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SUPERIOR COURT OF CALIFORNIA
COUNTY OF MERCED

WATER AUDIT CALIFORNIA, A Public Benefit Corporation,	) Case No. 22CV-03034
Plaintiff and Petitioner,	) VERIFIED COMPLAINT) FOR DECLARATORY) AND INJUNCTIVE RELIEF;) VERIFIED PETITION FOR WRIT) OF MANDATE
THE MERCED IRRIGATION DISTRICT AND DOES 1 to 1,000,	) *CCP §§ 526, 1021.5, 1060, 1085;*) *FGC §§ 5901, 5935, 5936, & 5948*
Defendants and Respondents.	) Jury trial requested

MEMORANDUM OF POINTS AND AUTHORITIES

TABLE OF AUTHORITIES

Cases

Statutes

Constitutional Provisions

I. Introduction.

1. Plaintiff and Petitioner Water Audit California ("Petitioner" or "Water Audit") brings this action, on its own behalf and on behalf of the general public and in the public interest, to remedy the failure of the Defendant and Respondent Merced Irrigation District ("Respondent" or "District") to comply with statutory obligations and duties to the public trust in its operation of the Crocker-Huffman Dam ("Dam") on the Merced River.

2. California *Fish and Game Code* ("*FGC*") *§§ 5935* and *5936* require the District to maintain the fishway on the Dam ("fishway") in good operating condition to allow the free passage of fish.

3. Petitioner seeks a declaratory judgment, an injunction, and/or a writ of mandate to compel the District to comply with its statutory duties.

II. Parties.

4. Water Audit is a public benefit corporation organized and existing under the laws of the State of California. Water Audit is a "person" under *California Corporations Code § 18* ("'Person' includes a corporation as well as a natural person"); *§ 15901.02(y)* ("'Person' means an individual . . . corporation . . ."); and *§ 25013* ("'Person' means an individual, a corporation . ..."). Water Audit brings this action on its own behalf and as a private attorney general advocating for the interests of all of the people of California.

5. The District is a public corporation of the state, organized as an irrigation district formed pursuant to the laws of California. (See *Water Code, div. 11*).

6. Water Audit does not know the true names of defendants and respondents DOES 1 to 1,000, inclusive, and therefore sues them with these fictitious names. Water Audit is informed and believes, and on the basis of such information and belief, alleges that each of these parties is in some manner legally responsible for the events and happenings alleged herein. Water Audit is further informed and believes, and on the basis of such information and belief alleges, that at all times mentioned the defendants and respondents were the partners, agents, coventurers, and/or employees of their co-defendants and respondents, and in doing the things herein alleged were acting within the course and scope of such agency and employment. Alternatively, the DOES have acted in reliance on permission granted by the District in their failure to maintain the fishway and their future action must be equitably amended to avoid future injury to the public trust. Alternatively, the DOES have acted without permission in their failure to maintain the fishway and their future action must be equitably amended to avoid injury to the public trust. The Petitioner will seek leave to amend to insert the true names of the DOES when such parties have been identified.

7. The District and DOE defendants/respondents will collectively be referred to as "defendants."

III. Venue.

8. The venue is proper in this court under the California *Code of Civil Procedure* ("*CCP*") *§395(a)* because the Dams and associated fishways, the waters discussed herein, and the offices of the District, are all within the County of Merced, California.

IV. Jurisdiction.

9. Water Audit seeks an injunction, (*CCP § 526*) declaratory relief (*CCP § 1060*), and a writ of mandate (*CCP §1085*). Each of these is within the jurisdiction of this court. California *Constitution art. VI, sec. 1 & 4.*

10. Water Audit has performed all conditions precedent to filing suit or is excused from such conditions. *Water Code § 1851*.

11. Water Audit has given notice to the District of its intended litigation. See the Declaration of William McKinnon WAC 000199 et seq.

12. The Crocker-Huffman Dam is not a Federal Energy Regulatory Commission ("FERC") project. "Crocker-Huffman dam is located downstream of the Merced River Project dams." https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/docs/mrcdrvr2179/study_dispute.pdf, page 1.

13. The U.S. Supreme Court has held that while application of state law may be preempted either by (a) federal law occupying the field, or (b) a conflict with federal law that makes it impossible to comply with both state and federal law, the federal government's environmental regulation does not preempt state environmental regulations that are not in actual conflict. *California Coastal Comm'n v. Granite Rock Co.* 480 U.S. 572 at pp. 581-583.

14. There are no FERC regulations pertaining to the fishway.

15. This Court has subject matter jurisdiction because the causes of action arise, inter alia, under the *California Fish & Game Code*, ("*FGC*"); the *California Water Code*; the *Code of Civil Procedure Code* ("*CCP*"); and the California public trust doctrine.

16. The courts have recognized the State's responsibility to protect public trust uses whenever feasible. (*See*, e.g., *Audubon, supra, 33 Cal.3d 435*; *California Trout, Inc. v. State Water Resources Control Bd.* (1989) 207 Cal.App.3d 585, 631; *California Trout, Inc. v. Superior Court* (1990) 218 Cal.App.3d 187, 289.

V. Facts.

17. The District is the owner and operator of four dams on the Merced River. *See* Figure 1.

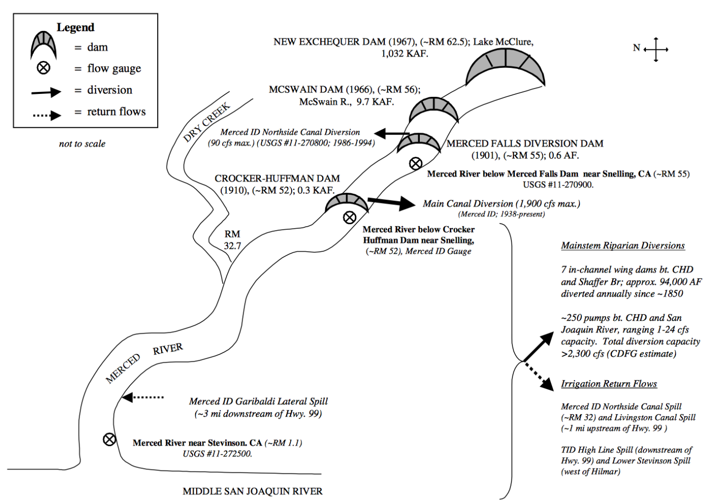

Figure 5.5. Lower Merced River Dams, Diversions, and Gauges
Data sources: USGS and CDEC web sites, CDWR DSD Bulletin17-00, Stillwater Sciences 2001

San Joaquin Basin Ecological Flow Analysis **5.11**

Figure 1: San Joaquin Basin Ecological Flow Analysis[1]

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[1] Prepared for the Bay-Delta Authority by the Natural Heritage Institute, Berkeley, California. (August 2003)

18. The upper three dams, the New Exchequer, McSwain and Merced Falls dams, are undergoing relicensing by the Federal Energy Regulatory Commission ("FERC"). The New Exchequer and the McSwain Dams are administered as FERC Project No. 2179, and the Merced Falls Dam as FERC Project No. 2467. See e.g. *Final Environmental Impact Statement for Hydropower Licenses. https://elibrary.ferc.gov/eLibrary/idmws/common/opennat.asp?fileid=14063280*

19. This matter concerns only the Crocker-Huffman diversion dam, (NID[2] CA 00672) which is not subject to federal jurisdiction or FERC review.

Figure 2: Overview of Crocker-Huffman Dam complex
McKinnon Declaration WAC 000017

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https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/exhibits/ar_nhi/ar_nhi_exh11.pdf

[2] US Army Corps of Engineers National Inventory of Dams at: https://nid.usace.army.mil/#/dams/search/sy=@name:crocker%20huffman&viewType=map&resultsType=dams&advanced=false&hideList=false&eventSystem=false

Figure 3: View of the Crocker-Huffman Dam from the river right bank.
In the foreground is the ogee spillway. Beyond that is the fish ladder, followed by the primary dam crest.
McKinnon Declaration WAC 000018

20. A fishway was installed to allow the passage of fish upstream and downstream of the Dam (the “fishway”).

21. The California Department of Fish and Wildlife (“CDFW”) operates the Merced River Hatchery (MRH) downstream of the Dam. The MRH produces Chinook salmon for sport fishing.

Figure 5. View looking upstream at the fish ladder at the Crocker-Huffman Dam. One of the original orifices is visible. All weirs have been notched to the river-left side (to the right side of the photo).

Figure 4: NOAA Technical Memorandum. McKinnon Declaration WAC 000019

22. The federal and state regulators have directed the District to reopen the fishway.

23. In November 2009, CDFW wrote to the District:

> [T]he Crocker-Huffman diversion dam impedes the passage of resident and anadromous fish up and down stream except during rare high flow events. Meanwhile, the fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead rainbow trout (*O. mykiss*) anadromous fish populations in the Merced River have deteriorated to extremely low levels. Given this background and the current situation, the Department has determined that fish passage at the Crocker-Huffman Diversion Dam must be restored. McKinnon Declaration WAC 000002-3

24. In November 2010, NOAA Fisheries wrote to the District:

> Based on our inspections and in consideration of input from the other participants, NOAA Fisheries-Engineering Branch believes that fish passage at Crocker-Huffman Dam and Merced Falls Dam should be re-established as a near-term, interim measure toward habitat restoration and recovery of Merced River's anadromous fish populations. Such actions are consistent with NMFS' long-term recovery goals in the Merced River watershed. In addition, re-establishment of fish passage has recently been identified as a conservation measure needed to maintain compliance with State Fish & Game code.
> McKinnon Declaration WAC 000006

> Based on this site inspection, no obvious reasons were discovered that indicate the current fish ladder will not function for fish passage if it were placed back in service and hydraulically tuned to obtain its optimal flow conditions. … Based on this site inspection, no obvious reasons were discovered that indicate the current fish ladder will not function for fish passage if it were placed back in service and hydraulically tuned to obtain its optimal flow conditions. NOAA Technical Memorandum, McKinnon Declaration WAC 000021

VI. Regulatory Background.

25. As set forth below, the District has failed in its ministerial statutory duties under the *FGC* and its common law duties under the public trust doctrine to protect public trust fish by keeping the fishway in good repair and open and free from obstructions to the passage of fish at all times.

