FINAL BIOLOGICAL OPINION

AGENCY:	U. S. Federal Energy Regulatory Commission, Washington, D. C.
ACTION:	Issue New License to United Water Conservation District for Operation of the Santa Felicia Hydroelectric Project (P-2153-012)
CONSULTATION CONDUCTED BY:	National Marine Fisheries Service, Southwest Region
DATE ISSUED:	May 5, 2008
TRACKING #:	SWR/2002/02704: APS

I. CONSULTATION HISTORY

On December 1, 2005, NOAA's National Marine Fisheries Service (NMFS) received from the Federal Energy Regulatory Commission (Commission) a written request to consult formally and a draft biological assessment (BA) for the Santa Felicia Hydroelectric Project, on Piru Creek, Los Angeles County. The Commission proposes to issue a new license to United Water Conservation District (United) for operation of the project. Because the proposed action is expected to adversely affect the endangered Southern California Distinct Population Segment (DPS) of steelhead (*Oncorhynchus mykiss*), and critical habitat for this species, the Commission requested formal consultation. After reviewing the draft BA, NMFS determined formal consultation could not begin because the BA did not adequately describe how the proposed action would affect endangered steelhead and critical habitat, as the regulations governing interagency coordination require (50 CFR § 402.14). In a January 25, 2006, letter to the Commission (electronically filed on February 15, 2006), and again during a June 29, 2006, teleconference with the Commission, NMFS requested the required information for initiating formal consultation (NMFS 2006a). On February 7, 2007, NMFS received the required information and initiated formal consultation (NMFS 2007a).

Other communications that are part of the consultation history include (1) the Commission's April 13, 2006, letter response to NMFS' comments on the Commission's BA; (2) a teleconference with the Commission on August 17, 2006, which is summarized in a Communications Memo filed by the Commission; (3) the Commission's May 21, 2007, formal request for consideration of supplemental information; (4) NMFS' June 7, 2007, response to the Commission's formal request; (5) a teleconference with the Commission on December 14, 2007, which is summarized in a Communications Memo filed by the Commission; and, (6) a meeting with the Commission on March 4, 2008. The Commission's May 21, 2007, letter that requested consideration of supplemental information came after the 90-day consultation period had concluded on May 7, 2007. In light of the Commission's request, which effectively extended the duration of the formal consultation, NMFS requested in the letter of June 7, 2007, that both United and the Commission provide written concurrence to extend the duration of the formal consultation for 60 days. United and the Commission provided their written concurrence in a letter of June 20, 2007 (United) and June 18, 2007 (Commission). In a letter of June 5, 2007, United requested the opportunity to review and comment on the draft biological opinion.

United's letter of June 20, 2007, requested that NMFS consider additional information and eight "lay-person" questions related to the historical stocking of steelhead in the Piru Creek watershed. The Commission had not formally requested that NMFS consider the additional information and questions in the ongoing formal consultation. In a letter of July 23, 2007, NMFS requested that the Commission provide NMFS with written notification to clarify whether the Commission would like NMFS to consider the additional information and questions outlined in United's June 20, 2007, letter in the ongoing formal consultation. If the Commission did want NMFS to consider the additional information and questions, NMFS requested that the Commission and United provide written concurrence to extend the duration of the formal consultation for 90 days from the date of the Commission's letter (NMFS would then expect to transmit the draft biological opinion to the Commission no later than 45 days after the conclusion of the extended duration of formal consultation). If the Commission did not want NMFS to consider the additional information and questions, NMFS expected to transmit the draft biological opinion to the Commission no later than 45 days from August 6, 2007 (the date for conclusion of the previously extended duration of formal consultation). In a letter of August 28, 2007, United consented to NMFS' request to extend the duration of the formal consultation. Anticipating the Commission would request NMFS to consider the additional information, NMFS proceeded to consider the subject information. In a letter of September 7, 2007, the Commission found that the additional information provided by United is appropriate for this consultation. As a result, the Commission granted the request for the time extension to complete formal consultation until December 6, 2007, with a final biological opinion anticipated by January 21, 2008.

NMFS' July 23, 2007, letter to the Commission, commented on United's June 20, 2007, letter. In particular, NMFS outlined potential issues related to the contents of United's letter and suggested coordination with United may be necessary to resolve what appeared to be unsubstantiated statements presented in United's letter. Upon further consideration, which included coordination with NMFS' Science Center in Santa Cruz, California, NMFS' Regional Office determined that coordination with United was unnecessary to proceed with due consideration of the proposed action, including information United provided in the June 20, 2007, and previous submittals. NMFS no longer believed a need existed to contact and coordinate with United in this regard as was suggested in NMFS' letter of July 23, 2007 (page 7, United Water Conservation District 2008).

On November 8, 2007, NMFS electronically filed a draft biological opinion with the Commission. The draft biological opinion concluded the proposed action is likely to jeopardize the continued existence of the endangered Southern California DPS of steelhead and is likely to destroy or adversely modify critical habitat for this species. The draft biological opinion included a reasonable and prudent alternative that is necessary and appropriate to avoid the likelihood of jeopardizing the continued existence of the DPS and destroying or adversely modifying critical habitat. On December 14, 2007, NMFS, the Commission, and United held a public teleconference to discuss the bases for the conclusions and refine the reasonable and prudent alternative. During the teleconference, United and the Commission confirmed they would submit to NMFS their comments on the draft biological opinion. By letters of January 11, 2008, United and the Commission provided their comments on the draft biological opinion to NMFS.

United's letter of January 16, 2008, as well as the Commission's letter of January 17, 2008, agreed to extend, by 60 days, the 45-day period in which the biological opinion must be delivered to provide an opportunity for further discussion of the draft biological opinion and related comments. In a January 25, 2008, letter, NMFS acknowledged that agreement to change the delivery date of the biological opinion to March 21, 2008. The Commission's letter of January 17, 2008, was also a request that NMFS consider, in the final biological opinion, the measures outlined in Exhibit A of United's January 11, 2008, letter as part of a reasonable and prudent alternative rather than part of the Commission's proposed action. In its letter of January 25, 2008, NMFS acknowledged this request, and NMFS has considered this request in developing this final biological opinion.

On March 4, 2008, United, Commission staff, and NMFS met to discuss certain comments on the draft biological opinion, how NMFS addressed the comments, and ideas for refining the sub-elements of the reasonable and prudent alternative. During the meeting, United, NMFS, and the Commission agreed to extend the date upon which the final biological opinion is due to May 5, 2008. The Commission reaffirmed this agreement in a letter of March 18, 2008. In addition, during the meeting there was general agreement on certain revisions to the first element of the draft biological opinion's reasonable and prudent alternative to be included in the final biological opinion. On March 24, 2008, NMFS distributed text reflecting its understanding of revisions to the reasonable and prudent alternative of the draft biological opinion agreed upon at the meeting. On April 1, 2008, Commission staff provided NMFS with comments and suggested edits to the text that NMFS distributed. NMFS did not receive any other comments and suggested edits to that text, and NMFS considered the Commission staff's comments and suggested edits in developing this final biological opinion.

To produce this final biological opinion, the draft biological opinion was revised in response to the substantive comments received from United and the Commission on the draft biological opinion. The reasonable and prudent alternative was refined based on the comments and discussion on the draft during the March 4, 2008, meeting. Our responses in this biological opinion to the comments often include a reference to the specific source (e.g., United Water Conservation District 2008, or Federal Energy Regulatory Commission 2008) and page number of the comment, particularly when such reference is necessary. The appendices to the draft biological opinion are omitted from the final biological opinion for practical reasons, including to ease the process for electronically transmit the biological opinion for filing, though the appendices remain a part of the record that is the basis of this consultation. This biological opinion is based on the best scientific and commercial data available, including the description of the proposed action (Federal Energy Regulatory Commission 2007a). A complete administrative record for this consultation is maintained on file at NMFS' Southwest Regional Office (501 W. Ocean Blvd., Suite 4200, Long Beach, California 90802).

II. DESCRIPTION OF THE PROPOSED ACTION AND ACTION AREA

A. Description of the Federal Action and the Proposed Action

The Federal action is the Commission's issuance of a new license to United. The Federal Power Act (FPA) authorizes the Commission to issue licenses for hydroelectric project works, including dams and reservoirs. The license the Commission issues to United must include conditions, based on recommendations from federal and state fish and wildlife agencies, that are expected to adequately and equitably protect, mitigate and enhance fish and wildlife, including related spawning grounds and habitat.

The proposed action involves the preferred alternative identified in the BA, a combination of United's proposed project and the environmental measures that Commission staff recommended for inclusion in the license (Table 2-1). For an expected term of 50 years, the license would allow United to (1) operate a 200-foot tall, 1,260-foot-long earth-filled dam (Santa Felicia Dam), (2) operate an 87,000 acre-foot reservoir (Piru Lake) (which inundates 121 acres of forest land and a portion of Piru Creek[1]), (3) operate an un-gated spillway and related works, (4) operate a two-unit powerhouse with a total installed capacity of 1,434 kW, (5) operate appurtenant facilities, (6) deliver water to downstream agricultural users, and (7) implement several environmental measures. The reservoir would continue to capture and then store wet and dry-season inflows with subsequent release during the dry season (typically a 50-day release during September and October) to agricultural users and incidentally for hydroelectric generation. The primary purpose of the project is groundwater recharge within the over-drafted Santa Clara River basin; hydroelectric generation is not dependable due to the limited operation of the project (Federal Energy Regulatory Commission 2007a).

When considering effects of the action on a species or critical habitat, NMFS is required to consider the direct and indirect effects of the action "together with the effects of other activities that are *interrelated* or *interdependent* [emphasis added] with that action" (50 CFR §402.02). "Interrelated actions" refers to those activities "that are part of a larger action and depend on the larger action for their justification," whereas "interdependent actions" refers to activities "that have no independent utility apart from the action under consideration" (50 CFR §402.02). Elements of operation of Pyramid Dam (a feature of the California Aqueduct Project) on the mainstem Piru Creek upstream of Santa Felicia Dam and operation of the Vern Freeman Diversion Dam on the mainstem Santa Clara River (Figure 2-1) are interrelated with the proposed action. This determination is based on the fact that elements of operation of Pyramid Dam and the Vern Freeman Diversion Dam are part of United's larger action to maintain groundwater recharge in the over-drafted Santa Clara River basin, which is the primary purpose of this project. While other activities may contribute to maintain groundwater recharge in the Santa Clara River Basin (page 8, United Water Conservation District 2008), these activities are not part of United's larger action, and therefore are not interrelated with the proposed action.

[1] The past construction and operation of Santa Felicia Dam are a part of the environmental baseline. The Commission's license would allow United to maintain Santa Felicia Dam and continue to inundate a portion of Piru Creek, and therefore the future existence and operations of the dam will continue into the future due to the proposed action. Consequently, continued existence and operation of the dam represents effects of the proposed action that must be considered as effects of the proposed action in this biological opinion.

Table 2-1.—Steelhead-related measures that are planned as part of the proposed action (Federal Energy Regulatory Commission 2007a).

Description of measure
• Develop in consultation with NMFS, U.S. Fish and Wildlife Service, and California Department of Fish and Game, a flushing flow trigger plan that would establish the timing, duration, and appropriate flows needed to transport sediment in lower Piru Creek in a manner that does not disrupt *O. mykiss* (steelhead and rainbow trout) populations or habitat. Use appropriately sized tracer gravels to enable an accurate assessment of flows that would potentially mobilize gravel that is suitable for *O. mykiss* spawning, to minimize or eliminate effects on redds. Mapping and monitoring of habitat for *O. mykiss* would provide an indication of the amount of habitat that is embedded with fine-grained sediment. The flow-trigger plan would incorporate an experimental release that not only is intended to assess flows that would disturb redds, but also would provide a basis for assessing the effectiveness of the proposed flushing flow in dispersing embedded sediment with follow-up monitoring.
• Develop and implement a groundwater and surface water flow monitoring program. The program would focus on assimilating Piru Basin groundwater elevation data and lower Piru Creek surface water flow data to determine groundwater-surface water relationships. The program also would be used to indicate when steelhead migration conditions are suitable in lower Piru Creek (via connectivity with the Santa Clara River) and trigger steelhead monitoring activities. Use aerial reconnaissance and photographs to document connectivity through the Santa Clara River and lower Piru Creek during the steelhead migration season.
• Conduct a fish passage corridor connectivity study over a five-year period, in consultation with NMFS and California Department of Fish and Game, to identify and evaluate fish passage alternatives, opportunities, and constraints associated with the corridor in lower Piru Creek and system connectivity to suitable habitat for juvenile and adult salmonids. This measure is intended to identify those measures that could be implemented to provide a migration corridor for steelhead around potential barriers in lower Piru Creek, between its confluence with the Santa Clara River and Santa Felicia Dam.
• Develop a steelhead monitoring plan in consultation with NMFS and California Department of Fish and Game with the following elements: (1) monitor for steelhead use within lower Piru Creek downstream of Santa Felicia dam; (2) identify hydraulic indicators to initiate field steelhead monitoring activities; (3) implement monitoring activities; (4) implement tissue and scale sampling to investigate steelhead origin, growth rates, and genetics; (5) provision to provide monthly reports electronically (email) to NMFS and California Department of Fish and Game during the steelhead migration season of the number of adult and juvenile steelhead counted at the Freeman diversion, and surface flow connectivity in the Santa Clara River upstream of the Freeman diversion to and including lower Piru Creek; (6) monitor adult steelhead presence and spawning activity if upstream migrating steelhead are documented at Freeman diversion and sufficient connectivity exists between Freeman diversion and lower Piru Creek to allow successful adult steelhead passage; (7) monitoring for juvenile steelhead if a spill event occurs at Santa Felicia Dam; (8) annual monitoring for juvenile *O. mykiss* in lower Piru Creek following the presence of adult steelhead spawning; and (9) annual reporting of monitoring results to NMFS and California Department of Fish and Game.
• Develop in consultation with NMFS, U.S. Fish and Wildlife Service, and California Department of Fish and Game, a lower Piru Creek habitat monitoring plan that includes the (1) a protocol for United’s proposed testing of the effect of releases from the low-flow outlet works on temperature and dissolved oxygen in lower Piru Creek, (2) the protocol for United’s proposed benthic macroinvertebrate monitoring to evaluate effectiveness of potential sediment management and habitats measures to be implemented, (3) provisions for taking spot measurements for temperature, dissolved oxygen, and pH at appropriate time intervals and at multiple locations downstream of the cone valves, (4) provisions for mapping suitable habitat for *O. mykiss* spawning and rearing under minimum flows resulting from United’s proposed minimum flow formulas and at release of 5 cfs, (5) provisions for mapping and monitoring riparian vegetation, and (6) provisions for reporting the monitoring results to NMFS, U. S. Fish and Wildlife Service, and California Department of Fish and Game.
• Within one year of the Commission’s issuance of the license to United, United will develop an “overarching monitoring plan” for submittal to the Commission for approval, that includes (1) United’s proposed groundwater and surface flow monitoring plan, (2) the recommended flushing flow trigger plan, (3) United’s proposed steelhead monitoring plan, and (4) the recommended lower Piru Creek habitat monitoring plan.
• The overarching monitoring plan also would include (1) provisions for altering the minimum flows from those being calculated by the minimum flow formulas as proposed by United, to allow a specified minimum flow release of 5 cfs if monitoring reveals the presence of *O. mykiss* spawning, juvenile, or adults in lower Piru Creek, or alternate flow should *O. mykiss* presence occur simultaneously with either Arroyo toad or California red legged frog, (2) provisions for notifying the Commission of any deviation from the minimum flow formulas should also be included within the overarching monitoring plan.
• Develop in consultation with NMFS, U. S. Fish and Wildlife Service, and California Department of Fish and Game, a flow management and enhancement plan, based on the first 5 years of implementation of the overarching monitoring plan. The flow management and habitat enhancement plan should include a decision matrix that specifies the magnitude and timing of minimum flows (within the confines of the recommended minimum flow formula, 1.4 to 5 cfs) and flushing flows, designed to benefit the aquatic and riparian species that are determined to be present during each year. The plan would also include an evaluation of the benefits and costs of habitat enhancements that could be implemented to enhance *O. mykiss* as appropriate. Such measures could include measures to enhance upstream and downstream migration of steelhead to and from lower Piru Creek. The plan would include a discussion of any measures that United proposes to implement and a schedule for implementation, and any recommended modifications to the operations of the Santa Felicia Project based on the first 5 years of monitoring and evaluations, as well as proposed amendments to any conditions that may be specified in a new license for this project. The plan would define procedures that would be implemented in the event the monitoring should document the presence of steelhead. The plan would include provisions for (1) reporting an assessment of the habitat benefits and costs of implementing any potential habitat enhancements identified during the habitat monitoring plan, (2) identifying which specific measures United proposes to implement, (3) outlining the reasons for selecting the preferred measures based on the presence or absence of steelhead, and (4) providing a schedule for implementation of the measures.
• Implement the minimum flow formulas to calculate the minimum flow releases below Santa Felicia Dam that would mimic the natural inflow to Lake Piru, up to a maximum of 5 cfs. This would result in United releasing the calculated natural inflow to Lake Piru plus 1 cfs whenever the natural inflow diminishes to 4 cfs or less. United proposes this change in minimum flow as a measure to control bullfrogs. In the event that steelhead monitoring reveals the presence of steelhead in lower Piru Creek, the Commission staff recommend that United deviate from its proposed calculated minimum flow releases and provide a continuous 5 cfs minimum flow to lower Piru Creek while steelhead of all life stages are present.
• Modify the ramping schedule of the conservation release to reduce fish stranding in lower Piru Creek. Releases from the dam would be doubled no faster than every 2 hours, flows over 100 cfs would be reduced no faster than 100 cfs every 8 hours, and flows less than 100 cfs would be halved no faster than once every 8 hours. All adjustments to flow would be made between 7AM and 4 PM.

In accordance with 50 CFR §402.02, and despite contrary suggestions, elements (but not necessarily the entirety of) operations of Pyramid Dam and the Vern Freeman Diversion Dam are both part of, and rely upon, the larger action (pages 7-9, United Water Conservation District 2008). This rationale is explained more fully below.

With regard to operation of Pyramid Dam, the California Department of Water Resources and the City of Los Angeles (licensed operators of Pyramid Dam) are under contract to deliver water to United at Lake Piru (Federal Energy Regulatory Commission 2007b). Operation of Pyramid Dam supplies water to downstream users through operation of Santa Felicia Dam at levels that would not otherwise exist if not for Pyramid Dam. For instance, surface water that would not be captured and stored in Lake Piru (e.g., in the case of high-flow events exceeding storage, causing spills) can be stored in Pyramid Lake for later delivery to United at Lake Piru (Federal Energy Regulatory Commission 2007b). United operates Santa Felicia Dam to deliver large quantities of stored water during, for example, the dry season downstream to the Vern Freeman Diversion Dam (Bureau of Reclamation and United Water Conservation District 2005, Federal Energy Regulatory Commission 2007a). While contribution of Pyramid Dam operations to United's larger action has been characterized as "very minor" and not relying on United's larger action for "justification" (page 9, United Water Conservation District 2008), the regulations at 50 CFR §402.02 do not define a threshold for judging interrelatedness of an activity, and because Pyramid Dam supplies water to downstream users at levels that would not otherwise exist if not for Pyramid Dam, elements of operations of Pyramid Dam are therefore determined to be interrelated with the proposed action.

United operates the Vern Freeman Diversion Dam to redirect surface water from the Santa Clara River (i.e., from within the action area; see section entitled "Description of the Action Area") to nearby percolation ponds for recharging the over-drafted groundwater basin and to surface-water users in the Oxnard Plain (Bureau of Reclamation and United Water Conservation District 2005). In particular, the Vern Freeman Diversion Dam is needed to redirect water that is released from Santa Felicia Dam to the Oxnard Plain including surface-water diverters (Bureau of Reclamation and United Water Conservation District 2005, Federal Energy Regulatory Commission 2007a, United Water Conservation District 2008). Providing the diverted water directly to the downstream agricultural users can preclude the users from pumping, thereby maintaining groundwater recharge. While the Vern Freeman Diversion Dam may not depend on the proposed action for justification (page 9, United Water Conservation District 2008), to meet the overall purpose of recharging the over-drafted groundwater basin and delivering surface water to users in the Oxnard Plain, the Vern Freeman Diversion Dam and Santa Felicia Dam are jointly operated and are therefore interrelated actions. Although the "benefits" of operating the Vern Freeman Diversion Dam may "primarily accrue outside the action area" (page 9, United Water Conservation District 2008), the diversion dam and related effects of its operation on endangered steelhead and critical habitat are within the action area (defined in the section "Description of the Action Area").

NMFS is consulting with the Bureau of Reclamation (Bureau) on effects of the operations of the Vern Freeman Diversion Dam on endangered steelhead and critical habitat for this species. On September 30, 2005, NMFS issued a draft biological opinion to the Bureau and United, which concluded the diversion operations are likely to jeopardize the continued existence of endangered steelhead and are likely to destroy or adversely modify critical habitat for this species (NMFS

2005a). Since issuance of the draft biological opinion, NMFS, United, and the Bureau worked to define operational criteria that would be expected to minimize, to some degree, the adverse effects of diversion operations on endangered steelhead and critical habitat. The final criteria were provided to NMFS in fall 2007, and NMFS prepared another biological opinion based on these revised operational criteria. As of this writing, NMFS issued another draft biological opinion on April 22, 2008, that concludes the proposed operation of the Vern Freeman Diversion Dam is likely to jeopardize the continued existence of the endangered steelhead and is likely to destroy or adversely modify critical habitat for this species. The Bureau has discretion over the diversion operations until 2011, when United expects to repay the loan to the Bureau. Thereafter, NMFS expects United would pursue and obtain a U. S. Endangered Species Act (ESA) section 10(a)(1)(B) incidental take permit to cover the effects of operating the Vern Freeman Diversion Dam on endangered steelhead and critical habitat for this species.

B. Description of the Action Area

This biological opinion adopts much of the action area defined in the BA (Federal Energy Regulatory Commission 2007a), and in accordance with 50 CFR §402.02, the "action area" refers to "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" and includes effects due to interrelated and interdependent activities. The action area considered in this biological opinion involves (1) the mainstem Piru Creek inundated by Pyramid Lake and Pyramid Dam, (2) the mainstem Piru Creek extending from Pyramid Dam downstream to Lake Piru, (3) the mainstem Piru Creek inundated by Lake Piru and Santa Felicia Dam, (4) the mainstem Piru Creek extending from Santa Felicia Dam downstream to the confluence with the Santa Clara River, and (5) the Santa Clara River extending from the mouth of Piru Creek downstream to the ocean including the estuary (Figure 2-1). Physical and biological characteristics of the Santa Clara River watershed, including portions of the action area, can be found in Mann (1975), Bell (1978), Schwartzberg and Moore (1995), Paybins *et al*. (1998), Reichard *et al*. (1999), Bureau of Reclamation and United Water Conservation District (2004), Kelley (2004), Bureau of Reclamation and United Water Conservation District (2005), Federal Energy Regulatory Commission (2007a, b), Densmore *et al*. undated. The general basis for defining the action area as above (page 9, United Water Conservation District 2008) is described as follows.

The mainstem Piru Creek inundated by Pyramid Lake and Pyramid Dam (#1 above) and the mainstem downstream of Pyramid Dam (#2) are included in the action area because operation of Pyramid Dam is interrelated with the proposed action (as described earlier) and the effects of its operation and presence include habitat loss and fragmentation of the mainstem Piru Creek (owing to the separation of habitat due to the impassible presence of the dam) and flow alterations in the mainstem creek downstream of the dam. The mainstem Piru Creek inundated by Lake Piru and Santa Felicia Dam (#3) represents a loss and fragmentation of habitat for steelhead (including habitat in tributaries to the mainstem such as Fish Creek and Agua Blanca Creek) due to the ongoing impassable presence and operation of Santa Felicia Dam. Including the mainstem Piru Creek extending from Santa Felicia Dam downstream to the confluence with the Santa Clara River (#4) and the Santa Clara River downstream to the ocean (#5) is necessary because operation of Santa Felicia Dam affects the amount and extent of streamflow, and therefore critical habitat, for endangered steelhead.

Contrary to suggestions (page 9 and 11, United Water Conservation District 2008), the boundary of the action area is not defined by the extent of critical habitat for this species, but is defined by federal regulation and an understanding of how the proposed action, including interrelated and interdependent activities, may affect endangered steelhead (50 CFR §402.02). Including in the action area the lands that may benefit from the proposed action (see page 11, United Water Conservation District 2008) is not a specific requirement of federal regulation when defining the action area (50 CFR §402.02) and are not addressed in this biological opinion because there is no known effect to steelhead in these lands. While some of the lands serviced by the Vern Freeman Diversion Dam are outside the designated action area (page 9, United Water Conservation District 2008), steelhead and their habitat are not found in such areas, and therefore the serviced lands are not included in the boundary for the action area considered in this biological opinion. The confusion with the description of the action area (page 9, United Water Conservation District 2008) is apparently due to the illustration of the action area (Figure 2-1), which depicts a geographic area that is larger than the defined action area. The purpose of illustrating the action area is two fold. First, the illustration is intended to allow readers to grasp the geographical boundary of the action area, particularly those readers that may not be familiar with the Santa Clara River watershed. Second, because this biological opinion references activities outside the action area that create effects within the action area, we felt it important that the illustration be sufficiently broad to depict the location of such activities. The action area is defined both above and in the legend of Figure 2-1.

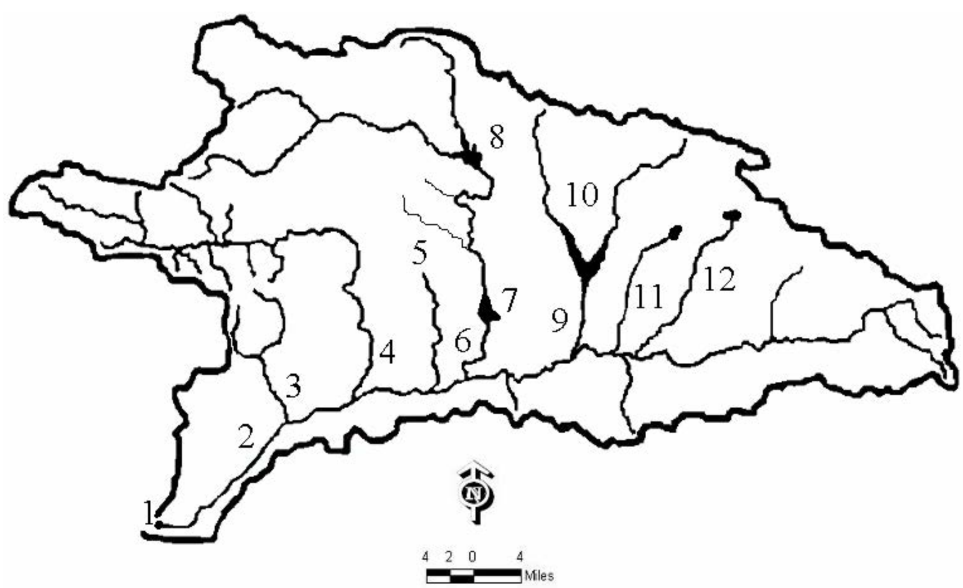

Figure 2-1.—The Santa Clara River watershed and action area. The action area generally involves the mainstem Piru Creek inundated by Pyramid Lake and dam downstream through the Santa Clara River extending from the mouth of Piru Creek downstream to the ocean including the estuary. For a specific description of the action area, see the section entitled "Description of the Action Area." This map exceeds the action-area boundary to allow the reader to locate activities disclosed in this biological opinion that, while outside the action area, influence steelhead habitat conditions within the action area. The principal features are: 1=estuary, 2=Vern Freeman diversion, 3=Harvey diversion dam within the Santa Paula Creek sub-basin, 4=Sespe Creek sub-basin, 5=Hopper Creek sub-basin, 6=Piru Creek sub-basin, 7=Lake Piru formed by Santa Felicia Dam, 8=Pyramid Lake formed by Pyramid Dam, 9=Castaic Creek sub-basin, 10=Castaic Lake formed by Castaic Dam, 11=Dry Canyon and 12=Bouquet Canyon reservoirs.

III. STATUS OF THE LISTED SPECIES AND CRITICAL HABITAT

This section describes the status of the species that is the basis of this biological opinion and which is listed under the ESA. Comments NMFS received on the draft biological opinion specifically requested a clear distinction between the listed anadromous form of *O. mykiss* and the non-listed resident form of *O. mykiss* (e.g., page 11 and elsewhere, United Water Conservation District 2008). Hence, this section now provides the information on this distinction as well as additional information responding to similar comments on the anadromous and resident forms of this species.

A. Overview of the Listed Species and Terminology

Oncorhynchus mykiss exhibit two principal life-history forms: "anadromous" and "resident." The anadromous form spends a portion of its overall life history in the ocean before returning to freshwater for spawning. The resident form spends its entire life in freshwater. Only the anadromous form and their progeny downstream of impassible barriers to upstream migration are listed under the ESA (NMFS 2006b). The terms "steelhead" and "anadromous *O. mykiss*" are often used to describe the anadromous form, including their progeny, and in this regard are used in this biological opinion. Through the construction of dams and other man-made barriers to steelhead migration (page 12, United Water Conservation District 2008), steelhead that historically migrated to the ocean, matured, and returned to their natal freshwater stream for spawning, are now confined to freshwater. Because these individuals are sequestered to freshwater upstream of impassable barriers, they are termed "residualized" or "non-listed steelhead" in this biological opinion because they exist upstream of an impassible barrier and are therefore not listed under the ESA (NMFS 2006b). The resident form within the action area is neither listed under the ESA nor under the jurisdiction of NMFS (NMFS 2006b), but is important to the viability of steelhead because, as described in greater detail below, the resident form can give rise to the anadromous form and vice versa (page 12, United Water Conservation District 2008). The discussion of the resident form is provided in this biological opinion solely to allow a better understanding of how the proposed action would affect the anadromous form.

The listed unit of anadromous *O. mykiss* is termed a "distinct population segment" or DPS (NMFS 2006b), and the listed unit contains several individual or fish-bearing watersheds. The DPS recognizes only the anadromous *O. mykiss*, whereas the term "evolutionarily significant unit," or ESU, refers to both the non-anadromous (or resident) and anadromous (or residualized) *O. mykiss*. In accordance with the listing decision, this biological opinion solely uses the DPS terminology and provides NMFS' conclusion as to the likelihood of jeopardy to the species based only on effects to the listed DPS.

B. Summary Description of the Listed Species

Steelhead are native to Pacific coast streams extending from Alaska to northwestern Mexico (Moyle 1976, Behnke 1992, NMFS 1997, Good *et al*. 2005). The geographic range of this steelhead DPS extends from the Santa Maria River, near Santa Maria, to the California–Mexico border (NMFS 1997, 2002, 2006b). NMFS listed southern California steelhead as an endangered species under the ESA on August 18, 1997 (NMFS 1997), and reaffirmed the endangered status on January 5, 2006 (NMFS 2006b).

Steelhead show mixed age composition in freshwater (e.g., Spina 2003, Spina *et al*. 2005), and exhibit a polymorphic life history with some individuals not migrating to the ocean before maturing and reproducing (i.e., resident and residualized *O. mykiss*), and some individuals (from both the anadromous and resident forms, page 12, United Water Conservation District 2008) giving rise to progeny that exhibit an anadromous reproductive cycle (e.g., Zimmerman and Reeves 2000, Thrower *et al*. 2004a, McPhee *et al*. 2007). Through the construction of dams that lack fish-passage facilities (i.e., migration barriers), steelhead trapped as juveniles have matured and reproduced in freshwater, and many reservoirs in California contain "residualized" steelhead, as determined through genetic analyses (Nielsen *et al*. 1997, Girman and Garza 2006, Boughton and Garza 2008). Some reservoirs are known to still produce juveniles that smolt and migrate to the ocean and return as adults to the base of barriers to natal areas (e.g., Thrower *et al*. 2004a, b, A. Spina, fish biologist, NMFS, pers. obs.).

C. The Resident Form of *O. mykiss* and Viability of the Anadromous Form

Information indicates the resident form of *O. mykiss* contributes to the viability of the anadromous form. The two life-history forms can be sympatric and genetically similar (Docker and Heath 2003, Narum *et al*. 2004, McPhee *et al*. 2007) and the resident form can produce anadromous progeny and vice versa (Zimmerman and Reeves 2000, McPhee *et al*. 2007). These findings emphasize the survival advantage of the resident form to the anadromous form of *O. mykiss*, particularly under certain environmental conditions. Extended periods of no or low rainfall can limit migratory conditions and preclude steelhead from reaching freshwater spawning areas. During such periods, resident *O. mykiss* can be the only life-history form spawning and producing progeny with the innate ability to resume anadromy, which favors future persistence of the anadromous form. By contrast, the anadromous form can recolonize watersheds following periods of extended drought and transient extirpation of the resident form. The innate ability of *O. mykiss* to produce anadromous individuals is sufficiently strong to resist decadal freshwater confinement (Thrower *et al*. 2004a, b), and such is the case in many southern California reservoirs (e.g., Nielsen *et al*. 1997).

D. Natural Presence of Steelhead in the Piru Creek Drainage

Evidence indicates a natural population of steelhead was present in the Piru Creek sub-basin prior to the construction of Santa Felicia Dam. The evidence includes findings of genetic studies and reports, and observations of steelhead prior to the construction of the dam.

***Findings of genetic studies.*—**The findings of Nielsen *et al*. (1997) and Girman and Garza (2006) (see also Boughton and Garza 2008), which are largely based on the collection of juvenile *O. mykiss* from freshwater habitats in southern California, including the Piru Creek drainage, indicate that native southern California steelhead (currently non-listed steelhead) exist and dominate reproducing populations of *O. mykiss* in the Piru Creek drainage upstream of Pyramid Dam and Santa Felicia Dam. The fish upstream of both dams are largely or entirely descended from relic *O. mykiss* populations that included anadromous forms ascending Piru Creek prior to construction of Santa Felicia Dam (Girman and Garza 2006, Boughton and Garza 2008). While a planting program resulted in the annual stocking of thousands of young steelhead in the Piru Creek drainage between the 1890s and 1938 (United Water Conservation District 2007a, b, page 16, United Water Conservation District 2008), the genetic investigations have distinguished the planted steelhead from the native ancestral stock of southern California steelhead. If steelhead in the Piru Creek watershed (including non-listed steelhead upstream of Santa Felicia Dam) were largely or entirely descended from planted steelhead from Fillmore Hatchery or northern California hatcheries, one would expect genetic similarity between the out-of-basin transfers and steelhead. This expectation was not observed. Rather, the findings indicate the Santa Clara River populations of *O. mykiss*, including Piru Creek, are closely related to all (cf. page 15, United Water Conservation District 2008) other steelhead populations native to southern California (Girman and Garza 2006, Boughton and Garza 2008). Additional information on the genetics of steelhead in the Santa Clara River basin is presented later in this section.

***Reports of steelhead.*—**Besides the foregoing genetic studies indicating that steelhead ascended Piru Creek and tributaries prior to the construction of Santa Felicia Dam, and steelhead ancestry (i.e., non-listed steelhead) still exists upstream of both Pyramid Dam and Santa Felicia Dam, steelhead have been reportedly observed in the drainage prior to the construction of Santa Felicia Dam. For instance, several large adult steelhead were taken from Agua Blanca Creek prior to the construction of Santa Felicia Dam (Figure 3-1). United Water Conservation District (2007a) reports on a note describing a conversation between a California Department of Fish and Game employee (B. Evans) and an angler (L. Kellan) who "fished Piru Creek for many years." According to United's report, "Kellan told Evans he had observed steelhead in the Gold Hill area [of Piru Creek] in 1944-45." Some appear to have deliberately attempted to discredit Kellan's observations, citing various reasons (United Water Conservation District 2007a, page 19 in United Water Conservation District 2008), but given the findings of the genetic studies and the adult steelhead caught (and then photographed) in the Piru Creek drainage before construction of Santa Felicia Dam, Kellan's observations appear reliable.

***Argument against historical natural presence of steelhead in the Piru Creek drainage.*—**Some have commented that steelhead never existed naturally in the Piru Creek watershed and the extensive out-of-basin transfers of anadromous *O. mykiss* are responsible for the genetic findings and anecdotal reports of steelhead in the drainage (e.g., Federal Energy Regulatory Commission 2007c, pages 1-3 in Federal Energy Regulatory Commission 2008, United Water Conservation District 2007a, b, and pages 13 to 18 and 32 to 35 in United Water Conservation District 2008). The contention that steelhead are not native to the watershed is based on (1) early scientific publications, which are interpreted as not mentioning presence of steelhead in the watershed, (2) historical field surveys by the California Department of Fish and Game, which are interpreted as evidence that habitat characteristics and conditions of the Piru Creek sub-basin are not appropriate for growth and survival of the indigenous steelhead (which, interestingly, contradicts the assertion that the out-of-basin transfers survived and produced the contemporary population of *O. mykiss* in the Piru Creek drainage), and (3) natural percolation of groundwater in the Santa Clara River, which is presumed to create a migration barrier for steelhead (again, contradicting the assertion that the out-of-basin transfers survived and produced the contemporary population of *O. mykiss* in the Piru Creek drainage).

Figure 3-1.—Several large adult steelhead captured from Agua Blanca Creek, tributary to Piru Creek, upstream of the present location of Santa Felicia Dam (*c*. 1915). Photograph courtesy of Ed Henke, Historical Research, Ashland Oregon.

After carefully reviewing and considering these arguments, as well as performing a review of the available information regarding the presence of steelhead in the Santa Clara River watershed and relevant ecological reports and articles including information on which these arguments are based, NMFS continues to conclude that steelhead were naturally present in the Piru Creek drainage prior to the construction of Santa Felicia Dam, and non-listed steelhead persist in the drainage upstream of Santa Felicia Dam. The basis for NMFS' conclusions is presented as follows.

Historical out-of-basin transfers of anadromous O. mykiss. Out-of-basin transfers are reported to not contribute substantially to the production of naturally spawned steelhead. Although there has been a long history of extensive and widespread transplantations of non-ancestral *Oncorhynchus sp*. (including *O. mykiss*) over broad geographic ranges, such plants have generally failed to establish new runs because, in part, wild anadromous salmonids are resistant to introgression from out-of-basin transfers (Campton and Johnston 1985, Utter 2001, Utter 2004, Quinn 2005). The literature indicates that heat-tolerant forms of *O. mykiss*, which evidence indicates do exist in southern California streams (Matthews and Berg 1997, Spina 2007), can resist introgression and allow ancient gene pools of steelhead to persist (Utter 2001).

The plantings did not persist because out-of-basin transfers are not adapted to the environmental conditions of the receiving waters (Reisenbichler 1988, Currens *et al*. 1997, Utter 2001, Utter 2004, Quinn 2005). Steelhead populations, like other salmon species, exhibit local adaptations to the freshwater environment in which they exist, and steelhead at the southern extent of their geographic range are exposed to chronic environmental conditions that differ from those conditions experienced by northern conspecifics (e.g., Matthews and Berg 1997, Spina *et al*. 2005, Spina 2007). Most of the out-of-basin transfers to the Piru Creek drainage came from Shasta Hatchery in northern California (United Water Conservation District 2007b). This hatchery received its eggs from Baird Hatchery on the McCloud River in northern California. With the completion of Fillmore Fish Hatchery in the 1940s, the planting of fry and fingerlings from northern California stock was curtailed, and a brood stock was developed over time to produce fast growing fish for planting, including in Piru Creek. The problem with the Fillmore strain of *O. mykiss* is that it was deliberately domesticated by selection to perform well in a hatchery setting, and the genetic changes that have taken place favoring growth and survival under artificial conditions are detrimental to survival under harsh natural conditions (Behnke 1992). Transfers from other basins are not expected to tolerate well the instream conditions at the southern geographic extent of the species' range. Experiments involving transplants of fish show that local populations have superior performance over fish transplanted from different basins (Quinn 2005). As United Water Conservation District (2007b) states when referencing an historic article from the Los Angeles Times, the plantings of fish were not successful:

> "As far back as February 9, 1986 the LA Times stated 'It is somewhat unfortunate, perhaps that these beautiful fish are mainly denizens of the northern and central portions of the State, Many efforts have been made to keep trout in the rivers of Southern California, but these have not met with success that was experienced in the north" (page 4-3, United Water Conservation District 2007b).

Besides not being adapted to the conditions of the receiving waters, the instream habitat at the location receiving the planted fish was not conducive to long-term survival or growth of the planted fish. Prior to the construction of Santa Felicia Dam, most if not all of the out-of-basin steelhead were planted in the mainstem Piru Creek (United Water Conservation District 2007b). Such plants are not expected to have persisted through the summer for at least a few reasons. First, much of the mainstem appears to have been, and still is, prone to water temperatures (United Water Conservation District 2007b and reports therein) that exceed the upper heat tolerance of northern conspecifics (Spina 2007), which formed the basis of the plantings from the late 1890s to the early 1900s. Second, the historical function of the mainstem Piru Creek was likely and primarily a corridor for steelhead migrating to upstream spawning and rearing habitats from the ocean, not the principal oversummering rearing and growing areas within tributaries to the mainstem (e.g., Lockwood Creek, Fish Creek, Agua Blanca Creek). Third, according to the CDFG field logs (which are provided in United Water Conservation District 2007b), the mainstem did experience instream drying in the areas observed.

Another reason why the planted areas are not expected to support long-term survival of the out-of-basin transfers involves olfactory imprinting and homing of anadromous salmonids (Quinn 2005). Anadromous salmonids use odors learned at the smolt stage (olfactory imprinting) to locate and return to their natal river (homing). Homing can be precise and fish released in locations as smolts often return to the released areas as adults. The out-of-basin transfers noted for the Piru Creek drainage were confined primarily, if not exclusively, to mainstem Piru Creek.

Despite not being adapted to the physical, physicochemical, and biological conditions of southern California streams, if an out-of-basin transfer is hypothetically assumed to survive long enough to reach the adult stage and return to Piru Creek (e.g., page 18, United Water Conservation District 2008), one would expect the individual to return to and spawn at the release point within the mainstem. Nest creation in mainstems is not conducive to production of young because wild indigenous anadromous salmonids have evolved to migrate into the extreme fringes of watersheds, including tiny tributaries were the habitat characteristics and conditions are appropriate for the production of progeny (Montgomery *et al*. 1999). In the mainstem, the nests and developing embryos would be susceptible to extremes in flows, particularly the scouring effects of high winter flows.

