimum at Nacimiento	

	Current Operations with Flow Prescription Requirements	Current Operations without Flow Prescription Requirements	No Operations
	Dynamic minimum storage at Nacimiento Reservoir		
Factoring into water right limit?	Dynamic Release from Storage limit	Changed table to reflect 25 cfs minimum at Nacimiento	
<b>SLO Allotment</b>			
Amount and Timing	17,500 afy taken directly from Nacimiento Reservoir distributed through year according to table	No changes	<b>Removed</b>
Factoring into minimum storage?	Nacimiento Reservoir minimum storage target of 22,300 af on Oct 1 Dynamic minimum storage at Nacimiento Reservoir	No changes	
Factoring into water right limit?	Dynamic Release from Storage limit at Nacimiento Reservoir	No changes	
Water Rights			
Collection to Storage Limit	Oct 1 to Jul 1 each year (no collection to storage allowed starting Jul 1)	No changes	
Nacimiento Reservoir	377,900 afy	No changes	
San Antonio Reservoir	220,000 afy	No changes	
Release from Storage Limit	Jan 1 to Dec 31 each year	No changes	
Nacimiento Reservoir	180,000 afy	No changes	
San Antonio Reservoir	210,000 afy	No changes	