26. The state holds the fish in its streams in trust for the public. (*California Trout, Inc. v. State Water Resources Control Bd*. (1989) 207 Cal.App.3d 585, 630.)

27. Fish have for many years been blocked from natural spawning by the inoperative fishway. “[M]ore than 100 miles of habitat historically available to Chinook salmon and CV steelhead[3] is permanently blocked by Crocker-Huffman Dam, the most upstream point a salmon or steelhead is able to migrate for spawning purposes. … The Merced River below Crocker-Huffman Dam is impacted by loss of flow, reduced quantity of spawning habitat due to loss of suitable gravel, and poor water quality.” https://www.fisheries.noaa.gov/west-coast/habitat-conservation/san-joaquin-river-basin#merced-river

28. *FGC § 1600* states:

> The Legislature finds and declares that the protection and conservation of the fish and wildlife resources of this state are of utmost public interest. Fish and wildlife are the property of the people and provide a major contribution to the economy of the state, as well as providing a significant part of the people's food supply; therefore their conservation is a proper responsibility of the state. This chapter is enacted to provide conservation for these resources.

29. "[S]ection 1600 of the Fish and Game Code expressly indicates that the Legislature's intent in enacting section 1603 was to provide for the protection and conservation of fish and wildlife resources, a goal that the Legislature declared to be `of [the] utmost public interest.'" (*People v. Ramsey* (2000) 79 Cal.App.4th 621, 636.)

30. The Crocker-Huffman Dam is located in California Department of Fish and Wildlife (“CDFW”) Region 4. (https://wildlife.ca.gov/Regions)

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[3] While federal protections focus on the salmonid species, California law is more expansive. *FGC § 45* states: "’Fish’ means wild fish, mollusks, crustaceans, invertebrates, or amphibians, including any part, spawn, or ova thereof.”

31. *FGC § 5901* states:

> Except as otherwise provided in this code, it is unlawful to construct or maintain in any stream in Districts … 4 … any device or contrivance that prevents, impedes, or tends to prevent or impede, the passing of fish up and down stream.

32. *FGC §§ 5935 and 5936* impose an unambiguous ministerial duty on the District to maintain fishways to allow the passage of fish.

33. *FGC § 5935* states:

> The owner of any dam upon which a fishway has been provided shall keep the fishway in repair and open and free from obstructions to the passage of fish at all times. (Emphasis added.)

34. *FGC § 5936* states:

> It is unlawful to willfully destroy, injure, or obstruct any fishway. (Emphasis added.)

35. *FGC § 5948* states in pertinent part:

> No person shall cause or having caused, permit to exist any log jam or debris accumulation or any other artificial barrier … which will prevent the passing of fish up and down stream or which is deleterious to fish …

VII. Causes of Action.

FIRST CAUSE OF ACTION
DECLARATORY RELIEF – CCP § 1060;
FGC §§ 5935 & 5936
and the public trust doctrine
MERCED IRRIGATION DISTRICT
and Does 1 to 1000

36. The Petitioner incorporates and restates the preceding paragraphs as if set forth in full here.

37. A controversy exists between Water Audit and the District concerning the obligations of the District to comply with *FGC §§ 5935 and 5936* and the public trust doctrine.

38. Water Audit made a demand on the District to reopen the fishway and gave notice of its intention to commence litigation if remediation was not promised. McKinnon Declaration WAC 000200

39. The District responded in pertinent part:

> We do not believe that a state or federal court would have the authority to address or consider the issues raised in your letter in light of the ongoing FERC relicensing process involving MID's federally licensed facilities. We believe any lawsuit involving the issues raised in your letter would be preempted by the FERC proceeding, or at the very least would be premature and unripe pending further action by FERC in connection with the relicensing process. (Emphasis added.) McKinnon Declaration WAC 000207

40. Water Audit asserts that the Crocker-Huffman Dam fishway is not exempted by FERC process, and therefore this court has jurisdiction to order compliance with the *FGC*.

41. Declaratory relief is available to a party "who desires a declaration of his or her rights or duties with respect to another . . ." (*CCP § 1060*)

42. Citizens may enforce a State agency's affirmative duty to comply with the public trust doctrine in court. (*Audubon*, 33 Cal.3d at p. 431 n.11, citing *Marks v. Whitney*, 6 Cal.3d at pp. 261–62; *see also Center for Biological Diversity* 166 Cal.App.4th 1349, 1366 (2008) ["the public retains the right to bring actions to enforce the trust when public agencies fail to discharge their duty"].

43. "Declaratory relief operates prospectively, serving to set controversies at rest before obligations are repudiated, rights are invaded, or wrongs are committed. Thus, the remedy is to be used to advance preventative justice, to declare rather than execute rights. [Citation.]" (*Kirkwood v. California State Automobile Assn. Inter-Ins. Bureau* 193 Cal.App.4th 49, 59 (2011). In essence, declaratory relief operates to declare future rights, not to address past wrongs. (*Canova v. Trustees of Imperial Irrigation Dist. Employee Pension Plan* 150 Cal.App.4th 1487, 1497 (2007).)

44. A party seeking declaratory relief must show a very significant possibility of future harm. *Coral Construction, Inc. v. City and County of San Francisco* 116 Cal.App.4th 6, 17 (2004). In assessing whether declaratory relief is available, a court determines whether “a probable future dispute over legal rights between parties is sufficiently ripe to represent an ‘actual controversy” within the meaning of the statute authorizing declaratory relief (*CCP § 1060*), as opposed to purely hypothetical concerns.” (*Steinberg v. Chiang* 223 Cal.App.4th 338, 343 (2014).)

45. Water Audit asserts that the ministerial duty of the District to comply with *FGC §§ 5935* and *5936* is clear, unambiguous, and non-discretionary.

46. Water Audit asserts that the failure to maintain the fishway is a continuing injury to the public trust. The public trust doctrine “begins and ends with whether the challenged activity harms a navigable waterway[4] and thereby violates the public trust ...” (*Envtl. Law Found. v. State Water Res. Control Bd.*, 26 Cal.App.5th 844, 855-860). Any “analysis begins and ends with whether the challenged activity harms a navigable waterway and thereby violates the public trust.” (*Id*. at 860).

47. Mere proximity does not equal preemption.

48. Crocker-Huffman Dam is a non-hydro dam, is not under FERC jurisdiction, and is outside of the FERC licensing boundary.

49. Federal law that authorizes and controls FERC does not occupy the entire field of fish passage generally, or fishways specifically, nor create a conflict that makes it impossible to comply with both state and federal law. *California Coastal Comm'n, supra.*

50. A complaint for declaratory relief is legally sufficient if it sets forth facts showing the existence of an actual controversy relating to the legal rights and duties of the parties and requests that the rights and duties of the parties be adjudged by the court.

51. If these requirements are met and no basis for declining declaratory relief appears, the court should declare the rights of the parties whether or not the facts alleged establish the plaintiff is entitled to the favorable declaration. (*Ludgate Ins. Co. v. Lockheed Martin Corp*. 82 Cal.App.4th 592, 606 (2000).)

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[4] The Merced River is a navigable waterway. https://www.spk.usace.army.mil/Missions/Regulatory/Jurisdiction/Navigable-Waters-of-the-US/

52. Water Audit and the District have a real and present controversy concerning the operation of the Crocker-Huffman Dam on the following issues:

(a) Whether the FERC proceedings regarding the New Exchequer, McSwain and Merced Falls dams allow the District to refuse to comply with present statutory duties and constraints under, *inter alia, FGC* § *5901, 5935, 5936* & *5948,* and common law duties under the public trust doctrine.

(b) Whether *FGC § 5935* requires that the District must keep the fishway in good repair, and open and free from obstructions to the passage of fish at all times.

(c) Whether the District must cease obstructing the fishway so as to comply with *FGC § 5936.*

WHEREFORE Water Audit prays for relief as hereinafter set forth.

SECOND CAUSE OF ACTION
INJUNCTION
***CCP § 526; FGC § 5935* & 5936**
and the public trust doctrine
MERCED IRRIGATION DISTRICT
And Does 1 to 1000

53. The Petitioner incorporates and restates the preceding paragraphs as if set forth in full here.

54. *FGC §§ 5935* and *5936* make it mandatory that the District provide the maintenance necessary to repair, maintain and maintain the free passage of fish through the fishways at dams. “We must presume that governmental agencies will obey and follow the law.” (*East Bay Mun. Utility Dist. v. Department of Forestry Fire Protection* 43 Cal.App.4th 1113, 1132 (1996))

55. *CCP § 525 states:* “An injunction is a writ or order requiring a person to refrain from a particular act.”