The genetic findings provide empirical evidence that the out-of-basin transfers did not contribute substantially to the production of native steelhead in the Santa Clara River watershed, including the Piru Creek sub-basin (Boughton and Garza 2008), despite comments to the contrary (e.g., pages 1-3 in Federal Energy Regulatory Commission 2008, pages 13-18 in United Water Conservation District 2008). The following selected quotes from Boughton and Garza (2008)[2] are part of responses to comments NMFS received on the genetic findings and contention that steelhead naturally ascended and spawned in the Piru Creek drainage prior to the construction of Santa Felicia Dam:

> "[The Girman and Garza (2006)] study demonstrated unambiguously that fish in Piru Creek, and everywhere else in the study area, are predominately of recent steelhead ancestry. It also demonstrated that there is substantial reproductive isolation between native, naturally-spawning fish and hatchery trout that have been planted throughout the system for decades."
>
> "The genetic evidence is unequivocal that the *O. mykiss* populations inhabiting Piru Creek are of primary steelhead ancestry and the ecological evidence for steelhead presence in Piru Creek is similarly strong."
>
> "…our finding that Piru Creek populations are most closely related to other Santa Clara River populations and that Santa Clara River populations are clearly dominated by ancestry of southern coastal steelhead origin, very clearly demonstrates that some level of anadromy existed in Piru Creek fish prior to construction of the dams. No reasonable scenario involving hatchery stocking could explain these patterns. Moreover, our study on the historical population structure of *O. mykiss* in California, including fish from the Salinas River, in the same genetic group as the Santa Clara River fish, demonstrates the importance of migration in determining the distribution and population structure of steelhead in coastal California. Given the high degree of coastal steelhead ancestry in contemporary Piru Creek populations and the extraordinary demonstration of the ubiquity of historical anadromous migration in California, we conclude that anadromous steelhead must have been present in Piru Creek in the recent past and that they have contributed to the ancestry of contemporary populations."

[2] In referencing Boughton and Garza (2008), NMFS considered for purposes of this biological opinion only the information in Boughton and Garza that is the basis for NMFS' conclusion described herein that native steelhead volitionally ascended Piru Creek prior to the construction of Santa Felicia Dam.

Early Scientific Publications. Early scientific publications indicate that the southern geographic extent of steelhead extends to southern California and includes the Santa Clara River. Jordan and Evermann (1923) (as cited in United Water Conservation District 2008) state that steelhead are present in the Santa Clara River, Ventura County. The Bureau of Fish Conservation (1951) reported that steelhead ascend the Santa Clara River to headwaters in the Piru Creek drainage (Evans 1951).

Although not considered an "early scientific publication," a monograph produced by one of the leading authorities on the origin and distribution of salmon and trout describes the history of steelhead (Behnke 1992). The description provides further evidence that the historical distribution of this species included southern California:

> "…the coastal subspecies of rainbow trout arose, perhaps in the Sacramento basin, and spread both south to Mexico and north to Alaska, from where the subspecies moved to the Kamchatkan Peninsula in Asia during late- or postglacial times. Such a history is consistent with the modern distribution of redband and coastal rainbow trout…" (page 164)
>
> "Coastal rainbow trout are distributed along the North American coast from the Kuskokwim River of Alaska to Baja California." (page 169)
>
> "Anadromous steelhead populations are found in both coastal rainbow and redband trout groups. The only steelhead I presently classify with redband trout are those ascending the Columbia River east of the Cascade Range and those in the Fraser River above Hell's Gate." (page 169)

Historical California Department of Fish and Game surveys. Despite the suggestions that habitat in the Piru Creek drainage is not appropriate for steelhead (e.g., pages 13, 32 to 35, and elsewhere, United Water Conservation District 2008), evidence indicates the habitat characteristics are appropriate for spawning and rearing of the indigenous *O. mykiss* including steelhead.

The field-log notations regarding habitat quality and character should not be used to discount the appropriateness of the Piru Creek drainage as living space for southern steelhead, for at least a few reasons. First, CDFG personnel were assessing the suitability of the instream habitat for receiving plants of hatchery trout, not for native *O. mykiss* including juvenile steelhead. Second, while the field logs document occasionally low and intermittent dry-season surface flows and elevated water temperatures, such conditions are features of habitat for native steelhead at the southern extent of its geographic range (e.g., Matthews and Berg 1997, Spina 2003, Spina *et al*. 2005, Boughton *et al*. 2006, Spina 2007). Steelhead oversummering in southern California streams are adapted to the modest natural habitat conditions and are able to withstand the natural low concentrations of dissolved oxygen and elevated water temperatures, which exceed the temperature preference and upper heat tolerance reported for northern conspecifics and the species as a whole. This species has evolved traits to tolerate natural inhospitable environmental conditions characterized by normal variability and extremes in water temperature and streamflow.

Inferring the spawning and rearing potential of the entire Piru Creek drainage based on observations of the mainstem Piru Creek is not a reliable estimate of the spawning and rearing capability of the drainage as a whole. Many of the field-log observations are representative of the mainstem Piru Creek, particularly in the lower and middle sections, not the upper reaches and tributaries to the mainstem where much of the spawning and nursery habitats are known to exist (e.g., Moore 1980a). The historical function of much of the mainstem Piru Creek was most likely a primary migration corridor for steelhead migrating to and from upstream spawning and rearing habitats and the ocean. The migratory behavior and ecology of steelhead is such that this species will migrate deep into a river system to the extreme fringes of the watershed, such as tributaries to mainstems where the stream characteristics and conditions are conducive to the production of young (Montgomery *et al*. 1999). As a result, adult steelhead are spawning, and juveniles are rearing, within the tributaries to mainstems, not mainstems proper, which, in southern California, can be prone to dewatering and desiccation during the dry season, as was noted in the CDFG field logs.

That the habitat quality in the Piru Creek drainage is suitable for spawning and rearing is corroborated by evidence of actual spawning and rearing of *O. mykiss* upstream of Santa Felicia Dam. Several tributaries in the middle and upper watershed (e.g., Fish Creek, Agua Blanca Creek, Lockwood Creek) provide much habitat, in some cases several miles, for spawning and rearing, and reproduction of *O. mykiss* has been noted in the drainage (Moore 1980a, Deinstadt *et al*. 1990) upstream of Santa Felicia Dam. Even now, large adult *O. mykiss* leave Piru Lake and Pyramid Lake and undertake migrations during winter and spring in Piru Creek and spawn in upstream tributaries (Bloom 2005, pers. comm. R. Bloom, CDFG, September 18, 2007). Much of the information reported in United Water Conservation District (2007b) pertains to Piru Creek, and less typically Agua Blanca Creek. Fish Creek does not appear to be mentioned. Not fully considering Agua Blanca Creek or Fish Creek underestimates the spawning and rearing potential of the drainage because these two tributaries are known spawning and nursery areas for *O. mykiss* (Moore 1980a), as described below.

With regard to Agua Blanca Creek, during a late summer survey in 1979, the U. S. Forest Service inspected 14 miles of the 16 mile creek (Moore 1980a). Stream discharge at the time of the survey ranged from 1.0 to 2.0 ft^3/s (cfs), and the stream was rocky with swift-water habitats. Many rainbow trout were observed in numbers that were ranked from fair to abundant. Size of the trout observed ranged from 2 to 16 inches, indicating natural production in the creek and the habitat is capable of supporting multiple age groups and life stages. Some instream habitat elements were rated as excellent and oversummering habitat was rated good. Upper reaches of the creek are believed to provide the primary spawning and nursery habitat within this specific tributary.

With regard to Fish Creek, evidence indicates instream habitat characteristics and conditions, and production of *O. mykiss*, were good in this creek (Moore 1980a). During a late summer survey in 1979, the U. S. Forest Service inspected the lower 1.25 miles of Fish Creek (out of the total 6 miles of stream). Stream discharge was 2.5 cfs and pools and riffles, which are used extensively by juvenile *O. mykiss* (e.g., Spina 2000, Spina 2003), were commonly observed through the inspected reach, and rainbow trout were noted as being abundant. The trout ranged in length from about 1 to 3 inches, probably most being age-0 trout, indicating natural production in the creek, though a few larger individuals (age 1 and 2) were observed as well. Moore (1980a) concluded "fish Creek is the <u>only</u> spawning tributary available to trout in Piru Creek between Pyramid Lake and Agua Blanca Creek and appears heavily used as such."

Lockwood Creek, a tributary to Piru Creek in the upper basin, was also found to have suitable habitat for *O. mykiss*, and was referred to as "an ideal little trout stream" (California Division of Fish and Game stream survey, September 18, 1946.). The Bureau of Fish Conservation (1951) reported that habitat for resident trout was in the headwaters of the Piru Creek drainage and steelhead migrated through the Santa Clara River to reach habitats in the headwater tributaries within the Piru Creek basin. At least 3 miles of habitat has been reported for Buck Creek (Douglas 1953).

Natural percolation of surface water into the river channel bed. One key aspect of the hydrology of the Santa Clara River is that while evidence indicates surface flows can percolate entirely into the channel bed during the dry season and periods of low flow, there is no reliable information indicating the percolation can render the Santa Clara River mainstem impassible during those periods when steelhead would be migrating. Steelhead have evolved to exploit rain-induced pulses of river discharge, and both adult and juvenile lifestages have been found to migrate during periods of elevated winter and spring discharge (Shapovalov and Taft 1954, Spina *et al*. 2005). Prior to the construction of Santa Felicia Dam, river discharge is expected to have been elevated and continuous throughout the Santa Clara River during periods when steelhead were migrating. Even today after the construction of dams in the upper watershed (e.g., Santa Felicia Dam, Pyramid Dam, Castaic Dam), elevated continuous wet-season discharge in the Santa Clara River in the vicinity and downstream of the confluence with Piru Creek is not uncommon, and the mainstem Santa Clara River is known to flood during rainfall events.

C. Life History and Habitat Requirements of Steelhead

Because the anadromous form of *O. mykiss* is listed under the ESA and is the basis of this biological opinion, only the life history and habitat requirements of the anadromous form are described here (page 19, United Water Conservation District).

Steelhead in southern California are categorized as "winter run" because they migrate into natal streams between December and early May, arriving in reproductive condition and spawning shortly thereafter. Adults may migrate several miles, hundreds of miles in some watersheds, to reach their spawning grounds. Steelhead have evolved to migrate deep into the extreme fringes of a watershed to exploit the environmental conditions that favor production of young (e.g., Montgomery *et al*. 1999). Individuals spend one or two years in the ocean, though in many populations a small fraction of fish will spend a third year at sea. The most common life-history patterns of first-time spawners in coastal basins of California are 2/1 (smolt age/ocean age), 2/2 and 1/2 (Busby *et al.* 1996). Steelhead differ significantly from other species of Pacific salmon in that not all steelhead adults die after spawning; some individuals may return to the ocean and then spawn a second, third, or even fourth time. Roughly 10%-20% of steelhead will survive to spawn a second time, and less than 5% may spawn a third or even fourth time. Female steelhead excavate a nest in the streambed and then deposit their eggs. After fertilization by the male, the female covers the nest with a layer of gravel, and the embryos incubate within this gravel pocket. Hatching time varies from about three weeks to two months depending on water temperature. The young fish emerge from the nest two to six weeks after hatching.

For anadromous *O. mykiss*, the period of freshwater residency can range from one to three years, with longer residence in northern latitudes. Steelhead migrate to sea for the first time after two or three years in fresh water (Busby *et al*. 1996), but in watersheds that include highly productive environments, juveniles can reach sufficient size to smolt after one year (Bond 2006). Smolting juveniles migrate downstream in spring, generally between March and June or July with peaks in April and May (Shapovalov and Taft 1954, Spina *et al*. 2005). The timing of emigration appears to be influenced by photoperiod, streamflow, and temperature. Immature steelhead may rear in a lagoon or estuary for several weeks prior to entering the ocean. Additional details about steelhead life history can be found in Shapovalov and Taft (1954), Barnhart (1986, 1991), Bjornn and Reiser (1991), Spina 2003, Spina *et al*. 2005, and Quinn (2005).

Habitat requirements of steelhead in streams generally depend on the life history stage (Cederholm and Martin 1983, Bjornn and Reiser 1991). Generally, discharge, water temperature, and water chemistry must be appropriate for adult and juvenile migration. Low discharge, high water temperature, physical barriers, low dissolved oxygen, and turbidity[3] (high levels) may delay or halt upstream migration of adults and timing of spawning, and downstream migration of juveniles and subsequent entry into the estuary, lagoon, or ocean. Suitable water depth and velocity, and substrate composition are the primary requirements for spawning, but water temperature and turbidity are also important. Dissolved oxygen concentration, pH, and water temperature are factors affecting survival of incubating embryos. Fine sediment, sand and smaller particles, can fill interstitial spaces between large substrate particle types, thereby reducing waterflow through and dissolved oxygen levels within a nest. Juvenile steelhead require living space (different combinations of water depth and velocity), shelter from predators and harsh environmental conditions, food resources, and suitable water quality and quantity, for growth and survival during summer and winter. Juvenile steelhead rear in riffles, runs and pools (*e.g.,* Roper *et al*. 1994, Spina *et al.* 2005) during much of a given year where these habitats exist, but can show specific habitat requirements as indicated by the similarity of microhabitat use despite changes in microhabitat availability in some streams (Spina 2003). Steelhead in southern California streams can be tolerant of warm water, remaining active and feeding at temperatures that that are higher than the temperature preferences and heat tolerances reported for the species based on individuals from northern latitudes (Spina 2007).

D. Population Viability

One prerequisite for predicting the effects of a proposed action on a population includes an understanding of whether the population is likely to experience viability, i.e., the hypothetical state(s) in which extinction risk of the broad population is negligible over a 100-year period and full evolutionary potential is retained (Boughton *et al*. 2006). NMFS equates this likelihood of viability with the likelihood of both the survival and recovery for purposes of conducting the jeopardy analysis under section 7(a)(2) of the ESA. Four principal parameters were used to evaluate the extinction risk for the endangered Southern California DPS of steelhead: abundance, population growth rate, population spatial structure, and population diversity. These specific parameters are important to consider because they are predictors of extinction risk, and the parameters reflect general biological and ecological processes that are critical to the growth and survival of steelhead (McElhany *et al*. 2000). Guidelines or decision criteria have been defined

[3] Defined as "suspended particulate matter affecting the amount of light that is scattered or absorbed by a fluid." With regard to the influence of turbidity on migration of steelhead, the ecological literature provides no unequivocal causal relationship between turbidity and migration. Therefore, whether turbidity in fact influences migration is currently unknown. Challenges related to developing a clear understanding of whether turbidity influences upstream migration of adult steelhead includes (1) the relationship between turbidity and discharge, which can be positively related to one another, and (2) discharge alone has been found to influence migration.

for each of the four parameters to further the likelihood of viability evaluation, and these guidelines were considered and are *emphasized* for ease of reference in the following evaluation. Because some of the guidelines are related or overlap, the evaluation is at times necessarily repetitive. The terms "broad population" and "DPS" are used synonymously throughout this discussion, and differ from "population unit" which here means an individual steelhead-bearing watershed. Although we do apply this evaluation solely to the anadromous form of *O. mykiss* (i.e., one segment of *O. mykiss*) (pages 19 to 21, United Water Conservation District 2008), there is no ecological rule precluding such application to a specific form of a polymorphic species and the anadromous form is considered a distinct population segment (NMFS 2006b). The evaluation is specifically intended to provide insights into the likelihood of viability of the listed (anadromous) form of *O. mykiss*, not the species (*O. mykiss*) as a whole.

Before proceeding with the evaluation, some common understanding of the inherent meaning of population viability is needed. Population viability is based on a few key concepts, which provide the basis for judging the persistence of a population in the wild. The bases for these concepts can be found in the many publications regarding population ecology, conservation biology, and extinction risk (e.g., Pimm *et al*. 1988, Berger 1990, Primack 2004, see also McElhany *et al*. 2000 and Boughton *et al*. 2006). Comprehending these concepts is essential for understanding the basis for NMFS' conclusion regarding the likelihood of viability of the endangered Southern California DPS of steelhead. There are three basic concepts (adapted from Boughton *et al*. 2006) and these have been deliberately simplified for ease of understanding. This summary concludes with a discussion of how these concepts are expected to apply to the endangered Southern California DPS of steelhead.

The first concept is that for a population to persist indefinitely, on average each adult fish in the population has to give rise to at least one adult fish in the next generation (i.e., the population of adults must replace itself year after year). In nature, population abundance fluctuates for a variety of reasons including random changes in environmental conditions (often referred to as *environmental stochasticity*). If the fluctuations are large enough, the number of individuals in the population can fall to zero, even though the population may be relatively large initially. There are certain traits that reduce the likelihood that a population would be driven to extinction by random events, which leads us to the second concept.

The second concept involves the size of the population. The larger the population, the less likely the population is to become extinct. In nature, the number of births, deaths, and matings are important to the viability of a population. Essentially, the likelihood of extinction is reduced if the birth rate is high (the population is replacing itself – the first concept). In the case of death rates, the larger the population, the less likely that random deaths will cause large reductions in the number of individuals in the population. High birth rates, and low death rates favor persistence of the population. In the case of matings, the larger the population, the larger the number of potential mates and the reduced likelihood that individuals will fail to locate a mate. Similarly, the larger the population, the less likely that all mates will fail to produce eggs. Large population size is the single most important trait to protect a population from being driven to extinction due to random events.

The third concept involves the relationship of vital events (e.g., births and deaths). The more correlated that vital events tend to be across the population, the larger the population must be to reduce the likelihood of extinction. For instance, if environmental stochasticity causes a more or less similar change in death rates across the population, we would say that the death rates are correlated (i.e., not independent). Similarly, if random perturbations cause birth rates to increase similarly across the population, we would say that the birth rates are also correlated. Now here is the point: if vital events are correlated across the population, we would expect, for example, the death rates across the population to decrease in synchrony (i.e., death rates would decrease across the habitats in which the species exist, not just in localized areas). This is different than a situation where the vital events are not correlated, in which case we would not expect, for example, the death rates across the population to simultaneously decrease. Rather, we would expect that abundance of some individuals in some areas would not decrease. Therefore, if vital events are correlated across a population, a sufficiently large population is needed to reduce the likelihood that chance fluctuations would reduce the number of individuals to zero.

With regard to how these concepts are expected to apply to the endangered Southern California DPS of steelhead, the largest populations are needed to support an effective recovery strategy. The role of the largest populations in recovery is based on population theory, which suggests the largest populations would have the highest viability if restored to an unimpaired condition (see Boughton *et al*. 2006). The influence of environmental stochasticity on the DPS is expected to be high, and because environmental stochasticity increases extinction risk to the population, and to compensate for the environmental influences, the Southern California DPS therefore needs to have a larger average size than a broad population that is not as affected by chance fluctuations in environmental conditions (Boughton *et al*. 2006). The expected sources of environmental stochasticity in the Southern California DPS involve drought (and associated features such as high temperatures, low streamflow, lack of sandbar breaching at the mouths of rivers), floods, and wildfire. In June 2007, extensive instream drying was reported for many coastal streams in the DPS (M. McGoogan, NMFS, pers. comm.). Under such conditions stream temperature can increase dramatically, exceeding the heat tolerance of fish, and dissolved-oxygen concentration can fall below levels tolerable for steelhead. Finding dead or dying juvenile steelhead is not uncommon under such conditions. Recently, dead juvenile steelhead (including "non-listed steelhead") have been observed in the Ventura River (Ventura County) (A. Spina, NMFS, pers. obs.), in Cold Springs Creek[4] (Santa Barbara County) (M. McGoogan, NMFS, pers. comm.), and Sisar Creek[5] (Ventura County) (M. Capelli, NMFS, pers. comm.) (Figure 3-2). In July 2007, the "Zaca" wildland fire was reported and burned over 200,000 acres within and near Santa Barbara County, including steelhead-bearing drainages (www.fs.fed.us/r5/lospadres). What follows now is the evaluation of the likelihood of viability for the endangered Southern California DPS of steelhead, beginning with the abundance parameter.

[4] Cold Springs Creek is located above a debris basin (page 21, United Water Conservation District 2008). Because the anadromous form of *O. mykiss* cannot currently access the reach of creek upstream of the debris basin, the residualized steelhead that remain in the creek upstream of the basin are considered non-listed steelhead.

[5] Sisar Creek is a coastal stream that is accessible to steelhead. While steelhead access may have been temporally disrupted by winter 2005 damage to the fish ladder at Harvey Dam, the damage was recently remedied and the temporary disruption, if present, does not mean that steelhead did not in the recent past access Sisar Creek (page 21, United Water Conservation District 2008).

Figure 3-2. Dead juvenile steelhead retrieved from a "shrinking pool" in Sisar Creek on June 16, 2007. Note the multiple size, and therefore age, classes of fish.

***Abundance*.—**Information about population size provides an indication of the sort of extinction risk that a population faces. For instance, small populations are at a greater risk of extinction than large populations because the processes that affect populations operate differently in small populations than in large populations (e.g., Berger 1990, Pimm *et al*. 1988, Primack 2004). Variation in environmental conditions leading to low levels of species survival or fecundity for extended time can cause extinction of small populations (a slightly expanded discussion of the extinction risk that small populations face is presented in the section, "Effects of the Proposed Action"). What follows is an evaluation of the abundance of steelhead in the DPS in the context established by the guidelines for the abundance parameter (i.e., viable population size guidelines, McElhany *et al*. 2000). The endangered Southern California DPS of steelhead must meet all of the population guidelines to be considered viable with regard to the abundance parameter.

In consideration of the population guidelines below, one must recognize that while an extensive program was undertaken to populate the Santa Clara River watershed, including the Piru Creek sub-basin, with out-of-basin transfers of *O. mykiss*, empirical evidence indicates the transfers have not substantially contributed to the natural production of native steelhead in the Santa Clara River drainage (see the section entitled "Natural Presence of Steelhead in the Piru Creek Drainage"). Therefore, the stated historical run sizes described below are not believed to be *higher* than "any ancestral, pre-stocking run sizes" as has been suggested (page 22, United Water Conservation District 2008). The same can be stated for the numerical prescription for the population viability threshold (described below); there is no information to indicate the viability threshold exceeds historical or ancestral populations. Rather, "the numerical population viability threshold may exceed ancestral populations for the Santa Clara by some unknown amount, or it may not, depending on numerous ecological factors not yet fully understood' (page 8, Boughton and Garza 2008). One way to achieve the level of abundance needed for population viability (page 23, United Water Conservation District 2008), is to reverse the effects of anthropogenic activities on steelhead and its habitat (see also Boughton *et al*. 2007a for a discussion of how viability for listed steelhead can be attained). Such effects are included in the evaluation of the population guidelines.

A population should be large enough to have a high probability of surviving environmental variation of the patterns and magnitudes observed in the past and expected in the future. Recent findings indicate that 12,500 adult steelhead per generation (3 years for steelhead) (or 4,150 steelhead per year[6]) are needed for each individual population unit (steelhead-bearing watershed) if the Southern California DPS is to be viable (Boughton *et al*. 2007a). The historical run size of adults within the Southern California DPS of steelhead was roughly estimated to be at least 32,000 to 46,000; yet recent total run sizes for the same four waterways was estimated at less than 500 adults (Busby *et al*. 1996, Good *et al.* 2005[7]). With regard to the Santa Clara River, few adult steelhead have been reported there during the past several years (Table 4-1). The number of streams currently supporting the endangered Southern California DPS of steelhead has been greatly reduced from historical levels, and watershed-specific extirpations of steelhead have been documented (Boughton *et al*. 2005, Gustafson *et al*. 2007). Recent findings suggest widespread reductions in effective population size (see pp. 58 of McElhany *et al*. 2000 for definition and discussion) of southern California steelhead (Girman and Garza 2006). Overall, the broad population appears to be in a continued state of decline and not capable of surviving fluctuations in environmental conditions.

A population should have sufficient abundance for compensatory processes to provide resilience to environmental and anthropogenic perturbations. The developers of the numerical population viability threshold arrived at the value of 12,500 adult steelhead per generation (or 4,150 adult steelhead per year) based on the expectation that the numerical threshold would be sufficient to, in part, combat influences of environmental variability (e.g., irregular inter-annual patterns of precipitation) on the risk of extinction, without consideration of other influences such as anthropogenic activities (Boughton *et al*. 2007a). Because abundance of adult steelhead in the endangered Southern California DPS is currently, and substantially, lower than the viability threshold, the current abundance of adult steelhead is not believed to be capable of withstanding influences of environmental fluctuations, let alone perturbations due to anthropogenic activities, which are widespread throughout the DPS.

A population should be sufficiently large to maintain its genetic diversity over the long term. Genetic variability is important because differing genetic traits favor a population being able to survive and reproduce under changing environmental conditions. With regard to the endangered Southern California DPS of steelhead, anthropogenic activities (including migration barriers) have selectively eliminated some steelhead populations from the broad population (e.g., Boughton *et al*. 2005, Gustafson *et al*. 2007), leading us to conclude that much of the genetic diversity of the species has been lost (e.g., Levin and Schiewe 2001). This conclusion is further supported by findings of recent empirical studies documenting a decline in effective population size and genetic diversity in southern California steelhead (Girman and Garza 2006). That the

[6] The developers of this numerical prescription acknowledge the criterion may be biologically infeasible for some waterways, particularly small coastal basins (Boughton *et al*. 2007a).
[7] Note that the reference Good *et al*. (2005) is not "superfluous" (*sensu* page 22, United Water Conservation District 2008) because new data and updated analyses are presented therein, as a careful review would reveal.

Southern California DPS has low abundance is reason alone to expect a loss of genetic traits that are needed to respond and adapt to a changing environment because such is a problem inherent with small populations (Primack 2004).

A population should be sufficiently abundant to provide important ecological functions throughout its life cycle. The number of individuals required to provide such functions depend mostly on the structure of the species' habitat and biology (McElhany *et al*. 2000). Currently, the number of adults in the subject DPS (estimated at 500 individuals, Busby *et al*. 1996, Good *et al.* 2005) is considerably less than the minimum number of adults needed to maintain the viability of independent populations within the DPS (4,150 adults per independent population, Boughton *et al*. 2007a). The underlying basis for the minimum viability threshold includes the functional response of steelhead populations to environmental conditions, and the species' biology, ecology, and genetics, as well as consideration of extinction risk (Boughton *et al*. 2007a). Consequently, the minimum viability threshold is expected to reflect the abundance required to support the expression of biological and ecological functions. With regard to the species' habitat, a variety of anthropogenic factors have reduced the quality and quantity of habitat for steelhead (Busby *et al*. 1996, Good *et al.* 2005), and certain habitat functions have been either eliminated or reduced (e.g., in the case of a dam blocking migration of steelhead to historical spawning and rearing habitats, or in the case of water releases from dams that are inadequate for steelhead habitat needs).

Population Growth Rate[8].—The productivity of a population (i.e., the number of individuals generated over a specified time interval) can reflect conditions, for example, environmental conditions, that influence the dynamics of a population and determine abundance. In turn, the productivity of a population allows an understanding of the performance of a population across the landscape and habitats in which it exists and its response to those habitats (McElhany *et al*. 2000).

A population's natural productivity should be sufficient to maintain its abundance above the viable level. Natural productivity can be measured as the ratio of naturally-produced spawners born in one broodyear to the number of fish spawning in the natural habitat during that broodyear. Under the foregoing scenario, the spawner-to-spawner ratio should fluctuate around 1.0 or higher to maintain abundance, i.e., cohorts should be replacing one another at least equally. While information regarding natural productivity of the Southern California DPS is lacking, the magnitude of the decline in the abundance of adult steelhead in the DPS (Busby *et al*. 1996, Good *et al.* 2005) indicates the number of spawners has not been replenished and the number of adults in the subject DPS (estimated at 500 individuals, Busby *et al*. 1996, Good *et al.* 2005) is considerably less than the minimum number of adults needed to maintain the viability of independent populations within the DPS (4,150 adults per independent population, Boughton *et al*. 2007a).

A viable population that includes naturally spawning hatchery fish should exhibit sufficient productivity from naturally-produced spawners to maintain population abundance at or above viability thresholds in the absence of hatchery subsidy. NMFS is not aware of any evidence indicating naturally spawning hatchery steelhead are substantially contributing progeny to the endangered Southern California DPS of steelhead. While extensive and widespread stocking of

[8] See Boughton *et al*. (2007a) for a discussion of how viability for listed steelhead can be attained (page 23, United Water Conservation District 2008).

steelhead has occurred in southern California streams historically (e.g., United Water Conservation District 2007a,b), hatchery steelhead are not currently planted in the DPS except upstream of long-standing barriers to anadromy (Boughton *et al*. 2007a). Empirical evidence indicates the historical plants from Fillmore Fish Hatchery and hatcheries from northern California have not contributed substantively to the reproduction and perpetuation of native steelhead ancestry in southern California (Girman and Garza 2006, Boughton *et al*. 2007b, Boughton and Garza 2008, Garza undated). Hatchery fish or not, the natural productivity in the DPS is not sufficient to maintain abundance of the broad population above the minimum viability threshold.

A viable population should exhibit sufficient productivity during freshwater life-history stages to maintain its abundance at or above viable thresholds. The number of adults in the subject DPS (estimated at 500 individuals, Busby *et al*. 1996, Good *et al.* 2005) is considerably less than the minimum number of adults needed to maintain the viability of independent populations within the DPS (4,150 adults per independent population, Boughton *et al*. 2007a). Recent genetic studies document a decrease in effective population size and genetic diversity (Girman and Garza 2006), both of which indicate a reduction in freshwater productivity. Consequently, the level of production in freshwater (even if poor conditions have prevailed in the ocean) has not been sufficient to maintain abundance of the broad population above the minimum viability threshold.

A viable population should not exhibit sustained declines in abundance that span multiple generations and affect multiple brood-year cycles. Evidence indicates abundance of wild steelhead in the Southern California DPS has declined dramatically (Busby *et al*. 1996, Good *et al.* 2005), and many watershed-specific extinctions of this species have been reported (Nehlsen *et al*. 1991, Boughton *et al*. 2005, Gustafson *et al*. 2007). Recent efforts to monitor abundance of adult run sizes in some of the larger watersheds continue to show either no, or extremely low, numbers of returns over a period of several years (e.g., see Table 4-1 of this biological opinion) or multiple generations (assuming a 3-year generation for steelhead). The broad population is not currently viable because estimated run sizes (500 individuals, Busby *et al*. 1996, Good *et al.* 2005) are considerably less than the minimum threshold needed for the DPS to be viable.

A viable population should not exhibit trends or shifts in traits that portend declines in population growth rate. The warnings have come and gone – population growth rate of the Southern California DPS of steelhead has declined to dangerously low levels. Evidence indicates abundance of steelhead in the DPS has declined dramatically (Busby *et al*. 1996, Good *et al.* 2005), and many watershed-specific extinctions of this species have been reported (Nehlsen *et al*. 1991, Boughton *et al*. 2005, Gustafson *et al*. 2007). Recent data show adult run sizes in some of the larger (or "core" populations, *sensu* Boughton *et al*. 2006) watersheds continue to show either no, or extremely low, numbers of returns (e.g., see Table 4-1 of this biological opinion). The decrease in effective population size noted for southern California steelhead (Girman and Garza 2006) suggest a decline in population growth rate.

Population Spatial Structure[9]**.—**Understanding the spatial structure of a population is important because the population structure can affect evolutionary processes and, therefore, alter the ability of a population to adapt to spatial or temporal changes in the species' environment (McElhany *et*

[9] See the section "Description of the Population Units" for a discussion of the distribution of anadromous *O. mykiss* in the Santa Clara River watershed (page 23, United Water Conservation District 2008).

al. 2000). Populations that are thinly distributed over space are susceptible to experiencing poor population growth rate and loss of genetic diversity (Boughton *et al.* 2007a).

Habitat patches should not be destroyed faster than they are naturally created. Anthropogenic activities have reduced the number of streams and amount of habitat available to steelhead, causing a net increase in the amount of steelhead habitat that is lost (Nehlsen *et al*. 1991, NMFS 1997, Boughton *et al*. 2005, NMFS 2006b). Man-made barriers constructed on numerous streams in the Southern California DPS have rendered the streams unavailable to adult steelhead (Boughton *et al*. 2005). Many water-storage projects have caused the elimination of hundreds of miles of spawning and rearing habitat for steelhead in this DPS. These projects include Twitchell Dam on the Cuyama River, Bradbury Dam on the Santa Ynez River, Casitas Dam on Coyote Creek, Matilija Dam on Matilija Creek, Santa Felicia Dam and Pyramid Dam on Piru Creek, and Rindge Dam on Malibu Creek (e.g., Good *et al*. 2005). Groundwater pumping and diversion of surface water contributes to the loss of habitat for steelhead, particularly during the dry season (e.g., NMFS 2005a, see also Spina *et al*. 2006). The extensive loss and degradation of habitat is one of the leading causes for the decline of steelhead abundance in southern California and listing of the species as endangered (NMFS 1997, 2006b). Because human activities have decreased the total area of habitat or the number of habitats, a negative trend on population viability is expected (McElhany *et al*. 2000).

Natural rates of straying among subpopulations should not be substantially increased or decreased by human actions. While there has been no systematic attempt to assess straying of adult steelhead in southern California streams, information suggests that anthropogenic activities have increased the potential of steelhead straying into non-natal streams. The rationale is based on the simple fact that because streams (or habitats needed for specific life-history functions) that used to support adult steelhead are no longer accessible to the adults (e.g., Boughton *et al*. 2005), these adults would need to enter streams that are in fact accessible. Dispersal of steelhead has been documented in the Southern California DPS, for instance in the case of Topanga Creek and San Mateo Creek (NMFS 2002, Boughton *et al*. 2006). Increased stray rates would be expected to reduce population viability, particularly if the strays are accessing unsuitable habitat or are breeding with genetically unrelated individuals (McElhany *et al*. 2000).

Some habitat patches should be maintained that appear to be suitable or marginally suitable, but currently contain no fish. Generally, habitat for steelhead has suffered destruction, modification, and curtailment and is not being maintained (e.g., Nehlsen *et al*. 1991, NMFS 1997, Boughton *et al*. 2005, Good *et al*. 2005, NMFS 2006b). Construction and the ongoing impassable presence of man-made structures throughout the Southern California DPS have rendered many habitats inaccessible to adult steelhead (Boughton *et al*. 2005). Within many stream reaches that are accessible to this species (but that may currently contain few or no fish), urbanization and exploitation of water resources has eliminated or dramatically reduced the quality and amount of living space for steelhead (e.g., Bureau of Reclamation and United Water Conservation District 2005, NMFS 2005a, see discussion on next page).

Source subpopulations (i.e., population units) should be maintained. The habitat supporting source populations is not being maintained. For example, a large housing development was recently constructed along lower Pole Creek, which is a tributary to the Santa Clara River, itself a “core” or “source” population (Boughton *et al*. 2006). The ecological effects of the development appear to include perpetuation of the long-standing migration problem for adult steelhead through the lower creek. Groundwater pumping and diversion of surface water is widespread in the Santa Clara River watershed and is known to reduce the quality and quantity of habitat for steelhead (NMFS 2005a, Federal Energy Regulatory Commission 2007a, b). A detailed review of factors affecting steelhead in southern California streams noted widespread degradation, destruction, and blockage of habitat for steelhead, including habitats supporting source populations (Busby *et al*. 1996, Good *et al*. 2005, Boughton *et al*. 2006), indicating habitats for source populations have not been maintained.

***Population Diversity*.—**Steelhead possess a suite of life history traits, such as anadromy, timing of spawning, emigration, and immigration, fecundity, age-at-maturity, behavior, physiological and genetic characteristics, to mention a few. The more diverse these traits (or the more these traits are not restricted), the more likely the species is to survive a spatially and temporally fluctuating environment. Factors that constrain the full expression of a trait are expected to affect the diversity of a species (McElhany *et al*. 2000). The specific traits of steelhead that have been altered in the Santa Clara River watershed (page 23, United Water Conservation District 2008) are described below and elsewhere in this biological opinion (e.g., see the section entitled "Effects of the Proposed Action").

Human-caused factors such as habitat changes, harvest pressures, artificial propagation, and exotic species introduction should not substantially alter variation in species' traits. In the Southern California DPS, steelhead anadromy has been either eliminated or reduced in many drainages (e.g., the Santa Clara River drainage) due to a variety of anthropogenic factors including the construction of fish-passage impediments (Boughton *et al*. 2005, Good *et al*. 2005, NMFS 2005a). All of the larger watersheds that historically supported steelhead now possess complete barriers precluding steelhead from a substantial amount of habitat (e.g., 71% of stream kilometers blocked in the Santa Maria Watershed, 58% of stream lies upstream of Bradbury Dam on the Santa Ynez River, Good *et al*. 2005). Most fish-passage barriers such as dams in the DPS do not allow safe migration of adult and juvenile steelhead (including remnant populations of non-listed steelhead that reside upstream of long-standing barriers) to and from spawning and rearing areas and the ocean. The loss or reduction in anadromy and migration of juvenile steelhead to the estuary or ocean is expected to reduce gene flow, which strongly influences population diversity (McElhany *et al*. 2000).

Natural processes of dispersal should be maintained – human-caused factors should not substantially alter the rate of gene flow among populations. Anthropogenic factors have altered the rate of gene flow in the endangered Southern California DPS of steelhead. One such factor is the construction and ongoing impassable presence of many dams throughout the DPS that do not possess fish-passage facilities (e.g., Levin and Schiewe 2001). Such dams prevent adult and juvenile steelhead from reaching intended habitats. Adults that cannot access streams or upstream habitats are expected to migrate into and colonize streams that are accessible (Boughton *et al*. 2006). Juvenile steelhead that are not allowed to engage in the spring emigration (e.g., Spina *et al*. 2005), as would be the case when a dam traps juveniles, are not expected to contribute to gene flow, thereby altering the pattern of natural gene flow. Another factor that has altered gene flow involves the numerous watershed-specific extinctions of steelhead in the Southern California DPS, many of which are related to anthropogenic activities (Nehlsen *et al*. 1991, Boughton *et al*. 2005, Gustafson *et al*. 2007). Each watershed-specific population of steelhead (and sub-basins within a watershed) can be viewed as a distinct gene pool of individuals that are adapted to the innate environmental conditions and characteristics of its home watershed (see review by Nehlsen *et al*. 1991 and references therein, Hendry *et al*. 2002). Therefore, loss of a population results in elimination of a substantial amount of genetic diversity and reduces gene flow throughout the broad population (Levin and Schiewe 2001). Evidence indicates genetic diversity in populations of southern California steelhead is low (Girman and Garza 2006).

Natural processes that cause ecological variation should be maintained. Habitat is the "templet" for ecological variation in a species (Southwood 1977) and, accordingly, when a species' habitat is altered, the potential for the habitat to promote ecological variation (e.g., in a species' ability to cope with fluctuating environmental conditions) is also altered. Much of the historical habitat for steelhead in southern California streams has been degraded, eliminated, simplified, and rendered inaccessible to the species (Nehlsen *et al*. 1991, Busby *et al*. 1996, Good *et al*. 2005), and existing habitats are not being maintained. For instance, the alteration in the pattern and magnitude of discharge downstream of dams or diversions (NMFS 2005a, Federal Energy Regulatory Commission 2007 a, b,) has resulted in a shift in the timing of the freshwater migration corridor or a restricted migration window (e.g., NMFS 2005a, this biological opinion). These effects are expected to translate into limited or no opportunities for steelhead to migrate during the wet season, the principal migration season. Loss or limited migration opportunities are expected to adversely affect the species' basic demographics and evolutionary processes, causing a reduced potential that the DPS can withstand environmental fluctuations. Activities that affect evolutionary processes (e.g., natural selection) have the potential to alter the diversity of the species; the widespread effects of anthropogenic activities in southern California are believed to have contributed to a decline in genetic diversity of southern California steelhead (Girman and Garza 2006).

In summary, the foregoing evaluation suggests the DPS is not viable and is at a high risk of extinction, i.e., low likelihood of viability. This finding is consistent with conclusions of past and recent technical reviews (Busby *et al*. 1996, Good *et al*. 2005), and the formal listing determinations for the species (NMFS 1997, 2006).

E. Description of the Population Units

The endangered Southern California DPS of steelhead (and therefore only listed individuals, page 25, United Water Conservation District 2008) comprises several population units (steelhead-bearing watersheds). While 46 drainages support this DPS (Boughton *et al*. 2005), only 10 population units possess a high and biologically plausible likelihood of being viable and independent[10] (Boughton *et al*. 2006). Although the geographic area of the DPS is broad, the individual population units are sparsely and unevenly distributed throughout the DPS with extensive spatial breadth often existing between nearest-neighbor populations (Boughton *et al*. 2005, NMFS 2005b, Boughton *et al*. 2006). Extinction of some population units has been observed as well as contraction of the southern extent of the species' geographic range (Boughton *et al*. 2005, Gustafson *et al*. 2007). One reason for the extensive spatial gaps between neighboring population units and the range contraction involves man-made barriers to fish migration (Boughton *et al*. 2005).

[10]Independent population: a collection of one or more local breeding units whose population dynamics or extinction risk over a 100-year time period is not substantially altered by exchanges of individuals with other populations (Boughton *et al*. 2006).

Information indicates the Santa Clara River population unit involves Sespe Creek, Santa Paula Creek, Hopper Creek, and Piru Creek (e.g., Moore 1980b, Boughton *et al*. 2006, Titus *et al*. 2006). Contrary to suggestion (page 23, United Water Conservation District 2008), the population units can include Piru Creek because evidence indicates steelhead naturally ascended Piru Creek prior to the construction of Santa Felicia Dam (Nielsen *et al*. 1997, Girman and Garza 2006, Boughton and Garza 2008). As of this writing, NMFS is not aware of information indicating the degree or extent that Castaic Creek, Boquet Creek, San Francisquito Creek, or Soledad Creek, contributed to the Santa Clara River population unit (page 23, United Water Conservation District 2008). There is no information indicating that the area of groundwater percolation in the Santa Clara River, near the confluence with Piru Creek, defines the easterly extent of anadromy in the Santa Clara River drainage (page 23, United Water Conservation District 2008). While surface flows may become intermittent during the dry season and periods of low flow, steelhead migrate during periods of elevated flows and river connectivity, and the mainstem Santa Clara River exhibits connectivity during and shortly after periods of rainfall sufficient to produce runoff (see also the section entitled “Natural percolation of surface water into the river channel bed” in this biological opinion).

F. Contribution of the Santa Clara River Steelhead Population Unit to DPS Viability and Relationship to Recovery

We describe here the characteristics of the Santa Clara River steelhead population that contribute to the viability of the entire endangered Southern California DPS of steelhead. The characteristics include the “independence” of the Santa Clara River population, and the functional value of the steelhead-bearing sub-basins within the watershed.

Independence of the Santa Clara River population.—The Santa Clara River population is considered an independent population (Boughton *et al*. 2006), and is therefore expected to support formation of steelhead numbers in several adjacent population units (Figure 3-3). The ability of individual population units to contribute to the viability of their overall broader population can vary (Thomas and Kunin 1999), and this is true for the population units making up the Southern California DPS (Boughton *et al*. 2006). The Santa Clara River steelhead population is one of only a few population units in this DPS that have been determined to have a high assurance of being independent and therefore is expected to contribute substantively to the viability of the DPS and recovery of the species. The creation and maintenance of populations in several adjacent population units, which is expected of the Santa Clara River population, effectively increases numbers of individuals in the broad population. Given the risk of extinction that small populations face (e.g., Pimm *et al*. 1988, Primack 2004), a larger number of individuals decrease the risk that the broad population would possess weakened viability.

If restored to an “unimpaired” condition, the Santa Clara River population unit is expected to be stable, i.e., able to withstand environmental stochasticity (Boughton *et al*. 2006). Population units in strictly coastal or inland areas of the DPS do not appear to be different in terms of their innate stability over the long term (Boughton *et al*. 2006), but some population units exist in areas where surface water can be perennial and where winter discharge (and therefore migration opportunities for steelhead) is more dependable. This has led to the identification of certain population units in the DPS that are expected to be more stable over the long term than other units not sharing such environmental features. The Santa Clara River was identified as such a population unit (Boughton *et al*. 2006).

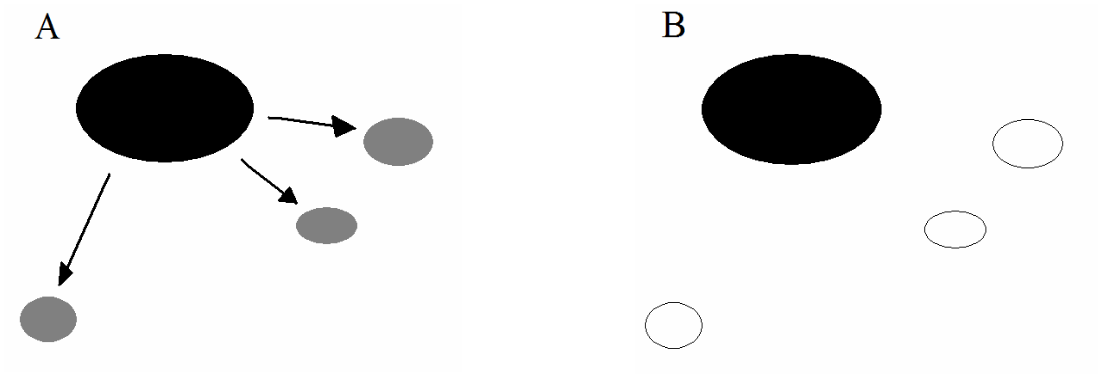

Figure 3-3.—Concept of source-sink dynamic (after McElhany *et al*. 2000, Primack 2004). Circles represent habitats (e.g., watersheds) with the size of the circle indicating the size of the population unit and habitat capacity (large circles represent source or core population units, whereas small circles represent sink or non-core population units). Shading represents population density: white indicates an empty habitat, black indicates high density, and grey indicates intermediate density. Arrows indicate migration. In favorable years, source populations show relatively stable numbers and several sink populations show arrival of immigrants (A). Populations in sink areas may become extinct in unfavorable years (B), but sinks or non-core populations can be recolonized by migrants from source populations when conditions are favorable.

The Santa Clara River population unit possesses ecologically significant attributes not found in most other population units. Examples of these attributes are as follows. The population unit represents a large distributional component of the overall range of the DPS (i.e., makes up a large part of the DPS), and the Santa Clara River population unit is the largest steelhead-bearing watershed in the DPS. Without this population unit, the number of large population units would be reduced to two: the Santa Ynez River and the Ventura River. The remaining units are small coastal populations, which by themselves, do not appear to favor viability and recovery of the DPS (Boughton *et al*. 2006). Larger river systems are important for a variety of reasons including that steelhead genetic diversity can be higher in larger versus smaller systems (Heath *et al*. 2001). The Santa Clara River population unit is an inland population, whereas the vast majority of population units are coastal. The value of inland populations lies in their innate habitat characteristics and conditions; inland population units extend into areas that are drier and warmer than those experienced by coastal population units, and inland population units also have longer migration routes. Such environmental features are expected to promote diversity (genetic, phenotypic, and ecological) and specific life-history traits (e.g., the ability to migrate long distances, and tolerate elevated temperatures and low flows during the dry season) that favor survival of the species (for evidence of variation in life history traits and adaptations to environmental characteristics, see Withler 1966, Schaffer and Elson 1975, and review by Nehlsen *et al*. 1991). The inland populations of steelhead appeared to have been the largest within southern California particularly during favorable water years (Boughton *et al*. 2006, Boughton *et al*. 2007a).

Functional value of the steelhead-bearing sub-basins within the watershed.—The independence of the Santa Clara River population unit is related to subpopulations within the watershed (individual steelhead-bearing streams in the watershed) and the quality and quantity of habitats available for the subpopulations.[11] The Piru Creek subpopulation possesses certain

[11] Key concepts in population theory are presented in this biological opinion, including a detailed discussion of the concepts at the beginning of section III, subsection D. Understanding these concepts is crucial for appreciating the importance of the subpopulations to the viability of the population unit (and likewise the value of the population units to the viability or

attributes that signify its ecological importance to the Santa Clara River population unit (note that in earlier sections of this biological opinion we discuss the evidence indicating historical natural presence of steelhead in the Piru Creek drainage, which refutes contrary suggestions, e.g., page 26, United Water Conservation District 2008). These attributes must be represented and maintained to promote long-term viability of the species (Boughton *et al*. 2007a). A review of these attributes is as follows.

The Piru Creek subpopulation (i.e., the geographic area the subpopulation would occupy) is located farther from the ocean than any of the other currently recognized subpopulations in the Santa Clara River watershed[12]. The distance of the upper reaches of the Piru Creek drainage from the ocean would require that steelhead have the physical ability to migrate long distances, a feature that promotes population diversity. The subpopulation extends into an area that is drier and warmer than those subpopulations located closer to the coast (Boughton *et al*. 2006), and such environmental conditions are expected to promote formation of specific adaptations that favor survival of steelhead (genetic and ecological diversity).

The Piru Creek subpopulation lies in the largest drainage (in terms of area) in the Santa Clara River watershed. Estimates indicate over 250 miles of stream network lie in this drainage, though we recognize that not all 250 miles of stream network may be suitable given the seasonality of some of the sub-basins (page 26 to 27, United Water Conservation District 2008). However, the function and value of ephemeral or seasonal drainages should not be discounted because adult *O. mykiss* actively seek out and spawn in seasonal streams, producing young that would otherwise not be produced (Erman and Hawthorne 1976). Given the extensiveness of the Piru Creek sub-basin, the potential to produce a large number of steelhead is therefore high.

Much of the Piru Creek subpopulation lies on U. S. Forest Service land, where anthropogenic activities are either not allowed or severely restricted. As a result, much of the habitat is high quality and least disturbed (A. Spina, pers. obs.). Several tributaries in the middle and upper watershed (e.g., Fish Creek, Agua Blanca Creek, Buck Creek, Lockwood Creek) provide much habitat (in some cases several miles) for steelhead to spawn and rear (e.g., Moore 1980a).

The Piru Creek sub-basin appears to serve as a refuge freshwater habitat that is safeguarding the anadromous species. This is based on the reproduction of *O. mykiss* and extensive suitable habitat noted there (Moore 1980a, Deinstadt *et al*. 1990) and the finding of residualized *O. mykiss* that exhibit ancestral native steelhead genetics upstream of Santa Felicia Dam and Pyramid Dam (Nielsen *et al*. 1997, Girman and Garza 2006, Boughton *et al*. 2007b, Boughton and Garza 2008, Garza undated). These fish probably still possess the ability to transform into smolts and migrate to the ocean (e.g., Thrower *et al*. 2004a). Even today, large adult *O. mykiss* leave Piru Lake (and Pyramid Lake) and undertake migrations during winter and spring in Piru Creek and spawn in upstream tributaries (Bloom 2005, pers. comm. R. Bloom, CDFG, Sept. 18, 2007). The characteristics of the population upstream of both dams, and the quantity and quality of habitat, suggest the area may one day be maintained as a large and naturally reproducing population for the purpose of conserving this endangered species.

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independence of the DPS), and the relationship among steelhead abundance, habitat quality and quantity, fluctuations in environmental conditions, and extinction risk.

[12] The Piru Creek subpopulation is the easterly-most subpopulation that is known to have historically occurred, but this does not preclude the possibility that other subpopulations existed further east (pages 23 and 26, United Water Conservation District 2008). It is not that NMFS does not believe more easterly populations existed; it is just that NMFS is not aware of information indicating that such is the case.

The Piru Creek watershed is expected to buffer the species against extirpation, particularly during periods of extended drought that are common to the region. Prolonged rain-free periods can cause streams to become intermittent, sometimes over extensive areas (e.g., Spina *et al*. 2005, Boughton *et al*. 2006, Boughton *et al*. 2007a). Migration of steelhead to and from spawning and rearing areas and the ocean is not likely under such conditions. Perennial waterways, as such exist often in protected areas within upper basins, can serve as refuges for fish during the drought conditions and may be the only place where reproduction of native steelhead is occurring. With regard to the Piru Creek drainage, the tributaries in the upper drainage (e.g., Agua Blanca Creek, Fish Creek, Buck Creek, Snowy Creek) can possess flowing water even during dry periods (United Water Conservation District 2007b). Given that *O. mykiss*, which are similar to other native southern California steelhead stocks (page 28, United Water Conservation District 2008), are produced in the habitats above Pyramid Dam and Santa Felicia Dam (see Moore 1980a, Nielsen *et al*. 1997, Girman and Garza 2006, Boughton *et al*. 2007b, Boughton and Garza 2008, Garza undated), such areas are expected to protect the progeny of *O. mykiss* during prolonged dry periods.

We believe the foregoing discussion is reasonable despite criticism that the discussion ignores natural variation in rainfall and relies on watershed size (pages 24 and 26, United Water Conservation District 2008). Although rainfall does contribute to establish and maintain living space for steelhead, snow-melt runoff and natural seeps or springs can form extensive aquatic habitat even during extended rainfall-free periods. Therefore it is not appropriate to assume that rainfall is the only creator of aquatic habitat. While the Santa Clara River watershed can exhibit temporal variations in rainfall, so does the entire southern California region including all other steelhead-bearing watersheds within the Southern California DPS of steelhead. Hence, inter-annual rainfall variation does not discount the functional value of the sub-basins within the Santa Clara River watershed or other watersheds within the DPS. The greater amount of runoff noted for Sespe Creek (page 26, United Water Conservation District 2008) may be due, in part, to the extensive amount of rock in this sub-basin, which would be expected to promote rates (and volumes) of runoff that are higher than observed in sub-basins with little exposed rock. With regard to watershed size, it is well documented, and intuitive, that larger watersheds provide greater habitat availability and genetic diversity (e.g., Heath *et al*. 2001).

Our conclusion that the sub-basin is important to conserving anadromy does not relate to the suggestion that "middle Piru Creek has been artificially maintained with imported water as *O. mykiss* habitat since the 1973 completion of Pyramid Dam" (page 28, United Water Conservation District 2008). Rather, our conclusion is generally and primarily based on the functional value of the spawning and rearing tributaries upstream of Santa Felicia Dam. Although Pyramid Dam captures and stores water within the Piru Creek watershed, Aqua Blanca Creek and Fish Creek lie downstream of the dam and represent sources of unimpaired flows to the mainstem Piru Creek. Because adult and juvenile steelhead migrate during periods of rain-induced elevated river flows, we generally do not expect steelhead immigrants or emigrants would have been limited to or perished in the mainstem Piru Creek or Santa Clara River prior to the construction of either Santa Felicia Dam or Pyramid Dam (page 28, United Water Conservation District 2008).

G. Status of the Species' Critical Habitat

This section describes designated critical habitat for the endangered Southern California DPS of steelhead, including critical habitat within the action area that is the basis of this biological opinion. Comments received on the draft biological opinion (e.g., page 29, United Water Conservation District 2008) requested clarification on the location of critical habitat in the action area and the rationale underlying the designation of critical habitat. Hence, this section now provides the requested clarification and underlying rationale.

***Critical habitat within the action area*.—**Figure 3-4 illustrates the distribution of critical habitat in the Santa Clara River watershed. Within the action area, critical habitat exists in (1) Piru Creek extending from the base of Santa Felicia Dam downstream to the confluence with the Santa Clara River, (2) the Santa Clara River from the confluence with Piru Creek downstream to the Pacific Ocean, and (3) the Santa Clara River estuary. Information on the overall designation of critical habitat is presented in the section below "Designation of critical habitat for endangered steelhead."

***Underlying rationale for the designation of critical habitat.*—**Section 3 of the ESA defines critical habitat as (1) specific areas within the geographical area occupied by the species at the time of listing, on which are found those physical or biological features that are essential to the conservation of the listed species and that may require special management considerations or protection, and (2) specific areas outside the geographical area occupied by the species at the time of listing that are essential for the conservation of a listed species. Our regulations direct us to focus on ''primary constituent elements,'' in identifying these physical or biological features. NMFS undertook an extensive effort to identify critical habitat for endangered steelhead, and because a description of the effort is beyond the scope of this biological opinion, we refer readers to the final rule in which NMFS designated critical habitat (NMFS 2005b) for discussion and rationale behind the designation.

***Designation of critical habitat for endangered steelhead.*—**Critical habitat for the Southern California DPS was designated on September 2, 2005 (NMFS 2005b). We summarize here relevant information from the final rule regarding the primary constituent elements and activities with the potential to affect critical habitat; the final rule provides more detail. The designation identifies primary constituent elements that include sites necessary to support one or more steelhead life stages and, in turn, these sites contain the physical or biological features essential for conservation of the DPS. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and estuarine areas. The physical or biological features that characterize these sites include water quality, quantity, depth, and velocity, shelter/cover, living space, and passage conditions. Activities with the potential to affect critical habitat for the Southern California steelhead DPS include: (1) forestry, (2) grazing and related rangeland activities, (3) agriculture and associated water withdrawals for agriculture, (4) road building or maintenance, (5) modifications of the creek channel or bank, (6) urbanization, (7) sand and gravel mining, (8) mineral mining, (9) dams, (10) irrigation impoundments and water withdrawals, (11) wetland (including estuaries) loss or removal, (12) introduction of exotic or invasive species, and (13) impediments to fish passage (NMFS 2005b).

Habitat for steelhead has suffered destruction and modification, and anthropogenic activities have reduced the amount of habitat available to steelhead (Nehlsen *et al*. 1991, NMFS 1997, Boughton *et al*. 2005, NMFS 2006b). In many watersheds throughout the Southern California DPS, the damming of streams has precluded steelhead from hundreds of miles of historical spawning and rearing habitats (*e.g.*, Twitchell Reservoir within the Santa Maria River watershed, Bradbury Dam within the Santa Ynez River watershed, Matilija Dam within the Ventura River watershed, Rindge Dam within the Malibu Creek watershed, Pyramid Dam and Santa Felicia Dam on Piru Creek). These dams created physical barriers and hydrological impediments for adult and juvenile steelhead migrating to and from spawning and rearing habitats. Likewise, construction and ongoing impassable presence of highway projects have rendered habitats inaccessible to adult steelhead (Boughton *et al*. 2005). Within stream reaches that are accessible to this species (but that may currently contain no fish), urbanization (including effects due to water exploitation) have in many watersheds eliminated or dramatically reduced the quality and amount of living space for juvenile steelhead. The number of streams that historically supported steelhead has been dramatically reduced (Good *et al*. 2005). Groundwater pumping and diversion of surface water contributes to the loss of habitat for steelhead, particularly during the dry season (e.g., NMFS 2005a, see also Spina *et al*. 2006). The extensive loss and degradation of habitat is one of the leading causes for the decline of steelhead abundance in southern California and listing of the species as endangered (NMFS 1997, 2006b).

The critical habitat analytical review teams assembled as part of the effort to designate steelhead critical habitat ranked the conservation value of habitat for watersheds known to be occupied by steelhead (NMFS 2005b). The conservation value of habitat within the Santa Clara River watershed was ranked “high,” meaning the habitat is currently (at the time of the evaluation) high quality and expected to be supportive of species recovery. We emphasize that this ranking is relative to the potential of the habitat; although habitat in the Santa Clara River watershed has been degraded, we conclude that the habitat is of high value for recovery of the species. Moreover, the action area possesses a considerable amount of critical habitat relative to the total amount in the Southern California DPS (NMFS 2005b).

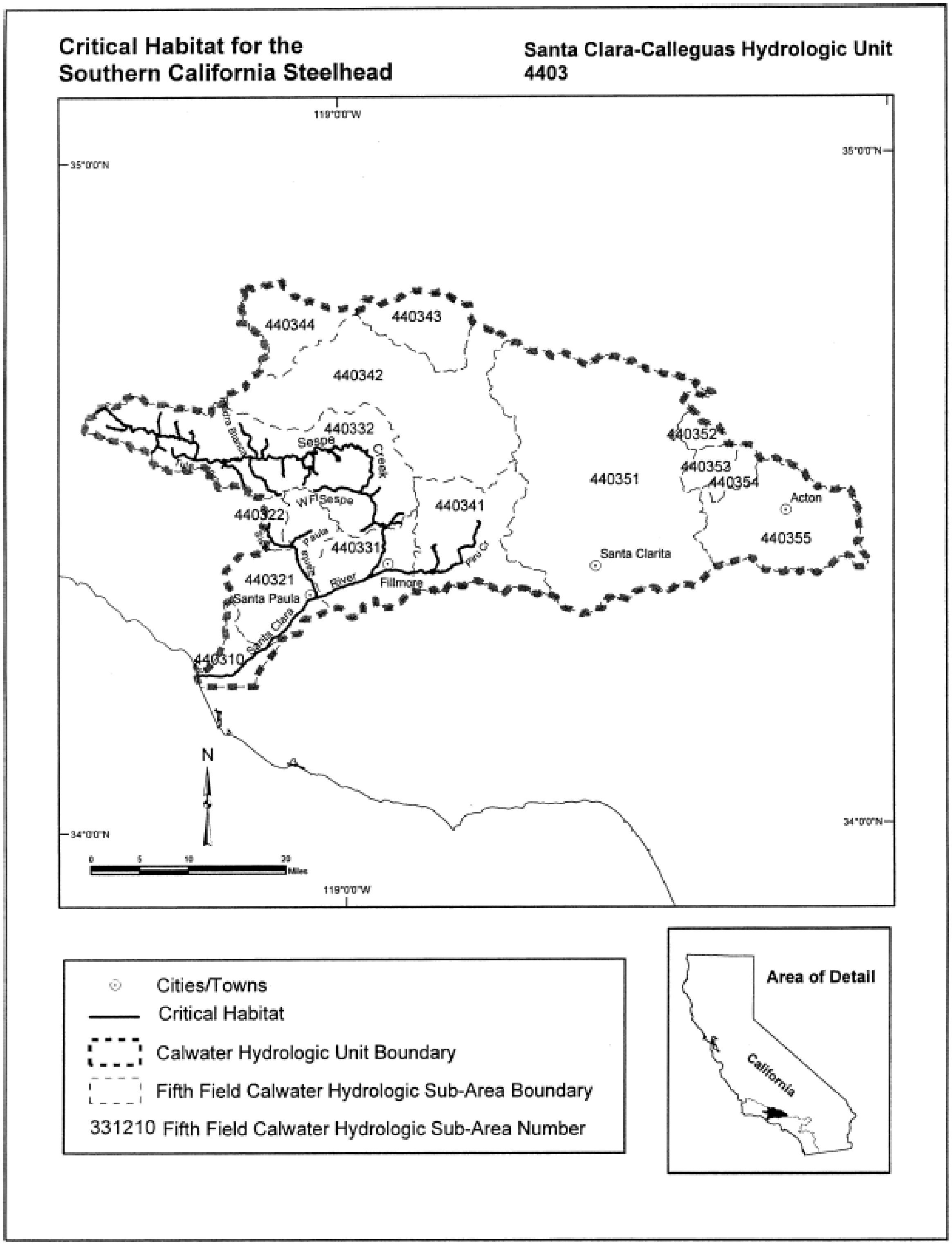

Figure 3-4.—Critical habitat designated in the Santa Clara River watershed (taken from NMFS 2005b). In the Piru Creek drainage, critical habitat begins at the base of Santa Felicia Dam and extends henceforth downstream to the Santa Clara River and then downstream to the Santa Clara River Estuary. See NMFS' critical habitat rule (NMFS 2005b) for the reasoning behind the designation.

IV. ENVIRONMENTAL BASELINE

In this section we review the environmental baseline, which:

> "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 impacts of State or private actions which are contemporaneous with the consultation in process" (50 CFR §402.02).

Specifically, this section reviews the effects of past and ongoing factors leading to the current status of the endangered Southern California DPS of steelhead and critical habitat within the action area. The effects of past and present activities leading to the current status of the DPS and critical habitat within the action area constitute the environmental baseline (page 29, United Water Conservation District 2008). When necessary to develop an understanding of how the effects of past and ongoing factors have lead to the current environmental baseline, analyses rely on data representing "pre-impact" conditions. For example, to understand how construction and operation of a water-storage facility has lead to the current pattern and magnitude of river discharge downstream of the facility, comparing the pattern and magnitude of river discharge before and after the construction of the facility is useful. Such an approach to assess effects may lead some to conclude that NMFS is incorrectly defining the environmental baseline as the condition prior to construction and operation of the dam, but such is not the case. Past and ongoing factors have created conditions that continue into the future, and therefore an understanding of how the factors have altered the environment is necessary to know the effects that contribute to the current environmental baseline.

A. Status of Critical Habitat and Steelhead in the Action Area

The historical function of the action area, in particular the mainstem Santa Clara River, could have included steelhead rearing because past accounts indicate water was at times present along some of the mainstem Santa Clara River (Outland 1971, Mann 1975), but not all areas of the mainstem Santa Clara River were consistently wet (page 29, United Water Conservation District 2008), and juvenile anadromous salmonids are known to rear in mainstem habitats (Peterson 1982, Tschaplinski and Hartman 1983, Leider *et al*. 1986, Hartman and Brown 1987, Loch *et al*. 1988, Murphy *et al*. 1997, Bramblett *et al*. 2002, Spina *et al.* 2005). Today, due to a variety of anthropogenic activities (which include exploitation of surface and ground water resources, Bureau of Reclamation and United Water Conservation District 2005), the functional value of critical habitat in the action area has been diminished, and some functions appear to have been eliminated (e.g., rearing is not expected in the mainstem Santa Clara River). Diversion and retention of surface water alone has altered the timing, frequency, duration, magnitude, and rate-of-change of surface water in the action area (described later in this biological opinion). While the reach of Piru Creek extending from Santa Felicia Dam to the confluence with the mainstem Santa Clara River has the potential to support spawning and rearing steelhead (Bureau of Reclamation and United Water Conservation District 2004), effects due to past and current dam-related flow alterations in the creek (as described elsewhere in this biological opinion) reduce the functional value of critical habitat in this area for steelhead.

Recent information on the abundance of steelhead in the action area is available. Fish-trapping activities at the Vern Freeman Diversion Dam since 1994 (Bureau of Reclamation and United Water Conservation District 2004) show relatively few juvenile steelhead and even fewer adult steelhead (no more than 2 in any year) (Table 4-1). A recent survey of the Santa Clara River from the mouth of Sespe Creek to Fillmore during the wet season found no steelhead (Swift 2003). Despite installing an electronic fish-counting and video-surveillance system in the Vern Freeman fish ladder in 2002, no steelhead has been counted (pers. comm., M. McEachron, 2005, hydrologist, United Water Conservation District, Santa Paula, California). With regard to the Piru Creek drainage, reproduction of *O. mykiss* has been noted there (Moore 1980a, Deinstadt *et al*. 1990) as well as residualized *O. mykiss* that exhibit ancestral native steelhead genetics upstream of Santa Felicia Dam and Pyramid Dam (Nielsen *et al*. 1997, Girman and Garza 2006, Boughton *et al*. 2007b, Boughton and Garza 2008, Garza undated). These fish probably still possess the ability to transform into smolts and migrate to the ocean (e.g., Thrower *et al*. 2004a).

Contrary to suggestions (page 30, United Water Conservation District 2008), the foregoing reference to reproduction of *O. mykiss* in the Piru Creek drainage is biologically significant and does have a bearing on anadromy, even though *O. mykiss* in Piru Creek upstream of Santa Felicia Dam are not listed under the ESA. *O. mykiss* is a polymorphic species showing both non-anadromous and anadromous forms, and the non-anadromous form can give rise to anadromous forms and vice versa. The findings of Nielsen *et al*. (1997) and Girman and Garza (2006) indicate that the *O. mykiss* in the Piru Creek drainage exhibit genetics that are similar to other native southern California steelhead (Boughton and Garza 2008). Specifically, the *O. mykiss* populations in the Piru Creek sub-basin are of "primary steelhead ancestry" (Boughton and Garza 2008, see also Girman and Garza 2006). We agree, however, with the contention (page 30, United Water Conservation District 2008) that the *O. mykiss* of the Piru Creek drainage are descendents of native southern California steelhead and therefore possess the anadromy trait and may contribute to the total smolts observed at the Vern Freeman Diversion. Such is consistent with the findings referenced above and elsewhere in this biological opinion, and the behavior and ecology of the species. See also the section "Contribution of the Santa Clara River Steelhead Population Unit to DPS Viability and Relationship to Recovery."

Table 4-1.—Reported number of adult and smolt steelhead captured or observed (in the case of adults during 1999-2001) at the Vern Freeman diversion (Bureau of Reclamation and United Water Conservation District 2004).

Year	Adult	Smolt
1994	1	81
1995	1	111
1996	2	82
1997	0	414
1998	Not monitored	2
1999	1	3
2000	2	876
2001	2	75
2002	0	0

B. Threats to Steelhead in the Action Area

A number of past and present anthropogenic activities have reduced the quality and quantity of critical habitat within the action area for the endangered Southern California DPS of steelhead, and have killed steelhead. These activities involve construction and operation of water storage and diversion facilities, conversion of wildlands, wastewater release to the river, land-use activities, groundwater pumping, historical plantings of out-of-basin *O. mykiss*, and possibly sportfishing and introduction of exotic non-native species (Schwartzberg and Moore 1995, Bureau of Reclamation and United Water Conservation District 2004, Kelley 2004, Bureau of Reclamation and United Water Conservation District 2005, United Water Conservation District 2007b). While some activities are physically located outside the action area, the activities adversely affect critical habitat and steelhead in the action area (e.g., in the case of land-use activities causing input of sand and smaller particles to habitats within the action area, or in the case of a water storage or diversion facility altering the downstream pattern and magnitude of discharge in the action area). Therefore, such activities are considered in the discussion of factors affecting steelhead and critical habitat in the action area. The factors affecting steelhead and critical habitat in the action area are described as follows, beginning with construction of dams. While NMFS received many comments on this specific section of the draft biological opinion (e.g., United Water Conservation District 2008), the bulk of the comments argue that steelhead are not natural in the Piru Creek sub-basin. Because NMFS has already responded to such and similar comments earlier in this biological opinion (e.g., see section entitled, "Natural Presence of Steelhead in the Piru Creek Drainage"), the same or similar comments are not addressed here.

***Construction and Ongoing Impassable Presence of Dams*.—**The damming of Piru Creek (through construction of Santa Felicia Dam and Pyramid Dam) blocks steelhead from historical spawning and rearing habitat because none of these reservoirs were constructed to allow fish passage. The amount of historical spawning and rearing habitat rendered unavailable to this species in the Santa Clara River watershed due to the construction of dams is substantial. Santa Felicia Dam blocks 95% percent of the steelhead habitat within the Piru Creek watershed; more than 30 miles of stream lies between Santa Felicia Dam and Pyramid Dam alone (NMFS 2006c and references therein).

The construction and ongoing impassable presence of dams in the watershed, including the action area, has reduced the amount of spawning and rearing habitat available to the species, and is expected to have contributed to declines in steelhead abundance within the action area (e.g., Nehlsen *et al.* 1991, Rieman and McIntyre 1995, Neraas and Spruell 2001, Rieman and Allendorf 2001, Morita and Yamamoto 2002). Blockage of a significant portion of the historically available upstream spawning and rearing habitats was identified as one of the principal factors for decline of the endangered Southern California DPS of steelhead (NMFS 2006b). Dams blocking passage of steelhead to upstream habitats constitute an obstruction within a freshwater migration corridor for the species and, therefore, an impact to steelhead habitat.

***Construction of Diversions*.—**The construction of diversions can have effects on fishery resources that are similar to the effects of dams, particularly when the diversion is large (i.e., functions over a relatively broad range of discharges) and is not designed to allow fish migration (Blahm 1976, Mundie 1991, Smith *et al*. 2000). Given the effects of diversions on fishery resources, the construction of several diversions within the Santa Clara River watershed (Table 4-2) is of concern. Only the Harvey Diversion Dam and Vern Freeman Diversion Dam are known to possess a fish ladder that is intended to allow passage of steelhead. The fish ladder at the Harvey Diversion Dam was constructed in early 2000. This ladder was damaged during the 2005 winter storms (Bureau of Reclamation and United Water Conservation District 2005), but was repaired in summer 2007 (pers. comm., S. Glowacki, NMFS, April 1, 2008). While the "effectiveness" of the fish ladder at the Vern Freeman Diversion Dam has been assessed (McEachron 2005), the findings and conclusions of the assessment are not reliable (for a detailed critique of McEachron 2005 see Appendix B of the original September 30, 2005, draft biological opinion prepared for the Bureau of Reclamation for operation of the Vern Freeman Diversion Dam). As an example, the assessment concluded that the fish ladder was effective in passing steelhead because Pacific lamprey (*Lampetra tridentata*) were observed in the ladder. Such a conclusion is inappropriate because evidence indicates fish ladders can be species and size selective (Godinho *et al*. 1991, Bunt *et al*. 1999, Laine *et al*. 2002). Unlike steelhead, lamprey have an eel-like body and rely on different behaviors than steelhead to ascend a ladder. When migrating, lamprey use its oral disc to attach and hold onto surfaces between brief periods of burst swimming (Mesa and Moser 2004, Adams 2006). Because fish ladders can favor passage of some species and not others, inferring a species' ability to locate and ascend a fish ladder based on the ability of another species can lead to spurious conclusions.

Operation of Water Storage and Diversion Facilities**.—**The exploitation of surface water can adversely affect the physicochemical and biological characteristics of streams (Poff *et al*. 1997) and is believed to have contributed to the population decline of anadromous salmonids throughout much of their range (Mundie 1991, Hedgecock *et al*. 1994, Moyle 1994). Because many primary constituent elements of critical habitat are flow related (NMFS 2005b), any activity that affects the amount of water in streams increases the potential for impacts to steelhead critical habitat as well (e.g., in the case where a diversion reduces the amount of water downstream, the flow reduction would reduce the amount of freshwater rearing sites for steelhead, a primary constituent element of critical habitat). The operation of dams and diversions can affect fishery resources and critical habitat by reducing discharge, attenuating peak winter and spring discharges, causing widely fluctuating discharges, and entraining fish. In turn, these impacts can have significant adverse consequences for stream-fish populations through shifts in species composition and distribution, reduced fish abundance and growth, and fish stranding and displacement (Mundie 1991). Consequently, the magnitude and degree of surface-water exploitation in the Santa Clara River watershed (and action area) are of concern. A description of how surface-water diversions and water-storage projects in the Santa Clara River watershed are known or believed to affect steelhead and critical habitat is presented as follows, beginning with diversion facilities.

Diversion Facilities.—The Vern Freeman Diversion Dam is a major water diversion in the Santa Clara River watershed, and is permitted to divert a maximum of 375 cfs from the Santa Clara River and no more than 144,630 acre-feet per water year. Briefly[13], operation of the Vern Freeman Diversion Dam alters the pattern and magnitude of discharge (and therefore critical habitat and primary constituent elements such as freshwater migratory corridors) downstream of the diversion, and indirectly and directly affects juvenile and adult steelhead. Diversion operations (1) reduce the magnitude of discharge and sometimes eliminate flow entirely, (2) cause fluctuating discharge, (3) increase the discharge recession rate, (4) abbreviate discharge duration within individual rain-induced discharge pulses, (5) reduce migration opportunity (i.e., favorable conditions that allow an individual to move between or among habitats) for adult and juvenile steelhead, and (6) increase the potential for stranding, delaying, and precluding migration. Live and dead steelhead have been found when tending to the Vern Freeman Diversion Dam (e.g., lowering flows to inspect or clean features of the diversion) (Carpenter and Wise 1999, Kentosh 1999, United Water Conservation District 1999, United Water Conservation District 2006, pers. comm., S. Howard, Fishery Biologist, United Water Conservation District, May 8, 2007). In the past, live steelhead collected at the diversion have been captured (a total of ten smolts and two "resident rainbow trout" were captured in 2007, see also Table 4-2) and then trucked to and released in the Santa Clara River or Ventura River estuaries or upstream of the diversion in the Santa Clara River or Santa Paula Creek near 12th Street.

United undertakes a "trap-and-truck" program at the Vern Freeman Diversion Dam (page 37, Untied Water Conservation District 2008), but the degree to which this specific program contributes to minimizing effects of the diversion operations is uncertain for at least a few reasons. First, the program does not account for parr steelhead, which while found in the annual spring emigration, are not prepared for ocean existence (Spina *et al*. 2005 and references therein, see also "www.unitedwater.org/freeman/88151282_20070628_063546.pdf", which shows a parr captured by United staff at the Vern Freeman Diversion Dam on the Santa Clara River). The transport provision that NMFS is aware of includes no means to distinguish the juvenile steelhead that are prepared for ocean existence (e.g., smolts) from the juveniles that are not (parr). Under the current plan, parr would be released into the ocean or estuary; we suspect these life stages would perish if released into the ocean because they are not physiologically prepared to exist in a strictly saline environment. Second, capturing steelhead at the diversion and then transporting them downstream for release in the estuary or ocean would preclude the individuals from biological benefits related to emigrating through the remaining 11 miles of river. Some of these benefits involve an area (and time) for individuals to grow (Dietrich and Cunjak 2007) and complete the physiological changes necessary for ocean existence (Hoar 1976, Quinn 2005) prior to reaching the estuary or ocean. Truncating the emigration of steelhead increases the likelihood that individuals will be smaller and not prepared to tolerate a saline environment, both of which do not favor survival.

Although the actual fate of any steelhead that does become stranded due to operation of the Vern Freeman Diversion Dam is unclear, a few different possibilities exist. First, if not found by rescue crews, a stranded steelhead may perish. Second, though rescued, the steelhead could die during transport or after relocation. Third, a stranded steelhead could be rescued and relocated

[13] A detailed description of how past diversion operations altered the pattern and magnitude of discharge downstream of the diversion can be found in the administrative record for the consultation with the Bureau of Reclamation on operation of the Vern Freeman Diversion Dam.

alive to suitable habitat, such as the river reach upstream of the diversion dam in the case of an adult steelhead (assuming the adult has not yet spawned), or the estuary and ocean in the case of a smolt. Even if a successful rescue is observed, such an event is not expected to fully minimize effects of the diversion operations because a stranding, for example in the case of an adult, would likely result in slowed migration, which can lead to energy costs to migrating fish and failure to reach spawning areas (Hinch and Rand 1998, Geist *et al*. 2000, Caudill *et al*. 2006, Caudill *et al*. 2007).

Besides effects due to operation of the Vern Freeman Diversion Dam, many other surface-water diversions in the watershed (Table 4-2) (including some on Piru Creek downstream of Santa Felicia Dam) attenuate discharge peaks and reduce discharge in the action area (Bureau of Reclamation and United Water Conservation District 2005, Nelsen 2006). The amount of water diverted upstream of the Vern Freeman diversion can be substantial because United staff have observed decreased discharge in the Santa Clara River (upstream of Vern Freeman) when upstream diversions were operating. For instance, the "12^{th} Street diversion" on Santa Paula Creek (tributary to the Santa Clara River) has been known to divert a magnitude of water that would make up more than 50 % of the discharge in Santa Clara River (Bureau of Reclamation and United Water Conservation District 2005). "Although these other diversions have some effect on steelhead, United's diversion quantities are larger than the aggregate of other diverters" (p. 16, Bureau of Reclamation and United Water Conservation District 2005). In addition to diversions listed in Table 4-2, other diversions consisting of hoses connected to pumps exist and are used for agricultural purposes (United Water Conservation District and Castaic Lake Water Agency 1996, Bureau of Reclamation and United Water Conservation District 2005). Altering the pattern and magnitude of discharge is of concern because primary constituent elements of critical habitat include freshwater rearing sites and freshwater migration corridors, which are water dependent.

Operation of unscreened surface-water diversions in the action area can disrupt migration of steelhead because such diversions increases the likelihood of entraining steelhead in diversions, canals, and conveyance pipes. The unscreened diversion on Santa Paula Creek, which withdraws a substantial portion of the discharge from the creek, is expected to entrain and prevent a large fraction of the smolts attempting to migrate while the diversion is operating from reaching the ocean (Bureau of Reclamation and United Water Conservation District 2005). The diversion on Piru Creek, which is operated without a NMFS-approved fish screen (page 38, United Water Conservation District 2008), downstream of Santa Felicia Dam possesses the potential for entraining juvenile steelhead originating from upstream habitats (Bureau of Reclamation and United Water Conservation District 2005). At the Vern Freeman Diversion Dam, an earthen dike was constructed each year (beginning in early 1900 and ending with the construction of the current Vern Freeman Diversion Dam in 1991) and was not screened. As a result, United "would have diverted all smolts when we were diverting 100% of the water and some portion when we were bypassing some" (July 19, 2005, pers. comm., M. McEachron, United Water Conservation District) (page 38, United Water Conservation District 2008).

Contrary to suggestions (page 38-39, United Water Conservation District 2008), discussing the effects of past operations of the Vern Freeman Diversion Dam as well as other anthropogenic activities is necessary because the effects due to such past operations and activities have contributed to the current status of the Southern California DPS of steelhead and critical habitat for endangered steelhead (i.e., the environmental baseline).

Table 4-2.—Known water diversions in the Santa Clara River watershed (United Water Conservation District and Castaic Lake Water Agency 1996, Bureau of Reclamation and United Water Conservation District 2005, Nelsen 2006). Operators or diversions listed more than once are operating under a different license or permit. Note the source documents do not reference a known irrigation diversion on Sisar Creek. While many of these structures are upstream of the action area, effects of the diversions extend downstream into the action area.

Stream	Operator or diversion name
Piru Creek	Piru Mutual Water Company
Piru Creek	Rancho Temescal
Piru Creek	United Water Conservation District
Hopper Creek	The Nature Conservancy
Hopper Creek	Robert Asimow
Pole Creek	Flying A Ranch
Pole Creek	Alfred A. and Francis L. Martinez
Sespe Creek	Sanford I. Drucker
Sespe Creek	Sanford I. Drucker
Sespe Creek	Sanford I. Drucker
Sespe Creek	Sanford I. Drucker
Sespe Creek	Sanford I. Drucker
Sespe Creek	Fillmore Irrigation District
Santa Paula Creek	Pajaro Partners, Inc.
Santa Paula Creek	Pajaro Partners, Inc.
Santa Paula Creek	Steven A. and R. Wigley Smith
Santa Paula Creek	Canyon Irrigation District
Santa Paula Creek	"Harvey Diversion Dam"
Santa Clara River	California Department of Fish and Game
Santa Clara River	Santa Clara Water and Irrigation District
Santa Clara River	Central Coast Production Credit Association
Santa Clara River	Camulos Ranch, "Camulos Diversion"
Santa Clara River	"12th Street Diversion"
Santa Clara River	United Water Conservation District, "Vern Freeman diversion"

Water-Storage Facilities.—Lakes and reservoirs within the Santa Clara River watershed (Table 4-3) capture and then store winter and spring runoff and alter the pattern and magnitude of discharge in downstream tailwaters (Hazel *et al*. 1976, Bureau of Reclamation and United Water Conservation District 2005). The flow alteration is consistent with other reported effects of dam operation on streamflow (e.g., Richter *et al*. 1996, 1997, 2003). Altering the pattern and magnitude of discharge is of concern because primary constituent elements of critical habitat include freshwater rearing sites, freshwater spawning sites, and freshwater migration corridors, which are flow dependent.

Table 4-3.—Name and characteristics of water-storage facilities in the Santa Clara River Watershed. While these facilities (other than Lake Piru) are physically outside the action area, their effects extend downstream into the action area (sources: http://www.wrpinfo.scc. ca.gov/watersheds/sc/sc_profile.html, and http://endeavor.des.ucdavis.edu/newcara).

Name	Stream dammed	Surface area (acres)	Dam height (feet)	Year completed	Designed storage (acre feet)
Bouquet Canyon Reservoir	Bouquet Canyon Creek	628	190	1934	36,500
Dry Canyon Reservoir	Dry Canyon Creek	1,140	66	1912[a]	1,140
Castaic Lake	Castaic Creek	2,235	340	1973	324,000
Pyramid Lake	Piru Creek	1,360	386	1973	180,000
Lake Piru	Piru Creek	1,240	213	1955	88,340

[a] Other sources indicate this reservoir was placed in service in 1913 (United Water Conservation District and Castaic Lake Water Agency 1996). In January 1966, the reservoir was "taken out of service," but continues to impound water during storms.