56. *CCP § 526* states in the pertinent part:

> a) An injunction may be granted in the following cases:
>
> (1) When it appears by the complaint that the plaintiff is entitled to the relief demanded, and the relief, or any part thereof, consists in restraining the commission or continuance of the act complained of, either for a limited period or perpetually.
>
> (2) When it appears by the complaint or affidavits that the commission or continuance of some act during the litigation would produce waste, or great or irreparable injury, to a party to the action.
>
> (3) When it appears, during the litigation, that a party to the action is doing, or threatens, or is about to do, or is procuring or suffering to be done, some act in violation of the rights of another party to the action respecting the subject of the action, and tending to render the judgment ineffectual.
>
> (4) When pecuniary compensation would not afford adequate relief.
>
> (5) Where it would be extremely difficult to ascertain the amount of compensation which would afford adequate relief.
>
> (6) Where the restraint is necessary to prevent a multiplicity of judicial proceedings.
>
> (7) Where the obligation arises from a trust.

57. In this case, an injunction would be identical in purpose and function as a writ of mandate. Consequently, to the extent traditional mandate constitutes a proper remedy, the remedy of injunctive relief is also proper. *Venice Town Council, Inc. v. City of Los Angeles* (1996) 47 Cal.App.4th 1547, 1563 fn. 9

58. Water Audit reiterates all of the allegations, facts, and authority set forth in the Third Cause of Action as if set forth in full at this place.

WHEREFORE Water Audit prays for relief as hereinafter set forth.

THIRD CAUSE OF ACTION
WRIT OF MANDATE
CCP § 1085; FGC § 5935
and the public trust doctrine
MERCED IRRIGATION DISTRICT
And Does 1 to 1000

59. The Petitioner incorporates and restates the preceding paragraphs as if set forth in full here.

60. *FGC §§ 5935* and *5936* require that the District, as owner of the Crocker-Huffman Dam, provide the maintenance necessary to repair, maintain and maintain the free passage of fish through the fishway at the Dam, and explicitly must not obstruct the passage of fish. "We must presume that governmental agencies will obey and follow the law." (*East Bay Mun. Utility Dist. v. Department of Forestry Fire Protection* 43 Cal.App.4th 1113, 1132 (1996))

61. The record proves the environmental injury caused by the District's unlawful conduct. For very limited examples, see McKinnon Declaration WAC 000002 -000199.

62. Nevertheless, *FGC §§ 5935* and *5936* do not require consideration of such matters. They could not be more explicit: if a fishway is present, it must be operational. There are no qualifications, equivocations or limitations.

63. Compliance with California statute is mandatory by agencies of the State. Laws, regulations, and other standards are policy decisions made by the Legislature. A subdivision of the State, such as the District, must apply those standards as adopted.

64. If an agency refuses to perform a ministerial duty, an affected party may seek a writ of mandate. A writ of mandate may be issued by any court to any corporation, board, or person, to compel the performance of an act which the law specially enjoins, as a duty resulting from an office, trust, or station. (*CCP § 1085(a)*)

65. *CCP § 1085* is the proper vehicle for challenging a ministerial act of an agency. (*Morton v. Board of Registered Nursing* (1991) 235 Cal.App.3d 1560, 1566, fn. 5).

66. The general rule is that the petitioner must show he or she has some special interest to be served or some particular right to be preserved or protected through the issuance of the writ, (*Waste Management of Alameda County, Inc. v. County of Alameda* (2000) 79 Cal.App.4th 1223, 1232)

67. However, "where an issue is one of public right, and the object of the action is to procure the enforcement of a public duty, it is sufficient that the plaintiff be interested as a citizen in having the laws executed and the duty in question enforced. [Citations omitted]" *Waste Management of Alameda v. City. of Alameda* (2000) 79 Cal.App.4th 1223, 1233. The exception promotes the policy of guaranteeing citizens the opportunity to ensure that no governmental body impairs or defeats the purpose of legislation establishing a public right. *(Green v. Obledo* (1981) 29 Cal.3d 126, at page 144)

68. The District's obligations under the public trust arise from its ministerial obligation to provide for free passage of public trust fish in the fishway. The District's failure to perform its statutory duties under the *FGC* is evidence of the violation of its duties to do no unnecessary injury to the public trust.

69. A writ must be issued in all cases where there is not a plain, speedy, and adequate remedy, in the ordinary course of law. (*CCP § 1086*; *Brown v. Superior Court* 5 Cal.3d 509, 514 (1971).)

70. The issuance of a writ is mandatory when an adequate legal remedy is not available *and* the other requirements for a writ have been met. (*May v. Board of Directors* (1949) 34 Cal.2d 125, 133–134.)

71. "Two basic requirements are essential to the issuance of the writ: (1) A clear, present and usually ministerial duty upon the part of the respondent [numerous citations omitted] and (2) a clear, present and beneficial right in the petitioner to the performance of that duty [numerous citations omitted] *Venice Town Council, Inc. v. City of Los Angeles* (1996) 47 Cal.App.4th 1547, 1558

72. "Mandamus will lie to compel a public official to perform an official act required by law. (Code Civ. Proc., § 1085) Mandamus will not lie to control an exercise of discretion, i.e., to compel an official to exercise discretion in a particular manner. Mandamus may issue, however, to compel an official both to exercise his discretion (if he is required by law to do so) and to exercise it under a proper interpretation of the applicable law." *Common Cause v. Board of Supervisors* (1989) 49 Cal.3d 432, 442

73. The District's duty to provide the maintenance necessary for the fishway is a ministerial act required to comport with the *FGC*.

74. The District has admitted no fault and will continue its conduct unless ordered by the Court to do otherwise.

75. A writ of mandate may be issued when there is not a plain, speedy, and adequate remedy in the ordinary course of law. (*CCP §§ 1086* & *1103(a); Phelan v. Superior Court* (1950) 35 Cal.2d 363.)

76. The injury to the public trust cannot be remedied or mitigated by an award of damages. There is no regulatory process for relief.

77. The allegations, as set forth herein, entitle Water Audit to a writ as an equitable remedy. (*see Camp v. Board of Supervisors* (1981) 123 Cal.App.3d 334, 355).

78. Pursuant to *FGC § 5935* the District must keep the fishway in good repair, and open and free from obstructions to the passage of fish at all times.

79. The District must cease obstructing the fishway so as to comply with *FGC § 5936.*

WHEREFORE Water Audit prays for relief as hereinafter set forth.

VIII. Prayers for Relief.

For the First Cause of Action for Declaratory Relief

1. Water Audit seeks a declaration from the Court that the presently pending Federal Energy Regulatory Commission Project No. 2179, and Project No. 2467 do not pertain to the fishway on the Crocker-Huffman Dam;
2. Water Audit seeks a declaration from the Court that the District has a ministerial duty pursuant to *FGC § 5935* to maintain the fishways at the Dams in good repair, open and free from obstructions to the passage of fish at all times; and
3. Water Audit seeks a declaration from the Court that the District has a ministerial duty pursuant to *FGC § 5935* to immediately put the fishways at the Dams into good repair, and re-open them free from obstructions to the passage of fish; and

4. Water Audit seeks a declaration from the Court that the District has a ministerial duty pursuant to *FGC § 5936* to refrain at all times in the future from willfully destroying, injuring, or obstructing any fishway associated with the Dams.

For the Second Cause of Action for an Injunction

1. Pursuant to *FGC § 5935,* the Court order the District to keep the fishway on the Crocker-Huffman Dam in good repair, open, and free from obstructions to the passage of fish at all times.
2. Pursuant to *FGC § 5936,* the Court order the District to cease obstructing the fishway to the passage of fish.

For the Third Cause of Action for Writ of Mandate

1. Pursuant to *FGC § 5935,* the Court order the District to keep the fishway on the Crocker-Huffman Dam in good repair, open, and free from obstructions to the passage of fish at all times.
2. Pursuant to *FGC § 5936,* the Court order the District to cease obstructing the fishway to the passage of fish.

For all Causes of Action

1. Water Audit seeks any and all other available relief as appropriate;
2. Costs of suit, expenses, including reasonable attorney fees according to the *California Code of Civil Procedure § 1021.5*, and other provisions of law; and
3. Such other and further relief as the Court deems appropriate.

September 19, 2022

William McKinnon
Attorney for Water Audit California

IX. Verification

Pursuant to *CCP § 446(a)*, I William McKinnon, attorney for Water Audit California, provide my signature on this verification, as the director of Water Audit California is absent from the county of my office and/or is unable to verify this complaint and petition.

I have read the foregoing VERIFIED COMPLAINT FOR DECLARATORY AND INJUNCTIVE RELIEF; VERIFIED PETITION FOR WRIT OF MANDATE and know the contents thereof. I am informed and believe the matters therein to be true and on that ground allege that the matters stated therein are true. The same is true of my own knowledge, except as to those matters which are avowed in declarations or stated to be on information and belief, and as to those matters, I believe them to be true.

I declare under penalty of perjury that the foregoing is true and correct and that this verification was executed at Grass Valley, California, this 19th day of September 2022.

____

William McKinnon

X. Word Count

I certify that according to the Word computer program used to prepare this brief that the Appellant Water Audit California's Complaint and Petition herein contains 4,396 words, not including the cover, the Tables of Contents and Authorities, the verification, this certificate, and the signature blocks.

I declare under the penalty of perjury under the laws of the State of California that the foregoing is true and correct. Executed on September 19, 2022, in Grass Valley, California.