Flow-related effects of Santa Felicia Dam operations have contributed to the current condition of critical habitat and status of steelhead in the action area. An analysis of historical discharge data using the Indicators of Hydrologic Alteration software and U. S. Geological Society (USGS) gage data, #11110000, for the period 1928 to 1971 was selected to allow an understanding of effects of Santa Felicia Dam past operations on the pattern and magnitude of flows in Piru Creek prior to the completion of Pyramid Dam. While the specified record is not complete (lacks certain years) (page 40, United Water Conservation District 2008), the analysis of this record still provides a reasonable assessment of the pattern and magnitude of discharge in the creek and the findings are largely consistent with those reported by other investigators (Hazel *et al*. 1976). Findings from this analysis indicate the dam operations alter the natural magnitude of discharge in Piru Creek within the action area (Figure 4-1). The magnitude of median monthly discharge after construction of Santa Felicia Dam is low throughout much of the year relative to discharge before construction of the dam. The reduction in discharge after construction of the dam is most evident during winter and spring. Scrutiny of the characteristics of peak-discharge events in Piru Creek further reveals that operation of the dam has attenuated the magnitude (Figure 4-2) and frequency and duration (Figure 4-3) of such events. The discharge alterations noted as effects from operations of Santa Felicia Dam are expected to have adversely affected steelhead and critical habitat for this species because relatively frequent high-flow events, of reasonable duration, during winter and spring are needed to support the migratory behavior and ecology of steelhead and certain life-history stages such as immigration, emigration, and spawning (Shapovalov and Taft 1954, Spina *et al*. 2005). Effects of Santa Felicia Dam operations are not confined to Piru Creek because evidence indicates that regulation of the creek has distorted the runoff relationship between the creek and the Santa Clara River. This effect of the dam operations is viewed as harmful for steelhead attempting to enter and migrate through Piru Creek, particularly during the indicated periods in Figure 4-4 when flows are "high" in the Santa Clara River and "low" in the creek.

Contrary to suggestion (page 40, United Water Conservation District 2008), the daily mean flow was used as input into the hydrologic model, but the model was set to produce median statistics as the output to characterize flow magnitudes, which is appropriate and biologically meaningful (Richter *et al*. 1996, Richter *et al*. 1997). The median statistic was used in the analysis instead of the mean because Santa Felicia Dam regulates discharge, and extreme discharge events such as spills or deliberate short-lived releases of large water quantities substantially bias the daily mean upward. The median statistic is less sensitive to outliers (extreme high flow events) than the mean and can be a better measure than the mean for highly skewed distributions.

We agree that because the median monthly flows in Piru Creek for August and September are estimated at 1 cfs (page 40, United Water Conservation District 2008), half of the historical flows (during the period considered) would be higher or lower than 1 cfs during August or September. United concludes that the reach of creek that now lies downstream of Santa Felicia Dam would have served only as a migration corridor (page 40, United Water Conservation District 2008). However, this reach of creek served primarily as a migration corridor, though under certain flow-dependent conditions (e.g., low-flow conditions occurring at or near the time when adults entered Piru Creek), steelhead may have spawned and temporarily reared there. Changing environmental conditions may have prompted young steelhead to migrate upstream to perennial habitats (such as Agua Blanca Creek or Fish Creek) particularly as dry-season flows declined and water temperature increased (Bramblett *et al*. 2002) in the lower mainstem Piru Creek.

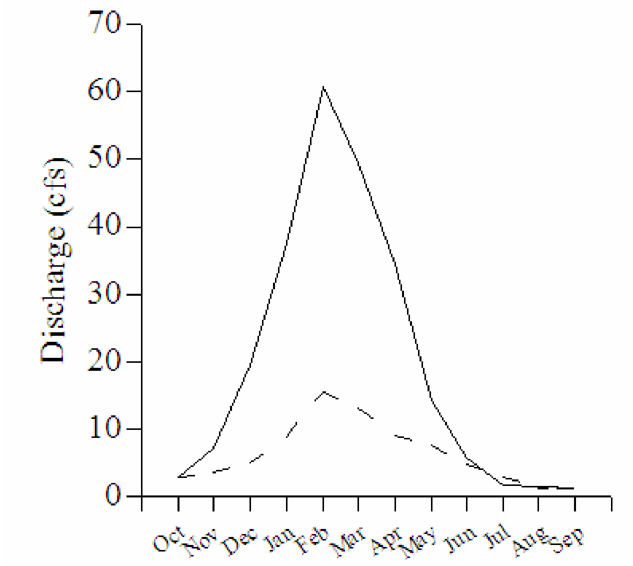

Figure 4-1.—Median monthly discharge in Piru Creek before (solid line) and after (dashed line) construction of Santa Felicia Dam. Obtained from IHA analysis (USGS gage #11110000), period of record 1928 to 1955, prior to construction of the dam, and 1956 to 1971, after construction of the dam.

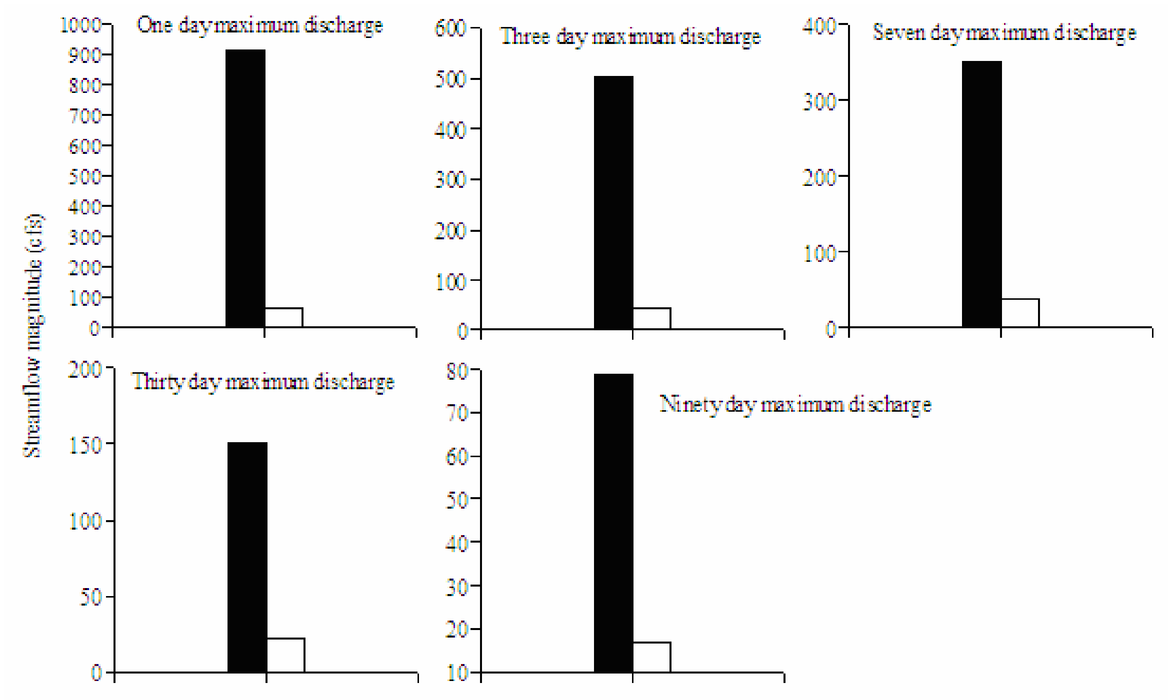

Figure 4-2.—Median maximum discharge in Piru Creek before (filled bar) and after (unfilled bar) construction of Santa Felicia Dam obtained from an IHA analysis (USGS gage # 11110000). Period of record is 1928 to 1955, prior to construction of Santa Felicia Dam, and 1956 to 1971, after construction.

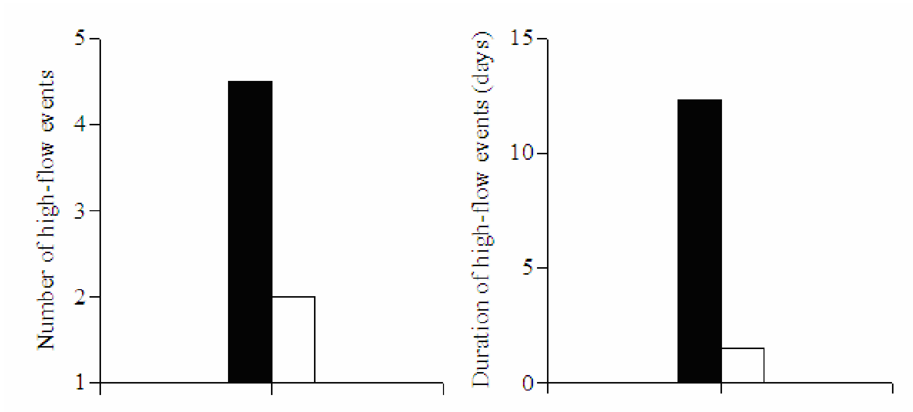

Figure 4-3.—Median number of high-flow events (left panel) and duration of high-flow events (right panel) in Piru Creek before (filled bar) and after (unfilled bar) construction of Santa Felicia Dam. "High-flow events" are defined as any daily discharge that exceeds the 75% quartile discharge for all pre-impact discharges for a particular time period (Richter *et al*. **1996, 1997). Obtained from an IHA analysis (USGS gage # 11110000). Period of record is 1928 to 1955, prior to construction of Santa Felicia Dam, and 1956 to 1971, after construction.**

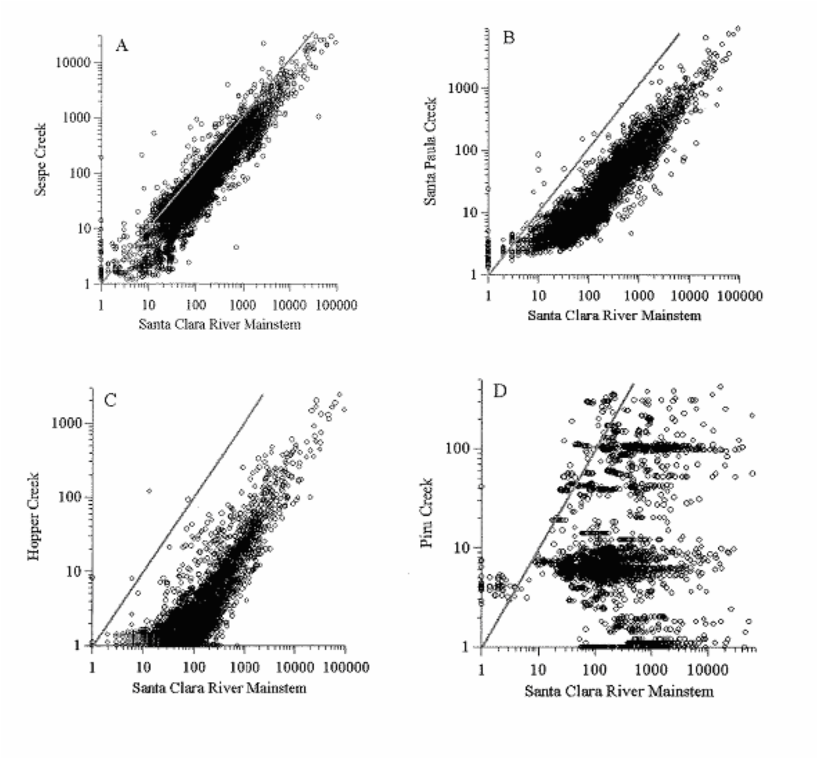

Figure 4-4.—Daily mean discharge (cfs) during January through May at the confluence of Sespe Creek (A) (1955-1985, 1990-2002, USGS gage 11113000, *N* = 6065), Santa Paula Creek (B) (1955-2002, USGS gage 11113500, *N* = 6958), Hopper Creek (C) (1955-1983, USGS gage 11110500, *N* = 4235), and Piru Creek (D) (1973-2002, USGS gage 11119800, *N* = 4235) with the Santa Clara River. The diagonal line is the point where discharge between sites is equal (taken from NMFS 2005a). While Piru Creek (D) does not show spills (page 41, United Water Conservation District 2008), an analysis performed later in this biological opinion does show spills and the findings indicate that operation of Santa Felicia Dam alters the pattern and magnitude of discharge in Piru Creek (see Figure 4-5), as is indicated in graph D above.

United's suggestion that the period analyzed has no scientific basis (page 40, United Water Conservation District 2008) is unsubstantiated. Designing hydrologic analyses as we have is common and especially recommended when attempting to assess hydrologic alteration due to anthropogenic activities such as operation of dams (Richter *et al*. 1996, Richter *et al*. 1997). We agree that climatic differences before and after dam construction could in theory explain the differences in hydrology depicted in Figure 4-1 through 4-3. For instance, if the regional condition prior to the construction of the dam was more or less wet, but then shifted to below normal following dam construction, one could conceivably expect the findings reported here. For this reason, we assessed the possibility that climate differences before and after dam construction account for the difference in hydrology characteristics we report here. We selected the USGS stream gage 11110500 on Hopper Creek near Piru, California to represent regional climate in the Santa Clara River watershed. This gage was selected because (1) it lies in a waterway where no dam is present, (2) the period of record for this gage (1930 to 1983) overlaps substantially with the period of record for the USGS stream gage that is the basis of our analyses represented in Figure 4-1 through 4-3 and is therefore a reasonable representation of regional conditions before and after construction of Santa Felicia Dam, and (3) no other similar streamflow data meeting the criteria above (i.e., unregulated waterway, sufficient period of record, represents conditions before and after construction of Santa Felicia Dam) could be located within the Santa Clara River watershed. The daily mean discharge data for the Hopper Creek gage were plotted and inspected.

The graph shows that streamflow conditions in Hopper Creek are more or less similar before and after Santa Felicia Dam was constructed in the mid 1950s (Figure 4-5). The average daily mean streamflow in Hopper Creek prior to and after dam construction are 5.0 cfs (SD = 44.6) and 7.3 cfs (SD = 62.0). We therefore conclude that a difference that may exist in climate condition before and after construction of Santa Felicia Dam is not sufficient by itself to explain the hydrology characteristics reported here for Piru Creek following construction of Santa Felicia Dam. The findings reported here and which are represented in Figure 4-1 through 4-3 are therefore reasonable to develop an understanding of how operation of Santa Felicia Dam influences the pattern and magnitude of discharge in Piru Creek downstream of the dam.

A year-by-year analysis of available hydrology data for Piru Creek provides finer-scale information regarding how operations of Santa Felicia Dam influence discharge characteristics in Piru Creek downstream of the dam. To perform the analysis, hydrology data were obtained and used to represent discharge in Piru Creek without Santa Felicia Dam operations (but with Pyramid Dam[14] operations, which is reasonable given that operation of this dam is part of the environmental baseline and therefore an understanding of the past and present effects of the dam operations is necessary) (USGS gage #11109600, located immediately upstream of Piru Lake), and discharge in Piru Creek with Santa Felicia Dam present (#11109800, located downstream of

[14] We note that a draft proposal exists to modify the operations of Pyramid Dam to promote an "inflow-outflow scenario," which if implemented may cause low streamflow in the mainstem Piru Creek downstream of Pyramid Dam during summer and late fall (Federal Energy Regulatory Commission 2007b). NMFS has commented on the proposal (National Marine Fisheries Service 2007b), and because the specific flow schedule that is to be adopted at Pyramid Dam was not clearly specified in the draft proposal, the future operations of Pyramid Dam, and the implications of the future operations for the pattern and magnitude of streamflow in Piru Creek downstream of Pyramid Dam, are uncertain. Therefore, a specific flow scenario, other than that due to the past and present effects of operations of Pyramid Dam on the pattern and magnitude of stream in the creek, cannot be adequately predicted or assumed at this time. Overall, the analysis presented above represents a reasonable assessment of the condition of the environmental baseline in the context of the proposed action.

Santa Felicia Dam). Pairing the hydrology data by date and year from both stream gages was required to perform the analysis, and the selected period of record (October 1, 1988 through September 30, 2004) allowed such a pairing. The stream gage downstream of Santa Felicia Dam is located upstream of the confluence between the creek and spillway channel, and therefore does not measure spills of water from the dam crest. However, daily spill data for the period of record were incorporated into the analysis to develop a complete understanding of the pattern and magnitude of discharge in Piru Creek. For each of the water years (within the period of record), discharge in Piru Creek with and without Santa Felicia Dam operations were plotted and then inspected.

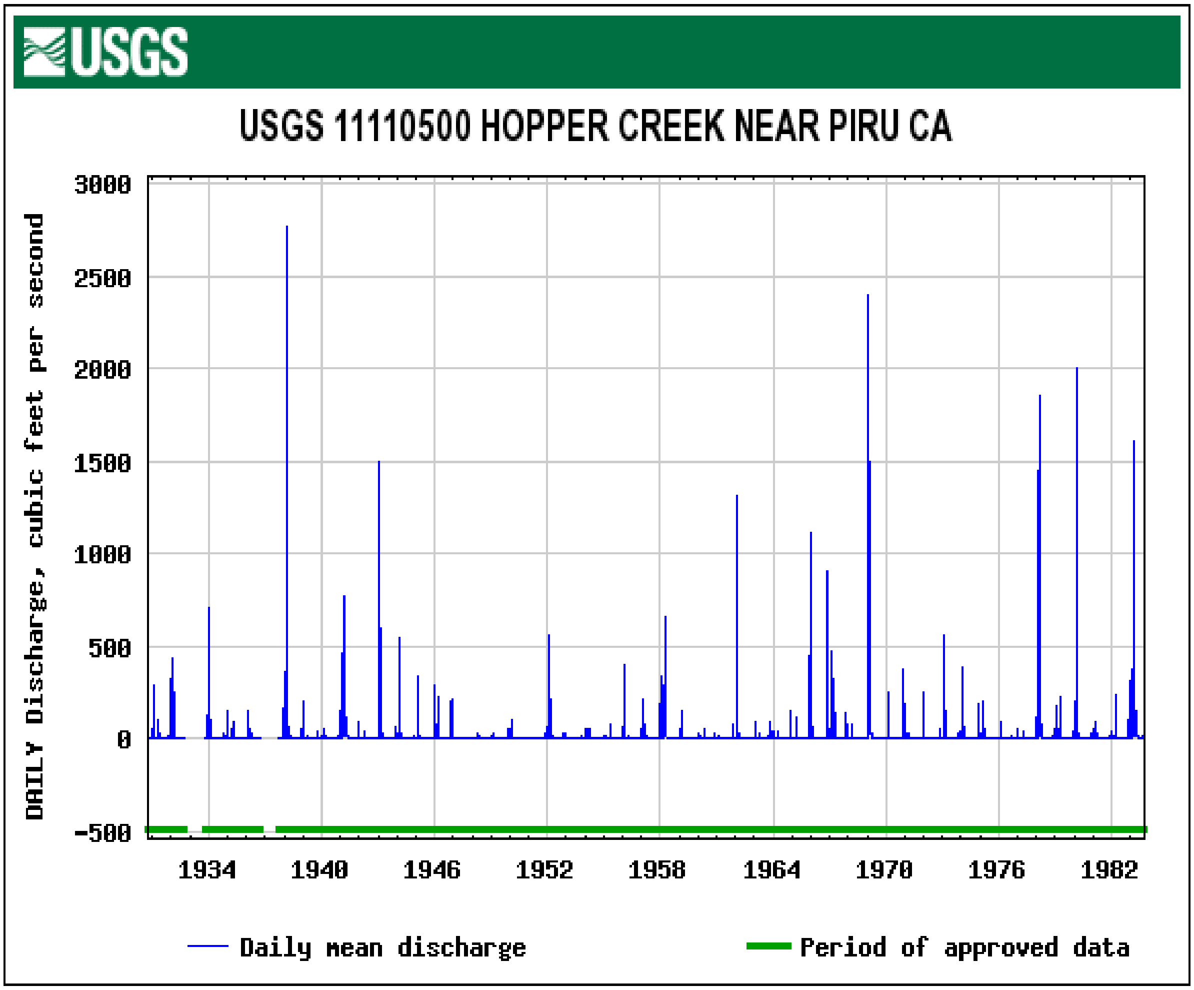

Figure 4-5.—Daily mean discharge (cfs) in Hopper Creek (USGS gage 11110500) during 1930 to 1983. Construction of Santa Felicia Dam was completed in 1955.

The findings from the foregoing analysis further corroborate that operation of Santa Felicia Dam alters the timing, and reduces the magnitude, frequency, and duration of discharge in Piru Creek (Figure 4-6). In the absence of Santa Felicia Dam operations, discharge in Piru Creek generally follows a seasonal pattern that includes (1) high magnitude flows during winter and spring, and low flows during summer and fall, (2) frequent "peak" discharge events during winter and spring, with peak durations lasting a few to several days, (3) a period of elevated and extended discharge during spring, and (4) year-round discharge even during the dry season. By contrast, under the operation of Santa Felicia Dam, discharge in Piru Creek is frequently different than the seasonal pattern of flows determined for the condition without Santa Felicia Dam operations, which includes natural runoff from principal tributaries such as Fish Creek and Aqua Blanca Creek that enter the middle reach of Piru Creek downstream of Pyramid Dam. Frequently, with the operation of Santa Felicia Dam, there are periods when (1) elevated and peak discharges downstream of Santa Felicia Dam do not correspond with what would be expected for winter and spring, (2) discharge is low (or high) when the paired condition is high (low), (3) the number, duration, and magnitude of the peak discharges are reduced, (4) discharge often approaches extremely low levels during the dry season, and (5) operation of the dam causes discharge to rapidly increase and decrease, for instance during the fall when high-magnitude flows are released.

The influence of the operation of Santa Felicia Dam on the pattern and magnitude of discharge in the Santa Clara River was assessed based on flow records. The USGS stream gage (#11108500) on the Santa Clara River at the Ventura-Los Angeles County line (located a short distance upstream from the confluence with Piru Creek) was used in the analysis. To model discharge in the Santa Clara River in the absence of the operation of Santa Felicia Dam, the daily mean discharge as reported by the USGS stream gage immediately upstream of Piru Creek (#11109600) was added to the discharge for the Santa Clara River, as measured at the County line. To model discharge in the Santa Clara River under the operation of Santa Felicia Dam, the daily mean discharge reported at the USGS stream gage downstream of the dam (#11109800) was added to the discharge in the Santa Clara River measured at the County line. The daily estimates of spills over the dam were added to the flow file as in previous analyses. The period of record is from October 1, 1988 to September 30, 1996. This period of record was selected because it was the only available record that provided the ability to assess the influence of Santa Felicia Dam operations on discharge in the Santa Clara River as is considered here. Discharge in the Santa Clara River with and without operational influences of Santa Felicia Dam was plotted and inspected. The stream gage used to represent streamflow does not appear to capture the full percolation influence of the Piru Basin on surface flows in the Santa Clara River (e.g., page 42 to 43 and 47, United Water Conservation District 2008), and therefore the surface flows represented by the forgoing analysis, particularly the dry-season flows, probably overestimate the true magnitude of surface flow in the Santa Clara River in the area of the confluence of Piru Creek with the Santa Clara River.

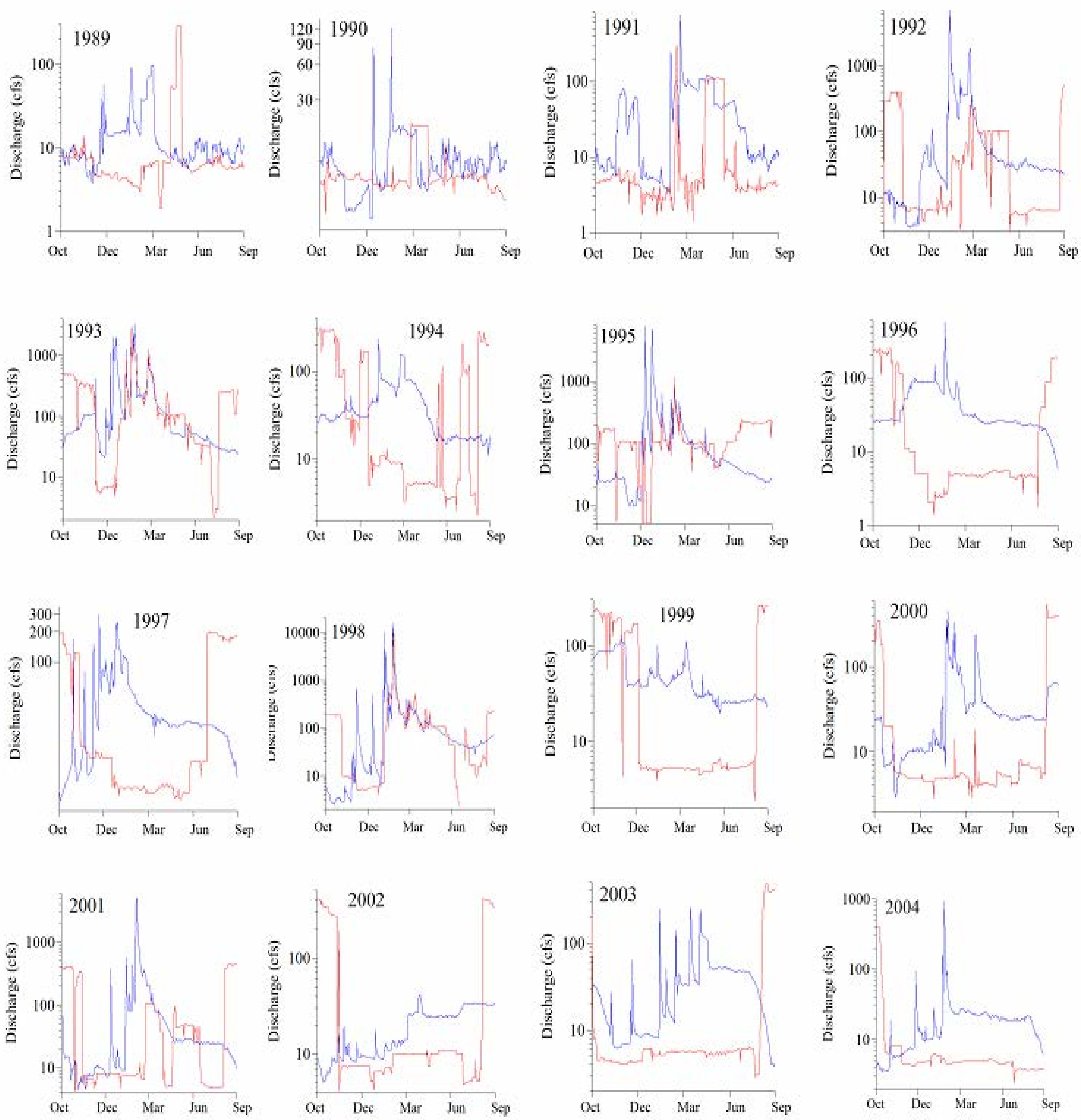

Figure 4-6.—Influence of the operation of Santa Felicia Dam on the pattern and magnitude of discharge in Piru Creek downstream of the dam. The blue line in each graph represents discharge in Piru Creek as expected without Santa Felicia Dam operations (but with Pyramid Dam operations) (USGS gage #11109600, located immediately upstream of Piru Lake), whereas the red line represents discharge in Piru Creek with Santa Felicia Dam operations (#11109800, located downstream of Santa Felicia Dam). Period of record is October 1, 1988 through September 30, 2004.

Overall, the amount of surface water in the Santa Clara River in the area of the Piru Basin is expected to be lower than what is depicted in the resulting analyses, particularly during summer and late fall. However, the analysis is expected to be a reasonable representation of the influences of the operations on the pattern and magnitude of flows in the Santa Clara River given that percolation influences are expected to be consistent between the two conditions considered in the analysis (with and without operations due to Santa Felicia Dam) owing to the paired design of the analysis (see the section "Natural percolation of surface water into the river channel bed," and elsewhere in this biological opinion, for more information about why we do not expect United's argument involving surface water percolation to affect the analyses or findings reported here).

The findings from the analysis indicate operation of Santa Felicia Dam does influence the pattern and magnitude of discharge in the Santa Clara River in the vicinity of the Los Angeles-Ventura County line (Figure 4-7). Both the peaks in discharge and the magnitude of post-peak discharges are typically higher in the Santa Clara River in the absence of operation of Santa Felicia Dam. The findings show that operation of Santa Felicia Dam causes discharge patterns (e.g., discharge spikes, and out-of-season elevated flows) that are not expected in the absence of the operation of the dam. The influence of Santa Felicia Dam operations on the pattern and magnitude of discharge in the Santa Clara is of concern because the river is the principal migratory corridor for endangered steelhead in the watershed, and specific discharge levels and seasons are necessary to support migration of this species (Harrison *et al*. 2006). In the section entitled, "Effects of the Action," NMFS evaluates how the proposed action may affect migration opportunities for steelhead in the Santa Clara River as expected under the proposed action.

Another impact from operation of Santa Felicia Dam is that steelhead downstream of the dam cannot access the historical spawning and rearing habitat upstream of the dam because no fish-passage facility exists at the dam. When Santa Felicia Dam was completed in the mid 1950s, the dam precluded steelhead from access to miles of waterway. The completion of Pyramid Dam in the early 1970s further fragmented historical spawning and rearing habitat for steelhead. Currently, estimates indicate at least 30 miles of habitat for steelhead lies between Santa Felicia Dam and Pyramid Dam (Figure 4-8, see also the U. S. Fish and Wildlife Service's Fish Passage Decision Support System for a complete map of the stream network within the Piru Creek sub-basin). The estimated miles of habitat include sites of spawning and rearing habitat. Generally, blocking steelhead from spawning and rearing habitats within the Piru Creek-Santa Clara River watershed is ecologically significant because the Piru Creek sub-basin is one of the largest sub-basins in the Santa Clara River watershed (Figure 4-9).

Release of water from dams to satisfy anthropogenic needs affects steelhead (Bureau of Reclamation and United Water Conservation District 2005). Considering operations at Santa Felicia Dam provides a useful example. Operation of the dam involves capturing wet-season discharges and subsequent release of the stored water during late summer and fall to downstream spreading grounds (water percolation areas) and agricultural users. "The usual strategy for releases is to convey as much of the water as possible to the Freeman diversion, without spilling there" (p. 22, Bureau of Reclamation and United Water Conservation District 2005). These water deliveries result in rapid release of high magnitude discharges (> 200 cfs) for 50 days

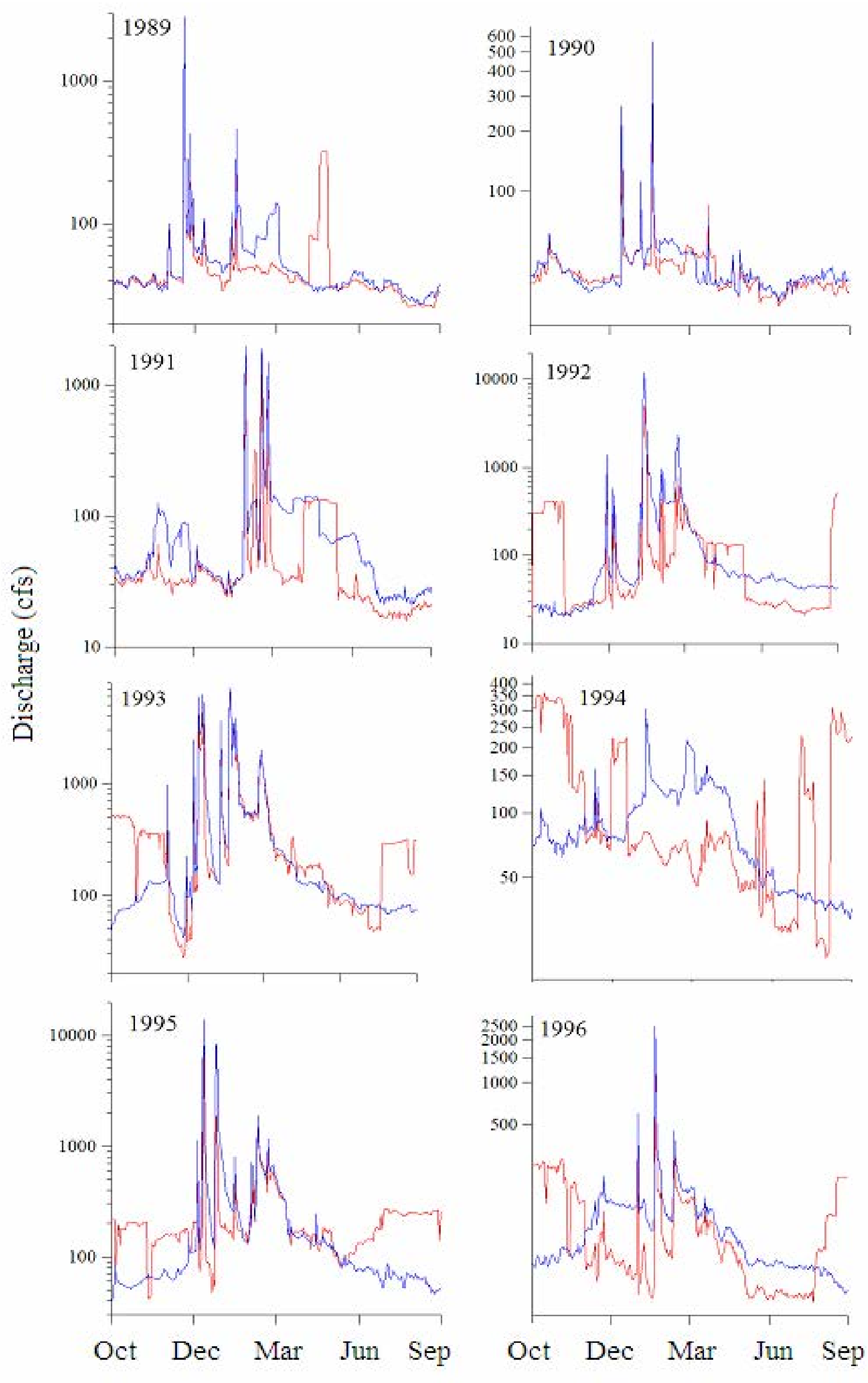

Figure 4-7.—Influence of the operation of Santa Felicia Dam on the pattern and magnitude of discharge in the Santa Clara River. The blue line in each graph represents discharge in the Santa Clara River as expected without Santa Felicia Dam operations (but with Pyramid Dam operations), whereas the red line represents discharge in the Santa Clara River under the operation of Santa Felicia Dam.

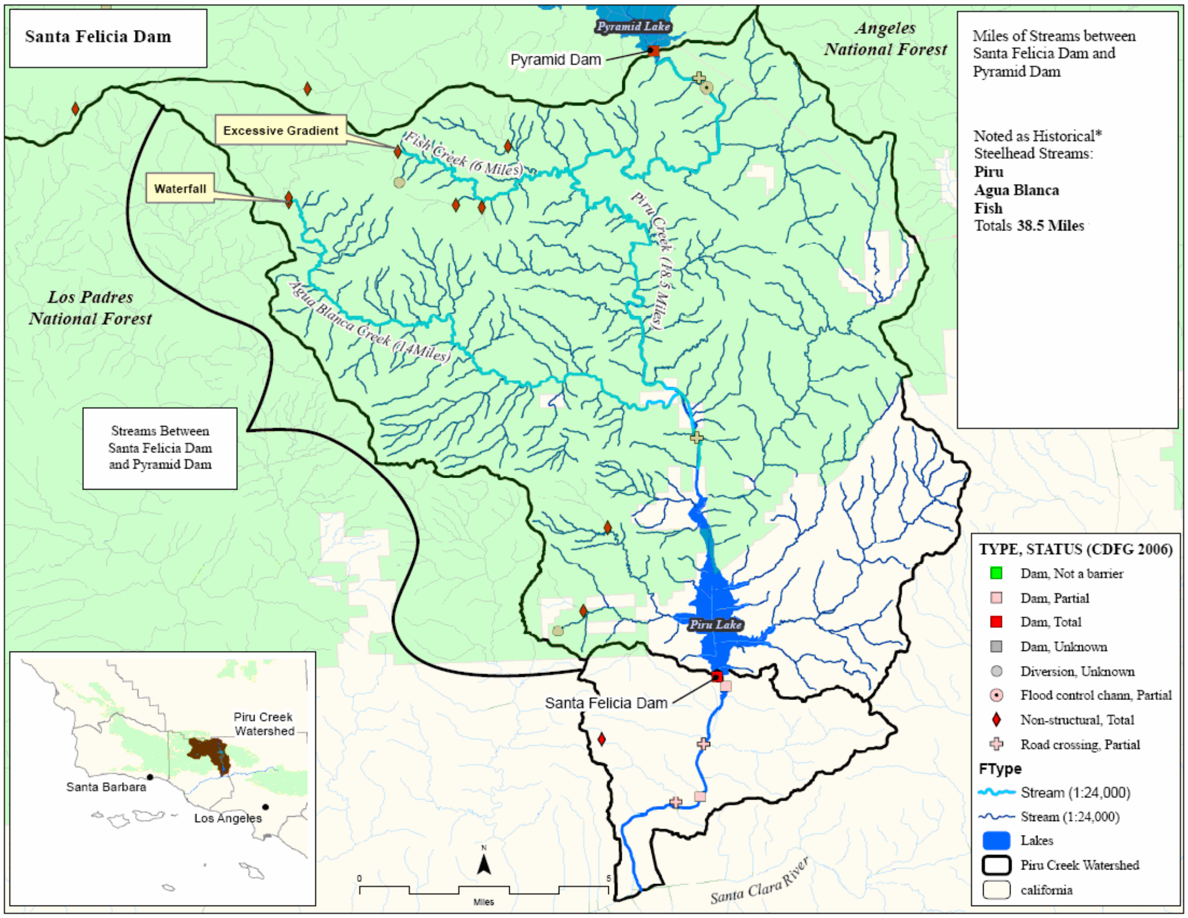

Figure 4-8.—Distribution of stream network in reaches upstream of Santa Felicia Dam. Piru Creek (18.5 miles), Fish Creek (6 miles), and Agua Blanca Creek (14 miles) are reported as being historical steelhead waterways (Moore 1980a, Titus *et al*. 2006). The light blue line is used in this figure to show historical streams for steelhead.

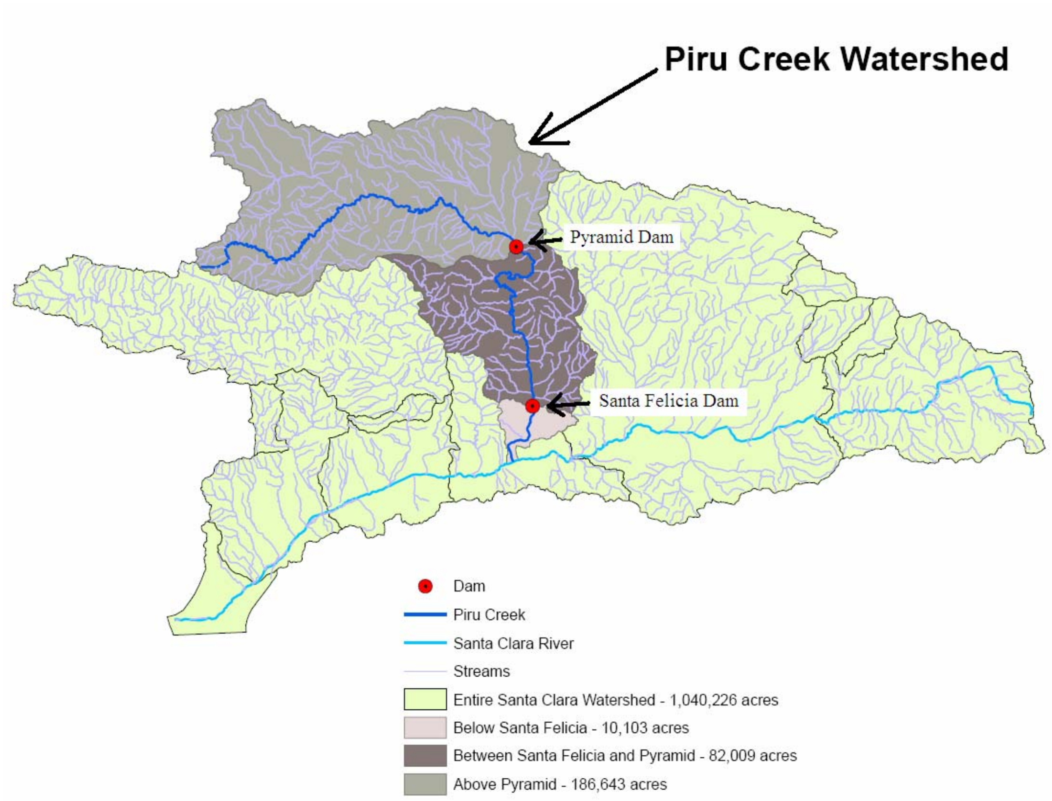

Figure 4-9.—Illustration of the Santa Clara River watershed, and the amount and extent of stream network in Piru Creek sub-basin upstream and downstream of Santa Felicia and Pyramid dams.

depending on the type of current water year (see Figure 3-1 through 3-3 in Bureau of Reclamation and United Water Conservation District 2005, Federal Energy Regulatory Commission 2007a). These high flows can start and stop quickly, resulting in an increased potential of stranding and killing fish (Cushman 1985, Bradford 1987). The high-magnitude flows are released during late summer and fall, usually before the watershed has experienced significant rainfall. The characteristics of such discharges are not commensurate with providing freshwater rearing and spawning sites, and a freshwater migration corridor.

The flow-related effects of dams can trigger adverse geomorphic changes on downstream instream habitats (Ligon *et al.* 1995, Kondolf 1997, Poff *et al.* 1997). The geomorphic changes can include (1) winnowing of undersized cobble, gravel, sand, silt, and clay from the channel bed, (2) coarsening of the channel-bed material, (3) halting the development of mid-channel bars and islands, and creating a single-thread channel, (4) reducing recruitment of sediment from adjacent banks and the floodplain, including those substrate particle types that contribute to form spawning habitat for anadromous salmonids, (5) eliminating spawning areas, (6) simplifying instream habitat for fish, (7) creating "habitat bottlenecks" that limit abundance of anadromous salmonids, (8) channel incising and decreased inundation of the floodplain, (9) armoring of the channel and tributary incision, (10) encroaching riparian vegetation into the stream channel, and (11) filling pools with sediments. Some of the noted effects of the current operations of Santa Felicia Dam on the pattern and magnitude of discharge in Piru Creek are identical to those effects that are reported to cause these geomorphic changes in riverine habitats (Ligon *et al.*

1995). Accordingly, that Santa Felicia Dam is reported to have caused geomorphic effects on Piru Creek downstream of the dam (e.g., an incised channel, and coarsening of the channel bed) is not surprising (Federal Energy Regulatory Commission 2007a).

Evidence indicates that periodic spills of water over Santa Felicia Dam have scoured the creek in some sections down to bedrock, thereby exacerbating the degraded quality of the freshwater migration corridor in Piru Creek (Federal Energy Regulatory Commission 2007a). According to the supporting document, "multiple locations" were observed in Piru Creek where the channel had been scoured to bedrock. Further, scour was noted "…just downstream of the bridge on Piru Canyon Road at approximately [river mile] 4.6, where channel conditions now appear to form a potential fish passage barrier…" (pp. 29, Federal Energy Regulatory Commission 2007a).

Construction and operation of Pyramid Dam is another factor affecting endangered steelhead and their critical habitat. The dam is located on Piru Creek about 15 miles upstream of Lake Piru. Principal sources of water to Pyramid Lake involve Piru Creek, Cañada de Los Alamos, and the West Branch of the California Aqueduct Project from Castaic Lake (Federal Energy Regulatory Commission 2007b). Evidence indicates that operation of Pyramid Dam has altered the pattern and magnitude of discharge in Piru Creek downstream of Pyramid Dam. For instance, construction of the dam has caused a reduction in the magnitude of peak discharge and a reduction in the maximum average daily discharge (Federal Energy Regulatory Commission 2007b). Construction and ongoing impassable presence of Pyramid Dam lead to habitat fragmentation and loss of many miles of stream for steelhead (Figures 4-8 and 4-9).

***Conversion of Wildlands*.—**Changes in land use through conversion of lands can increase input rates of nitrogen and sand and smaller particles to receiving waters and therefore critical habitat for steelhead. This can lead to reductions in the quality of habitat and abundance of desirable aquatic species, and increased eutrophication of receiving waters such as estuaries and streams (Weaver and Garman 1994, Bowen and Valiela 2001, Quist *et al*. 2003). Consequently, the proliferation of urban areas within the Santa Clara River watershed and development of sewage-treatment plants discharging treated sewage to the river and estuary year round (United Water Conservation District and Castaic Lake Water Agency 1996, Bureau of Reclamation and United Water Conservation District 2005) are of concern.

Over the last several decades, numerous urban areas have developed within the Santa Clara River watershed (*e.g.*, Valencia, City of Fillmore, City of Santa Paula, Santa Clarita). The amount of urbanized acreage increased from 72,600 acres in 1969 to 121,870 acres in 1980 (Schwartzberg and Moore 1995) with many developments along and adjacent to the Santa Clara River. The past and ongoing conversion and development of lands have increased the potential for runoff of pollutants and sand and smaller particles to surface water and therefore steelhead critical habitat. Increased concentrations of nitrates exceeding California's drinking-water standard (45 mg/l) have been detected in the mainstem Santa Clara River and are believed to be related to wastewater treatment (and agricultural practices) (United Water Conservation District and Castaic Lake Water Agency 1996).

With regard to the Santa Clara River estuary, evidence indicates this habitat has experienced alteration and loss of its natural form and function (Bureau of Reclamation and United Water Conservation District 2005, Nautilus Environmental 2005). Because changes in land use due to development of urban areas can increase input rates of nitrogen to receiving waters and have undesirable effects on the aquatic environment (Bowen and Valiela 2001), urbanization within the Santa Clara River watershed and operation of sewage-treatment plants have to the potential to increase rates of nitrogen input to receiving waters and degradation of steelhead critical habitat including the estuary (Bureau of Reclamation and United Water Conservation District 2005). The historical loss of estuary habitat, and reduction in habitat quality, is expected to have caused a reduction in the amount and quality of estuarine habitat for steelhead. The loss of estuarine habitat within the Santa Clara River watershed is of concern because estuary habitat is a primary constituent element of steelhead critical habitat that contain features essential to the conservation of the species, and provide numerous values to anadromous salmonids (Smith 1990, Thorpe 1994). The values include physiological transitions between fresh and saltwater for adults and juveniles, and feeding and growing areas for juveniles (NMFS 2005b), including the "lagoon-anadromous" type of steelhead (Bond 2006).

Land-use Activities.—Activities such as agriculture, grazing, and sand and gravel mining have contributed to declines in steelhead abundance (Busby *et al*. 1996, NMFS 1997, Good *et al*. 2005, NMFS 2006b, see also Quist *et al.* 2003). Within the action area, agriculture is extensive along the riverbanks, and within the floodplain, and during the wet season probably contributes sediment-water slurry and residual pesticides to the mainstem Santa Clara River and therefore critical habitat for steelhead. Much of the mainstem Santa Clara River is essentially a sandy wash, a condition presumed to reflect past and present disturbance of upland areas, resulting in exposed soil and input of sand and smaller particles to surface waters.

The cattle grazing observed in the Santa Clara River watershed is expected to create conditions that are harmful to steelhead and their habitat, given the reported effects of grazing on aquatic habitats (e.g., Hicks *et al*. 1991, Platts 1991, Wohl and Carline 1996). That cattle graze in the watershed is corroborated through observations of cattle in riparian areas and streams within the Santa Clara River watershed (including along Piru Creek downstream of Santa Felicia Dam) (A. Spina, pers. obs.), as well as reports of formal cattle operations near the town of Piru and in Los Angeles County (Schwartzberg and Moore 1995). Observations of Pole Creek and selected areas in Piru Creek indicate the condition and characteristics of the streambanks and channel are consistent with those characteristics and conditions noted in streams where cattle grazing and bank trampling were prevalent.

Mining of sand and gravel in the Santa Clara River watershed has been undertaken since the early 1900s (Schwartzberg and Moore 1995), but has been recently curtailed. The early mining operations were probably performed with little regard for the aquatic environment given that regulations governing such mining did not come into existence until the early 1970s. Much of the early mining was confined to Montalvo, Saticoy, and Santa Paula. Mining caused extensive damage and alterations to the river channel, which included scarring of the river channel, removal of riparian vegetation, and creation of deep basins. The removal of sand and gravel was blamed for erosion and degradation of the channel bed noted in the river. Removal of sand and gravel has implications for fishery resources and steelhead critical habitat because the manner of removal is reported to adversely affect aquatic habitat and biota, including steelhead (Nelson *et al*. 1991, Weigand 1991, Brown *et al*. 1998, Harvey and Lisle 1998, Meador and Layher 1998). The extent that the effects of past mining activities are continuing to affect the quality and quantity of habitats in the action area today is not clear.

During the wet season, the Santa Clara River is turbid and can exceed 3,000 nephelometric turbidity units. The elevated turbidity probably reflects accelerated inputs of sand and smaller particles due to anthropogenic disturbances throughout the watershed. The high turbidity concentrations are of concern because reports suggest high turbidity levels may temporarily halt upstream migration of adult salmonids (Bjornn and Reiser 1991). If turbidity is impeding migration of adult steelhead, this would only exacerbate the existing conditions that are challenging conservation of the endangered Southern California DPS of steelhead and the quality and quantity of critical habitat for this species.

Groundwater Pumping.—A significant conclusion is that "…local groundwater pumping over the last 100 years has severely depleted groundwater basins and reduced the frequency and duration of surface flows, with subsequent effects on steelhead trout migration and rearing" (pp. 17, Bureau of Reclamation and United Water Conservation District 2005). Historical accounts indicate the mainstem Santa Clara River flowed year round (Mann 1975, Bureau of Reclamation and United Water Conservation District 2005), suggesting the availability of over-summering habitat (freshwater rearing sites) for juvenile steelhead in the mainstem. That juvenile steelhead historically reared in mainstem habitats would not be unexpected because such habitat use has been reported in studies conducted in Washington (Loch *et al*. 1988), British Columbia (Hartman and Brown 1987), Alaska (Johnson *et al*. 1994, Bramblett *et al*. 2002), and California (Spina *et al*. 2005). Given the functional value of mainstem habitats in the ecology of steelhead, loss of critical habitat such as freshwater rearing sites, through groundwater pumping, is considered unfavorable for the conservation of steelhead. Reductions in the frequency and duration of surface-flow connectivity between tributaries and the mainstem Santa Clara River, and within the river, increase the potential for disrupting emigration of juvenile steelhead (Bureau of Reclamation and United Water Conservation District 2004, 2005). The groundwater pumping in the Oxnard Plain, in upstream reaches (e.g., Piru Basin) and in sub-basins (e.g., City of Fillmore) increases percolation of surface water to groundwater and reduces surface flows in the Santa Clara River and (or) in tributaries prior to reaching the river.

Environmental Stochasticity.— The influence of environmental stochasticity within the action area is expected to be high (Boughton *et al*. 2006). The expected sources of environmental stochasticity involve drought (and associate features such as high temperatures, low streamflow, lack of sandbar breaching at the mouths of rivers), floods, and wildfire. Extended rain-free periods, which are fairly common in southern California, can lead to dramatic reductions in the amount and extent of surface flow during both the dry and wet season. At times, the reductions can be severe enough to cause dewatering over extensive instream areas, intolerably low concentrations of dissolved oxygen, and kills of steelhead, based on NMFS' observations and experience. Wildfire can increase inputs of sand and smaller particles to streams, and reduce the amount of habitat available to steelhead (e.g., Spina and Tormey 2000 and references therein). Based on NMFS' experience and knowledge of the action area, wildfire is common, occurring on the order of what appears to be one or more fires every 3 to five years, and the wildfires vary in severity and intensity. Climate change is expected to influence the action area, particularly through increases in air (and therefore water) temperature and decreases in precipitation, which in turn may decrease the amount of suitable habitat for steelhead.

Historical Plantings of Out-of-Basin O. mykiss.—Information indicates an extensive program was undertaken during the late 1890s to early 1900s to plant non-indigenous *O. mykiss* in the action area (United Water Conservation District 2007b). While the historical out-of-basin transfers did not establish the non-native stock or contribute substantially to production of indigenous steelhead (Girman and Garza 2006, Boughton and Garza 2008), the planted fish may have temporarily increased biotic interactions (i.e., competition) with native steelhead, particularly when the planted fish were introduced into waters where the native *O. mykiss* were present. Steelhead-accessible waterways are no longer planted with hatchery fish.

Sportfishing.—Angling for *O. mykiss* is allowed within portions of the action area, as a review of the California sportfishing regulations indicate. However, NMFS is not aware of information indicating the manner in which the angling may affect endangered steelhead within the action area.

Non-native Exotic Species.—While non-native species are known to exist in portions of the action area (e.g., Pyramid Lake and Lake Piru), NMFS is not aware of any information that would allow a clear understanding of the abundance and distribution of such species in the action area, and whether such species are adversely affecting endangered steelhead.

V. EFFECTS OF THE PROPOSED ACTION

In this section, we describe the expected effects of the proposed action on endangered steelhead and habitat for this species, including designated critical habitat. The effects were predicted based on an analysis of discharge records for Piru Creek and the Santa Clara River and a review and synthesis of available information regarding the proposed action, population theory and ecological principles, the effects of habitat changes on stream fish and aquatic habitat, and the life history and habitat requirements of steelhead. This approach is described more fully below.

A. Analytical Approach

Analysis of Discharge Records.**—**To assess the influence of the proposed action on discharge in Piru Creek, hydrology data for the creek were obtained from the USGS National Water Information System website, entered into an electronic spreadsheet, plotted and then inspected. The analysis had three levels: (1) discharge in Piru Creek without Santa Felicia Dam operations,[15] but with Pyramid Dam current operations,[16] (2) discharge in Piru Creek with Santa Felicia Dam current operations and Pyramid Dam current operations, and (3) discharge in Piru Creek as would be expected under the proposed action including Pyramid Dam current operations. Generally, the design of this analysis allows us to determine how the proposed action, including the effects of the environmental baseline, would affect steelhead and habitat for this species, including designated critical habitat. The first two levels allow an understanding of how operation of Santa Felicia Dam has altered the environmental baseline; the third level provides information on the effects of the proposed action that will be added to the environmental baseline. As the findings of our analyses reveal, the proposed action is expected to perpetuate past and ongoing effects of the operation of Santa Felicia Dam into the future.

The period of record (1989 – 2004) was selected to allow a complete paired analysis of the three levels. For the first level, data obtained from the USGS stream gage #11109600 was used. This gage is located immediately upstream of Lake Piru, and quantifies water releases from Pyramid Dam as well as principal tributaries (Fish Creek and Agua Blanca Creek) to the middle reach Piru Creek. For the second level, data obtained from stream gage #11109800 was used. This gage is located immediately downstream of Santa Felicia Dam, and quantifies regulated releases from the dam. The spillway channel connects with Piru Creek downstream of this gage, and therefore the gage does not measure spills. However, daily spill data for Santa Felicia Dam were added to the record of daily mean discharge measured at the gage to provide a complete record of daily mean discharge in Piru Creek downstream of the dam. For the third level, the complete record of daily mean discharge developed for the second level was used as the basic hydrology template and then was modified according to the proposed action (i.e., the criteria presented on page 62, Federal Energy Regulatory Commission 2007a). The specific modification is described next.

Under the proposed action, United will no longer release a minimum flow of 5 cfs from Santa Felicia Dam, regardless of inflow to Lake Piru. Instead, United will "…calculate the natural inflow to Lake Piru and implement minimum flow formulas to determine the required minimum flow to be released from Santa Felicia Dam" (page 62, Federal Energy Regulatory Commission

[15] For purposes of determining effects of the proposed action, this analysis assumes that Santa Felicia Dam is operated to release water when the water reaches Santa Felicia Dam.
[16] The term, "current operations," which is used throughout this biological opinion, involves past and present operations.

2007a). Functionally, United will release from the dam the calculated natural inflow with the addition of 1 cfs when the natural inflow to the lake is less than 4 cfs, with the total release from the dam not exceeding 5 cfs (the 5 cfs would only be exceeded during the release of water for downstream agricultural users in late summer or early fall, and during spills of water over the dam). In the analysis that NMFS performed, a minimum release of 5 cfs was assumed when inflow (as measured at the existing USGS gage# 11109600 in Piru Creek, above Lake Piru, which "accounts for nearly all of the Piru Creek drainage area upstream of Lake Piru," page 62, Federal Energy Regulatory Commission 2007a) fell below 4 cfs. This assumption was necessary because all the data needed to run the minimum flow formulas were not provided to NMFS. In reality, the minimum release from the dam would often be lower than 5 cfs under the proposed action (Federal Energy Regulatory Commission 2007a).

Discharge from Piru Creek can make up a substantial amount of the total discharge in the Santa Clara River, and therefore the influence of the proposed action on the pattern and magnitude of discharge in the Santa Clara River is of concern. Accordingly, NMFS performed similar hydrological analyses to evaluate the influence of the proposed operations of Santa Felicia Dam on discharge patterns and magnitude in the river. When the findings of such analyses are presented in this biological opinion, they are accompanied by a brief explanation of the analytical methods for ease of reference.

In recent comments on the draft biological opinion (pages 45 to 47, United Water Conservation District 2008), the foregoing analyses, and similar analyses presented earlier in this biological opinion, are misinterpreted and statements are presented that create an incorrect perception that the foregoing analyses are somehow flawed because, for example, (1) the analyses do not incorporate the "new flow regime" proposed for operation of Pyramid Dam, (2) the data are inappropriately combined or the analyses are not meaningful, and (3) pre-dam natural conditions in Piru Creek were not sufficient for steelhead migration in certain water-year types. Our response to such comments is as follows.

- The analysis described above is designed to examine the influence of the proposed action on the pattern and magnitude of discharge in Piru Creek downstream of Santa Felicia Dam, in addition to flow-related influences due to the environmental baseline (e.g., the past and present effects that have lead to the current status of the species and its habitat, critical and otherwise). In this context, including any supposed future proposed action or "new flow regime" due to operation of Pyramid Dam in the above analysis would not be consistent with the goal of assessing the influence of the proposed action. The analysis above captures the environmental baseline (and influences of the proposed action) through consideration of the past and present influences of Pyramid Dam operations on the pattern and magnitude of discharge in Piru Creek upstream of Lake Piru.
- With regard to the "new flow regime" proposed for implementation at Pyramid Dam, such a proposal is being contemplated, but information indicates this proposed action has not been finalized and remains in draft form. The Commission issued a draft Environmental Assessment (EA) regarding an application to amend the project license to revise the minimum flow schedule on March 1, 2007, and NMFS commented on the EA in a letter of April 27, 2007. The draft EA provided that the licensees operate that project under a temporary waiver of certain existing license requirements pending approval of the license amendment. On February 21, 2008, the Commission issued an order denying a request for rehearing on an order related to intervention in the proceeding on the license amendment (122 FERC ¶

61,150), which is the latest record of Commission action available to NMFS regarding that proceeding. The Commission has not consulted with NMFS under ESA section 7 regarding this proposed action, and the Commission has not issued an order to amend the project license to revise the minimum flow schedule. Thus, NMFS has not been provided sufficient information to conclude that this proposed action is reasonably certain to occur.

- Operations due to Santa Felicia Dam, not Pyramid Dam, ultimately define the pattern and magnitude of discharge in Piru Creek downstream of Santa Felicia Dam; even if operations at Pyramid Dam are altered to provide water releases that more closely resemble the natural flow regime (e.g., high winter and spring baseflows, rain-induced pulses in discharge during winter and spring, and low baseflows during summer and fall), such would only have consequences for that portion of our analysis that involves dry-season flows (note that the same can be said with regard to the 25 cfs released from Pyramid Dam during the summer, United Water Conservation District 2008). The above analyses focus typically on influences of the proposed action (operations of Santa Felicia Dam) on winter and spring discharges (the principal migration season for adult and juvenile steelhead), and less typically on dry-season flows. Overall, United's expressed concerns regarding our analyses are not corroborated and have little implications for conclusions regarding the dry-season flows that are to result from the proposed action for the foregoing reasons and because the Commission's own BA makes clear that the proposed action will often result in dry-season flows that are less than 5 cfs (Federal Energy Regulatory Commission 2007a), which our analyses confirm.
- Operation of Pyramid Dam does not influence the pattern and magnitude of discharge in the two principal tributaries (Agua Blanca Creek and Fish Creek) to Piru Creek downstream of Pyramid Dam, and these tributaries provide a substantial amount of water to Piru Creek and Lake Piru as the findings from the analyses reveal. The discharge in Piru Creek owing to contributions from Agua Blanca Creek and Fish Creek are regulated by operation of Santa Felicia Dam. Therefore, the foregoing analyses provide useful information regarding how the proposed action would affect the pattern and magnitude of discharge in Piru Creek downstream of Santa Felicia Dam independent of operation of Pyramid Dam.
- The findings from analyses presented in the section "Environmental Baseline" (in the subsection "Water-Storage Facilities") do exclude the influence of Pyramid Dam operations on the pattern and magnitude of discharge in Piru Creek downstream of Santa Felicia Dam. These findings show that the magnitude of median monthly discharge in Piru Creek are influenced by current operations of Santa Felicia Dam.
- With regard to "averaging all dry, normal and wet conditions together" (pages 46 and 47, United Water Conservation District 2008), how an analysis is performed largely depends on the purpose or objective of the analysis. In many of the analyses we perform, our interest is to determine the influence of the proposed action on the pattern and magnitude of discharge in Piru Creek downstream of Santa Felicia Dam and in the Santa Clara River downstream of the confluence with Piru Creek. The analyses are structured to compare the pattern and magnitude of discharge with and without the proposed action (occasionally, the analyses are stratified by seasonal periods to reflect migratory conditions for adult and juvenile steelhead). In this regard, the hydrologic record representing the "with" and "without" conditions both include periods of variable rainfall amounts, which is reasonable given the purpose of the analysis. The analyses are often paired using the same time period to represent the "with" and "without" conditions. Therefore, in many if not all analyses, the same hydrologic conditions (including percolation influences on hydrology) are compared to one another. The only

difference between the paired variables is that one includes the influential factor that is the basis of the analysis, i.e., the proposed action.

- Contrary to suggestions (page 46, United Water Conservation District 2008), the pattern and magnitude of discharge in Piru Creek prior to the construction of Santa Felicia Dam was sufficient for migration of adult and juvenile steelhead, as the ecological and genetic evidence for steelhead presence in the Piru Creek sub-basin indicates. Prior to dam construction, wet-season discharge often included magnitudes of a few hundred cfs to several thousand cfs. United's comparison of flows in the Santa Clara River to the work of Harrison *et al*. (2006) fails to acknowledge one important item: the comparison is based on a period of record that includes water-storage influences due to Santa Felicia Dam, Dry Canyon Reservoir, and Bouquet Canyon Reservoir. Therefore, United's findings represent the effects due to the environmental baseline, which is not appropriate when attempting to develop an understanding of "pre-dam" and "natural" flow conditions for migration of steelhead. It is therefore not surprising that United's findings indicate flows in the Santa Clara River were only occasionally appropriate for migration of adult steelhead during the period 1944 to 1972, based on the criterion of Harrison *et al*. (2006).

Information Review and Synthesis.—NMFS reviewed the expected effects of the proposed action (Federal Energy Regulatory Commission 2007a) and the ecological literature concerning the effects of habitat changes (e.g., such as those attributed to alterations in the pattern and magnitude of discharge) on fish and aquatic habitat to predict the effects of the proposed action on endangered steelhead and habitat for this species. A general knowledge of physical, ecological, and biological processes, population dynamics and theory, and the life history and habitat requirements of steelhead supplemented the information review, particularly where there was little or no information concerning effects of an impact on steelhead or the aquatic environment.

When assessing effects of the proposed action at the steelhead population and species level (i.e., the Santa Clara River population unit and the entire endangered Southern California DPS of steelhead), NMFS included consideration of (1) the factors that cause population abundance to collapse and become extinct, (2) the fact that the loss of individuals in a population is only one of several factors that can cause population abundance to collapse to the point of extinction, (3) the variety of factors that cause population collapse and extinction, (4) the current likelihood of viability of the affected population unit and condition of critical habitat as described in the environmental baseline, (5) the type, extent, and amount of effects due to the proposed action, (6) the status and distribution of the endangered Southern California DPS of steelhead, spatial structure, and population dynamics, (7) the value of the Santa Clara River population unit of steelhead to the viability of the Southern California DPS, and (8) how the proposed action would affect survival and recovery of the Southern California DPS. Evidence that anthropogenic barriers to fish migrations (habitat fragmentation and loss) can reduce fish population abundance, increase the risk of extinction, and cause extinctions of populations, can be found in Nehlsen *et al*. (1991), National Research Council (1996), Morita and Yamamoto (2002), Rieman and McIntyre (1993), Dunham *et al*. (1997), Boughton *et al*. (2005), and Gustafson *et al*. (2007).

With regard to population collapse and extinction, certain population-related attributes can create risk for a species (Pimm *et al*. 1988, Berger 1990, Primack 2004). A population made up of a small number of individuals is more susceptible to a risk of extinction than is a population made up of a large number of individuals. The number of steelhead in the Santa Clara River watershed and the endangered Southern California DPS of steelhead is small (NMFS 1997, Good *et al*. 2005, NMFS 2006b). The principal reasons why small populations are particularly susceptible to a rapid decrease of individuals and local extinction involve loss of genetic variability (and related genetic problems), demographic fluctuations in birth and death rates, and environmental variation (e.g., biotic interactions, food availability, fires, drought). Large population sizes minimize the effects due to loss of genetic variability and population and environmental fluctuations (Pimm *et al*. 1988, McElhany *et al*. 2000). Another attribute that can increase risk involves population variability. Populations whose number of individuals (e.g., density) are susceptible to large temporal variations are more likely to become extinct than populations whose densities are not inclined to large fluctuations over time. Steelhead abundance in southern California can vary substantially over time. Lastly, species that are short-lived exhibit a greater risk of extinction than long-lived species (Pimm *et al*. 1988). Steelhead are a short-lived species, with a generation time of 3 to 4 years.

Jeopardy Assessment.—The approach to assess whether the proposed action would jeopardize the continued existence of the endangered Southern California DPS of steelhead relied on information about the status and the current viability of the species at the DPS scale (presented earlier in the Status of the List Species and Critical Habitat section and the Environmental Baseline section), information on how the proposed action is expected to adversely affect steelhead at the individual and population level, and integration of the foregoing information in the section Integration and Synthesis of Effects. The information regarding the status and current viability of the species under the environmental baseline provides reference conditions at the population scale to which NMFS adds the effects of the proposed action in the Integration and Synthesis of Effects section. In the Effects on Steelhead section, NMFS identifies the effects that individual steelhead are expected to experience as a result of the proposed action, and the expected response of steelhead to the effects based on the life history and habitat requirements of this species. Finally, NMFS assesses whether the conditions that result from the proposed action, in combination with conditions influenced by other past and ongoing activities as described in the Environmental Baseline, will affect steelhead at the individual level. Once we have determined if the proposed action when added to environmental baseline conditions will affect the fitness of individual steelhead, the final steps in NMFS' jeopardy assessment are to evaluate first whether these fitness consequences are reasonably likely to result in changes in the likelihood of viability of the Santa Clara River steelhead population unit and the entire endangered Southern California DPS of steelhead. We complete this assessment by relying on the information available on the species and the specific population in terms of its current and needed abundance, productivity, diversity, and spatial structure characteristics, as presented in the Status of the Listed Species and Critical Habitat and Environmental Baseline sections.

Adverse Modification Risk Assessment.—The approach to determine if the proposed action is likely to result in the destruction or adverse modification of designated critical habitat involved consideration of how the proposed action would affect elements of critical habitat identified as essential to the conservation of the species. In the Status of the Listed Species and Critical Habitat section, our critical habitat adverse modification risk assessment begins with a discussion of the biological and physical features (primary constituent elements or essential features) in the entire designated critical habitat that are essential to the conservation of the endangered steelhead DPS, the current conditions of such features, and the factors responsible for the current conditions. In the Environmental Baseline section, we discuss the current condition of critical habitat in the action area, the factors responsible for that condition, the conservation role of those specific areas, and the relationship of critical habitat designated in the action area to the entire designated critical habitat at the scale of the DPS to the conservation of the endangered Southern California DPS of steelhead. In the Effects on Critical Habitat section, NMFS characterizes the effects of the proposed action on critical habitat designated in the action area and evaluates whether the designated critical habitat and primary constituent elements in the action area will continue to provide those features and functions that support the biological requirements of the species, or retain the current level of ability to establish those features and functions. With regard to critical habitat, this biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR §402.02. Instead, NMFS has relied upon the statutory provisions of the ESA to complete the foregoing analysis with respect to critical habitat. Therefore, in considering effects on critical habitat in the final steps of NMFS' assessment, NMFS assessed whether implementation of the proposed action would allow critical habitat to remain functional, or allow for primary constituent elements to be functionally established, to serve the intended conservation role for the species.

Assumptions.—In addition to assumptions already stated, NMFS assumed that alterations in the pattern and magnitude of discharge, including reductions in the amount and extent of surface flow, would translate into changes in the quality and quantity of freshwater migration corridors, freshwater spawning sites, and freshwater rearing sites for steelhead, with concomitant effects on individuals within the affected area. This assumption is reasonable given the flow-related dependency of many features of aquatic habitat and the inextricable connections among flow, riverine habitat, and steelhead life history, habitat requirements, and population metrics (e.g., Shapovalov and Taft 1954, Barnhart 1986, 1991, Harvey *et al*. 2005, Spina *et al*. 2005, Harvey *et al*. 2006, NMFS 2005b, Ligon *et al*. 1995, Konolf 1997, Poff *et al.* 1997).

Another assumption involves the future types of water years (amount of rainfall) as would be present during implementation of the proposed action. Many of the hydrologic analyses NMFS performed used historical and recent discharge records for Piru Creek and the Santa Clara River. These records involve a mix of below normal, normal, and above normal water years for the region, with the frequency of water-year types approximating a normal distribution. NMFS' analyses assume the discharge records are a reasonable representation of future hydrologic conditions as would occur under the proposed action, but there is reason to believe that precipitation in southern California will exhibit measurable decreases in the future (Hayhoe *et al.* 2004). If reduced precipitation does dominate the region in the future, the findings from NMFS' analyses presented here are expected to underestimate the effects of the proposed action on discharge in Piru Creek and the Santa Clara River because the findings from the analyses performed here and elsewhere (e.g., NMFS 2005a) indicate the effects of water diversion and storage activities are most pronounced during below normal and normal water years.

B. Effects on Critical Habitat

The proposed action is expected to perpetuate the existing alteration of the pattern and magnitude of discharge in the Piru Creek sub-basin and the Santa Clara River mainstem, and continue to cause habitat loss in the Santa Clara River watershed. While the proposed action includes numerous environmental measures, these are inadequate to offset the ecologically substantial habitat loss and discharge alterations that are expected to continue due to implementation of the proposed action. As discussed in the following, the remaining alterations in the pattern and magnitude of discharge are expected to have adverse consequences for steelhead critical habitat.

***Continue to Alter the Pattern and Magnitude of Discharge*.—**Generally, the findings from the hydrology analyses indicate the proposed action will continue to (1) reduce and eliminate the frequency and magnitude of discharge pulses (i.e., periods of elevated streamflow that are prompted by wet-season rainfall events) during winter and spring, (2) reduce the magnitude and duration of wet and dry-season baseflows (i.e., periods of "low" discharge between rainfall events), (3) cause unnatural high-magnitude discharges during spring, summer, or fall, that rapidly increase and decrease, and (4) alter the timing of peak discharge in Piru Creek downstream of Santa Felicia Dam (Figures 5-1 and 5-2). Such conditions are pervasive, occurring in no less than 81% of all water years considered (N = 16) (Table 5-1). The findings illustrate that current operations at Santa Felicia Dam capture and store wet and dry-season discharge, and then release the stored water typically during the dry season for hydroelectric generation and agricultural uses. These effects are expected to continue under the proposed action, and the operations related to the storage and release of water will continue to affect habitats needed to sustain steelhead. A discussion of the specific effects of the proposed action on the pattern and magnitude of discharge is as follows.

Table 5-1.—Summary of the flow-related conditions that the proposed action is expected to continue to create in Piru Creek downstream of Santa Felicia Dam, and the pervasiveness of each condition among the water years analyzed (*N* = 16) (1989-2004). Figures 5-1 and 5-2 present a graphical depiction of the findings for each of the water years analyzed.

Flow-related effects	Percent of water years exhibiting condition
Continue to reduce and eliminate the frequency and magnitude of discharge pulses (i.e., periods of elevated streamflow) during winter and spring.	94
Continue to reduce the magnitude and duration of wet and dry-season baseflows (i.e., periods of low discharge between rain events).	81
Continue to cause unnatural high-magnitude discharge during spring, summer, or fall, that rapidly increase and decrease.	94
Continue to alter the timing of the maximum peak discharge.	100

The proposed action is expected to continue to reduce the magnitude of the average minimum, median, and maximum daily mean discharges in Piru Creek downstream of the dam. The minimum discharge in the absence of Santa Felicia Dam current operations was higher than discharge due to current operations and the proposed action (Kruskal-Wallis test: H = 12.6, P = 0.002[17]) (Figure 5-3). A year-by-year inspection of dry-season baseflows (June – early September) corroborate that minimum flows were typically higher in the absence of dam current operations than for current operations and the proposed action. The median discharge was on average higher in the absence of Santa Felicia Dam current operations than for either the current operations or the proposed action (H = 10.3, P = 0.006) (Figure 5-3). The highest peak daily discharges during the principal migration season for steelhead (i.e., January through May) are several hundred cfs higher in the absence of Santa Felicia Dam current operations than for current operations or the proposed action (H = 7.1, P = 0.03) (Figure 5-3).

[17] Statistical significance based on a Type I error rate = 0.05.

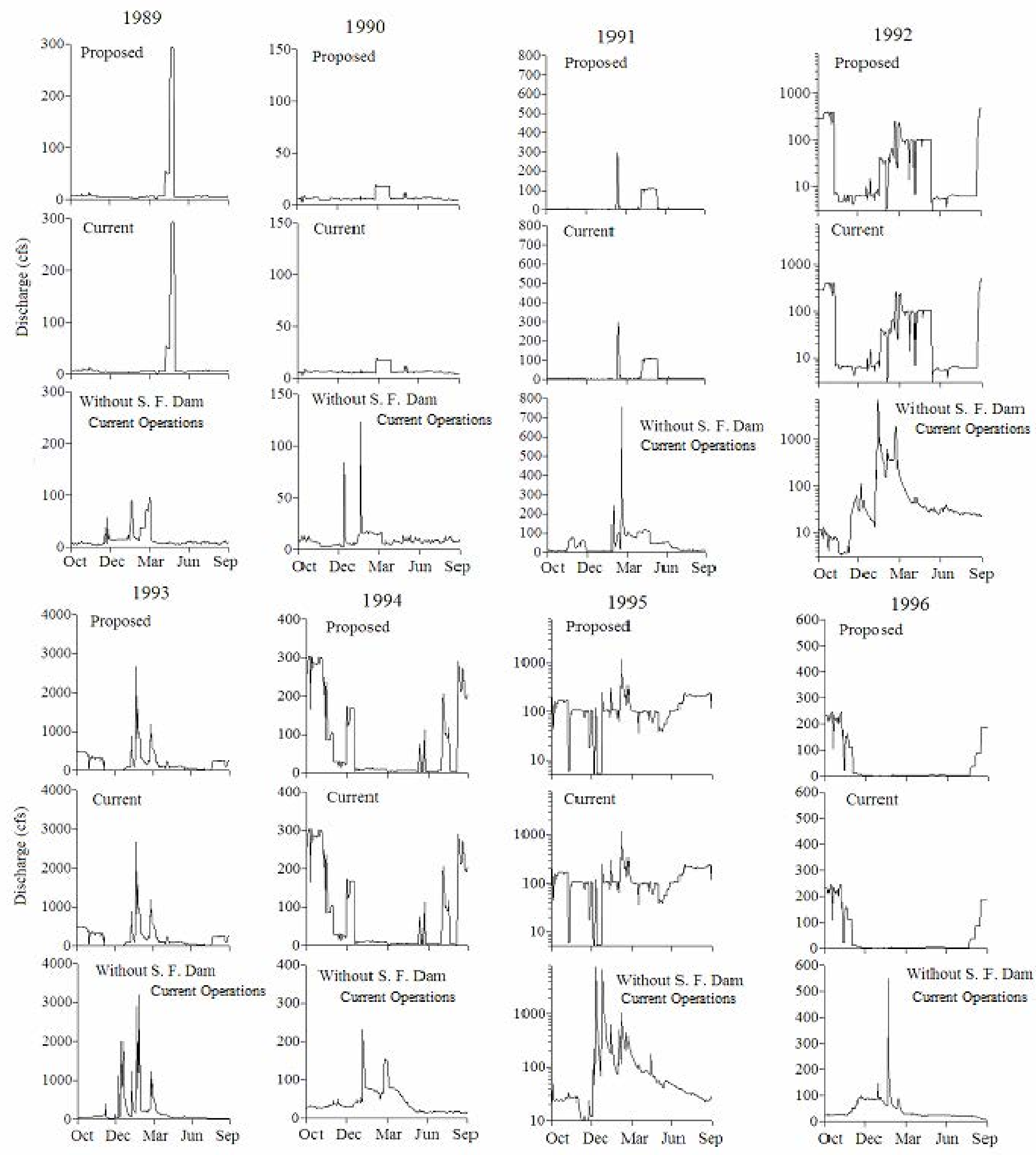

Figure 5-1.—Daily mean discharge in Piru Creek during 1989 to 1996 water years for three different conditions: "Without S. F. Dam Current Operations" (i.e., available discharge without past and present operations of Santa Felicia Dam, but with Pyramid Dam current operations), "Current" (*i.e.*, discharge due to past and present operations of Santa Felicia Dam), and "Proposed" (*i.e.*, the expected discharge resulting from United's proposed operating criteria, as defined in the Commission's BA).

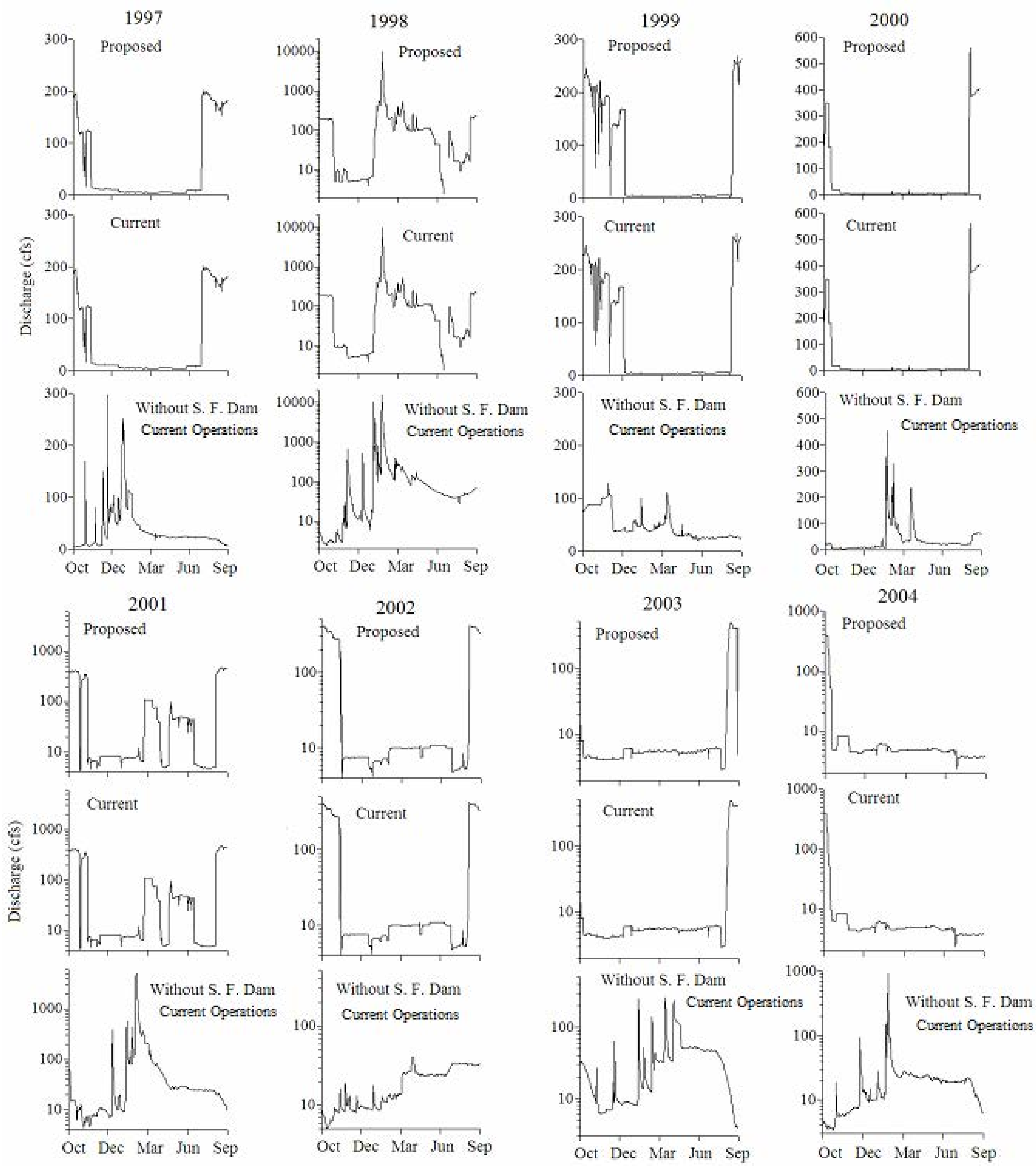

Figure 5-2.—Daily mean discharge in Piru Creek during 1997 to 2004 water years for three different conditions: "Without S. F. Dam Current Operations" (i.e., available discharge without past and present operations of Santa Felicia Dam, but with Pyramid Dam current operations), "Current" (*i.e.*, discharge due to past and present operations of Santa Felicia Dam), and "Proposed" (*i.e.*, the expected discharge resulting from United's proposed operating criteria as defined in the Commission's BA).

The proposed action is expected to continue to shift the timing of the highest annual peak discharge in Piru Creek from the wet season to the dry season, and reduce the frequency of such events during winter and spring (Table 5-2). Without Santa Felicia Dam current operations, the highest annual peak discharges were noted only in winter (81% of all events) and spring (19%), with 50% occurring in February. Under current operations and the proposed action, fewer such discharges are expected during winter (25%, and only 12% in February) and spring (12%), but peak discharges are expected during summer (37%) and fall (25%).

Contrary to contentions (United Water Conservation District 2008), the forgoing findings are stratified by water year (see Table 5-2) and therefore the findings are representative of different water-year types (e.g., "below normal," "normal," and "above normal"). Additionally, the findings are ecologically significant given that the migratory behavior and ecology of steelhead has evolved to exploit the timing of periods of elevated flows (see section entitled, "Effects on Steelhead," sub-section "Continue to Disrupt Migration of Adult and Juvenile Steelhead"). Many of the magnitudes of the peak flows reported in Table 5-2 do appear appropriate for migration of adult steelhead, based collectively on the findings of Harrison *et al*. (2006) and results of recent efforts to quantify minimum flows necessary for migration of steelhead in Piru Creek and the Santa Clara River (e.g., pers. comm., B. Hughes, CDFG, February 5, 2008, United Water Conservation District 2008).

The suggestion that steelhead migration, and therefore the functional value of the freshwater migration corridor, is limited solely to those periods when Santa Felicia Dam spills water (United Water Conservation District 2008) appears correct given that the proposed action includes no specific provision to release water for the purpose of facilitating a functioning freshwater migration corridor for endangered steelhead. The fact that migration would be confined solely to periods of spills represents an adverse effect of the proposed action because it is an effect that is expected to be perpetuated due to extending current operations of Santa Felicia Dam into the future. The specific basis for this conclusion is described in the many paragraphs that follow.

Inspection of Figures 5-1 and 5-2 provides evidence that the proposed action will perpetuate the long-standing practice of causing rapid increases and decreases of short-duration high-magnitude flows in Piru Creek downstream of Santa Felicia Dam. Many of the water years considered in the hydrologic analysis show periods when discharge in Piru Creek rapidly increases and then just as rapidly decreases under current operations and under the proposed action. Such increases in discharge often range from 200 to 400 cfs (typically for a duration of a few to several weeks) across water years, and are typically noted during the dry season and less typically during the wet season. This practice is undertaken to deliver water to downstream agricultural users (Federal Energy Regulatory Commission 2007a). The rapid increases and decreases in dry season (and sometimes wet season) discharge in Piru Creek under current operations and the proposed action are clearly distinctive from the pattern of discharge observed in the absence of Santa Felicia Dam current operations, as a review of the figures indicate.