William McKinnon
Attorney for Water Audit California

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SUPERIOR COURT OF CALIFORNIA

COUNTY OF MERCED

WATER AUDIT CALIFORNIA, A Public Benefit Corporation, Plaintiff and Petitioner, v. MERCED IRRIGATION DISTRICT AND DOES 1 to 1,000, Defendants and Respondents.	Case No. 22CV-03034 DECLARATION OF WILLIAM MCKINNON IN SUPPORT OF A VERIFIED COMPLAINT FOR DECLARATORY AND INJUNCTIVE RELIEF; VERIFIED PETITION FOR WRIT OF MANDATE

I, WILLIAM McKINNON, declare as follows:

1. I am an active member of the State Bar of California and the attorney of record of the Plaintiff and Petitioner Water Audit California herein. I make this declaration of my own personal knowledge, and if called could and would testify competently as follows.

2. The attached documents are true and correct copies of documents received from NOAA Fisheries in response to a Freedom of Information Act request.

3. Attached hereto as Exhibit A is a true and correct copy of the November 16, 2009 California Department of Fish and Game Letter to the Merced Irrigation District that addresses the Legal Requirements of California Fish and Game Code for Fish Passage at the Crocker-Huffman Diversion Dam.

4. Attached hereto as Exhibit B is a true and correct copy of the November 15, 2010 NOAA letter to the Merced Irrigation District and to the Pacific Gas and Electric Company that addresses NOAA's inspections and evaluations of NOAA and an attached NOAA Technical Memorandum which describes the nature of the site inspections and evaluations and recommendations.

5. Attached hereto as Exhibit C is a true and correct copy of the January 4, 2012 NOAA letter to the Merced Irrigation District and to the Pacific Gas and Electric Company that addresses resuming Fish Passage Operations at Crocker-Huffman and Merced Falls Dams.

6. Attached hereto as Exhibit D is a true and correct copy of the October 20, 2017 National Marine Fisheries Service (NMFS) draft final report on Genetic analysis of *Oncorhynchus mykiss* in the Upper Tuolumne and Merced Rivers to evaluate ancestry and adaptive genetic variation.

7. Attached hereto as Exhibit E is a true and correct copy of the 2018 published study of the NMFS study entitled: Genetic analysis of *Oncorhynchus mykiss* in the Upper Tuolumne and Merced Rivers to evaluate ancestry and adaptive genetic variation.

8. Attached hereto as Exhibit F is a true and correct copy of the April 25, 2022 letter from FERC Hydropower Branch Supervisor NMFS, WCR, Central Valley Area Office, to the Federal Energy Regulatory Commission, which is in reference to NOAA's National Marine Fisheries Service, West Coast Region, Provides Technical Assistance, pursuant to the Endangered Species Act and the Magnuson-Stevens Fishery Conservation and Management Act, Regarding the Supplemental Environmental Impact Statement for the

Merced River (P-2179) and Merced Falls (P-2467) Hydroelectric Projects, Merced River, California.

9. Attached hereto as Exhibit G is a true and correct copy of the demand for fishway remediation made by Water Audit California to the Merced Irrigation District on August 29, 2022.

10. Attached hereto as Exhibit H is a true and correct copy of the response to the aforesaid demand transmitted by Merced Irrigation District to Water Audit California on September 8, 2022.

I declare the foregoing to be true, subject to the penalty of perjury.

Executed at Grass Valley, California, this 16th day of September 2022.

____

William McKinnon

EXHIBIT A

California Natural Resources Agency
DEPARTMENT OF FISH AND GAME
Central Region
1234 East Shaw Avenue
Fresno, California 93710
www.dfg.ca.gov

***ARNOLD SCHWARZENEGGER**, Governor*
***DONALD KOCH,** Director*

November 16, 2009

Hicham Eltal
Deputy General Manager
Merced Irrigation District
744 West 20th Street
Merced, California 95340

Re: Legal Requirements of California Fish and Game Code for Fish Passage at the Crocker-Huffman Diversion Dam

Dear Mr. Eltal:

The Department of Fish and Game (Department) has reviewed our previous direction regarding the fish ladder at Merced Irrigation District's (Merced ID) Crocker-Huffman Diversion Dam, in the context of current condition of the anadromous fish populations in the Merced River, historic and ongoing efforts to manage those populations, and Fish and Game Code (FGC) § 5901, which provides that "it is unlawful to construct or maintain" any barrier "that prevents, impedes, or tends to prevent or impede, the passing of fish up and down stream," unless otherwise authorized by the FGC.

The Department and Merced ID have made several adaptive changes at the Crocker-Huffman Diversion Dam over the years to reduce the impact the diversion and dam have on fish resources. At one time, Merced ID operated a fishway at Crocker-Huffman. Then, in the early 1970s, the Department recommended closing the fish ladder in conjunction with construction of an experimental spawning channel adjacent to the diversion dam. At that time, the Department believed a spawning channel, along with minimum flow releases required by the Federal Energy Regulatory Commission from upstream hydropower projects (Nos. 2467 and 2179), would provide the best opportunity for restoring salmon on the Merced River. Unfortunately the spawning channel experiment failed and Merced ID may no longer rely on the Department's letter from the 1970s. Additional management actions are necessary to maintain and recover anadromous fish in the Merced River.

Today, the Crocker-Huffman diversion dam impedes the passage of resident and anadromous fish up and down stream except during rare high flow events. Meanwhile, the fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead rainbow trout (*O. mykiss*) anadromous fish populations in the Merced River have deteriorated to extremely low levels. Given this background and the current situation, the Department has determined that fish passage at the Crocker-Huffman

Diversion Dam must be restored. FGC §5935 states "the owner of any dam upon which a fishway has been provided shall keep the fishway in repair and open and free from obstructions to the passage of fish at all times". The Department directs Merced ID to consult with the Department to i) make a determination regarding anadromous fish passage adequacy of the existing (but closed) Crocker-Huffman Dam fishway and ii) assist the Merced ID in developing a Crocker-Huffman anadromous fish passage plan[1].

We do not expect nor desire that opening the existing fishway take place in an immediate and unplanned manner, but rather in a thoughtful and collaborative manner that leads to improved fish habitat and fish populations, as well as fitting with Merced ID's operational needs to the greatest extent possible.

My staff and I look forward to working with Merced ID to restore the passage of resident and anadromous fish over the Crocker Huffman Diversion Dam, as required by the Fish and Game Code. If you have any questions regarding this letter, please contact Mr. Dean Marston, Environmental Program Manager, of my staff at (559) 243-4014, extension 241.

Sincerely,

Original signed by Jeffrey R. Single, Ph.D.

Jeffrey R. Single, Ph.D.
Regional Manager

cc: Page Three

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[1] This plan would include, but not be limited to, identifying the timeframes for fish passage implementation, restoration of anadromous fish habitat upstream of Crocker-Huffman in conjunction with passing fish upstream of Crocker-Huffman, and development of provisions to preclude further impacts to the Merced River anadromous fish populations as a result of operation of a fishway at Crocker-Huffman Dam.

cc: Mr. Timothy Welch
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

Mr. Steve Edmondson
National Marine Fisheries Service
777 Sonoma Avenue, Suite 325
Santa Rosa, California 95404

Mr. Ramon Martin
Anadromous Fish Restoration Program
U.S. Fish and Wildlife Service
4001 North Wilson Way
Stockton, California 95205

Mr. James Eicher
Bureau of Land Management
63 Natoma Street
Folsom, California 95630

Ms. Vicky Whitney
Division of Water Rights
State Water Resources Control Board
Post Office Box 100
Sacramento, California 95812-0100

Mr. Steve Nevares
Pacific Gas and Electric Company
245 Market Street
San Francisco, California 94105

Mr. Brian Johnson
California Trout
870 Market Street, No. 1185
San Francisco, California 94102

Mr. Chris Shutes
California Sportfishing Protection Alliance
1608 Francisco Street
Berkeley, California 94703

EXHIBIT B

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
777 Sonoma Ave., Room 325
Santa Rosa, California 95404-4731

November, 15, 2010

In response, refer to:
SWR/F/SWR3:RW

John Sweigard
General Manager
Merced Irrigation District
P.O. Box 2288
Merced, California 95344-0288

Steve Nevares
PG&E, M.C. N11D
P.O. Box 770000
San Francisco, California 95117

Dear Mr. Sweigard and Mr. Nevares:

NOAA's National Marine Fisheries Service (NMFS) conducted two separate site inspections and evaluations of the in-river structures composing the Merced River and Merced Falls water and power delivery system. These site inspections occurred on February 2, 2010, and November 3, 2010. In addition to NOAA personnel, other participants in these site evaluations included personnel from California Department of Fish and Game (CDFG), U.S. Fish & Wildlife Service, Winzler and Kelly, Ecosystems Sciences, and GeoEngineers.

Based on our inspections and in consideration of input from the other participants, NOAA Fisheries-Engineering Branch believes that fish passage at Crocker-Huffman Dam and Merced Falls Dam should be re-established as a near-term, interim measure toward habitat restoration and recovery of Merced River's anadromous fish populations. Such actions are consistent with NMFS' long-term recovery goals in the Merced River watershed. In addition, re-establishment of fish passage has recently been identified as a conservation measure needed to maintain compliance with State Fish & Game code.

In the case of the Merced Falls and Crocker-Huffman fish ladders, we request hydraulic start-up testing beginning in January or February, 2011. Continued operations will depend on the outcome of these operational tests, and be developed in accordance with CDFG and NOAA Fisheries management objectives for Merced River anadromous fish resources. In addition, we recommend hydraulic evaluation and testing of the now-defunct "spawning channel" as an alternate means of fish passage at the Crocker-Huffman site. Adaptive management should be employed toward the incremental design, construction, and operation of safe, timely, and effective fish passage and protection systems, as well as the enhancement of riverine habitats for native anadromous fish species. These actions should be coordinated to involve technical specialists from NMFS-Engineering and other interested resource agencies and stakeholders. We are very interested in assisting the District and PG&E in this important stewardship action on the Merced River.