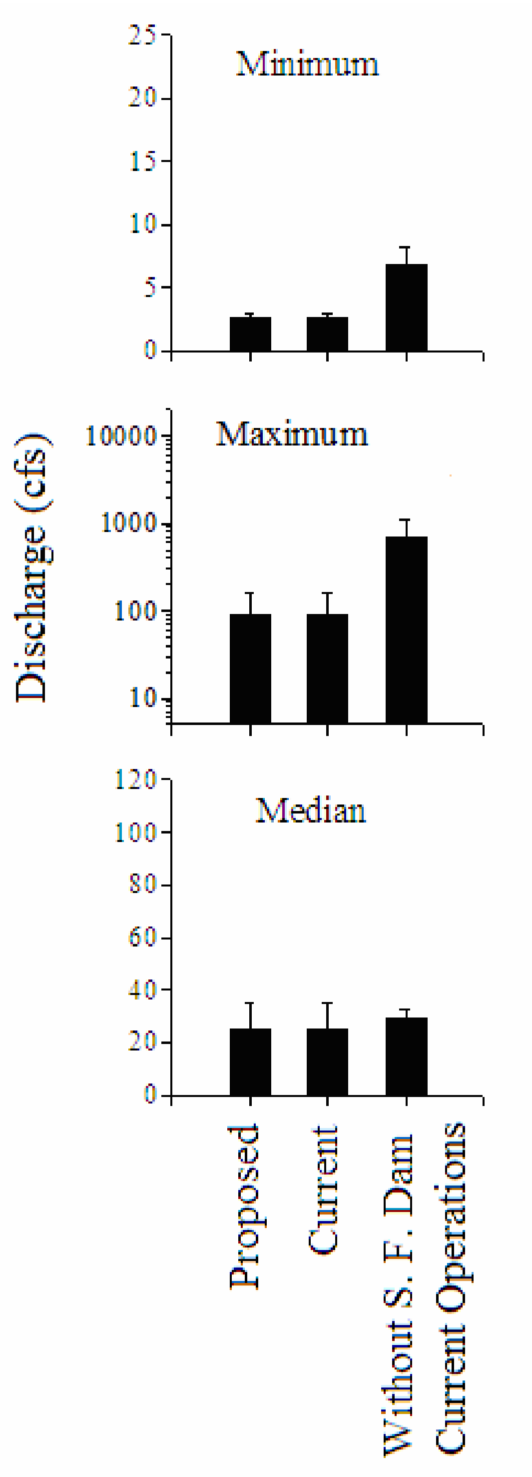

Figure 5-3.—Comparison of the average minimum, maximum (during the principal migration season for steelhead, January through May), and median daily mean discharge (+ 1 SE) in Piru Creek among three different conditions: "Without S. F. Dam Current Operations" (i.e., available discharge without past and present operations of Santa Felicia Dam, but with Pyramid Dam current operations), "Current" (*i.e.*, discharge due to past and present operations of Santa Felicia Dam), and "Proposed" (*i.e.*, the expected discharge resulting from United's proposed operating criteria as defined in the Commission's BA).

Table 5-2.—Date of highest peak daily mean discharge in Piru Creek during water years 1998 to 2004 (the available record) due to the proposed action and current operations, and in the absence of Santa Felicia Dam current operations. The highest peak daily mean discharge (cfs) is presented within parentheses. More than one date indicates the peak discharge occurred more than once within a single water year (water year is defined as October 1 through September 30).

Water year	Without S. F. Dam current operations	Current operations	Proposed action
1989	Mar 25, 1989 (97)	May 13-16, 1989 (294)	May 13-16, 1989 (294)
1990	Feb 17, 1990 (123)	Mar 28-29, 1990 (19)	Mar 28-29, 1990 (19)
1991	Mar 19, 1991 (755)	Mar 12, 1991 (296)	Mar 12, 1991 (296)
1992	Feb 12, 1992 (6900)	Sep 30, 1992 (506)	Sep 30, 1992 (506)
1993	Feb 26, 1993 (3200)	Feb 20, 1993 (2681)	Feb 20, 1993 (2681)
1994	Feb 7, 1994 (231)	Oct 10, 1993 (305)	Oct 10, 1993 (305)
1995	Jan 10, 1995 (7700)	Mar 11, 1995 (1179)	Mar 11, 1995 (1179)
1996	Feb 20, 1996 (550)	Oct 14, 1995 (248)	Oct 14, 1995 (248)
1997	Dec 22, 1998 (298)	Aug 4, 1997 (202)	Aug 4, 1997 (202)
1998	Feb 23, 1998 (15000)	Feb 25, 1998 (9500)	Feb 25, 1998 (9500)
1999	Nov 28, 1998 (129)	Sep 20, 1999 (269)	Sep 20, 1999 (269)
2000	Feb 23, 2000 (456)	Sep 7, 2000 (560)	Sep 7, 2000 (560)
2001	Mar 6, 2001 (5030)	Sep 17, 2001 (463)	Sep 17, 2001 (463)
2002	Apr 28-29, 2002 (41)	Sep 5, 2002 (418)	Sep 5, 2002 (418)
2003	Apr 15, 2003 (260)	Sep 11-13 & 15, 2003 (481)	Sep 11-13 & 15, 2003 (481)
2004	Feb 26, 2004 (926)	Oct 1, 2003 (402)	Oct 1, 2003 (402)

The proposed action is expected to continue to create flow-related effects that extend from Santa Felicia Dam downstream into the Santa Clara River in the vicinity of the Los Angeles – Ventura County line during the principal migration season for steelhead (Figure 5-4). To assess the influence of the proposed action on the pattern and magnitude of discharge in the Santa Clara River, an approach similar to the one described for Piru Creek was used and generally followed the analysis described earlier for the Santa Clara River. Recall that the USGS stream gage (#11108500) on the Santa Clara River at the Ventura-Los Angeles County line (located a short distance upstream from the confluence with Piru Creek) was used in the analysis. To model discharge in the Santa Clara River in the absence of the operation of Santa Felicia Dam, the daily mean discharge as reported by the USGS stream gage immediately upstream of Piru Creek (#11109600) was added to the discharge for the Santa Clara River, as measured at the County line. To model discharge in the Santa Clara River under the proposed operation of Santa Felicia Dam, flow data was obtained from stream gage #11109800. This gage is located immediately downstream of Santa Felicia Dam, and quantifies regulated releases from the dam. The spillway channel connects with Piru Creek downstream of this gage, and therefore the gage does not measure spills. However, daily spill data for Santa Felicia Dam were added to the record of daily mean discharge measured at the gage to provide a complete record of daily mean discharge in Piru Creek downstream of the dam. This complete record of daily mean discharge was used as the basic hydrology template and then was modified according to the proposed action (i.e., the criteria presented on page 62, Federal Energy Regulatory Commission 2007a).

The findings indicate that the daily mean discharge in the Santa Clara River was frequently higher in the absence of Santa Felicia Dam current operations than discharge representing current operations and the proposed action. This feature is most apparent in water years 1989, 1991, 1992, 1994, and 1996. The maximum discharge in the Santa Clara River was also often higher (at times nearly 2000 cfs higher) in the absence of Santa Felicia Dam current operations than discharge representing current operations and the proposed action. With regard to the duration of the discharge pulses, in the absence of Santa Felicia Dam current operations the descending limb of each discharge pulse was typically protracted (and at a higher magnitude) as compared to the descending limb of pulses due to current operations and the proposed action (Figure 5-4). Based on these findings, the proposed action is expected to perpetuate lower discharge and short duration runoff in the Santa Clara River (at least in the vicinity of the Los Angeles – Ventura County Line), which is projected to adversely affect migration of adult and juvenile steelhead (this latter point is addressed more fully in the section entitled, "Effects on Steelhead").

The flow-related effects due to the proposed action are expected to extend from the mouth of Piru Creek downstream 19 miles in the Santa Clara River to the Vern Freeman Diversion Dam (Figure 5-5). Such effects were identified by considering the discharge in the Santa Clara River in the vicinity (upstream) of the Vern Freeman Diversion with and without current operations of Santa Felicia Dam and the proposed action using an approach that is similar to the analytical approach described above to assess the influence of the proposed action on flows in the Santa Clara River in the vicinity of the county line. Most of the water years analyzed (75%) indicate the proposed action would reduce both the magnitude and duration of flows, assuming the same or similar range of hydrologic conditions. However, as Figure 5-5 reveals, not all years show evidence of effects due to the proposed action because in such cases discharge under the proposed action (and current operations) is nearly identical to discharge in the absence of current operations due to Santa Felicia Dam (e.g., water years 1993, 1995). Effects appear to be most pronounced in water years that produce intermediate or below normal flows (e.g., years of normal or below normal rainfall), which are common for the southern California region. As we have stated for the hydrologic analyses in general (see earlier discussion in the section "Analytical Approach"), while the specific magnitude of flows depicted in the graphs might overestimate the true magnitude of flow in the Santa Clara River due to percolation of water into groundwater basins (e.g., page 47 and 48, United Water Conservation District 2008), the findings of NMFS' analysis represent a reasonable understanding of how the proposed action influences discharge because percolation effects are consistent between the two paired conditions (with and without the operations due to the proposed action); the only difference between the two conditions is the influence of the operations due to the proposed action. Additionally, the subject analysis is based on flow data near the Vern Freeman Diversion Dam, which is downstream of the percolative influence due to the Piru Basin. It is important to point out that the years cited (e.g., 1989, 1991, 1992, 1994, and 1996) as not having enough flow to provide migration of adult steelhead in the Santa Clara River (see page 47, United Water Conservation District 2008) represent effects that included influences of the environmental baseline (i.e., past operations of operations due to Santa Felicia Dam, Pyramid Dam, Castaic Dam, Dry Canyon Reservoir, and Bouquet Canyon Reservoir), not "natural" or "pre-dam" conditions.

The foregoing discussion addressed effects of the proposed action on the pattern and magnitude of surface flows in Piru Creek downstream of Santa Felicia Dam and the Santa Clara River downstream of the confluence with Piru Creek. These effects are expected to translate into adverse effects on the quality and quantity of freshwater migration corridors, freshwater spawning sites, and freshwater rearing sites for steelhead, all primary constituent elements of critical habitat. Accordingly, the following presents a discussion of the expected effects of the proposed action on freshwater migration corridors, freshwater spawning sites, and freshwater rearing sites, based on the flow-related effects documented in the previous discussion. We begin now with a discussion of the effects on freshwater migration corridors for steelhead.

***Continue to Reduce the Quality and Quantity of the Freshwater Migration Corridors*.—** Freshwater migration corridors for steelhead include water quantities that are sufficient to support adult and juvenile mobility and survival (NMFS 2005b). Sufficient water quantities at a frequency supporting adult and juvenile migration include those associated with elevated discharge pulses during winter and spring, which are necessary for migration of adult and juvenile steelhead (Shapovalov and Taft 1954, Spina *et al.* 2005). Because the proposed action is expected to continue to reduce (if not eliminate) the magnitude, duration, and frequency of wet-season discharge in Piru Creek downstream of the dam, the conservation value of the freshwater migration corridor in Piru Creek is projected to continue to be reduced and sometimes eliminated. Specific effects on freshwater migration corridors within the action area are described as follows.

The proposed action is expected to frequently shift the timing of the freshwater migration corridor from the wet season to the dry season, thereby often completely eliminating the freshwater migration corridor for adult and juvenile steelhead. Adult and juvenile steelhead migrate during the winter and early spring, typically during periods of rain-induced pulses in river discharge (Shapovalov and Taft 1954, Spina *et al.* 2005). Because the freshwater migration corridor is a necessary element of the species' life history and habitat requirements, and given the ecological importance of the seasonal timing of the freshwater migration corridor for adult and juvenile steelhead, frequently shifting the freshwater migration corridor for this species to

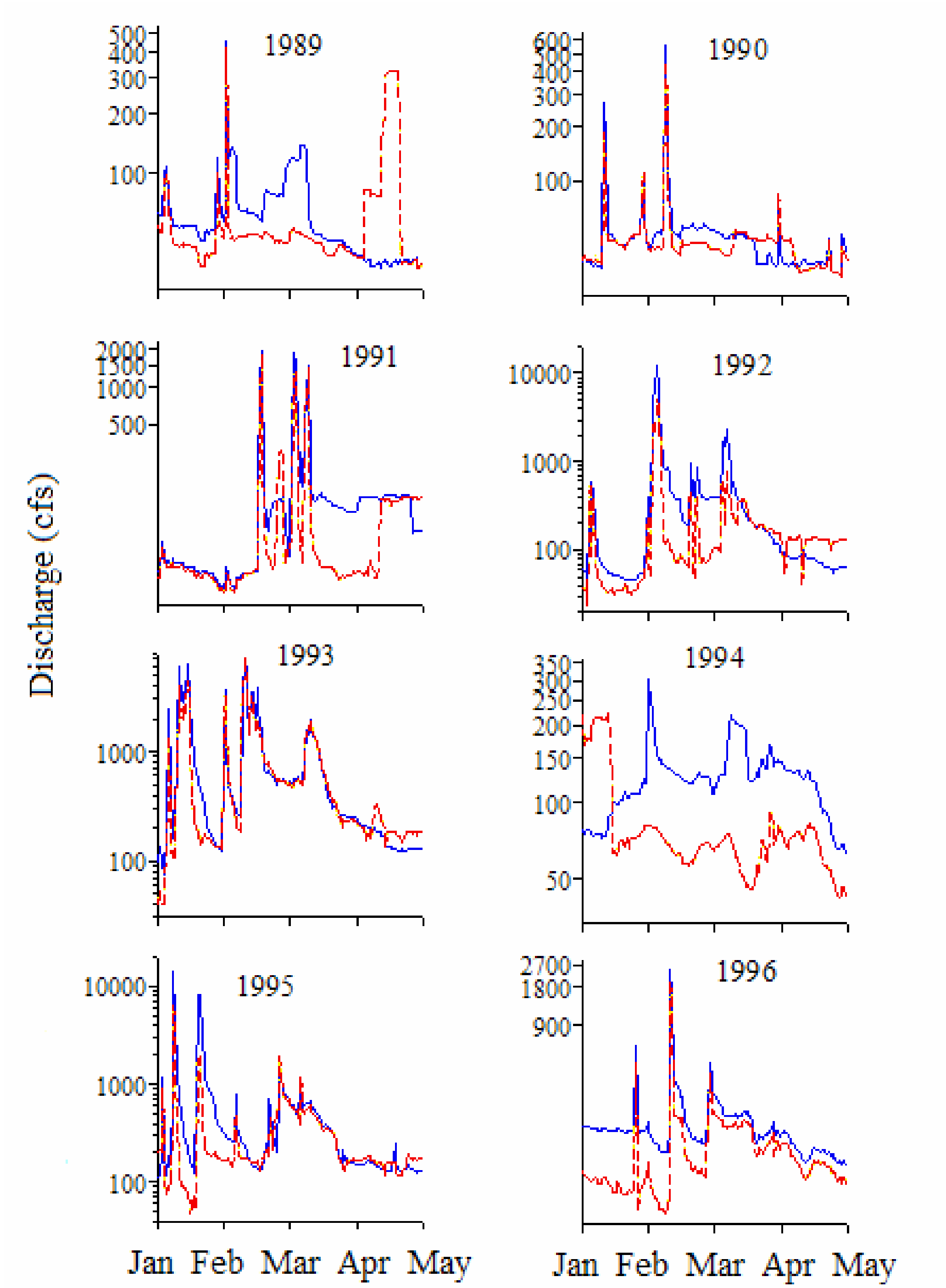

Figure 5-4.—Daily mean discharge (cfs) during principal steelhead migration season in the Santa Clara River at the Los Angeles – Ventura County line during 1997 to 2004 water years (the available record) for three different conditions: "Without S. F. Dam" (available discharge without Santa Felicia Dam current operations, but with Pyramid Dam current operations) (blue line in graph), "Current" (*i.e.*, discharge due to past and present operations of Santa Felicia Dam) (yellow line), and "Proposed" (*i.e.*, expected discharge resulting from United's proposed operating criteria as defined in the Commission's BA) (red line) (note all conditions include effects due to operation of Pyramid Dam). The daily mean discharge due to current operations and the proposed action are similar, hence generally only the red line (proposed action) is visible.

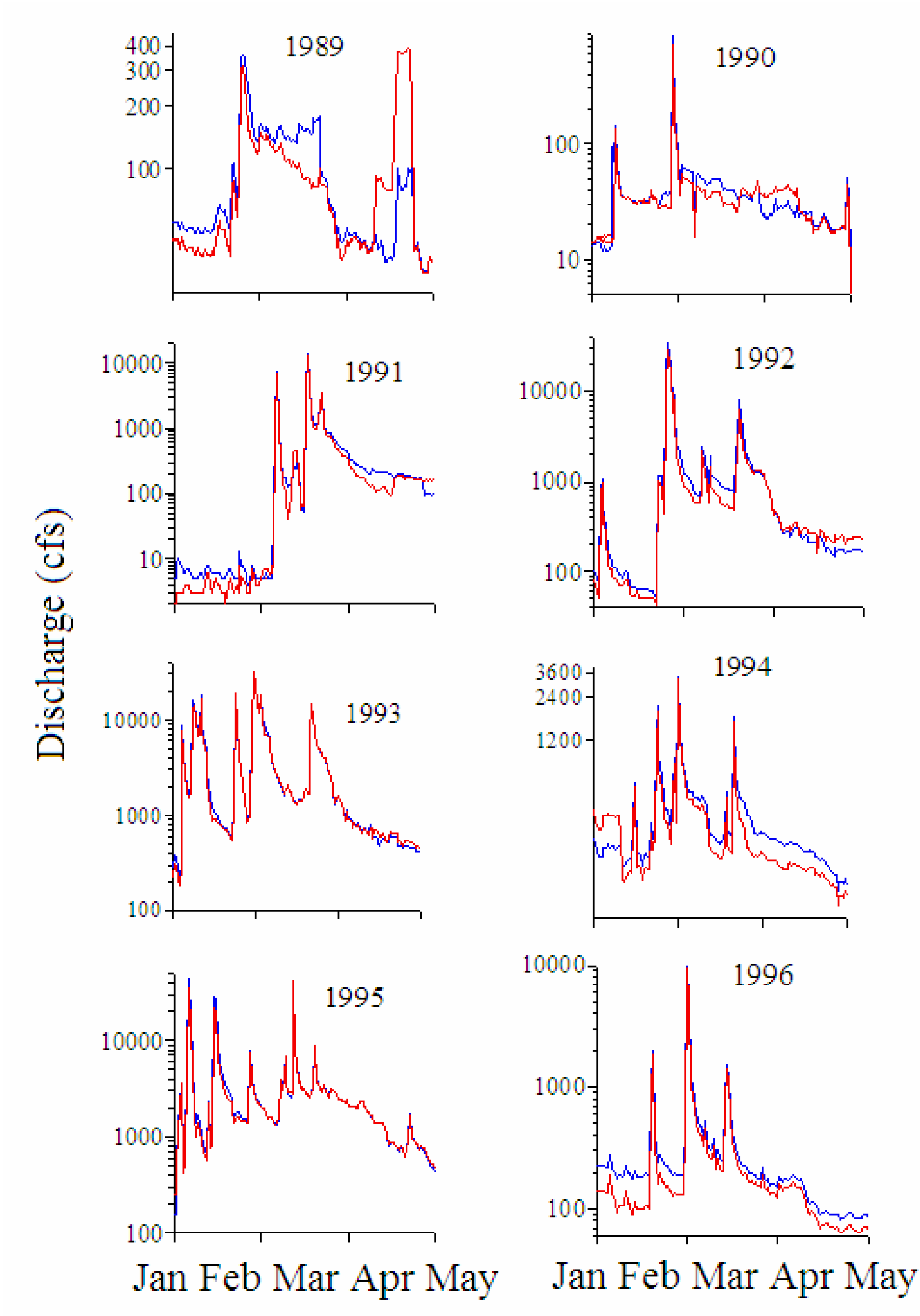

Figure 5-5. —Daily mean discharge in the Santa Clara River in the vicinity (upstream) of the Vern Freeman Diversion Dam during the principal migration season for steelhead. Three different flow conditions are represented: without current operations of Santa Felicia Dam (blue line in graph), with current operations of Santa Felicia Dam (yellow line), and with the proposed operations of Santa Felicia Dam (red line) (note all conditions include effects due to operation of Pyramid Dam). Because the current operations and proposed operations are essentially the same, the red and yellow lines overlap and only the red line is visible.

the dry season constitutes a reduction in the conservation value of the species' critical habitat. The proposed action includes no water release from Santa Felicia Dam for the specific purpose of creating and maintaining an ecologically meaningful freshwater migration corridor for adult and juvenile steelhead during winter and spring.

The proposed action is expected to continue to decrease the frequency and duration that discharge in Piru Creek downstream of Santa Felicia Dam would be suitable for steelhead migration. Analysis of the depth-discharge relationship for a selected area of Piru Creek indicates a *minimum*[18] discharge of 30 cfs is necessary to provide a *minimum* depth of 1.0 ft in Piru Creek (upstream of Highway 126, not in lower Piru Creek or at the confluence with the Santa Clara River) (CDFG 2005), which is a typically applied depth criterion for passage of adult steelhead (NMFS 2001, CDFG 2005) (based on review of unimpaired hydrology for Piru Creek, state and federal agencies recommend similar discharges for Piru Creek during the steelhead migration season, e.g., CDFG 2005, NMFS 2006d). Information indicates that flows of 200 cfs are necessary to attain one-foot depth near the mouth of Piru Creek (i.e., lower Piru Creek downstream of Highway 126, near confluence with the Santa Clara River), which is believed necessary for migration of steelhead (page 49, United Water Conservation District 2008).

The hydrology record for Piru Creek was reviewed to determine the frequency and duration that discharge in the creek was 30 cfs or higher during the principal migration period for steelhead (January through May). This review was performed separately for three flow conditions (all of which include influence of Pyramid Dam operations): without current operations of Santa Felicia Dam, with current operations, and the proposed action. The record involved water years 1989 through 2004, the available record allowing a "paired" analysis of hydrology characteristics among the three condition types. A similar analysis was performed using 200 cfs (i.e., 200 cfs or higher) as the threshold criterion (pers. comm., B. Hughes, CDFG, February 5, 2008).

NMFS assumed in the foregoing analysis that because migratory behavior and ecology evolved under the natural flow regime (e.g., Richter *et al*. 1996, Richter *et al*. 1997, Lytle and Poff 2004), characteristics of the unimpaired flow regime (e.g., the timing, magnitude, duration, frequency, and rate of change of flows) would most closely comport with the life history and habitat requirements of steelhead. Therefore, departures of flow-related characteristics as would be expected under the proposed action from characteristic as observed under the "without current operations" condition would be useful for developing an understanding of how the proposed action may affect critical habitat (and steelhead). Keeping in mind the actual baseline comparison in this specific analysis includes the effects of Pyramid Dam operations on the pattern and magnitude of streamflow in Piru Creek, the "unimpaired flow regime" used in the analysis (i.e., "without current operations") is therefore already impaired due to the effects of Pyramid Dam operations (the same can be said for the analyses performed on the hydrology data for the Santa Clara River). For this reason, the findings below are used only to develop an understanding of effects of the proposed action that will be added to the environmental baseline, not as a basis to define an ecologically meaningful freshwater migration corridor for adult and juvenile steelhead. Elements of the latter would include an analysis of the pattern and magnitude

[18] We note that while "minimum" discharges may produce responses in flow-dependent habitat variables within localized areas such as a shallow riffle, minimum discharges do not represent the flow magnitudes needed to produce essential habitat functions for long-term survival of steelhead throughout a waterway.

of Piru Creek prior to the construction of Santa Felicia Dam and Pyramid Dam (e.g., NMFS 2006d).

The findings of this analysis show that the proposed action would reduce the average number of days that discharge in the creek is 30 cfs or higher during the migration season for steelhead (t = 4.7, df = 15, $P < 0.0005$[19]). Without current operations of Santa Felicia Dam, there are on average 91 days (SD = 50) within a given year when discharge in Piru Creek is 30 cfs or higher. By contrast, under current operations and the proposed action, the average number of days within a given year is reduced to 37 (SD = 51). The findings further show that the proposed action would affect the duration that flows remain at or exceed 30 cfs during the primary migration period for steelhead (test on difference in duration between the proposed action and without current operations of Santa Felicia Dam, t = 4.3, df = 15, P = 0.001). Without current operations, discharge was at 30 cfs or higher an average of 49 continuous days (SD = 44) within a given year, whereas under current operations and the proposed action, discharge remained at or exceeded 30 cfs an average of 20 continuous days (SD = 34) within a given year. Longer duration flows, as would exist in the absence of current operations and the proposed action, are expected to favor emigration and immigration of steelhead.

The findings from the analysis based on the 200 cfs criterion are similar to those obtained from the analysis using the 30 cfs criterion. Without current operations of Santa Felicia Dam, discharge in Piru Creek was 200 cfs or higher an average of 18 days (SD = 25) for an average continuous duration of 4 days (SD = 5) within a given year. Under the current operations and the proposed action, an average of 9 days (SD = 18) each year would see discharges of 200 cfs or greater, for an average duration of 2 days (SD = 4) within a given year. Overall, a 50 % reduction in the frequency and duration that discharges equal or exceed 200 cfs is expected to result from the proposed action.

Contrary to suggestions (page 50, United Water Conservation District), the foregoing analysis based on the 30 cfs and 200 cfs criteria are relevant to steelhead migration and the influences of the proposed action on this species and its critical habitat. The flow criteria are ecologically meaningful because each was derived from scientifically sound methods for developing an understanding of flow-depth requirements for fish, and each is believed necessary to get steelhead into and out of Piru Creek. The findings provide an understanding of how the proposed action would be expected to affect the attainment of such flow-based criteria, which is necessary to develop an understanding of how the proposed action may affect endangered steelhead and critical habitat for this species. Percolative influences on the magnitude of migration flows for steelhead would be expected to exacerbate the effects of the proposed action on this species and its critical habitat (page 51, United Water Conservation District 2008).

The proposed action is expected to continue to decrease the frequency and duration that discharge in the Santa Clara River (near the Los Angeles – Ventura County line) would be suitable for migration of steelhead (Table 5-3). River discharges of 500 cfs or more are needed to generate a distribution of water depths that are suitable for migration of steelhead in the Santa Clara River in the vicinity of the mouth of Piru Creek (Harrison *et al*. 2006). Based on an analysis of the frequency and duration that discharge in the Santa Clara River was 500 cfs or

[19] Because discharge in Piru Creek during the principal steelhead migration season is the same under the current operations as for the proposed action, only the discharge resulting from the proposed action was included in this statistical test, which was performed using a paired *t*-test.

higher, discharge would be suitable on 17 continuous days (on average each year) during the principal steelhead migration season (Jan through May) in the absence of current operations of Santa Felicia Dam. By contrast, under current operations of Santa Felicia Dam and the proposed action, discharge would be expected to be suitable only 12 continuous days each year, on average. With regard to the duration (in continuous days) that discharge would promote a distribution of depths that are suitable for migration of adult steelhead, the "without current operations" produced an average duration of 5 days, whereas under current operations and the proposed action, the average duration was 4 days. Similar findings were obtained when considering discharges equal to or greater than 700 cfs (Table 5-3).

Table 5-3.—Average number of continuous days (and mean duration, in days) per year (1989 – 1996, *N* = 8) during the principal migration season for steelhead when flows in the Santa Clara River (at the Los Angeles – Ventura County line) have equaled or exceeded two river discharges for three different flow conditions: with and without current operations of Santa Felicia Dam, and the proposed action (all conditions include the effects of current operations of Pyramid Dam).

River discharge	Without current operations	With current operations	Proposed action
500 cfs	17.4 (5.3)	12.3 (3.8)	12.3 (3.8)
700 cfs	11.1 (4.0)	7.8, (3.4)	7.8 (3.4)

The effects of the proposed action on the freshwater migration corridor in the Santa Clara River are expected to extend downstream to the Vern Freeman Diversion Dam. River discharges of 800 cfs or more are necessary to promote a distribution of water depths needed for steelhead migration in the river between the estuary and Santa Paula Creek (Harrison *et al*. 2006). Analyses of a recent record of discharge in this area of the river (at the Vern Freeman Diversion) show that proposed action reduces the frequency and duration that discharge in the Santa Clara River would be suitable for migration of steelhead (Table 5-4). Under the proposed action, river discharge was 800 cfs or greater an average of 41 continuous days per year (water years considered: 1989 – 1996). In the absence of the current operations of Santa Felicia Dam, river discharge was 800 cfs or higher an average of 45 continuous days per year. The average duration (in days) that flows were 800 cfs or higher is also expected to be affected by the proposed action (Table 5-4). Overall, the proposed action is expected to reduce the frequency and duration that the freshwater migration corridor is suitable for steelhead.

Table 5-4. Average number of continuous days (and mean duration, in days) per year (1989 – 1996, *N* = 8) during the principal migration season for steelhead when flows in the Santa Clara River (at the Vern Freeman Diversion Dam) have been 800 cfs or higher for three different flow conditions: with and without current operations of Santa Felicia Dam, and the proposed action (all conditions include the effects of current operations of Pyramid Dam).

River discharge	Without current operations	With current operations	Proposed action
800 cfs	45.3 (11.8)	41.2 (9.1)	41.2 (9.1)

Because the proposed action essentially represents an extension of current operations of Santa Felicia Dam, the periodic spills of water over the dam are expected to continue to scour the creek to bedrock in some sections (Federal Energy Regulatory Commission 2007a). The continued scouring is projected to adversely affect critical habitat for steelhead because, in part, the continued impact reduces the ability of the aquatic habitat to establish primary constituent elements necessary for the conservation of the species. One such element involves the freshwater migration corridor, and evidence indicates the scouring due to the spills of water have adversely affected migration conditions for steelhead. According to the BA, "multiple locations" were observed in Piru Creek where the channel had been scoured to bedrock. Further, scour was noted "…just downstream of the bridge on Piru Canyon Road at approximately [river mile] 4.6, where channel conditions now appear to form a potential fish passage barrier…" (pp. 29, Federal Energy Regulatory Commission 2007a).

As part of the proposed action, a groundwater and surface water flow management program and a fish-passage corridor connectivity study are proposed (Table 2-1). These measures are not expected to reduce effects of the proposed action on the quality or quantity of the freshwater migration corridor for a variety of reasons (Table 5-5). In particular, these measures do not minimize the effects of the ongoing alteration in the pattern and magnitude of discharge, and disruption of sediment transport due to the continued operation of Santa Felicia Dam under the proposed action, and do not provide the pattern and magnitude of water releases from the dam that are conducive for steelhead emigration and immigration within Piru Creek and the Santa Clara River. These measures, which essentially consist of monitoring of environmental conditions and evaluating alternatives, will not minimize the effects of the proposed action on critical habitat for endangered steelhead. The effects on the freshwater migration corridor due to the current operation of Santa Felicia Dam are therefore expected to continue under the proposed action, despite the proposed measures.

***Continue to Reduce the Likelihood that Freshwater Spawning Sites would be Created and Maintained*.—**Freshwater spawning sites are those "…with water quantity and quality conditions and substrate supporting spawning, incubation and larval development" (page 52521, NMFS 2005b). Adult steelhead arrive in areas for spawning during the wet season, and spawning can occur in winter or spring, based on NMFS' observations (A. Spina, pers. obs.). Based on the migratory behavior and ecology of steelhead and their habitat requirements related to spawning, the area of Piru Creek that now lies downstream of the dam was probably used more as a migration corridor and less so as an area of spawning. Effects of the proposed action on freshwater spawning sites are still of concern, however, because the proposed action contains no provision to compensate for the amount of spawning habitat rendered inaccessible to steelhead by the ongoing impassable presence of Santa Felicia Dam (reviewed in greater detail in later sections of this biological opinion). What follows is a discussion of why the proposed action is not expected to promote freshwater spawning sites for steelhead in Piru Creek downstream of Santa Felicia Dam.

Generally, natural (unimpaired) flow regimes are considered to be most effective in the development and preservation of riverine habitats for fish (Poff *et al.* 1997). In the absence of unimpaired flows (or specific water releases from dams to encourage the development and maintenance of riverine habitat), streams can become incised and dominated with large substrate particle types (e.g., through the winnowing of small cobbles and gravels), vegetation can encroach into the channel, and extensive accumulations of sand and smaller particles can be observed. These features are expected to limit the amount and quality of spawning habitat for anadromous salmonids (Cordone and Kelley 1961, Ligon *et al*. 1995). In the current operations of Santa Felicia Dam and the conditions expected from the operations under the proposed action, the reduced high flows do not allow for necessary channel maintenance (e.g., flushing of sand and smaller particles from the channel bed) and creation of pool-riffle sequences in Piru Creek (freshwater spawning sites often form at the transition between such habitats), and channel incision and habitat simplification have been noted (Federal Energy Regulatory Commission 2007a).

Table 5-5.—Deficiencies common to the proposed groundwater and surface-flow monitoring plan and fish-passage corridor connectivity study for Piru Creek downstream of Santa Felicia Dam (Federal Energy Regulatory Commission 2007a).

Deficiency
Lacks a clear statement of the ecological goals and study objectives, which are necessary to guide the development and implementation of a reliable monitoring plan and connectivity study.
Lacks an implementation schedule and any discussion of the timing and frequency of sampling or monitoring.
Lacks a clear commitment to collaborate with resources agencies (e.g., California Department of Fish and Game, or the National Marine Fisheries Service) on the development of an agency-approved plan.
Lacks a commitment to prepare a findings report and to share the findings with resources agencies such as the California Department of Fish and Game, or the National Marine Fisheries Service.
Lacks any requirement to use the findings obtained through the monitoring or study to define ecologically meaningful operating criteria for Santa Felicia Dam, and to use such criteria to in fact guide operation of the dam.
Lacks a description of the specific methods (including analytical approaches) that would be used as part of the monitoring plan and connectivity study.
Lacks a list of performance or effectiveness criteria to judge data related to the monitoring plan and connectivity study.
Lacks a means of minimizing the continuing effects of the operation of Santa Felicia Dam on habitat for steelhead and migration of this species.
Lacks a program that will track performance of the monitoring plan or connectivity study, respond to new information or changing conditions, and detect and reconcile deficiencies or problems in a timely manner.

The pattern and magnitude of water releases in Piru Creek downstream of the dam are not expected to correspond with those discharges that are necessary to form steelhead spawning sites. The relationship between steelhead freshwater spawning sites (i.e., the quality and quantity of such sites) and unimpaired discharge in Piru Creek is not well understood owing to a lack of data. One approach for developing an understanding of species' flow requirements in light of ecological uncertainty involves using knowledge of the characteristics of the pre-impact natural flow regime (i.e., pre-dam) and the type and magnitude of hydrologic alteration caused by an impact, such as construction of a dam, as bases for quantifying parameters for use as flow recommendations (Richter *et al*. 1997, Richter *et al*. 2003). Because this protocol is based on characteristics of the natural flow regime, reliance on this protocol has two principal benefits: (1) the innate ability to simultaneously address the habitat requirements of a native species, and (2) the likelihood of producing those essential habitat functions necessary to sustain species recovery. NMFS has assessed the pre-impact natural flow regime of Piru Creek (NMFS 2006d), and these flow estimates can be used as a basis to compare with the discharge expected from the proposed action. Unimpaired discharge (median daily) in Piru Creek during the winter and spring (when steelhead are spawning) ranged from 61 cfs (February) to 14 cfs (May) (NMFS 2006d) prior to construction of Santa Felicia Dam. Under the proposed action, which is a continuation of current operations of Santa Felicia Dam, the median daily discharge in Piru

Creek downstream of the dam is expected to remain greatly reduced when freshwater spawning sites should be available for steelhead (Figure 4-1).

The altered sediment-transport regime of Piru Creek is expected to continue to translate into a reduced chance that freshwater spawning sites would become established. The dam withholds sediment, resulting in a creek that is sediment starved and a shift in channel-bed material to oversized cobble and boulder (Ligon *et al*. 1995, Kondolf 1997, Federal Energy Regulatory Commission 2007a). Because steelhead construct nests in gravel and small cobble, the coarsening of the channel bed decreases the functional value of Piru Creek as a spawning site for the endangered Southern California DPS of steelhead. Operation of the dam leads to extensive accumulations of sand and smaller particles in Piru Creek downstream of the dam (p. 28, Federal Energy Regulatory Commission 2007a), which are expected to reduce the quality of the freshwater spawning site (Cordone and Kelley 1961). The incised channel of the creek (Federal Energy Regulatory Commission 2007a) can reduce floodplain inundation and decrease recruitment of gravel for spawning (Ligon *et al*. 1995).

The rapidly fluctuating high-magnitude flows occasionally noted downstream of the dam are expected to reduce the likelihood that freshwater spawning sites would form and be maintained in Piru Creek. The elevated flows can scour the channel of Piru Creek to bedrock (Federal Energy Regulatory Commission 2007a) and are therefore capable of eliminating instream features that contribute to form freshwater spawning sites. The likelihood that scoured areas would be restored to conditions supportive of spawning is expected to be low because the type and amount of sediment imported to the creek from adjacent tributaries (Federal Energy Regulatory Commission 2007a) is largely not commensurate with the spawning requirements of steelhead, and the proposed action does not include measures to address the scouring and other geomorphic effects of the continued operation of Santa Felicia Dam on Piru Creek.

Under the proposed action, the licensee intends to address accumulations of sediment in Piru Creek downstream of the dam (see Table 2-1). While the plan is intended to minimize effects of the proposed action on Piru Creek downstream of Santa Felicia Dam, the plan suffers from design, planning, and implementation deficiencies, and the consequences of these are expected to be ecologically problematic (Table 5-6). For instance, knowing the geomorphic effects of a dam on the downstream tailwater is a fundamental and critical prerequisite to undertaking remedial activities (Ligon *et al*. 1995), yet the proposed action lacks this basic feature.

***Continued Reduction in the Quality and Quantity of the Freshwater Rearing Sites*.—**Such sites possess:

> "…water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks" (page 52521, NMFS 2005b).

Table 5-6.—Deficiencies related to the proposed flushing flow trigger plan for Piru Creek downstream of Santa Felicia Dam (Federal Energy Regulatory Commission 2007a).

Deficiency
Lacks study objectives and ecological goals, which are necessary to guide the development and implementation of a meaningful and reliable plan. Could lead to development and implementation of an inappropriate plan or a plan that would produce spurious conclusions or irrelevant findings.
Lacks an implementation schedule. As a result, there is no certainty regarding when the plan would in fact be implemented and completed, and no assurance that the effects of the proposed action would be minimized.
Lacks a clear commitment to collaborate with resources agencies (e.g., California Department of Fish and Game, or the National Marine Fisheries Service) on the development of an agency-approved plan. May lead to preparation of a plan that is based on inadequate studies and field methods.
Lacks a commitment to prepare a findings report and to share the findings with resources agencies such as the California Department of Fish and Game, or the National Marine Fisheries Service for the purpose of developing an approach to resolve biological concerns revealed through the findings. May lead to adoption of a water-release schedule that is inappropriate or inadequate, or harmful to aquatic biota.
Lacks any requirement regarding plan implementation. As a result, there is no certainty that the plan would in fact be implemented or completed. The sediment-related problems due to current operations may continue to persist indefinitely under the proposed action.
Lacks a description of the methods or study sites that would be used to measure the effects of any water releases on mobilization and transport of sand and smaller particles through Piru Creek downstream of Santa Felicia Dam (note that the statement to place and monitor tracer gravels is vague and does not allow an understanding of the specific methods that would be used to assess effects of the water releases on the condition and characteristics of surficial sediment types). Could lead to implementation of a plan that is not capable of providing meaningful findings or that would result in findings that would not be expected to guide management in the selection of an appropriate flushing flow.
Lacks a list of performance or effectiveness criteria to judge whether water releases were in fact "appropriate" for flushing sand and smaller particles from Piru Creek. Does not identify or define the target post-release conditions or channel bed characteristics that would constitute a "successful" or "effective" flushing flow. Could lead to spurious conclusions and adoption of an inappropriate flushing flow.
Lacks an analytical or inferential component for quantifying the effects of the flushing flows on the character and condition of channel bed. No means of ensuring that the findings would be interpreted in an objective manner. Could lead to implementation of a plan that is not capable of providing meaningful findings or that would result in findings that would not be expected to guide management in the selection of an appropriate flushing flow.
Lacks a program that will track performance of the plan, respond to new information or changing conditions, and detect and reconcile deficiencies or problems in a timely manner.
Lacks a biological component for the purpose of quantifying the effects of the flushing flows on aquatic vertebrates in Piru Creek. May lead to the implementation or adoption of a flushing flow that is detrimental to aquatic biota or the habitats on which such individuals depend for growth and survival.
Lacks a procedure for evaluating and understanding the geomorphic effects of the continued operation of Santa Felicia Dam on Piru Creek. Increased risk of plan failure.

The foregoing features of the freshwater rearing site are essential to the conservation of steelhead because without such features juveniles cannot grow and survive. The natural movement of water, sediment, and woody debris, as such is observed in an unimpaired waterway (Poff *et al*. 1997), are responsible for creating and maintaining habitat features that make up freshwater rearing sites. However, aspects of the proposed action are expected to continue to disrupt the natural movement of water and sediment, and are projected to go on to diminish the functional value of Piru Creek as a freshwater rearing site for endangered steelhead, as the following discussion reveals.

The high-magnitude water releases (frequently > 200 cfs) from the dam during the dry season are expected to temporarily decrease the quality and quantity of the freshwater rearing site throughout much of the creek. During the dry season, juvenile steelhead can hold position and feed in water velocities ranging from 0.4 to 1.4 cm/s, and water depths of 8 cm to 62 cm (Barnhart 1986, Spina 2003 and references therein). This life stage is known to use mesohabitats of moderate to swiftly-flowing water, such as runs and pools (e.g., Spina 2003, Spina *et al*. 2005). Based on the physical characteristics of Piru Creek downstream of the dam and a flow-depth relationship for the creek (e.g., CDFG 2005), a minimum discharge of about 10 cfs is likely to promote a distribution of water depths and velocities, and mesohabitat types, throughout much of the creek that agree with the dry-season habitat requirements of juvenile steelhead. Given the magnitude of the unseasonal high-magnitude water releases, and the observable and reported effects of flow fluctuations on stream attributes (including reductions in stream areas that are suitable for rearing life stages) (e.g., Curtis 1959, Kraft 1972, Cushman 1985, Nehring and Anderson 1993, Latterell *et al*. 1998, CDFG 2005), the high-magnitude water releases are expected to greatly increase water velocities and depths, and decrease the proportion of pools and runs, throughout much of the creek. This is projected to reduce the amount of the creek that would be suitable as a freshwater rearing site. The alteration in the freshwater rearing site due strictly to the high-magnitude water releases during the dry season is expected to be temporary, lasting as long as the water releases.