Enclosed to this letter is a NOAA Technical Memorandum which describes the nature of the site inspections and our evaluations which led to the above recommendations. Please respond to this letter within 30 days of receipt to begin a dialogue about taking steps to restore fish passage in the Merced River. If you have any questions, please feel free to call me at 707-575-6063.

Sincerely,

Richard L. Wantuck
Regional Supervisor
Hydropower and Fisheries Bioengineering Programs

Enclosure

cc: Steve Edmondson, NMFS
Bill Foster, NMFS
John Wooster, NMFS
Maria Rea, NMFS
Monica Gutierrez, NMFS
Larry Thompson, NMFS
Jeff Single, CDFG
Dean Marston, CDFG
Tim Heyne, CDFG
Annie Manji, CDFG
Ramon Martin, USFWS
Daniel Walsh, USFWS

NOAA Technical Memorandum

Date: November 15, 2010

From: NOAA Fisheries, Southwest Region,
Fisheries Bioengineering Branch

Subject: Evaluation of Fish Passage and Habitat Conditions in the Merced River reach between New Exchequer Dam and Crocker-Huffman Dam

1.0 Introduction

On February 2, 2010, personnel from NOAA's National Marine Fisheries Service (NMFS) and the California Department of Fish and Game conducted a Merced River field inspection, with the purpose of evaluating the fish passage and habitat conditions in the Merced River reach between New Exchequer Dam and Crocker-Huffman Dam. Site inspections included stops at New Exchequer Dam, McSwain Dam, Merced Falls Dam, Crocker-Huffman Dam, and the Merced River Hatchery. The main goal of this field trip was to assess the fish passage conditions and facilities at Crocker-Huffman Dam and Merced Falls Dam.

The tour and inspection of Merced River projects had the following goals:

1. Observe, evaluate, and record physical parameters of the fish ladders at the Crocker-Huffman Dam and Merced Falls Dam;
2. Assess the potential for re-establishing fish passage operations for steelhead, Chinook salmon, lamprey, and other resident riverine species;
3. Observe and evaluate conditions of the fish ladder at the Merced Falls Dam;
4. Observe and evaluate river habitat conditions in reaches between Crocker-Huffman Dam and New Exchequer Dam; and

5. Evaluate and formulate conceptual plans for potential fish ladder renovations, re-operation, or other methods of upstream and downstream fish passage at the various facilities in the Merced River.

On November 3, 2010, another inspection took place of the same Merced River dams, fish passage facilities (including the now-defunct spawning channel), hatchery, diversion canals, and associated structures. In addition, this field trip included a more detailed inspection and evaluation of: (a) fisheries habitat potential between dams, (b) options for fish passage and other related facilities between the dams, and (c) the quality of the historic anadromous fish habitat above Lake McClure and fish passage conditions along the main stem of the river - all the way to Yosemite Valley. Personnel from NOAA Fisheries and California Department of Fish and Game were accompanied by consultants from Ecosystem Sciences, GeoEngineers, and Winzler & Kelly - who were hired by NOAA Fisheries to provide third party, expert opinions on matters relating to fish passage and habitat quality in the Merced River. The trio of consultants represented scientists and engineers experienced in fisheries biology, fluvial geomorphology, and hydraulic and civil engineering. Preliminary reports from this second field trip generally confirmed the conclusions reached from the February 2, 2010, investigation, which are presented below. Preliminary evaluations of habitat and passage conditions above Lake McClure indicated that conditions necessary to support anadromous fishes are very likely to still exist upstream of Lake McClure. More detailed studies of the upstream reaches should be conducted within the FERC Integrated Licensing Process for the Merced River hydroelectric facilities, or through other programs in the future. A more detailed technical report by the consulting team will be forthcoming in 2011. This technical memorandum focuses specifically on the fish passage conditions at Crocker-Huffman and Merced Falls Dams.

2.0 Background

One of the most obvious negative effects of the Merced Irrigation District's (MID) water and power complex on the Merced River is the blockage of fish passage by multiple dams. MID owns and operates the New Exchequer, McSwain, and Crocker-Huffman facilities, while Pacific Gas & Electric owns the Merced Falls project facility. With the advent of these water development projects, vast amounts of historic fish habitats have been blocked – and downstream habitat has been significantly altered - thus contributing to the dramatic decline in anadromous fish populations over the course of recent decades.

NMFS' primary concern, with respect to this watershed, is the significant inter-related and inter-dependent adverse effects caused by these projects on habitats for anadromous fish species native to the Merced River. NMFS also recognizes that there are potentially hundreds of stream miles - upstream of Crocker-Huffman Dam and the other hydroelectric project facilities - which may be suitable for future restoration of steelhead, spring-run and fall-run Chinook salmon, and Pacific lamprey habitat.

The NMFS-Southwest Region Hydropower Branch, along with other state/federal agencies and interested stakeholders, is currently involved in a Federal Energy Regulatory Commission (FERC) hydropower licensing process for the two hydropower projects on the Merced River - including the New Exchequer and McSwain Dams- known as the 'Merced River Project,' and the smaller 'Merced Falls Project' located just downstream. It is through FERC's Integrated Licensing Process (ILP) that appropriate, updated operating conditions and facility modifications can be established as terms of a new license issued from the Federal Energy Regulatory Commission. New license conditions are needed because the terms of the first 50- year FERC license failed to adequately conserve and protect the native anadromous fish resources in the Merced River. Thus, the projects have operated for nearly a half century in a manner that has had a very detrimental effect on the Merced River's anadromous fish populations. This situation prompted NMFS, in furtherance of its role as a federal agency with management responsibility for anadromous fish species, to conduct fish passage engineering evaluations of the facility developments of the Merced River – beginning with the first major obstacle to fish passage: Crocker-Huffman Dam.

Crocker-Huffman dam is an MID facility located downstream of the MID and PG&E hydroelectric projects. It was the main focus of this field investigation because it is the first constructed in-river facility which inhibits passage of anadromous fish in this river system. The continued existence of this dam means that in-stream flow and temperature conditions are altered, resulting in a profound effect on fish passage, habitat accessibility, and habitat quality. The dam was originally equipped with a pool and weir fish ladder. The ladder was shutdown in the 1970's when a small hatchery with an experimental, "artificial spawning channel" was constructed adjacent to the dam to attempt to mitigate for lost spawning habitat upstream. Although the spawning channel was not successful (and later abandoned), MID did not resume fish ladder operations at the conclusion of the spawning channel experiment. Thus, while some anadromous fish passage is known to occur at Crocker-Huffman under certain flow conditions – the overall effect is that spawning, rearing, and holding of anadromous fish in reaches upstream of Crocker-Huffman Dam is substantially retarded due to the lack of operable and effective fish passage facilities. Rainbow trout and other resident fish species of various life stages are also severely restricted in their movement due to the habitat fragmentation caused by Crocker-Huffman Dam.

Pacific Gas and Electric owns and operates the Merced Falls dam and hydropower facility located on the Merced River approximately three river-miles upstream from Crocker-Huffman dam. This dam is equipped with a pool-and-weir fish ladder, but because the fish ladder operations ceased at the Crocker-Huffman dam, the fish ladder operations at Merced Falls were terminated as well. The reason for termination of fish facility operations in the early 1970's was the belief that projects' impacts could be satisfactorily mitigated by a small experimental spawning channel and hatchery facility at the Crocker-Huffman site. In hindsight, satisfactory mitigation did not occur, and naturally spawning anadromous fish populations in the Merced River have struggled to survive in the lower reaches below Crocker-Huffman Dam.

Further upstream of the Merced Falls Dam, MID operates the FERC-licensed Merced River Project: comprised of McSwain Dam and New Exchequer Dam along with their associated hydroelectric facilities. McSwain Dam is a rock-fill structure - 97 feet in height, 1500 feet in length. It provides hydraulic head to generate some electricity, while also creating a relatively small impoundment reservoir to act as a re-regulating afterbay for the operations of the New Exchequer Dam - the largest dam in the system further upstream. Standing 479 feet (146 meters), New Exchequer is a rock fill-dam with a concrete reinforced face. Completed in 1967, New Exchequer impounds an artificial reservoir (Lake McClure) with a capacity of 1, 032,000 acre-feet. This dam is a complete barrier to in-stream fish passage and it inundates many miles of historic anadromous fish habitat upstream.

The Merced River once supported prolific runs of spring and fall-run Chinook salmon. Historic evidence indicates that spring-run Chinook were the most prevalent salmonid species in the Merced watershed (and other San Joaquin River tributaries) for many centuries – numbering in the hundreds of thousands - prior to the recent era of dam-building and water diversion in the San Joaquin Valley of California. In contrast, over the last fifty years - with the advent of the dam and water diversion complex – naturally-spawned anadromous fish have been functionally extirpated from historic habitats in lower Yosemite Valley.

Even though the Merced River has been heavily impacted by dams and water diversions, it still exhibits a small, hatchery-supported run of fall-run Chinook salmon. In addition, steelhead and Pacific lamprey- indigenous to the Merced River, struggle to persist under the adverse conditions imposed by the water and power developments, particularly in the drier water years. Merced River steelhead are relatively few in number compared to historical populations; thus the species is listed as threatened under the federal Endangered Species Act. Pacific lamprey also inhabitant the Merced River. These fish are able to pass upstream of Crocker-Huffman Dam to a certain degree because of their unique ability to use "suction" to attach themselves to dams, associated structures, and other migrating fishes while working their way upstream.