The proposed action is expected to reduce the value of Piru Creek as a freshwater rearing site. The high-magnitude water releases from Santa Felicia Dam for agricultural users are typically confined to a relatively short period within a given year. At other times of the year, or whenever the high-magnitude releases of water are not present, discharge in Piru Creek downstream of the dam will be lower than what would be otherwise available if not for operation of Santa Felicia Dam, as the hydrologic analyses reveal. Reduced discharges in riverine environments generally correspond with a reduction in the "suitability" and distribution of sites that are appropriate for growth and survival of stream fish (e.g., generally water column depth and velocity are positively related to the magnitude of discharge). Management activities that reduce the depth and velocity of streams would be expected to decrease the functional value of the affected area as a rearing site for steelhead (Harvey and Nakamoto 1997, Harvey *et al.* 2005, Harvey *et al.* 2006, Spina *et al.* 2006).

Another flow-related reason why the proposed action is expected to reduce the value of Piru Creek as a freshwater rearing site involves the specific magnitude of the water releases that are proposed, and the basis for the releases. The minimum recommended base flows (i.e., the water release before and after periods of rainfall) for Piru Creek downstream of Santa Felicia Dam range from 9 to 96 cfs (CDFG 2005), yet the proposed action is expected to result in a much lower "blanket" flow of less than 5 cfs (Federal Energy Regulatory Commission 2007a). Besides the fact that the proposed flow is much less than the minimum recommended flow, the proposed flow lacks variability, which is an important and ecologically meaningful attribute of unimpaired waterways (e.g., Poff *et al*. 1997). With regard to the basis for the water releases United proposes, the specific magnitude of the release is not a reliable science-based assessment of the flows that are necessary to create and maintain freshwater rearing sites for endangered steelhead, or to compensate for the extensive loss of oversummering habitat due to the ongoing impassable presence and operation of the dam (this latter point is described more fully in the section entitled, "Effects on Habitat not Designated as Critical Habitat,"). Overall, the reduced dry-season discharge owing to the proposed action is projected to continue to reduce the value of Piru Creek as a freshwater rearing site.

The proposed action lacks provisions to encourage development and maintenance of a properly functioning riparian corridor along Piru Creek. Riparian corridors are important to aquatic habitats because they contribute to the functional value of freshwater rearing sites and provide numerous benefits to aquatic environments and stream-fish populations including filtering pollutants from runoff (Hall and Lantz 1969, Karr and Schlosser 1978, Lowrance *et al.* 1985, Wesche *et al*. 1987, Gregory *et al.* 1991, Platts 1991, Welsch 1991, Castelle *et al.* 1994, Lowrance *et al.* 1995, Wang *et al.* 1997). Runoff and input of harmful chemicals to Piru Creek is of concern given the extensive agricultural production observed along the creek. Riparian trees and shrubs can create cover for juvenile steelhead in the form of shade or overhanging vegetation, and streamside vegetation can contribute woody debris to streams. Once in streams, the debris alters water column depth and velocity, increases habitat complexity, and creates and maintains habitat for fish (Lisle 1986). While the proposed action does not specify measures to develop and maintain a properly functioning riparian corridor, information indicates such provisions are necessary in settings where the natural hydrologic processes have been altered through river regulation (Richter and Richter 2000), such as the current situation in Piru Creek downstream of Santa Felicia Dam. Overall, the proposed action is expected to continue to create conditions that diminish the functional value of the riparian corridor for contributing to the quality and quantity of the freshwater rearing sites in Piru Creek because, through the proposed action, water releases from the dam will continue to be managed for agricultural water supplies and power generation, not for developing and maintaining a properly functioning riparian corridor.

Multiyear freshwater residence of juveniles requires a diversity of habitats (Murphy *et al*. 1989, Johnson *et al*. 1994, Spina 2000, Spina 2003), yet certain aspects of the proposed action are expected to continue to reduce habitat complexity in Piru Creek downstream of the dam. The continued loss of a substantive sediment supply to Piru Creek due to operation of Santa Felicia Dam and, as a result, channel incision and simplification (Federal Energy Regulatory Commission 2007a, Ligon *et al*. 1995, Kondolf 1997) are projected to carry on unfavorable alterations of critical habitat for endangered steelhead. The release of sediment-starved water causes winnowing of undersized substrate particles, and a coarsening of the channel-bed material, which are considered to reduce the complexity and quality of habitat for anadromous salmonids (Ligon *et al*. 1995, Kondolf 1997). These conditions have been noted in Piru Creek downstream of the dam and are expected to persist due to the proposed action (Kondolf 1997, Federal Energy Regulatory Commission 2007a). Streamside vegetation provides a source of woody debris to streams. Once in the stream, woody debris can create and maintain habitat for fish (Lisle 1986). The absence of woody debris in Piru Creek (Federal Energy Regulatory Commission 2007a) promotes habitat simplification, thereby reducing the value of the creek as a freshwater rearing site.

The proposed action is expected to propagate the occasional scouring of portions of the Piru Creek channel and expose bedrock (Federal Energy Regulatory Commission 2007a). Freshwater rearing sites for juvenile steelhead include boulder and cobble substrate particle types. Such rock provides cover for juvenile steelhead and a colonizing surface for macroinvertebrate species that steelhead consume. The substantially increased streamflows that can be associated with periodic spill events due to the dam have caused removal of channel-bed material (e.g., rocks and fine sediment) and exposed bedrock in some areas of the creek. Given the value of rock to the freshwater rearing sites, the continued scouring is expected to continue to diminish the quality and quantity of the freshwater rearing sites within locally scoured portions of Piru Creek.

As part of the proposed action, a lower Piru Creek habitat monitoring plan, an overarching monitoring plan, and a flow management and enhancement plan are proposed (Table 2-1). These measures are not expected to reduce effects of the proposed action on the quality and amount of the freshwater rearing site for steelhead. The provisions specified in these plans, including the flow-management plan, do not minimize the effects of the continued alteration of the pattern and magnitude of discharge or geomorphic-related impacts due to the ongoing operation of Santa Felicia Dam. The provisions that are specified in the flow-management plan do not provide the pattern and magnitude of water releases from the dam that would be expected to create and maintain freshwater rearing sites within Piru Creek. The monitoring and mapping of instream conditions and characteristics, and simple contemplation of habitat enhancements, are not adequate, by themselves, for truly minimizing the effects of the proposed action on critical habitat for endangered steelhead. The effects on the freshwater rearing site due to the current operation of Santa Felicia Dam are therefore expected to continue under the proposed action (see Table 9-1 for additional deficiencies related to plans proposed for development under the proposed action).

The previous discussion considered the consequences of the flow-related effects of the proposed action on critical habitat for the endangered Southern California DPS of steelhead. Besides creating flow conditions that are largely inhospitable to the life history and habitat requirements of steelhead, the proposed action is expected to continue to perpetuate physical effects related to fragmentation and loss of habitat. Accordingly, the following section describes the continued habitat fragmentation and loss that is expected due to the proposed action.

C. Effects on Habitats not Designated as Critical Habitat

The purpose of this section is to describe the effects of the proposed action on habitat for steelhead. The proposed action is expected to adversely affect steelhead habitats that are not currently designated as "critical habitat" under the ESA (see NMFS 2005b), but nonetheless such habitats could provide important ecological functions to sustain growth and survival of the species, and are necessary to secure the viability and support recovery of the species (Boughton *et al*. 2007a). Within the action area, such habitats lie upstream of Santa Felicia Dam and Pyramid Dam. The effects of the proposed action on such "non-designated" habitats are described in the sections that follow.

Contrary to suggestion (page 52, United Water Conservation District 2008), neither the listing notice (NMFS 2006b) nor the critical habitat designation (NMFS 2005b) "indicate that anadromy ends at Santa Felicia Dam." Specifically, the listing notice indicates that only anadromous *O. mykiss* downstream of impassable barriers are listed as endangered under the ESA. Because Santa Felicia Dam blocks steelhead from historical spawning and rearing habitat, the upstream extent of listed steelhead in Piru Creek extends to the base of Santa Felicia Dam. Likewise, the critical-habitat designation identifies the upstream extent of critical habitat for steelhead at the base of Santa Felicia Dam. Neither the listing notice nor the critical-habitat designation preclude the notion or possibility of anadromy upstream of Santa Felicia Dam, particularly when one considers the definition of anadromy. Put simply, anadromy is a trait that compels certain fish species or individuals to rear in freshwater for a time before migrating to the ocean for growth and maturation. At sexual maturity, individuals leave the ocean and return to natal areas in freshwater to spawn. Earlier in this biological opinion, NMFS reviewed the extensive genetic and ecological evidence indicating steelhead naturally and volitionally ascended Piru Creek prior to the construction of Santa Felicia Dam, and steelhead (albeit “non-listed steelhead”) continue to persist in the Piru Creek sub-basin above Santa Felicia Dam. Therefore, “anadromy” does indeed exist upstream of Santa Felicia Dam, but the anadromous trait cannot be fully expressed owing to the ongoing impassible presence of the dam.

Continue to Cause an Obstruction in the Steelhead Migration Corridor.**—**Santa Felicia Dam prevents listed adult steelhead (anadromous *O. mykiss*) from accessing historical spawning habitats upstream of the dam, and the proposed action does not specify a provision to restore access of adult steelhead to historical spawning habitats within the Piru Creek sub-basin. Continued operation of the dam would carry on the existing obstruction in the steelhead migration corridor and continue to reduce the amount of habitat for this species (Federal Energy Regulatory Commission 2007a). Continued operation of the dam without provision to reconnect anadromy to historical habitats has the functional effect of causing fragmentation of the species' habitat. Habitat fragmentation has serious consequences for native aquatic organisms, including population extinction (Nehlsen *et al*. 1991, National Research Council 1996, Morita and Yamamoto 2002, Rieman and McIntyre 1993, Dunham *et al*. 1997, Boughton *et al*. 2005, and Gustafson *et al*. 2007).

***Continue to Reduce the Amount of Habitat Available to Anadromous* O. mykiss**.**—**Under the proposed action, Santa Felicia Dam would continue to inundate a portion of Piru Creek and reduce the amount of habitat available to listed anadromous *O. mykiss* for migration, spawning, and rearing (Federal Energy Regulatory Commission 2007a). Based on application of the U. S. Fish and Wildlife Service's Fish Passage Decision Support System, the loss of *stream network* (but not necessarily the amount of suitable habitat) due to Santa Felicia Dam exceeds 250 miles. This estimate includes the habitat upstream of Pyramid Dam. Between the dams, estimates indicate over 30 miles of stream exist (mainstem Piru Creek, Agua Blanca Creek, and Fish Creek) (Figure 4-7).

The amount of lost habitat due to continued operation of Santa Felicia Dam without a fish-passage facility is large relative to the total amount of habitat available in the Piru Creek sub-basin and the Santa Clara River watershed. The Piru Creek drainage comprises about 27% of the Santa Clara River watershed and contains between 25-28% of the total amount of historical steelhead spawning and rearing habitats (including over-summering habitat) within the Santa Clara River watershed. Within the Piru Creek sub-basin, 95% of the habitat lies upstream of Santa Felicia Dam (Moore 1980a, b, Stillwater Sciences 2005, Stoecker and Kelley 2005). The Piru Creek sub-basin is one of the largest sub-basins in the Santa Clara River watershed (Figure 4-8) and the Santa Clara River watershed is the largest steelhead-bearing drainage in the Southern California DPS. Therefore, the loss of habitat due to the proposed action perpetuates a substantial loss of habitat in the Southern California DPS of steelhead as a whole.

The habitat rendered inaccessible in the Piru Creek sub-basin is capable of supporting reproduction and rearing of age-0 and age-1 and older steelhead (Moore 1980a). Recent modeling efforts conclude that potential over-summering habitat for steelhead is available upstream of Santa Felicia Dam, which is important because over-summering habitat is considered to be the most geographically restricted habitat type for steelhead in southern California (Boughton and Goslin 2006) and therefore more of such habitat would be expected to further recovery of this species. While elevated temperatures have been occasionally noted in selected creek reaches upstream of Santa Felicia Dam (Moore 1980a, Federal Energy Regulatory

Commission 2007b), these temperatures are not considered to be ecologically problematic for the species because the temperatures are within the range of temperatures that juvenile steelhead have been observed to forage and remain active (Spina 2007).

***Continue to Reduce the Functional Value of the Instream Habitat Upstream of Santa Felicia Dam*.—**Elements of operation of Pyramid Dam that are interrelated to this proposed action create instream and geomorphic conditions (e.g., Federal Energy Regulatory Commission 2007b, NMFS 2007b) that diminish the functional value of the habitat. Water released from Pyramid Dam for delivery to United at Lake Piru is not expected to follow the natural pattern and magnitude of streamflow (NMFS 2007b), and given the importance of the natural flow regime to the ecological health of streams and aquatic organisms (e.g., Ligon *et al*. 1995, Poff *et al*. 1997), these water releases from the dam are expected to adversely affect the migratory behavior and ecology of the local population of *O. mykiss*, including the population of non-listed steelhead that still persists today upstream of Santa Felicia Dam (e.g., Nielsen *et al*. 1997, Girman and Garza 2006, Boughton and Garza 2008). The foregoing effects relate to listed steelhead because the effects on non-listed steelhead (including effects on individuals that arise from adverse effects on instream habitat) decrease the potential that non-listed steelhead would contribute ecologically to the population of listed steelhead.

D. Effects on Steelhead

In this section, NMFS describes the effects of the proposed action on the endangered Southern California DPS of steelhead. Information presented in sections III and IV of this biological opinion indicates listed anadromous *O. mykiss* exist in the Santa Clara River watershed albeit at critically low levels. Presence of this species appears intermittent at times, and the listed anadromous form is absent from most of the Piru Creek drainage due to the ongoing impassable presence of Santa Felicia Dam. These facts may not be readily apparent in the narrative of the effects, which we suspect creates the impression that steelhead are abundant and widespread. We emphasize that the description of the effects on steelhead was written with the intention of illustrating the expected effects when steelhead are present. Effects of the proposed action on critical habitat essential to the conservation of steelhead and the likelihood of survival and recovery of this species are expected regardless of the current low number of steelhead and should be viewed in the context of the low abundance of individuals in the current population. As a result, NMFS believes the proposed action would continue to create instream conditions and characteristics that suppress the abundance of steelhead and its ability to survive and reduce the likelihood of species' recovery.

Many of the effects reported in this section have been predicted from the empirical analyses of how the proposed action would affect the pattern and magnitude of discharge in Piru Creek and the Santa Clara River, the expected effects on critical habitat, and a knowledge of the life history and habitat requirements of steelhead. Generally, we do not repeat the discussion of flow-related effects and associated effects on critical habitat in this section (see the section, "Effects on Critical Habitat," which provides the underlying rationale and basis for the effects on steelhead).

What follows is a discussion of how the proposed action is expected to continue to (1) disrupt the migration of adult and juvenile steelhead, (2) interrupt steelhead spawning, incubation, and emergence, (3) harm juvenile steelhead, (4) preclude steelhead from historical spawning and rearing habitats, and (5) reduce the current likelihood this species will achieve viability, which NMFS has equated with the likelihood of both survival and recovery of the species. We note that because the proposed action is essentially similar to current operations, the effects of the proposed action reported here are projected to perpetuate the adverse effects due to the current operations. The effects of interrelated activities (elements of the operation of Pyramid Dam and the Vern Freeman Diversion Dam) are expected to exacerbate the negative consequences of the proposed action on endangered steelhead and their habitat.

Continue to Disrupt Migration of Adult and Juvenile Steelhead.—The reduction in the quality and quantity of the freshwater migration corridor is expected to perpetuate the existing disruption of the migration of adult and juvenile steelhead in Piru Creek and the Santa Clara River. This is based on the continued shift in the timing of the migration corridor from the wet-season to dry-season, and the altered pattern and reduced magnitude and duration of river discharge during the wet season that is projected to continue under the proposed action.

Shifting the migration corridor from the wet season to the dry season is expected to adversely affect steelhead because the timing of the migration of adults and juveniles is synchronized to the seasonal occurrence of peak discharges for the purpose of increasing their chance of survival (Lytle and Poff 2004). Frequently shifting the freshwater migration corridor for this species to the dry season is expected to often preclude the migration of the species, especially when no ecologically meaningful water releases are present to ensure unimpaired migration of the species into or out of Piru Creek. The proposed action includes no provision for releasing water to specifically ensure a properly functioning freshwater migration corridor for steelhead.

Continuing to alter the pattern and reduce the magnitude and duration of discharge downstream of Santa Felicia Dam during the steelhead migration season is expected to decrease the likelihood that adult and juvenile steelhead could emigrate and immigrate in Piru Creek. Because adult and juvenile steelhead migrate during periods of high-magnitude flows (Shapovalov and Taft 1954, Spina *et al*. 2005), the short-duration low flows that are often expected to continue to emanate from Santa Felicia Dam are not expected to support migration of adult or juvenile steelhead in Piru Creek. In particular, the "pulsed" winter and spring discharges (e.g., due to rainfall events that cause river discharge to increases) that prompt migration of adult and juvenile steelhead are expected to be frequently lacking from the pattern of discharge due to the proposed action.

The continued reduction in the quality of the freshwater migration corridor projected throughout the Santa Clara River within the action area is expected to perpetuate a decreased potential that steelhead could migrate through the river. Recent findings indicate flows of 500 cfs or more in Santa Clara River are needed to attain a distribution of water-column depths that are believed necessary for migration of adult steelhead (Harrison *et al*. 2006). Yet, the proposed action will continue to decrease the frequency and duration that flows throughout much of the river (particularly in the vicinity of the Los Angeles – Ventura County line) will provide a distribution of water depths that is suitable for steelhead migration. A disruption or delay in the migration of steelhead would be expected to harm the species because the distance traveled upstream and arrival time at spawning areas has ecological significance and may lead to use of non-preferred spawning habitats and decreased recruitment, and preclude some individuals from reaching spawning areas (Fleming and Reynolds 1991, Dickerson *et al*. 2005, Caudill *et al*. 2007).

Once river flows reach the Vern Freeman Diversion Dam, operation of the diversion is expected to worsen effects of the proposed action on adult and juvenile steelhead. NMFS' review of the diversion operations indicates the operations alter the pattern and magnitude of discharge (and therefore the freshwater migratory corridor) downstream of the diversion, and indirectly and directly affect juvenile and adult steelhead. With regard to discharge downstream of the diversion, operations can (1) reduce the magnitude of discharge and sometimes eliminate flow entirely, (2) cause widely fluctuating discharge, (3) increase the discharge recession rate, (4) abbreviate discharge duration within individual rain-induced discharge pulses and within individual wet seasons, (5) reduce migration opportunity for adult and juvenile steelhead, and (6) increase the potential for stranding, delaying, and precluding migration.

Continue to Disrupt Steelhead Spawning, Incubation, and Emergence.—Should adult steelhead migrate into Piru Creek, they are expected to encounter conditions that do not favor construction and survival of nests, including the developing young. The channel bed is reported to be coarse (Federal Energy Regulatory Commission 2007a), with no observable extensive area of surficial gravel or undersized cobble (A. Spina, NMFS, pers. obs.). These observations are neither surprising nor unexpected because Pyramid Dam and Santa Felicia Dam both withhold sediment (Federal Energy Regulatory Commission 2007a, b). Withholding sediment can cause a reduction in areas that could be expected to support construction of nests, resulting in decreased abundance of young salmonids (Ligon *et al*. 1995). For these reasons, adult steelhead in Piru Creek downstream of the dam are not expected to locate extensive areas that are suitable for nest construction.

Migration corridors are generally not suitable locations for spawning; nests constructed in the creek downstream of the dam would be susceptible to the scouring effects of the exceedingly high-flows noted in the creek (Federal Energy Regulatory Commission 2007a). In unimpaired waterways, adults can migrate into the extreme fringes of the watershed, including small tributaries, where flow-related characteristics and channel-bed conditions are well suited for production of young; such characteristics and conditions reduce the risk of channel-bed scour and nest destruction (Montgomery *et al*. 1999, and references therein). In Piru Creek, the proposed action is projected to continue to prevent adult steelhead from migrating to historical spawning and rearing tributaries that now lie upstream of Santa Felicia Dam and exploit habitats that favor production of young. Instead, adults would be limited to the creek downstream of the dam, which probably functioned primarily as a migration corridor historically, and less so as a spawning area.

The extensive accumulations of surficial sand and smaller particles noted in selected areas of Piru Creek downstream of the dam during the wet season increase the potential of adversely affecting steelhead spawning, incubation and emergence, should steelhead spawn there. High-levels of sand and smaller particles in streams can adversely affect development or production of young fish (Cordone and Kelley 1961), and input of such particles to Piru Creek from adjacent seasonal drainages is common during the wet season (Federal Energy Regulatory Commission 2007a). On a recent visit of the action area, NMFS noted numerous sources of such particles to Piru Creek downstream of the dam (A. Spina, NMFS, pers. obs.). While such particles are reportedly mobilized during the high-magnitude water releases provided to the downstream agricultural users in the dry season (Federal Energy Regulatory Commission 2007a), the high flows often happen after steelhead spawn and the young emerge from nests.

The flow volume in Piru Creek downstream of the dam due to the proposed action is expected to be inconsistent with the habitat requirements of adult steelhead. For instance, this life stage spawns at water depths that average 36 cm (~14 inches) (Barnhart 1986). Based on a depth-flow relationship for a selected area of Piru Creek downstream of Santa Felicia Dam (CDFG 2005), a minimum discharge of about 55 cfs is needed to produce a depth of 36 cm in the creek at the modeled location. By contrast, the proposed action is expected to produce discharges much less than 55 cfs during the steelhead spawning season for most water years. While the foregoing depth-flow relationship is based on a single point in the creek, the value of 55 cfs is within the range of the winter-time natural (unimpaired) flow regime of Piru Creek (e.g., median daily discharge of 37.6 cfs in January, 60.7 cfs in February, and 49.3 cfs in March, NMFS 2006d). Characteristics of the natural streamflow regime (i.e., prior to construction of Santa Felicia Dam) can be useful for developing an estimate of streamflow requirements for steelhead (Richter *et al*. 2003), particularly given that steelhead evolved under characteristics of the natural streamflow regime. The proposed action is not expected to produce essential habitat functions for steelhead and therefore is not expected to support survival or recovery of this species. The flow schedule is severely weighted by United's activities (e.g., storage and diversion of water for municipal and agricultural uses) and lacks the variability that is considered beneficial for the physicochemical and biological integrity of streams. The proposed action includes no specific provision to ensure water releases are managed to benefit spawning steelhead in Piru Creek.

Continue to Harm Juvenile Steelhead.**—**The proposed action is expected to continue to cause baseflows that are lower than those expected in the absence of Santa Felicia Dam current operations. The decreased flows are expected to perpetuate reductions in the quality and quantity of living space for juvenile steelhead, resulting in lower numbers (and growth) of juvenile steelhead in the creek (e.g., juveniles that migrate down from the remnant population above the dam or migrate to the creek from other parts of the watershed), as has been demonstrated through investigations of the relationships between population metrics for this species and flow-dependent habitat (Harvey *et al.* 2005, Harvey *et al.* 2006). Such effects are expected to persist throughout the term of the proposed action because the action does not provide flows for the essential functioning of over-wintering or over-summering habitat for juvenile steelhead.

The proposed action is projected to carry on the habitat simplification noted in Piru Creek downstream of the dam (Federal Energy Regulatory Commission 2007a). The creek generally lacks a diversity of habitats and many of the natural roughness elements (e.g., oversized boulders, large woody debris) known to alter water velocity and depth and provide shelter for juvenile steelhead (A. Spina, NMFS, pers. obs.). Because juveniles require complex habitat for living in freshwater (Murphy *et al*. 1989, Johnson *et al*. 1994, Spina 2000, Spina 2003), a reduction in habitat complexity is expected to adversely affect growth and survival (Harvey and Nakamoto 1997, Harvey *et al.* 2005, Harvey *et al.* 2006, Spina *et al.* 2006). This aspect of the proposed action is expected to contribute to the factors that continue to depress abundance of steelhead in Piru Creek downstream of the dam.

The proposed action is expected to perpetuate the long-standing practice of releasing high-magnitude short-duration flows from Santa Felicia Dam for downstream agricultural users (and hydropower generation). Such releases often exceed 200 cfs and typically occur in late summer or early fall, though on occasion the releases have been noted in spring. The timing of the release is of concern because early life stages of steelhead (e.g., age-0 individuals, < 100 mm total length) can be present in streams during spring and summer. Young fish have been found to be susceptible to downstream displacement from the high flows (Harvey 1987), and high flows can be negatively related to the abundance and survival of early life stages of fish (Seegrist and Gard 1972, Erman *et al*. 1988, Holtby and Healey 1986, Thorne and Ames 1987, Hayes 1995, Spina 2001). Evidence indicates that fluctuating flows can cause changes in fish behavior and habitat use (Pert and Erman 1994, Bunt *et al*. 1999, Scruton *et al*. 2003). The high flows can start and stop quickly, resulting in an increased potential of stranding and killing adult or juvenile steelhead that may be in Piru Creek downstream of Santa Felicia Dam (Cushman 1985, Bradford 1987). The high flows released from Santa Felicia Dam increase the potential of displacing or killing young steelhead.

NMFS is not confident that the proposed ramping schedule (Table 2-1) would in fact reduce fish stranding in Piru Creek or the Santa Clara River because the proposal does not appear to be biologically meaningful. The recommended standard ramping rate for reducing fish stranding is 2 inches/hour (Thomas R Payne & Associates 2004), yet the ramping rate that is the basis for the proposed schedule (in terms of inches/hour) is not known because it is not provided. Stranding-reduction plans are usually based on an understanding of the relationship among discharge, and water depth and velocity, and this relationship is typically developed from measurements taken along numerous transects allocated randomly throughout the action area. Again, the proposal gives no indication the ramping schedule is based on such an approach. Even more fundamental, the schedule does not appear to be founded on an understanding of the factors that cause fish stranding, the ramping rates that minimize the likelihood of fish stranding, or a review of the fishery literature regarding fish stranding. Such information is important for developing a meaningful stranding reduction plan. The proposed ramping schedule does not include a provision to evaluate the performance or effectiveness of the schedule for reducing fish stranding, or a provision to modify the ramping should the evaluation indicate the schedule is not protective of juvenile steelhead. There is no proposed mechanism to determine whether the schedule is reducing fish stranding. That the proposal is not biologically sound is corroborated by United Water Conservation District (2008) (page 54), which states that the means to define the ramping schedule simply involved "United review[ing] a range of natural pre-dam receding-limb hydrographs and select[ing] a conservative option." Operation of Pyramid Dam also lacks a biologically meaningful program for reducing the effects of fluctuating flows on native *O. mykiss* (non-listed steelhead) that depend on the mainstem Piru Creek and tributaries downstream of the dam (NMFS 2007b). Effects on non-listed steelhead reduce the potential that non-listed steelhead would provide an ecological benefit to listed steelhead in the action area and watershed.

The native steelhead (currently non-listed steelhead) that rear upstream of Pyramid Dam and Santa Felicia Dam (Nielsen *et al*. 1997, Girman and Garza 2006, Boughton and Garza 2008) are expected to be precluded from migrating downstream to the estuary and ocean. Neither dam possesses any sort of facility that would allow volitional passage of juvenile non-listed steelhead to downstream habitats. We believe that juvenile non-listed steelhead from these upstream habitats are still exhibiting behavior and ecology typical of the species (e.g., smolting, and downstream migration) because such has been observed in anadromous populations that are now sequestered to freshwater reservoirs and adjacent habitats (e.g., Thrower *et al*. 2004a, A. Spina, NMFS, pers. obs.). Juvenile non-listed steelhead are expected to be harmed when their natural migratory behavior is suppressed. Preventing this life stage from reaching intended habitats is expected to increase their susceptibility to predation (piscine predators exist in both reservoirs), reduce dispersal and gene flow among the population, and result in loss of certain life history traits that promote population diversity (genetic, phenotypic, and ecological). The foregoing effects relate to listed steelhead because the effects on non-listed steelhead decrease the potential that non-listed steelhead would contribute ecologically to the population of listed steelhead.

***Continue to Block Steelhead from Historical Spawning and Rearing Habitat.*—**Because Santa Felicia Dam lacks a fish-passage facility, and the proposed action is not expected to reconnect steelhead populations upstream and downstream of the dam, the proposed action is projected to continue to prevent volitional passage of endangered steelhead to historical spawning and rearing habitat. Blocking steelhead passage has the functional effect of causing habitat loss and fragmentation within the Piru Creek sub-basin, the Santa Clara River watershed, and the endangered Southern California DPS of steelhead. Blocking passage at Santa Felicia Dam has precluded the adult and juvenile listed anadromous *O. mykiss* from the Piru Creek sub-basin upstream of the dam. Additional background information regarding habitat loss and fragmentation, as well as a discussion of the expected consequences, are as follows.

A discussion regarding the effects on steelhead due to continued blocking of the species from historical spawning and rearing habitats first requires an understanding of the amount of habitat that the species is precluded from. The amount of habitat (in terms of miles) rendered inaccessible to steelhead migrating upstream from the ocean is substantial. Recent estimates indicate that more than 30 miles of spawning and rearing habitats exists upstream of Santa Felicia Dam and Pyramid Dam. This amount of habitat is substantial even when compared to the amount of habitat elsewhere in the Santa Clara River watershed and the entire endangered Southern California DPS of steelhead (NMFS 2005b). The quality of the lost habitat is also a consideration; most of the inaccessible habitat lies on U. S. Forest Service land, and the habitat appears to be high quality and least disturbed, based on NMFS' observations of the creek and adjoining tributaries in selected areas (A. Spina, pers. obs.). The habitat in this area is least susceptible to the anthropogenic effects that are known to reduce the quality and quantity of instream habitat on other waterways within the Santa Clara River watershed, including portions of Sespe Creek, Santa Paula Creek, and Hopper Creek, based on NMFS' familiarity with these waterways (A. Spina, pers. obs., Bureau of Reclamation and United Water Conservation District 2005). To summarily dismiss the ecological significance of the amount and quality of habitat lost in the Piru Creek sub-basin based on the amount of "available" habitat elsewhere in the Santa Clara River watershed (pages 199-200, Federal Energy Regulatory Commission 2007a) ignores the effects of habitat loss and fragmentation on population abundance, the small number of steelhead individuals in (and the status of) the endangered Southern California DPS, the limited amount of habitat available in the watershed and DPS, and the risk the habitat loss and fragmentation pose to the extinction of the entire DPS.

The continued bifurcation of habitat due to the proposed action is expected to reduce abundance of steelhead in the Piru Creek sub-basin. The continued loss of over 30 miles of instream habitat due to the proposed action (and interrelated activities, i.e., Pyramid Dam) is expected to continue to eliminate most of the Piru Creek sub-basin as living space for steelhead and maintain steelhead abundance at low levels (e.g., Nehlsen *et al*. 1991, Rieman and McIntyre 1993, National Research Council 1996, Dunham *et al*. 1997, Morita and Yamamoto 2002, Jager *et al*. 2006). The effects of the proposed action are expected to extend to steelhead descendents currently residing upstream of the dam (i.e., the remnant gene pool, Nielsen *et al*. 1997, Girman and Garza 2006, Boughton and Garza 2008) because upstream or tributary-specific population abundance may decrease (or become extinct, even over relatively short time periods, e.g., 50 years, Morita and Yamamoto 2002) when adult migrants are precluded from accessing upstream habitats (Jager *et al*. 2001, Neraas and Spruell 2001, Morita and Yamamoto 2002). The forgoing relates to listed steelhead for two principal reasons. First, effects on non-listed steelhead reduce the potential that non-listed steelhead would provide an ecological benefit to listed steelhead in the action area and watershed. Second, NMFS views the upstream or tributary-specific populations (and the corresponding living space) as being critical to further the recovery of the endangered Southern California DPS of steelhead, given the importance and value of the Santa Clara River steelhead population to the entire Southern California DPS (Boughton *et al*. 2006, NMFS 2006c, Boughton *et al*. 2007a, NMFS 2007b, c).

***Continue to Reduce Population Viability.*—**The projected effects of the proposed action and interrelated activities on the population of steelhead in the Piru Creek sub-basin are expected to continue to translate into a reduction in the abundance, population growth rate, population spatial structure, and population diversity of this species in the Santa Clara River watershed. This is due to the type, amount and extent of the effects on steelhead.

Given the value of the Santa Clara River population unit of steelhead to the viability of the DPS and its relationship to recovery, the effects of the proposed action and interrelated activities are expected to continue to reduce the likelihood of viability of the entire endangered Southern California DPS of steelhead by reducing both the prospects of species survival and chances of its recovery. The Santa Clara River steelhead population unit is one of only a few population units in the endangered Southern California DPS of steelhead that show a high potential of being independent and able to withstand environmental stochasticity once restored to viability. The Santa Clara River steelhead population is expected to support formation of steelhead numbers in several adjacent population units that would not otherwise exist if not for the core population. The formation and maintenance of population units effectively increases numbers of individuals in the broad population, and given the risk of extinction that small populations face (e.g., Pimm *et al*. 1988, Primack 2004), a larger number of individuals decrease the risk of weakened viability of the broad population. Consequently, this population is expected to contribute to the viability of the endangered Southern California DPS of steelhead and recovery of the species (Boughton *et al*. 2006). However, because the proposed action is expected to reduce the likelihood of viability of the Santa Clara River steelhead population unit, and its ability to withstand environmental stochasticity, the abundance of steelhead in adjacent population units (i.e., those that depend on abundance of steelhead in, or immigrants from, the Santa Clara River) is expected to be reduced as well.

VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Several future, state, local, or private actions are reasonably certain to occur within the Santa Clara River watershed (Table 6-1). While some of these actions are physically located outside the action area, they are expected to create effects that extend into the action area. For this reason, such actions are considered here.

These future actions are expected to increase the potential for adverse effects to steelhead. Increasing the amount of impervious surfaces within the watershed would be expected to increase the potential for dry and wet-season runoff and input of potentially toxic elements to surface water where steelhead are present. Ongoing urbanization is expected to cause elevated rates of treated-wastewater releases to streams, possibly increasing nitrogen loads and the likelihood of adverse effects on aquatic organisms. Housing developments constructed in or near the historical floodplain of the Santa Clara River or its tributaries are expected to cause, or perpetuate, loss of aquatic habitat.

Table 6-1.—Future, state, local, or private actions that are reasonably certain to occur within the Santa Clara River watershed.

Action	Project title and (or) source document
Allow mining of up to 100 million tons of sand and gravel within Soledad Canyon and an unincorporated area of Los Angeles County	Soledad Canyon Sand and Gravel Mining Project, Supplement to the draft EIR for the Soledad Canyon Sand and Gravel Mining Project, November 1999
Includes the development of 30 acres to construct a residential community with 437 multiple-family dwellings, a maximum of 10,000 ft^2 of commercial uses, associated recreation uses and on-site private roads	Soledad Townhomes, Initial Study, Master Case 04-344, April 2005
Includes the development of 96 single family residential lots, 218 apartment units, and 665 townhouse units, a school site, and recreational park	The Keystone, Master Case #03-358, Notice of Preparation of draft EIR, August 2004

VII. INTEGRATATION AND SYNTHESIS OF EFFECTS

This section combines the effects of the environmental baseline with effects of the proposed action and cumulative effects. The purpose of this assessment is to develop an understanding of how the combined effects may affect steelhead and critical habitat for this species. The methodology for this assessment involved identifying potential environmental effects associated with the actions listed in the Cumulative Effects section, integrating potential effects of these actions with the environmental baseline and expected effects of the proposed action, and qualitatively evaluating the combined effects of the actions listed in the Cumulative Effects section, the environmental baseline, and the proposed action on steelhead and critical habitat. The variety of factors that can cause a population to collapse and become extinct were also included in the assessment. Such factors include future climate and environmental fluctuations.

The larger river systems are believed to have been the historical foundation for the endangered Southern California DPS of steelhead (Boughton *et al.* 2007a). The Santa Clara River watershed is one such system because of the watershed's large size, spawning and rearing habitat quality, relatively reliable winter river discharge, and greater potential for being independently viable (Boughton *et al*. 2006). This drainage is the largest steelhead-bearing watershed within the Southern California DPS, and up to the mid-1940s, this system was estimated to support an annual run of 9,000 adult steelhead (Moore 1980b). However, the abundance of steelhead in the Santa Clara River, like other drainages throughout the DPS, has been dramatically reduced due to a variety of anthropogenic alterations to the watershed and waterways (NMFS 1997, Good *et al*. 2005, NMFS 2006b). Presently, the number of steelhead in the Santa Clara River watershed is small. Likewise, the number of steelhead comprising the DPS is small. Because the viability of small populations is especially tenuous, and such populations are susceptible to prompt decreases in abundance and possess a greater risk of extinction relative to large populations (Pimm *et al*. 1988, Berger 1990, Primack 2004), activities that reduce the quality and quantity of habitats, or that preclude formation of population units, are expected to compel the species toward extinction as individual population units become extinct (McElhany *et al*. 2000). Consequently, activities harming steelhead or destroying habitat, including critical habitat, within a population unit may have implications for the viability of the entire DPS.

A. Summary of Effects of the Environmental Baseline

Anthropogenic activities have severely depressed the abundance, population growth rate, population spatial structure, and population diversity of steelhead in the action area, the Santa Clara River watershed, and in the Southern California DPS. Currently, the Southern California DPS of steelhead is at a high risk of becoming extinct in the foreseeable future (i.e., the likelihood of viability is low).

B. Summary of Effects of the Proposed Action

With regard to critical habitat, the effects of the proposed action and interrelated activities are expected to continue to eliminate the conservation value of freshwater rearing sites and freshwater migration corridor in the Piru Creek sub-basin, and appreciably reduce the conservation value of the freshwater migration corridor in the Santa Clara River. The proposed action is expected to result in conditions that do not support formation and preservation of freshwater spawning sites in Piru Creek downstream of Santa Felicia Dam.

With regard to habitat for steelhead, the effects due to the proposed action and the operation of Pyramid Dam are expected to continue to cause extensive habitat loss and fragmentation, and reduce the functional value of habitat characteristics and conditions for non-listed steelhead within the action area upstream of Santa Felicia Dam. Continued operation of Santa Felicia Dam and operations of Pyramid Dam that are interrelated with the proposed action are expected to continue to create obstructions in the steelhead migration corridor, and perpetuate the reduction in the amount of spawning and rearing habitats available to listed anadromous *O. mykiss*. The forgoing relates to listed steelhead for two principal reasons. First, effects on non-listed steelhead reduce the potential that non-listed steelhead would provide an ecological benefit to listed steelhead in the action area and watershed. Second, NMFS views the upstream or tributary-specific populations (and the corresponding living space) as being critical to further the recovery of the endangered Southern California DPS of steelhead, given the importance and value of the Santa Clara River steelhead population to the entire Southern California DPS.

With regard to steelhead, the proposed action and interrelated activities are projected to exacerbate decreases in steelhead population size, population growth rate, population spatial structure, and population diversity. Such effects are expected to arise from the proposed action continuing to disrupt if not eliminate migration of steelhead into and out of Piru Creek, reduce migration opportunities and success in the Santa Clara River, and continue to preclude listed anadromous *O. mykiss* from most of the Piru Creek sub-basin. The proposed action possesses aspects that are expected to continue to reduce straying and gene flow into and out of the watershed, and decrease recruitment of steelhead progeny (*i.e.*, density of age-0 steelhead) in the watershed. The effects due to the proposed action are expected to extend to the Santa Clara River steelhead population unit and reduce the likelihood that the population unit would survive. Effects of the proposed action are expected to extend, as well, to the entire endangered Southern California DPS of steelhead, causing a decrease in the likelihood of viability of the DPS, in particular the effects of the action reduce the ability of listed anadromous *O. mykiss* to recover.

C. Combined Effects

The aggregate effects of the environmental baseline (i.e., the effects of past and ongoing activities), the proposed action and interrelated activities, and the actions identified in the Cumulative Effects section are expected to exacerbate rates of habitat loss and destruction and preclude formation of a viable steelhead population in the Santa Clara River watershed. The effects of environmental fluctuations and disturbances (e.g., floods, wildfire, and drought) and demographic accidents (e.g., varying or unpredictable birth and death rates, sex-ratio fluctuations that have significant effects for species with low abundance) are expected to create an added risk of DPS extinction to that arising from aggregate effects alone. With regard to climate change, information indicates that precipitation in southern California will exhibit measurable decreases in the future (Hayhoe *et al.* 2004). If reduced precipitation does dominate the region in the future, the findings from NMFS' analyses presented here are expected to underestimate the effects of the proposed action because the findings from the analyses performed here and elsewhere (e.g., NMFS 2007) indicate the effects of water diversion and storage activities are most pronounced during below normal and normal water years. The effects of the proposed action and environmental baseline alone are sufficient to appreciably reduce the likelihood of both the survival and recovery for the Santa Clara River population unit of steelhead and the endangered Southern California DPS of steelhead (i.e., reduce the likelihood of the species achieving viability). The effects from the stochastic environmental changes, demographic accidents, and combined effects (collectively referred to as *aggregate effects*) are expected to exacerbate the effects of the proposed action and environmental baseline on the likelihood of both the survival and recovery for the Santa Clara River population unit of steelhead and the endangered Southern California DPS of steelhead.

The conservation value of the freshwater migration corridor, freshwater spawning sites, and freshwater rearing sites within the action area is expected to continue to be reduced due to the aggregate effects of the environmental baseline, the actions identified in the Cumulative Effects section, and the proposed action. The combined effects (i.e., aggregate activities, and stochastic environmental changes) are (1) not expected to allow critical habitat in Piru Creek downstream of Santa Felicia Dam to remain functional to serve the intended conservation role for the species, and (2) expected to reduce the functionality of critical habitat in the Santa Clara River to serve the intended conservation role for listed anadromous *O. mykiss*.