From a NMFS perspective, the hydropower and irrigation diversion dams on the Merced River constitute one large, interdependent and interrelated power generation and water delivery complex. This complex has numerous negative impacts on <u>all</u> anadromous fish in the basin, but in particular, the dam and water delivery complex adversely modifies the habitat of ESA-listed steelhead (*Oncorhynchus mykiss*). Unauthorized 'take,' as defined in the federal Endangered Species Act, may be occurring due to the fish passage impediments represented the dams, as well as the unnatural changes to the river's flow and temperature regimes. There can be no arbitrary separation of these impacts because the physical facilities all function in coordination together, and for common purposes. Therefore, whether or not Crocker-Huffman dam is a FERC-licensed facility has no bearing on the direct, indirect, or cumulative effects it causes to fisheries resources - in combination with the related FERC-licensed facilities. It is part of an inter-related and inter-dependent network operated for power generation, irrigated agriculture and municipal/industrial uses.

It is the goal of NMFS hydropower program to restore functional habitats for anadromous fish in the Merced River. This includes habitat improvements in the lower Merced River and reestablishing access to currently blocked upstream habitats. The mechanism for the accomplishment of this goal is either through cooperative and voluntary habitat restoration partnerships, or via the imminent regulatory proceedings, including the FERC ILP process.

Of immediate importance is the restoration of anadromous fish passage at Crocker-Huffman Dam by placing the fish ladder in operation once again, and conducting a fish passage assessment to determine what renovations, refurbishment, or re-design is necessary. The NMFS analysis herein provides a basis to support the restoration of fish passage capability at Crocker-Huffman and Merced Falls dams. NMFS believes anadromous fish passage can be accomplished through relatively quick, cost-effective, and straightforward means. This is a prerequisite action step that needs to taken in the near term, in order to regain connectivity of the habitats upstream and downstream of the dam.

3.0 New Exchequer and McSwain Dams

The New Exchequer and McSwain Dams are the largest man-made, in-stream structures in the Merced River watershed. As such, they exert a profound impact on fisheries resources. However, these impacts are beyond the scope of this investigation and are not analyzed in this document. In the future, it is NMFS interest to investigate potential methods for re-establishing fish passage at, or around, these sites, and perhaps restoring anadromous fish habitat potential in the intervening river reaches.

4.0 Merced Falls Dam

The Merced Falls dam and hydropower facility is located on the Merced River approximately three river-miles upstream from MID's Crocker-Huffman dam. The dam is equipped with a fish ladder, but it is not currently operated. PG&E allowed the group to view and photograph the facility at the dam crest, and from the downstream bank of the river near the fish ladder entrance, but the engineers could not get close to all parts of the fish ladder. Neither the fish ladder nor the powerhouse was operating during the site visit, so no specific conclusions about hydraulic conditions or fish passage efficiency were made from observations made during the site visit. The visual inspection did reveal that the general design and layout of the fish ladder appeared to be appropriate for the site, but that the fish ladder entrance geometry in relation to riverine hydraulic conditions was not ideal. The uppermost pools of the fish ladder, those visible from the dam crest, were holding water and appeared to be physically intact. However, leakage from further down the ladder where the ladder crosses the tailrace suggested the structure may have some small holes or cracks that may need repair if the facility were to be operated on a regular basis. It was further noted that the ladder would need to be rid of invasive plant over-growth and some debris that has accumulated during the period that the ladder has been maintained in a dry, "stand-by condition."[1] The hydraulic conditions would need to be assessed during actual operations to determine whether the hydraulic conditions within the pools are acceptable, and whether the discharge from the powerhouse would adequately facilitate attraction of fish to the ladder entrance. It is not known whether the ladder design included an auxiliary water system. This may be a necessary design modification to promote more effective fish passage.

Another aspect of Merced Falls dam operations that would have significant effect on fish passage efficiency is the operation of the tainter gates, located immediately adjacent to the power plant tailrace. During the November 3, 2010 site visit, the plant was shut down and the downstream discharge was released via a partially opened gate. This resulted in a jet of cascading, turbulent flow that would likely obscure attraction to the fishway entrance if the fish ladder were also in operation. Further hydraulic engineering analysis is required to address this situation, in order to find alternate means of shaping the flow conditions near the vicinity of the fishway entrance when the hydroelectric plant is not operating.

[1] Note that during the November 3, 2010 field trip, the inspection revealed that the fishway had been substantially cleaned and vegetative growth had been removed from the fishway pools.

Figures 1 and 2: Two views of the fish ladder from the top of PG&E's Merced Falls Dam on the Merced River. Photos taken February 2, 2010.

5.0 Crocker-Huffman Dam and Fish Passage Options

The Crocker-Huffman Dam is the lowermost dam in the power and water delivery complex. It is controlled and operated by MID primarily to provide a diversion point for agricultural irrigation water. It has a primary crest length of approximately 470 feet and a secondary, ogee-shaped spillway of approximately 130 feet. The structure is approximately 20 feet in height. Between the two crest sections is an abandoned fish ladder (Figure 2). Because the fish ladder is not operating, upstream anadromous fish passage is compromised. However, Pacific lampreys are known to pass this structure during their migrations upstream. Also, there is anecdotal evidence that Chinook salmon and steelhead have been able to pass over the dam under certain hydraulic conditions, particularly during high flood events when the water level rises and streaming flow occurs over the top of the dam. Under these conditions, it is possible for anadromous fish to exploit passage opportunities at the margins of the dam/river interface, or possibly even as a "swim-through" condition as the dam's effects on flow are drowned out during flood flow peaks. Other anectodotal evidence indicates that anadromous fish have occasionally passed upstream via the old spawning channel, which can still provide continuous flow around Crocker-Huffman dam- as long as the inlet and outlet structures are opened. Low cost modifications to these structures could provide another effective avenue for anadromous fish passage at the Crocker-Huffman site.

5.1 Design of Existing Fish Ladder

Judging from observations and a limited survey of the site, the ladder was originally designed and constructed as a pool-and-weir fishway, with orifices in each weir near the bottom. The elevations at the weir crests are staggered, with one side being notched approximately 15 inches lower than the other. The ladder's overall slope is approximately 15%. In contrast, many modern fish ladder designs do not to exceed 10% slope. One notable exception is the Alaska Steepass fishway design, which has been employed under conditions where the ladder's slope was 20% or greater. The more modern design criteria is meant to apply to all fishways, including those that are much higher than Crocker-Huffman, so that the prevailing slope is gradual enough for anadromous fish to have the physical swimming ability and stamina to surmount such high ladders. It does not mean that anadromous salmonid species are incapable of upstream passage through a fish ladder at the slope and height of the Crocker-Huffman facility

Figure 3. Overview of the Crocker-Huffman Dam and associated facilities.

Most of the weirs in the existing fish ladder are not perpendicular to ladder side walls; weirs in the mid section of the ladder are angled with each weir's direction alternating either clockwise or counter clockwise (from a perpendicular the cross-section) by about five degrees. While this design is somewhat unorthodox, it does not result in hydraulic conditions that would prohibit fish passage. The orifices near the bottom measure approximately 1.5 feet wide by 2.0 feet high, alternating sides at each successive weir. Drops between tops of weirs vary between 1.4 and 1.7 feet. This range is within the leaping ability of adult steelhead trout, and it may also be passable by resident *O. mykiss* as well. If the orifices are placed back in operation, and modified if necessary, a swim-through situation might be available for various species and life stages as well.

At some point the orifices were plugged with concrete caps and the left sides of each weir were notched creating contracted weirs. Depths of notches are not consistent throughout and vary between 0.5 and 1.5 feet. The modifications were likely made to limit the amount of water passing through the ladder, either because the pools were too small to function well under orifice flow, and/or for water conservation measures.

Figure 4. View of the Crocker-Huffman Dam from the river right bank. In the foreground is the ogee spillway. Beyond that is the fish ladder, followed by the primary dam crest.

Figure 5. View looking upstream at the fish ladder at the Crocker-Huffman Dam. One of the original orifices is visible. All weirs have been notched to the river-left side (to the right side of the photo).

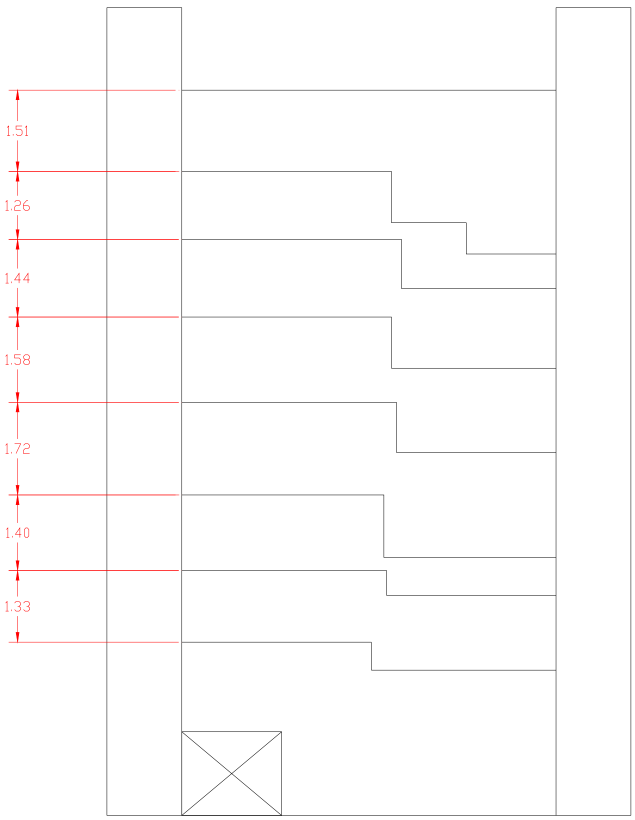

Figure 6. Sketch of weirs in the fish ladder at the Crocker-Huffman Dam, looking upstream. The original elevation differentials between each weir are labeled. Notches in the river-left side of each weir (to the right in the sketch) are shown to scale. All weirs have plugged orifices as shown in the lowest weir.

5.2 Structure Analysis

The fishway is a concrete structure that exhibits signs of wear and erosion from past usage, but appears to be physically intact so that it would adequately contain water and convey full flow if re-operated. The structure appears to be founded on a firm and solid foundation. The concrete walls and weirs are relatively thick compared to other small fish ladders. Past erosion of the weir surfaces is evident, and may be of some concern to future fish passage operations. In certain areas, reforming or re-armoring of the weir surfaces may be considered to improve ladder hydraulics. There are slots in the interior side walls that are apparently remnant inundations from the original forms used to pour the concrete during construction. There are no obvious provisions for installing intermediate seasonal weirs to optimize juvenile fish passage, but the structure could be modified to accommodate them if that was a fish passage objective.

5.3 Hydraulic Analysis of Fish Ladder

Data to calculate exactly how the ladder would operate hydraulically were not collected during the site visit. Since the ladder was in a shutdown condition at the time of the inspection, hydraulic measurements of flow characteristics could not be performed. However, the fish ladder's pools are sized to accommodate a minimum of approximately 5 cfs with an energy dissipation factor (EDF) of four. The fish ladder, under its original configuration (with orifices) would likely have an average head drop across each weir of 1.5 feet, and would likely have a flow of approximately 30 cfs. In the current pool-and-weir configuration, ladder flow would depend on head overtopping the upper most weir (exit weir). At present, a stop log gate is inserted in the exit weir, along the face of the dam crest. With heads of 0, 0.5, and 1.0 foot on the exit weir, flows through the ladder could be 0, 4, and 11 cfs, respectively. Given the size of the pools, if the ladder is to be operated, head on the exit weir should be approximately 0.5 foot to begin with, and modified as appropriate based on observations of flow in the ladder. If orifice flow was re-established, or other physical changes added, then the operating head and hydraulics should be re-assessed correspondingly.

5.4 Possible Fishway Improvements

In situ hydraulic testing of the current fish ladder would reveal what improvements, if any would be needed in order to provide acceptable levels of fish passage. Based on this site inspection, no obvious reasons were discovered that indicate the current fish ladder will not function for fish passage if it were placed back in service and hydraulically tuned to obtain its optimal flow conditions. However, in placing the ladder back in service, both structural and hydraulic engineering improvements could be considered to improve the original design. In addition, modifications to the dam and spillway controls should be considered in order to improve the existing facility for fish passage. For instance, a hydraulic analysis should be conducted once the flow is turned on to assess whether flow control through the pools can be maintained in the current configuration, or whether additional flow control modifications are necessary. Such measures might include, but are not limited to: (1) upgraded head gate flow controls (automatic or manual), (2) re-establishment of lower orifice flow, (3) modifications to weir crests and orifices, (4) inclusion of a turning pool at the ladder entrance, and (5) structural and hydraulic integration of an auxiliary water system (see Figure 6).

To allow for better conditions for fish passage at the Crocker-Huffman Dam, the ladder may be modified to improve fish attraction and fish passage, or the ladder may be replaced or augmented with additional fish passage systems meeting modern design criteria. Also, serious consideration should be given to operational changes to the dam its surrounding physical environment that could improve fishway performance including: (1) dam crest and spillway modifications, (2) improved head gate controls, (3) reconstructing the approach to the fishway to create better entrance and attraction conditions, (4) constructing a downstream bypass channel to improve connectivity with the river downstream, and (5) improving access to the fishway for easier operations, performance evaluations and maintenance.

Some physical aspects of the current ladder that could be addressed in a new ladder design, or to retrofit the existing ladder for increased fish passage efficiency are:

1. Drops across each weir should be more consistent. Currently they vary between 1.3 and 1.7 feet. Recommended drop heights are one (1.0) foot for adult salmonids (0.5 feet for salmonid juveniles).
2. Pool volumes should be increased in any new fishway designs; as current pool volumes are less than what is often used in modern fish ladder design criteria; but hydraulic evaluations could provide a means to adjust hydraulics and optimize flows within the parameters of this system.
3. An auxiliary water system could be added to significantly improve attraction flows to the ladder entrance.
4. Ladder entrance is not properly directed toward the main stream flow, and downstream channel modifications could be considered to improve entrance conditions.

5. Ladder location along the dam face is not the most optimal, given current channel characteristics.
6. More than one passage structure may be considered to provide multiple opportunities for passage on both banks of the river.
7. Special accommodations could be installed to promote better passage of Pacific Lamprey. These could be modifications to the ladder or dam itself, or an independent facility specifically designed for lamprey passage.

Fish ladder orientation is the one aspect that requires obvious improvement, with respect to the existing fish ladder design. Upstream-migrating salmonids are attracted to fast moving, cold water. To attract fish into fish ladders, sufficient water must emanate from the fish ladder entrance. At the Crocker-Huffman Dam, water emanating from the existing fish ladder does not project directly toward the main river current where salmonids will quickly find it. Thus, there may be some delay in upstream fish passage due to the sub-optimal fishway flow and orientation. Such delay might be more significant in other river systems where salmonids must migrate dozens of miles further upstream in order to reach spawning grounds, but in this case one of the short term objectives is to afford access to less than ten miles of the upstream river reach, particularly for its value as cold water holding and rearing habitat for adult and juvenile anadromous fish during summer months.

To improve attraction flow, an auxiliary water system (AWS) could be added to the fish ladder. An AWS usually diverts water from above the barrier to an oversized entrance pool within the ladder augmenting the amount of water emanating from the ladder entrance. To utilize auxiliary water at the existing ladder in this manner a new fish ladder entrance would need to be constructed at the downstream end of the fish ladder. A conceptual design is shown below.

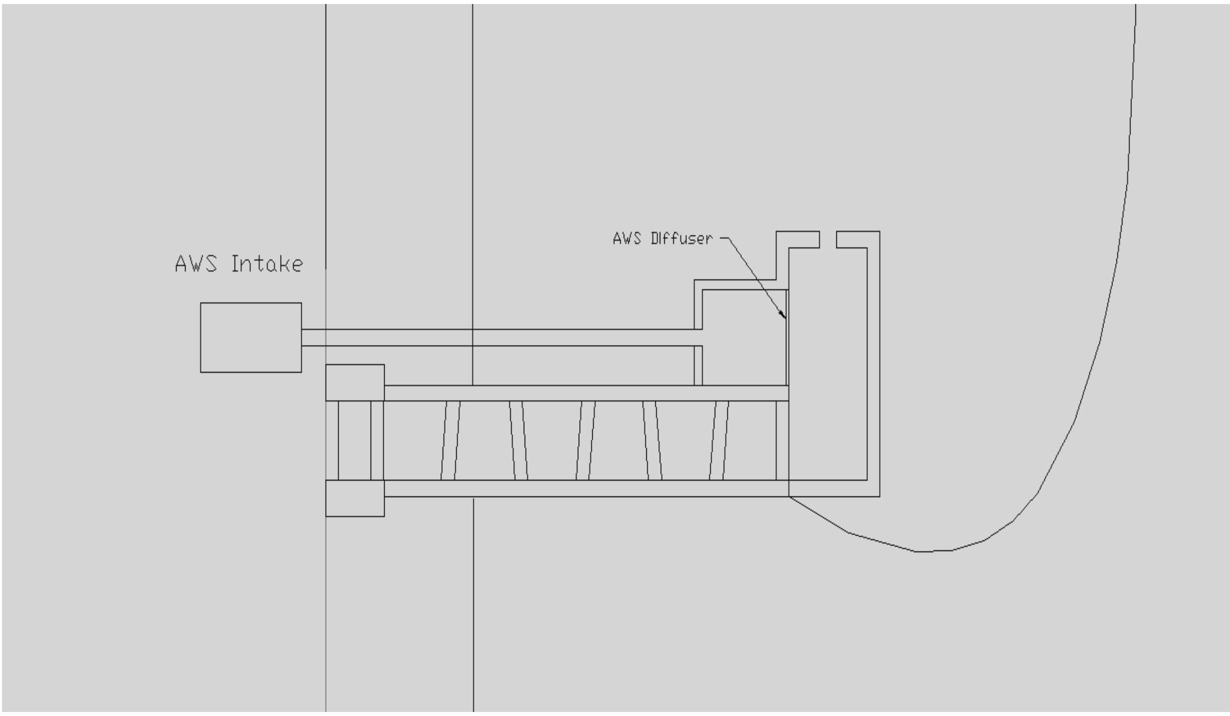

Figure 7. Possible new fish ladder entrance pool and auxiliary water supply system. This is a conceptual configuration. The actual AWS diffuser design may feature a side diffuser or an upwelling diffuser that is hydraulically optimized to provide smooth flow transitions and non-turbulent conditions.

Utilizing the existing fish ladder for passage will always involve a compromise in optimal efficiency due to the ladder's small size and relatively large jumps between individual pools. However, the existing ladder once provided fish passage to a significant degree, and can be made to do so again. Furthermore, certain structural and hydraulic modifications could be tried to improve and enhance fishway performance.