VIII. CONCLUSION

After reviewing the best available scientific and commercial information, status of the Southern California steelhead DPS, environmental baseline, expected effects of the proposed action, cumulative effects, and combined effects of the environmental baseline, proposed action, and future non-federal actions that are reasonably certain to occur, NMFS concludes the proposed action is likely to jeopardize the continued existence of the Federally endangered Southern California steelhead DPS, and is likely to destroy or adversely modify critical habitat for this species.

IX. REASONABLE AND PRUDENT ALTERNATIVE

Regulations (50 CFR §402.02) implementing section 7 of the ESA define reasonable and prudent alternatives as alternative actions, identified during formal consultation, that: (1) can be implemented in a manner consistent with the intended purpose of the action; (2) can be implemented consistent with the scope of the action agency's legal authority and jurisdiction; (3) are economically and technically feasible; and (4) would, NMFS believes, avoid the likelihood of jeopardizing the continued existence of a listed species or resulting in the destruction or adverse modification of critical habitat. NMFS believes the following reasonable and prudent alternative is necessary and appropriate to avoid the likelihood of jeopardizing the continued existence of the Southern California steelhead DPS or resulting in the destruction or adverse modification of critical habitat:

Implement a Santa Felicia Dam operations plan that requires establishing and preserving essential features of critical habitat for the endangered Southern California DPS of steelhead in Piru Creek and the Santa Clara River, and restoring anadromy of steelhead to the Piru Creek drainage. This reasonable and prudent alternative has three sub-elements and all three elements must be implemented to avoid jeopardizing the continued existence of the Federally endangered Southern California steelhead DPS, and destroying or adversely modifying critical habitat for this species. The presentation of the three sub-elements is followed by a brief discussion of how the reasonable and prudent alternative is expected to avoid jeopardizing the continued existence of the Federally endangered Southern California steelhead DPS, and destroying or adversely modifying critical habitat for this species. The sub-elements are as follows:

1. The Licensee shall implement a plan after receiving written NMFS agreement on the plan to minimize the geomorphic effects (e.g., effects to channel-bed morphology, substrate characteristics and condition) of Santa Felicia Dam and its operations on the quality and quantity of habitat for steelhead in Piru Creek downstream of the dam. The approach to minimize the geomorphic effects shall involve three principal steps: preparation of a study plan to quantify the geomorphic effects, implementation of the study plan, and subsequent preparation of a habitat-improvement plan and implementation of the habitat-improvement measures as identified in this habitat-improvement plan. These steps are described more fully as follows.

   (a) **Preparation of a study plan to quantify the geomorphic effects.** The Licensee shall prepare a study plan to quantify the geomorphic effects and submit this study plan to NMFS' Southwest Regional Office (501 W. Ocean Blvd., Suite 4200, Long Beach, California 90802) for review and potential agreement no later than 180 days from the date of the Commission's issuance of the project license to the Licensee. The purpose of this study plan is to quantify the type (sorts of effects), amount (quantity, e.g., surficial area), and extent (distribution or area over which effects extend) of geomorphic effects of Santa Felicia Dam and its operations on the quality and quantity of steelhead habitat in Piru Creek downstream of the dam. This study plan shall include: (1) a clear statement of the study objectives, (2) a description of the specific field methods that are based on scientifically valid and accepted protocols that will be used to quantify the type, amount, and extent of geomorphic effects, (3) a description of the methods that will be used to condense, analyze, and interpret the collected field data, (4) a description of the elements of a findings report that will describe and present the results obtained from implementing the study plan, and (5) schedules to guide the field sampling task, the data analysis task, and preparation of the findings report. Specific details of various elements of this study plan, including schedules, will be developed by the Licensee in cooperation with and agreement from NMFS prior to implementation of this plan. The Licensee shall be responsible for funding and completing this study and the findings report. No later than 60 days following the date of NMFS' letter commenting on the draft study plan, the Licensee shall submit to NMFS (at the foregoing address) for review a final study plan that addresses NMFS' comments. The Licensee must receive final NMFS' written agreement for this plan prior to implementing the plan. Upon receipt of final NMFS agreement, the Licensee shall commence implementation of the NMFS-agreed study plan.

(b) Execution of the study plan. The Licensee shall fund, conduct and complete this element in strict conformity as set forth in the plan developed in accordance with reasonable and prudent alternative element 1(a). The Licensee shall submit a draft findings report to NMFS (at the address provided above) and revise the report based on NMFS' comments (no later than 60 days after receiving NMFS' comments on the draft report) as necessary to receive final NMFS' written agreement on the findings report.

(c) Preparation of a habitat-improvement plan and implementation of the habitat-improvement measures as identified in this plan. The Licensee shall prepare a draft habitat-improvement plan and submit this plan to NMFS' Southwest Regional Office (501 W. Ocean Blvd., Suite 4200, Long Beach, California 90802) for review and potential agreement within one year from the date of the Commission's issuance of the project license to the Licensee. This plan shall: (1) identify the specific geomorphic effects determined from implementation of the study plan as defined in reasonable and prudent alternative element 1(a) (note that the findings report can be included in an appendix to this plan), (2) identify the specific habitat-improvement measures that will be undertaken to minimize each individual geomorphic effect, (3) describe the specific methods that will be undertaken to install each habitat-improvement measure, (4) detail the environmental and regulatory permits and approvals that will be needed prior to implementing the suite of habitat-improvement measures, and maintain the measures over time, (5) define effectiveness and performance criteria for each habitat-improvement measure, (6) describe the field methods that will be undertaken to monitor the long-term effectiveness (e.g., the attainment of management goals or objectives) and performance (e.g., function and longevity of the measures over time) of the habitat-improvement measures, (7) describe the specific field methods that will be used to maintain the habitat-improvement measures over time, (8) detail the decision criteria that will be used to judge effectiveness and performance of the habitat-improvement measures in the context of the long-term monitoring, (9) define schedules to guide implementation of the habitat-improvement measures and the conduct of the long-term effectiveness and performance monitoring, and (10) provide cost and engineering analyses, and detailed (engineered) design drawings for the habitat-improvement measures. Specific details of various elements of this plan, including schedules, will be developed by the Licensee in cooperation with and agreement from NMFS prior to implementation of this plan. The Licensee shall be responsible for funding and implementing the habitat-improvement plan. No later than 60 days following the date of NMFS' letter commenting on the draft habitat-improvement plan, the Licensee shall submit to NMFS (at the foregoing address) for review and potential agreement a final habitat-improvement plan that addresses NMFS' comments. The Licensee must receive final NMFS agreement for the final habitat-improvement plan prior to implementing the habitat-improvement plan. Upon receipt of final NMFS agreement on the plan, the Licensee shall commence implementation of the final plan as agreed upon by NMFS in accordance with the schedules provided therein.

2. The Licensee shall implement a plan after receiving written NMFS agreement on the plan to ensure that the magnitude, timing, frequency, duration, and rate-of-change of water released from Santa Felicia Dam into Piru Creek will provide unimpeded migration of adult and juvenile steelhead in Piru Creek downstream of Santa Felicia Dam and in the Santa Clara River from the confluence of Piru Creek downstream to the Vern Freeman Diversion Dam, formation and preservation of freshwater rearing sites for steelhead throughout Piru Creek downstream of Santa Felicia Dam, and creation and maintenance of freshwater spawning sites (including incubation and emergence life stages of steelhead) for steelhead throughout Piru Creek downstream of Santa Felicia Dam. The plan shall include three principal components: water-release schedules to provide essential habitat functions to support steelhead life history and habitat requirements, implementation and effectiveness monitoring, and adaptive management (note that the Licensee may present and detail these three components in three separate documents or plans). These components are described more fully as follows, which includes consideration of flow-related information recently provided in Exhibit A of United's January 11, 2008, comment letter. The Commission's January 17, 2008, letter requested that NMFS consider in the biological opinion the measures outlined in Exhibit A as part of a reasonable and prudent alternative.

(a) **Water-release schedules to provide essential habitat functions to support steelhead life history and habitat requirements.** The Licensee shall prepare a draft plan that details the water releases necessary to support unimpeded migration of adult and juvenile steelhead, and sites of rearing and spawning for steelhead throughout Piru Creek downstream of Santa Felicia Dam and the Santa Clara River downstream of the confluence with Piru Creek, and submit this plan to NMFS' Southwest Regional Office (501 W. Ocean Blvd., Suite 4200, Long Beach, California 90802) for review and potential agreement no later than 90 days after the Commission's issuance of the project license to the Licensee. This plan[20] shall: (1) clearly define the biological goals and objectives of the plan (i.e., water-release schedules to provide essential habitat functions to support steelhead life history and habitat requirements

[20] Although Exhibit A of United's January 11, 2008, letter could hypothetically be viewed as a "plan" for purposes of reasonable and prudent alternative 2(a), thereby rendering moot the need to prepare a plan as required under reasonable and prudent alternative 2(a), NMFS has carefully reviewed Exhibit A and concluded that the exhibit, by itself, generally does not ensure essential habitat functions to satisfy the life history and habitat requirements of endangered steelhead downstream of Santa Felicia Dam in Piru Creek and the Santa Clara River downstream of the confluence with Piru Creek. Therefore, NMFS continues to believe that a plan as required under reasonable and prudent alternative 2(a) is warranted, though NMFS acknowledges that aspects of Exhibit A may be included in the plan that is prepared as required by reasonable and prudent alternative 2(a).

throughout Piru Creek downstream of the dam to the confluence with the Santa Clara River and throughout the Santa Clara River downstream of the confluence with Piru Creek. Note that riparian vegetation is an essential feature of steelhead critical habitat), (2) identify water-release schedules based on the habitat requirements of adult and juvenile steelhead, (3) describe the specific science-based methods used to develop the water-release schedules for migration of adult and juvenile steelhead, steelhead spawning, and steelhead rearing, and (4) identify the daily- or monthly-specific quantities of water (in units of ft^3/s) that will be released from Santa Felicia Dam for providing migration of adult and juvenile steelhead, freshwater spawning sites, and freshwater rearing sites (NMFS expects that water releases from the dam for steelhead life history and habitat requirements will range from 7 to 25 cfs for baseflow conditions during "dry" and "wet-normal" water-year types, and at least 200 cfs for attraction and migration conditions, as is proposed in Table 1 within Exhibit A, of United's January 11, 2008, comment letter[21]). Specific details of various aspects of this plan, including schedules and triggering criteria for certain water releases and water-year types (e.g., Exhibit A, of United's January 11, 2008, comment letter), will be developed by the Licensee in cooperation with and agreement from NMFS prior to implementation of this plan. The Licensee shall be responsible for funding and implementing this plan. No later than 30 days following the date of NMFS' letter commenting on the water-release schedules and plan, the Licensee shall submit to NMFS (at the foregoing address) for review and potential agreement the final water-release schedules and plan that address NMFS' comments. The Licensee must receive final NMFS agreement for the final water-release schedules and plan prior to implementing the final water-release schedules and plan. Upon receipt of final NMFS agreement on the water-release schedules and plan, the Licensee shall commence implementation of the approved final water-release schedules and plan.

(b) Implementation and effectiveness monitoring. The Licensee shall prepare a draft plan that details the implementation of the water-releases schedules (as defined in accordance with reasonable and prudent alternative 2a) and the field monitoring that will be conducted to assess the effectiveness of the water releases for migration of adult and juvenile steelhead, and steelhead spawning and rearing, and submit this plan to NMFS' Southwest Regional Office (501 W. Ocean Blvd., Suite 4200, Long Beach, California 90802) for review and potential agreement no later than 90 days after the Commission's issuance of the project license to the Licensee. This plan shall include: (1) description of the specific methods that operators of Santa Felicia Dam (operators) will follow to ensure the water-release schedules are maintained, (2) a description of the specific precautionary measures that operators will undertake to ensure that no

[21] Exhibit A of United's January 11, 2008, letter indicates water releases would be provided for 10 years, and at the end of the 10-year period United would submit to the Commission a recommendation to continue, alter, or abandon the water-release requirement. NMFS assumes in this reasonable and prudent alternative that the water releases would continue beyond the 10 years proposed by United because there is currently no information from which to determine that the water releases would not be necessary to avoid jeopardy or destruction or adverse modification of the species' critical habitat at the end of 10 years. Therefore, NMFS assumes that the water releases would be required throughout the term of the license the Commission issues to the Licensee, but the adequacy of and necessity for the water releases may be reviewed by NMFS depending in part on the future status of listed steelhead and future findings obtained from effectiveness monitoring required in reasonable and prudent alternative 2(b).

water-release lapse occurs, (3) a description of the contingency measures that operators and the Licensee will implement should an accidental lapse in water release occur, (4) a description of the specific triggers and procedures that will be used to transition from one type of water release to another (e.g., water releases for steelhead migration versus water releases for steelhead rearing), (5) a description of the specific ramping rates and procedures that operators will institute to minimize stranding and related effects on steelhead, (6) biological goals and objectives (including criteria) of the effectiveness monitoring, (7) a description of the specific hypotheses that will be evaluated as part of the effectiveness monitoring, (8) a description of the biological, physical, and physicochemical response variables that will be quantified to assess the effectiveness of the water releases for providing essential habitat functions to support migration of adult and juvenile steelhead, and steelhead spawning and rearing, (9) a description of the specific field methods that will be used to quantify the response variables and evaluate the identified hypotheses, (10) a description of the field-sampling schedules for each of the response variables and specific hypotheses, and (11) the analytical methods and inferential models that will be used to evaluate or test specific hypotheses. Specific details of various aspects of this plan, including schedules, shall be developed by the Licensee in cooperation with and agreement from NMFS prior to implementation of this plan. The Licensee shall be responsible for funding and implementing this plan. No later than 30 days following the date of NMFS' letter commenting on the implementation and draft effectiveness-monitoring plan, the Licensee shall submit to NMFS (at the foregoing address) for review and potential agreement a final effectiveness-monitoring plan that addresses NMFS' comments. The Licensee must receive final NMFS agreement for the final effectiveness-monitoring plan prior to implementing the final effectiveness-monitoring plan. Upon receipt of final NMFS agreement on the plan, the Licensee shall commence implementing the final effectiveness-monitoring plan as agreed upon by NMFS in accordance with the schedules provided therein. The Licensee shall provide to NMFS (at the foregoing address) all raw data (in electronic and hardcopy formats) that is collected as part of the effectiveness-monitoring task. The Licensee shall prepare and submit to NMFS (at the foregoing address) annual reports that detail the findings from the effectiveness monitoring.

(c) Adaptive management. The Licensee shall prepare a draft plan that details an adaptive-management plan for the water releases necessary to provide essential habitat functions to support unimpeded migration of adult and juvenile steelhead, and sites of rearing and spawning for steelhead, and submit this plan to NMFS' Southwest Regional Office (501 W. Ocean Blvd., Suite 4200, Long Beach, California 90802) for review and potential agreement no later than 90 days after the Commission's issuance of the project license to the Licensee. The Licensee shall develop this adaptive management plan for operation of Santa Felicia Dam and all related appurtenances for the principal purpose of addressing uncertainties related to the water-release schedules. The uncertainties are expected to generally involve the appropriateness of the water-release schedules for providing essential habitat functions for growth and survival of steelhead in Piru Creek downstream of Santa Felicia Dam, creating and maintaining suitable spawning habitat in the creek downstream of the dam, attracting adult steelhead into Piru Creek downstream of Santa Felicia Dam, and facilitating migration of adult and juvenile steelhead through the mainstem Santa Clara River (downstream of the confluence with Piru Creek) and Piru Creek downstream of Santa Felicia Dam. To address these uncertainties, the Licensee's adaptive-management plan shall: (1) identify all of the uncertainties and the questions that need to be addressed to resolve each uncertainty, (2) identify biological goals and objectives for each uncertainty, (3) define and require the implementation of a monitoring program that is able to detect the necessary information to answer questions related to resolving uncertainty (note that aspects of the effectiveness-monitoring task may satisfy this specific requirement), and (4) define and implement a protocol that will respond to new information or changing conditions, detect and reconcile deficiencies or problems in a timely manner, and incorporate feedback loops that link implementation and monitoring to a decision-making process that results in appropriate changes in operations to benefit steelhead and their habitat. Specific details of various aspects of this plan, including schedules, shall be developed by the Licensee in cooperation with and agreement from NMFS prior to implementation of this plan. The Licensee shall be responsible for funding and implementing this plan. No later than 30 days following the date of NMFS' letter commenting on this plan, the Licensee shall submit to NMFS (at the foregoing address) for review and potential agreement a final plan that addresses NMFS' comments. The Licensee must receive final NMFS agreement for the final plan prior to implementing the final plan. Upon receipt of final NMFS agreement, the Licensee shall commence implementation of the final plan as agreed upon by NMFS in accordance with the schedules provided therein.

3. The Licensee shall provide passage of steelhead at or around Santa Felicia Dam, or other suitable alternative to passage. Prior to implementing this action, the Licensee shall implement a plan after receiving written agreement on the plan from NMFS to assess the feasibility of providing passage of adult and juvenile steelhead around or over Santa Felicia Dam. The approach to assess feasibility and implement a preferred alternative shall involve five principal steps: preparation and implementation of a plan that will guide the conduct of the steelhead-passage feasibility assessment, implementation of the assessment of steelhead-passage feasibility according to the plan, preparation of a steelhead-passage feasibility report, development of criteria to guide implementation timing of the preferred alternative, and implementation of the preferred alterative. These steps are described more fully as follows.

(a) **Preparation and implementation of a plan that will guide the conduct of the steelhead-passage feasibility assessment.** The Licensee shall fund and prepare a plan that will guide the conduct of the steelhead-passage feasibility assessment and submit this plan to NMFS' Southwest Regional Office (501 W. Ocean Blvd., Suite 4200, Long Beach, California 90802) for review no later than 8 months after the Commission's issuance of the license to the Licensee. The Licensee must receive written NMFS agreement for this plan prior to implementing the plan. The purpose of this plan is to describe the methods and schedules that will be used to guide the conduct and completion of the assessment of the steelhead-passage feasibility. To develop the plan, the Licensee shall comply with the following: (1) no later than 60 days after the Commission's issuance of the license to the Licensee, the Licensee shall convene at least one meeting with NMFS and the California Department of Fish and Game (interagency meeting) for the purposes of outlining the details and elements that will form the basis of the plan, and defining schedules, including a schedule for submitting the draft steelhead-passage feasibility report to NMFS in accordance with reasonable and prudent alternative 3(c); (2) the Licensee shall assemble and develop the information obtained from the interagency meeting to produce the draft plan for guiding the conduct of the steelhead-passage feasibility assessment; and (3) this plan shall include (A) a clear statement of objectives to guide the conduct of the assessment of the steelhead-passage feasibility, (B) a clear description of science-based investigations of steelhead behavior, ecology, and habitat requirements (to inform the assessment of steelhead-passage feasibility) as well as an analysis of the full range of physical steelhead-passage alternatives (volitional and non-volitional) and alternatives to steelhead passage, and engineering and cost analyses, (C) the requirement to convene a panel of professional technical fishery biologists, fish-passage biologists, and fish-passage engineers with expertise in the evaluation and design of fish passage at dams, who will participate in the assessment of steelhead-passage feasibility at Santa Felicia Dam, (D) a clear description of the specific methods that will be used to perform the various tasks related to the assessment of the steelhead-passage feasibility, including objective decision criteria for judging *feasibility*[22] in accordance with the information obtained through reasonable and prudent alternative 3(a)(3)(B), (E) task schedules and milestones to monitor and track performance of the assessment of the steelhead-passage feasibility over time, and (F) a contingency program to effectively address and resolve unforeseen circumstances in a timely manner.

(b) Implementation of the assessment of steelhead-passage feasibility. Upon receipt of NMFS' written agreement of the plan as provided in reasonable and prudent alternative 3(a), the Licensee shall conduct and complete the agreed-upon assessment of steelhead-passage feasibility in strict conformity as set forth in the plan developed in accordance with reasonable and prudent alternative 3(a). The Licensee shall be responsible for funding and completing the assessment of steelhead-passage feasibility.

(c) Preparation of a steelhead-passage feasibility report. Within three years and eight months from the date of the Commission's issuance of the project license to the Licensee, the Licensee shall prepare and submit a draft feasibility report to NMFS' Southwest Regional Office (501 W. Ocean Blvd., Suite 4200, Long Beach, California 90802) for review and potential written agreement from NMFS. The steelhead-passage feasibility report shall (1) describe the findings obtained from the assessment of the steelhead-passage feasibility and all related studies (see reasonable and prudent alternative 3a and 3b), (2) identify the preferred long-term solution to restore steelhead access to and from historical steelhead spawning and rearing habitats upstream of Santa Felicia Dam (if volitional steelhead passage is determined to be infeasible, then the study shall consider non-volitional steelhead passage; if non-

[22] Because United recently expressed concern regarding "the lack of sideboards" to guide the economic aspect of the feasibility study (pers. comm., J. Dickenson, United Water Conservation District, April 15, 2008), we here reiterate that regulations (50 CFR §402.02) implementing section 7 of the ESA in part define reasonable and prudent alternatives as alternative actions identified during formal consultation that "…are economically and technically feasible." We therefore expect that economic consideration will be included in the feasibility study that is required in this reasonable and prudent alternative.

volitional passage is determined to be infeasible, then the Licensee shall consult with NMFS to develop an alternative to steelhead passage [such as an habitat-compensation plan based on measurable biological criteria to minimize the effects of the loss of habitat upstream of Santa Felicia Dam on steelhead], which will be presented in the report), (3) include a plan and define schedules for implementing and completing the executable element(s) of the feasibility report, including the preferred long-term fish-passage solution once criteria are triggered under reasonable and prudent alternative 3(d) or alternative to steelhead passage, and (4) describe the environmental and regulatory permits and approvals that will be needed to implement the executable elements of the feasibility report. No later than 60 days following the date of NMFS' letter commenting on the draft feasibility report, the Licensee shall submit to NMFS (at the foregoing address) for review a final feasibility report and the selection of any preferred alternative, with a final engineering and cost analyses, that addresses NMFS' comments. The Licensee must receive written final NMFS agreement for the final feasibility report (including the preferred alternative) prior to implementation of any long-term passage solution, or alternative to steelhead passage. Upon receipt of written final NMFS agreement on the steelhead-passage feasibility report, and if the preferred alternative is an alternative to steelhead passage, the Licensee shall commence implementation of the preferred alternative in accordance with the schedules(s) defined in the feasibility report as agreed upon by NMFS (i.e., the Licensee shall skip reasonable and prudent alternative 3(d)). Upon receipt of written final NMFS agreement on the steelhead-feasibility report, and if the preferred alternative involves steelhead passage, the Licensee shall commence development of criteria in accordance with reasonable and prudent alternative 3(d).

(d) **Development of criteria to guide implementation timing of the preferred alternative.** If steelhead passage is identified as the preferred alternative in the final steelhead-passage feasibility report agreed upon by NMFS, the Licensee shall develop in coordination with NMFS and the California Department of Fish and Game measurable biological criteria to trigger implementation of the preferred alternative. The Licensee shall submit Licensee's draft criteria to NMFS (at the foregoing address) no later than 6 months of the date on which the Licensee receives written final NMFS agreement on the steelhead-passage feasibility report. No later than 30 days following the date of NMFS' letter commenting on the draft trigger criteria (initial letter), the Licensee shall submit to NMFS (at the foregoing address) for review the final trigger criteria that addresses NMFS' comments. Upon receipt of written final NMFS agreement on the final trigger criteria, the Licensee shall commence implementation of the preferred alternative in accordance with reasonable and prudent alternative 3(e).

(e) **Implementation of the preferred alternative.** Upon receipt of written final NMFS agreement on the steelhead-passage feasibility report, and if the preferred alternative is an alternative to steelhead passage, the Licensee shall commence and proceed with implementation of the preferred alternative in accordance with the schedule(s) defined in the feasibility report as agreed upon by NMFS. If steelhead passage is identified as the preferred alternative in the final steelhead-passage feasibility report agreed upon by NMFS, the Licensee shall commence implementation of the preferred alternative when the triggers identified in reasonable and prudent alternative 3(d) above are reached, and proceed with implementation in accordance with the schedule(s) defined in the feasibility report as agreed upon by NMFS. The Licensee shall be responsible for funding and implementing the preferred alternative whether it involves steelhead passage or an alternative to steelhead passage.

The elements of the reasonable and prudent alternative can be implemented in a manner consistent with the intended purpose of the action. NMFS' approach to collaborating with United on development of the water-release schedules (and water quantities specified therein) is not expected to result in water-release schedules that preclude United from storing and subsequently releasing water for groundwater recharge and agricultural users, or from generating power. With the proper consideration that is expected to result from development of the plan under reasonable and prudent alternative 2(a), aspects of the proposed water releases of Exhibit A of United's January 11, 2008, letter are expected to serve as a meaningful basis for ensuring essential habitat functions for endangered steelhead in Piru Creek and the Santa Clara River downstream of Santa Felicia Dam.

The elements can be implemented consistent with the scope of the action agency's legal authority and jurisdiction. Under the FPA, and when issuing the new license for the proposed action, the Commission must ensure the proposed action is best adapted to a comprehensive plan for, among other reasons, the adequate protection, mitigation, and enhancement of fish and wildlife, including related spawning grounds and habitat. In addition, the FPA requires that the license include conditions for adequately and equitably protecting, mitigating damages to and enhancing fish and wildlife, including related spawning grounds and habitat. The proposed action is inadequate for the protection, mitigation of damages to and enhancement of the endangered Southern California steelhead DPS, including related spawning grounds and habitat, for the same reasons that this biological opinion has concluded that the proposed action is likely to jeopardize the continued existence of the endangered Southern California DPS of steelhead, and is likely to destroy or adversely modify critical habitat for this species.

The elements of the reasonable and prudent alternative are expected to be economically and technically feasible because, in part, water releases are often undertaken at dams for the protection and conservation of fish species and dams are commonly made passable for fish (e.g., Colt and White 1991, Cada and Sale 1993, Smith *et al*. 2000). As part of the steelhead-passage feasibility study, which is a required sub-element of this reasonable and prudent alternative, further consideration will be given to the economic and technical feasibility of restoring steelhead access to historical spawning and rearing habitats upstream of Santa Felicia Dam. Therefore, the feasibility study will include more specific information regarding the economic and technical feasibility of the reasonable and prudent alternative.

The elements of the reasonable and prudent alternative address those deficient aspects of the proposed action that would perpetuate the reduction in the amount and quality of habitat for steelhead, and continue to cause a decrease in abundance of this species. Chief among these aspects are the adverse effects of habitat loss and fragmentation due to Santa Felicia Dam and its continued operation, habitat degradation (e.g., geomorphic effects) owing to operation of Santa Felicia Dam, and the lack of water releases from the dam to provide essential habitat functions for adult and juvenile steelhead in Piru Creek and the Santa Clara River. A summary of how the three sub-elements contribute to avoiding jeopardy of endangered steelhead and adverse modification or destruction of critical habitat for this species is as follows:

1. The first sub-element of the reasonable and prudent alternative is essential to address the degraded condition and characteristics of Piru Creek downstream of Santa Felicia Dam through remediation of habitat damages caused by the continued operation of Santa Felicia Dam. The reasonable and prudent alternative requires that the effects of the proposed action on channel-bed morphology, and substrate characteristics and condition would be remedied, resulting in increased habitat quality and quantity in Piru Creek for endangered steelhead. The anticipated ecological benefits of the physical improvements to the channel bed and banks in Piru Creek downstream of Santa Felicia Dam cannot be fully realized without ecologically meaningful water releases from the dam into Piru Creek.

2. The second sub-element of the reasonable and prudent alternative is essential to address the lack of water releases that provide essential habitat features necessary to sustain steelhead life history and habitat requirements downstream of Santa Felicia Dam in Piru Creek and the Santa Clara River downstream of the confluence with Piru Creek. The reasonable and prudent alternative requires implementation and maintenance of meaningful water releases to support unimpeded migration of adult and juvenile steelhead, and sites of rearing and spawning for steelhead throughout Piru Creek and the Santa Clara River downstream of the confluence with Piru Creek. The first and second sub-elements of the reasonable and prudent alternative (i.e., geomorphic effects and water releases) are insufficient by themselves to fully avoid jeopardy to the species until passage to historical habitats is granted because, for example, these specific sub-elements cannot account for the major ecological effects on the species that are related to habitat fragmentation and loss, which the proposed action is projected to perpetuate for the term of the license when implemented.

3. Therefore, the third sub-element of the reasonable and prudent alternative is essential to address the adverse effects of habitat loss and fragmentation due to continued operation of Santa Felicia Dam under the proposed action. This sub-element requires migration of adult and juvenile steelhead to and from historical spawning and rearing habitats upstream of Santa Felicia Dam and the Pacific Ocean, or compensation for the lost and fragmented habitat if passage is determined to be infeasible. The reasonable and prudent alternative requires the conduct of a reliable steelhead-passage feasibility study, and requires implementation of one or more alternatives if volitional passage of steelhead is determined to be infeasible. While the biological opinion makes clear that migration of adult and juvenile steelhead to and from historical spawning and rearing habitats upstream of Santa Felicia Dam is necessary to fully avoid jeopardy to the species, NMFS concludes the principal benefits of restoring steelhead migration, specifically migration of *adult* steelhead, to and from historical spawning habitat and the ocean will be realized when adult steelhead once again begin accessing Piru Creek from the Santa Clara River. Implementation of the second sub-element of the reasonable and prudent alternative will be necessary to provide for such migration of adult steelhead to Piru Creek, though we envision that some time will pass before steelhead "respond" to the water releases and begin returning to Piru Creek. Therefore, we conclude that the amount of time for implementing the preferred alternative would not result in jeopardy to the species.

Overall, the elements of the reasonable and prudent alternatives are expected to promote an increase in the amount and extent of suitable habitat for adult and juvenile steelhead, improve the functional value of habitat for steelhead, and lead to increased numbers of steelhead in the Piru Creek sub-basin and the Santa Clara River watershed. Accordingly, NMFS believes the elements of the reasonable and prudent alternative would avoid the likelihood of jeopardizing the continued existence of a listed species or resulting in the destruction or adverse modification of critical habitat. Because this biological opinion has determined the proposed action is likely to jeopardize the continued existence of the endangered Southern California steelhead DPS, and is likely to destroy or adversely modify critical habitat for this species, the Commission is required to notify NMFS of its final decision on the implementation of the reasonable and prudent alternative.

In their comments on the draft biological opinion, the Commission stated that NMFS' reasonable and prudent alternative closely resembles the Commission's recommended alternative (Federal Energy Regulatory Commission 2008). Consequently, the Commission questioned the basis for NMFS' conclusion that the proposed action is likely to jeopardize the continued existence of the endangered Southern California steelhead DPS, and is likely to destroy or adversely modify critical habitat for this species. In consideration of the Commission's recommended alternative, NMFS recognized that the Commission made an effort to minimize effects of the proposed action on endangered steelhead and critical habitat for this species. Upon careful consideration of the details of the recommended alternative, however, NMFS concluded the alternative did not possesses specific elements that would be reasonably certain to lead to either avoidance or a reduction of adverse effects, and in many instances the recommended alternative would not preclude the proposed action from perpetuating certain existing conditions, which are clearly not favorable for the long-term survival or recovery of this endangered species (see Table 9-1 for a comparison of certain aspects of the Commission's recommended alternative and the reasonable and prudent alternative).

Table 9-1.—Summary comparison of NMFS' reasonable and prudent alternative with the Commission's recommended alternative. Additional NMFS comments on the Commission's recommended alternative are presented in the section "Effects of the Proposed Action" of this biological opinion.

Subject	NMFS' reasonable and prudent alternative	Commission's recommended alternative
Geomorphic effects	Ensures that effects of the proposed action on the channel-bed morphology, and substrate characteristics and condition would be effectively minimized. Requires identification and implementation of those specific habitat improvements that are necessary to minimize effects of the proposed action on the physical creek environment, monitoring performance of the improvements over time, and further improvements should the monitoring results indicate such improvements are warranted.	The flushing flow trigger plan lacks the ability to minimize several of the geomorphic effects that are expected from the proposed action. The plan is intended to only address accumulations of fine sediment, not minimize the effects of the coarsening of the channel bed, channel incision, and habitat simplification that have been noted and are expected to extend into the future under the proposed action.
Water releases	Requires implementation of water releases necessary to support unimpeded migration of adult and juvenile steelhead, and sites of rearing and spawning for steelhead in Piru Creek downstream of Santa Felicia Dam and in the Santa Clara River downstream of the confluence with Piru Creek. Monitoring is required to assess the ecological effectiveness of the water releases, and an adaptive management plan is required to address uncertainty related to the appropriateness of the water-release schedules for providing essential habitat functions for steelhead.	The fish-passage corridor connectivity study, the groundwater and surface water flow monitoring program, and the flow-management and enhancement plan generally propose to "identify" and "evaluate" those measures that *could* be implemented. No meaningful water release is proposed that would be expected to restore and maintain essential habitat functions for the life history and habitat requirements of endangered steelhead in Piru Creek or the Santa Clara River downstream of the confluence with Piru Creek.
Fish passage	Ensures that ecological effects related to habitat loss and fragmentation, and blocking steelhead from historical spawning and rearing habitat upstream of the dam, would be effectively minimized. Outlines the provisions and incremental steps for conducting a reliable fish-passage feasibility study, and requires the identification and implementation of alternatives to volitional fish passage if such passage is determined to be infeasible. Alternatives to volitional fish passage involve non-volitional passage and habitat compensation for the amount of habitat that is lost due to the continued impassable presence of Santa Felicia Dam due to the proposed action.	The fish passage corridor connectivity study (a) focuses only on habitats downstream of Santa Felicia Dam, and (b) only proposes to "assess" fish-passage alternatives, opportunities, and constraints relative to the migration corridor, but does nothing to address the ecological effects due to habitat loss and fragmentation owing to the proposed action. The final EA does not constitute a reliable fish-passage feasibility study, and there is no information to indicate a reliable study was in fact performed. NMFS believes a reliable fish-passage feasibility study should include: (a) an outline of an overall course of study at the beginning of the investigation, (b) acquisition of primary data, (c) familiarize staff with project site, (d) identify possible alternatives, (e) analyze and rank top alternatives, (f) preliminary design of top alternatives, and (g) peer review project after critical decision steps.

X. INCIDENTAL TAKE STATEMENT

Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take of listed animal species that results from, but is not the purpose of, carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of the agency action is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, must be undertaken by the Commission for the exemption in section 7(o)(2) to apply, and assume the reasonable and prudent alternative will be implemented. The Commission has a continuing duty to regulate the activity covered by this incidental take statement. If the Commission (1) fails to assume and implement the terms and conditions or (2) fails to adhere to the terms and conditions of this incidental take statement through enforceable terms that are added to the license, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Commission must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement (50 CFR §402.14(i)(3)).

A. Amount and Extent of Take

With implementation of the reasonable and prudent alternative, NMFS expects execution of the proposed action on Piru Creek, Los Angeles County, California, will result in the incidental take of the endangered Southern California DPS of steelhead. The future plans that are required by the reasonable and prudent alternative to guide implementation of the sub-elements, and which once implemented are expected to cause take of steelhead, will be prepared after the Commission issues the license to the Licensee. While we do anticipate that take would result from implementation of such future plans, we do not know the specifics of the plans and therefore NMFS does not currently have available the information needed to reliably estimate the amount or extent of take of adult and juvenile steelhead. When such information becomes available, NMFS will amend this incidental take statement to specifically identify the amount and extent of take and any additional reasonable and prudent measures and terms and conditions that may be necessary to minimize and monitor incidental take of steelhead. We do not expect that injury or death of steelhead is likely to result from implementation of these plans because these plans will include precautionary measures to reduce the likelihood that steelhead injury and death would occur, and the expected methods for collecting and relocating steelhead possess a low risk of injuring or killing steelhead, particularly when precautionary measures are integrated with such methods. NMFS anticipates the following type of incidental take:

1. Collect adult and juvenile steelhead in Piru Creek and the Santa Clara River downstream of Santa Felicia Dam as part of monitoring the effectiveness of the water releases on the this species (reasonable and prudent alternative 2b);

2. Collect and then relocate juvenile steelhead as part of construction activities to minimize geomorphic effects of operation of Santa Felicia Dam on Piru Creek and improve habitat quality and quantity in Piru Creek downstream of Santa Felicia Dam (reasonable and prudent alternative 1c);
3. Collect and then relocate adult and juvenile steelhead in the Piru Creek sub-basin and the Santa Clara River as part of field investigations into the ecology and behavior of steelhead for informing the fish-passage feasibility study (reasonable and prudent alternative 3a); and,
4. If non-volitional steelhead passage is identified as the preferred alternative as required in reasonable and prudent alternative 3c, collect and then relocate adult and juvenile steelhead in the Piru Creek sub-basin and the Santa Clara River to restore steelhead passage to historical spawning or rearing habitat upstream of Santa Felicia Dam.

NMFS has enough information available to indicate that the proposed action with implementation of the reasonable and prudent alternative is likely to displace and strand steelhead. NMFS anticipates the proposed action may result in the injury or death of 10 adult steelhead and 1000 juvenile steelhead in Piru Creek downstream of Santa Felicia Dam and in the Santa Clara River downstream of the confluence with Piru Creek. This level of take was estimated from the information available to NMFS, expectations for the action area and effects of the proposed action, and knowledge of the ecology and behavior of steelhead. We recognize that this take estimate may be revised in the future, depending on the findings obtained from the monitoring that is required in this incidental take statement and the reasonable and prudent alternative. Given the expected frequency of take during the life of the proposed action, as well as the expectation that implementation of all the sub-elements of the reasonable and prudent alternative will result in increased abundance of this species and habitat, including critical habitat, in the Santa Clara River watershed, NMFS determined the amount of estimated incidental take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat for this species. Reasonable and prudent measures to minimize the number of displaced and stranded steelhead due to the proposed action are appropriate.

B. Effect of Take

In the accompanying Biological Opinion, NMFS concludes the anticipated level of take associated with the proposed action is not likely to jeopardize the continued existence of the endangered Southern California DPS of steelhead when all the sub-elements of the reasonable and prudent alternative are implemented.

C. Reasonable and Prudent Measures

NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize and monitor incidental take of steelhead.

1. Implement a water-release ramping rate for the purpose of minimizing steelhead stranding in Piru Creek downstream of Santa Felicia Dam.

2. Monitor the effectiveness of the ramping rate and number, size, and disposition of steelhead displaced and stranded in Piru Creek downstream of Santa Felicia Dam and in the Santa Clara River downstream of the confluence with Piru Creek.

We note that because operation of Santa Felicia Dam affects discharge in the Santa Clara River, NMFS believes that operational criteria deliberately crafted to minimize steelhead displacement and stranding in Piru Creek would as well minimize steelhead displacement and stranding in the Santa Clara River downstream of the confluence with Piru Creek. This is why the reasonable and prudent measure pertains solely to Piru Creek downstream of Santa Felicia Dam.

D. Terms and Conditions

In order to be exempt from the take prohibitions of the ESA, the Commission must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary:

1. The following terms and conditions implement reasonable and prudent measure No. 1.

    A. The Licensee shall implement a water-release ramping rate of 2 inches/hour to guide increases and decreases of water releases from Santa Felicia Dam to Piru Creek for the purpose of minimizing the likelihood of displacing and stranding steelhead in Piru Creek downstream of Santa Felicia Dam.

    B. The water-release ramping rate specified in term and condition 1A shall be based on an empirical relationship between discharge and water depth and velocity representing Piru Creek downstream of Santa Felicia Dam. To this end, the Licensee shall prepare a draft plan for developing this empirical relationship for Piru Creek to NMFS' Southwest Regional Office (501 W. Ocean Blvd., Suite 4200, Long Beach, California 90802) for review and potential agreement within 120 days from the date of the Commission's issuance of the project license to the Licensee. This plan shall include: (1) a description of the field sampling methods that will be used to collect the necessary field data for developing the discharge-depth (and water velocity) relationship, (2) the number of sampling locations and number of samples representing each location in Piru Creek, and the different magnitudes of creek discharge the collected data will represent, (3) the requirement that the sampling locations will be selected randomly, (4) a description of the sampling schedule, (5) a description of the analytical methods that will be used to develop the discharge-depth relationship, and (6) a requirement that the findings obtained from implementation of the plan that is required of this term and condition shall be provided to NMFS (at the foregoing address). Specific details of various elements of the plan that is required of this term and condition, including schedules, will be developed by the Licensee in cooperation with and agreement from NMFS prior to implementation of the plan. The Licensee shall be responsible for funding and implementing the plan. No later than 60 days following the date of NMFS' letter commenting on the draft plan as required in this term and condition, the Licensee shall submit to NMFS (at the foregoing address) for review and potential agreement a final plan that addresses NMFS' comments. The Licensee must receive final NMFS agreement for the plan prior to implementing the plan. Upon receipt of final NMFS agreement on the plan, the Licensee shall commence implementation of the final plan as agreed upon by NMFS in accordance with the schedules and methods provided therein.

2. The following term and condition implement reasonable and prudent measure No. 2.

   A. The Licensee shall prepare and implement a plan to evaluate the effectiveness of the ramping rate specified in term and condition 1A for minimizing displacement and stranding of steelhead in Piru Creek downstream of Santa Felicia Dam and the Santa Clara River downstream of the confluence with Piru Creek. This plan shall: (1) specify the field sampling program, including specific methods and sampling schedules, to evaluate the effectiveness of the ramping rate for minimizing the likelihood of stranding and displacing steelhead, (2) describe the methods to monitor the number, size, and disposition of displaced and stranded steelhead, (3) require that the ramping rate shall be modified in collaboration with NMFS should the findings of the field sampling program indicate the ramping rate is not minimizing steelhead stranding or displacement, and (4) require the preparation and submittal of reports to NMFS that detail the findings obtained from monitoring the effectiveness of the ramping rate and steelhead stranding and displacement. Specific details of various elements of this plan, including schedules and content of monitoring or findings reports, will be developed by the Licensee in cooperation with and agreement from NMFS prior to implementation of this plan. The Licensee shall be responsible for funding and implementing the plan. No later than 60 days following the date of NMFS' letter commenting on the draft plan, the Licensee shall submit to NMFS (at the foregoing address) for review and potential agreement a final plan that addresses NMFS' comments. The Licensee must receive final NMFS agreement for the plan prior to implementing the plan. Upon receipt of final NMFS agreement on the plan, the Licensee shall commence implementation of the final plan as agreed upon by NMFS in accordance with the schedules provided therein.

XI. REINITIATION OF FORMAL CONSULTATION

As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in this opinion, (3) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

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