5.4.1 Dam and River Channel Modifications

Fish could be attracted to the existing fishway with or without fish ladder modifications by concentrating flows to the river-right side of the dam. Currently, low river flows crest only the primary portion of the dam, leaving the ogee spillway high and dry and little water flowing from near the fishway to the main river channel. If the dam crest were modified to allow lower river flows to first crest the ogee spillway, fish would be attracted to that side of the river seeking passage beyond the dam. With such modifications, water cresting the ogee spillway at lower river flows would flow past the existing ladder, then parallel to the dam and into the main river channel. At higher flows, water cresting the ogee spillway could inundate the land mass immediately downstream of the spillway and flow parallel to the dam could be masked. Further hydraulic analysis is needed to explore this potential option, with particular attention to the minimization of predation zones as a new flow regime and channel equilibrium are established. Additionally, a better channel configuration could be established from the fish ladder entrance through the land mass immediately downstream of the ladder to the main river channel. Such modifications would need to be considered in the larger context of channel dynamics, resulting fish behavior, land ownership and use, and other factors.

5.4.2 Nature-Like Fish Passage

Fish passage might be effectively be reestablished at the Crocker-Huffman Dam location by renovating and redirecting fish passage through the existing, but now defunct, fish spawning channel. The channel is already constructed and could be simply reopened and modified to act as a nature-like fish bypass channel. Flow capacity of the spawning channel appears to be far greater than all but the largest concrete fish ladders, and the substantial flow would naturally attract salmonids to the fishway. The channel could be modified to provide even more water if it were shortened by cutting a bypass channel. The entrance to the channel already has a constructed fishway which effectively serves the fish hatchery as well. This facility could be modified and improved for dual-purpose usage.

It has been several decades since the original spawning channel experiment was abandoned. Some of the reasons for its failure are better understood today. It is conceivable that, with modern knowledge of fisheries biology, fluvial geomorphology, and hydraulic engineering design, a new channel experiment might be tried – the purpose of such an experiment would be to construct a hydraulically engineered “nature-like” fishway that serves multiple functions including, but not limited to: (1) fish passage around the dam, both upstream and downstream for adult and juvenile fish, (2) some ancillary ability to support spawning channel experimentation and related hydraulics research via a parallel, or “hybrid channel” approach,

(3) collection of adult spawners and holding in conjunction with on site facilities to conduct fisheries research functions, *e.g.*, fish health, water quality and disease detection/mitigation, fish tagging/marking, etc., and (4) support for modernized hatchery operations.

6.0 Fish Collection Facility/Hatchery and "Spawning Channel"

The group visited CDFG's Merced River Hatchery, located at the downstream end of the Ruben E. Schmidt Salmon Spawning Channel, immediately downstream of the Crocker-Huffman dam. The entrance to the facility is controlled by a head gate and a small fish ladder. These structures facilitate the collection of fish for hatchery reproduction and monitoring needs. The old spawning channel appears to still be hydraulically connected, and if flow were initiated from the head gate, it would likely pass through the same route as originally intended. It appears that the spawning channel has not been utilized for many years, thus it has become overgrown and filled in to some degree. Renovation and redesign would be required to make this channel function as a multi-purpose channel, whose primary purpose is as a nature-like fishway. Engineering design modifications to the entrance facility could serve the dual purposes of hatchery operations and upstream fish passage, as monitored by qualified operators on site.

Figure 8: entrance works to the Merced River fish ladder.

Figure 9: aerial view of Crocker Huffman Dam, Merced River Fish Hatchery facilities, old "spawning channel"

7.0 Conclusion

Based on the two site visits and the analysis conducted, NMFS-Engineering Program is of the opinion that there are immediate opportunities to re-establish a meaningful degree of fish passage capability in the lower Merced River. Restoration of fish passage functions, as outlined in this technical report, would be a short-term, interim solution to the problems caused by the Merced River and Merced Falls projects and the inter-related facilities (including Crocker-Huffman) that make up the water supply and power generation complex. More permanent solutions to the loss of anadromous fish habitat in the Merced River watershed could be developed through the FERC licensing process, or by other voluntary or regulatory means.

EXHIBIT C

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

JAN - 4 2012

In response refer to:
RLW/SWR: FERC P-2179/P-2467

John Sweigard, General Manager
Merced Irrigation District
P.O. Box 2288
Merced, California 95344-0288

Craig Geldard
Merced Falls Relicensing Project Manager
Pacific Gas and Electric Company
P.O. Box 770000, Mail Code N11C
San Francisco, California 94177

RE: Resuming Fish Passage Operations at Crocker-Huffman and Merced Falls Dams

Dear Mr. Sweigard and Mr. Geldard:

In February and October of 2010, NOAA's National Marine Fisheries Service (NMFS) fish passage engineers and biologists performed detailed, on-site assessments of the fish ladders at Merced Irrigation District's (MID) Crocker-Huffman Dam and Pacific Gas and Electric's (PG&E) Merced Falls Dam. At that time, our personnel documented that both existing fish passage facilities were in a "mothballed status," and neither have been operating since the early 1970's. We also evaluated the old, artificial spawning channel at the hatchery site, which was similarly shutdown. Our site visits confirmed that both the Crocker-Huffman and Merced Falls dams block upstream fish passage under most riverine conditions, with the exception of certain high flow events at the Crocker-Huffman location. We further determined the fish ladders could function hydraulically if water were once again allowed to flow through them. We noted that incremental, yet substantial improvements to fish passage could be achieved simply by resuming normal ladder operations; and that passage at both locations may be significantly enhanced if the existing ladders, dams, and the defunct "spawning channel" were re-engineered using modern fish passage design principles (see Enclosure A).[1]

Based on these inspections and analyses, NMFS requested that MID and PG&E commence start-up hydraulic testing of the Crocker-Huffman and Merced Falls fish ladders in November 2010

[1] NMFS' November 15, 2010, Technical Memorandum : Evaluation of Fish Passage and Habitat Conditions in the Merced River reach between New Exchequer Dam and Crocker-Huffman Dam.

(Enclosure A).[2] This was meant as a collaborative step toward resuming seasonal fish passage operations - initially for the *Oncorhynchus mykiss* species, as an interim fisheries conservation measure. Resuming fish passage facility operations at these two dams would allow adult and sub-adult *O. mykiss* to access cold water refugia in the upstream areas of the Merced Falls Reach and Merced Falls Reservoir during times when temperatures become unsuitably warm downstream of Crocker-Huffman Dam. Unfortunately, both MID and PG&E declined to comply with NMFS' request to start up their respective fish ladders. Therefore, NMFS is investigating whether unauthorized "take" of threatened Central Valley (CV) steelhead is occurring on an annual or seasonal basis downstream of the Crocker-Huffman Dam on the Merced River.

Statutory Basis of NMFS Interests

NMFS is responsible for the administration and enforcement of the Endangered Species Act (ESA) (16 U.S.C. § 1531 *et seq.*) and its associated implementing regulations. Subject to limited exceptions, it is unlawful for any person to "take" endangered species of fish or wildlife, or violate any regulation pertaining to any threatened species of fish or wildlife promulgated by the Secretary pursuant to relevant authority under the ESA. NMFS adopted regulations (50 CFR 223.203) under section 4(d) of the ESA, which make it unlawful for any person to take listed threatened species of salmon or steelhead, except in cases where the take is associated with an otherwise lawful activity under a NMFS-approved program.

The ESA defines "take" to mean, "...harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." The term "harm" has been defined by NMFS to mean the following:

> "An act which actually kills or injures fish or wildlife. Such an act may 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." [emphasis added].

Status of Anadromous Species in Merced River

Steelhead trout (*O. mykiss*) are present in the Merced and San Joaquin rivers, and the ocean-type CV steelhead Distinct Population Segment (DPS) is currently listed as threatened under the ESA (71 FR 834, January 5, 2006). Critical habitat has been designated for CV steelhead in the Merced River downstream of Crocker-Huffman Dam, the San Joaquin River, and in the Sacramento-San Joaquin Delta (70 FR 52488, September 2, 2005). Also inhabiting the lower Merced River is the CV fall/late fall-run Chinook salmon - an important commercial fish species for which essential fish habitat has been designated in the lower Merced River, pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSA).

In addition to our concerns about Project impacts to ESA-listed steelhead, NMFS also has concerns that the prevailing water management regime for the Merced River has similar

[2] National Marine Fisheries Service (NMFS). Letter from Richard Wantuck (NMFS) to John Sweigard (MID) and Steve Nevares (PG&E) Re: "Request for activation of fish ladders on Crocker-Huffman and Merced Falls Dams. November 15, 2010.

deleterious effects on all other anadromous, cold water species native to the Merced-San Joaquin watersheds including: CV fall/late fall-run Chinook salmon, CV spring-run Chinook salmon (currently being reintroduced to the San Joaquin watershed), green sturgeon, and Pacific lamprey.

Notification

NMFS has evidence that adverse modification of critical habitat for the CV steelhead DPS is re-occurring on an annual or seasonal basis - resulting in unauthorized take of a listed species. The mechanism of take is directly related to two factors under control of MID and/or PG&E: (1) operations of the riverine hydropower and water diversion complex, which frequently cause downstream, summer temperatures to exceed thermal limits for anadromous fish, and (2) the closure of fish passage facilities at Crocker-Huffman and Merced Falls dams, thus preventing anadromous fish species from accessing upstream habitats where cool water refugia exists.

Water temperature impairment of the lower Merced River is well documented. The U.S. Environmental Protection Agency (USEPA) has included water temperature impairment for the Merced River downstream of Crocker-Huffman Dam on the 2008-2010 Section 303(d) Listing in California (USEPA 2010; 2011). This was based, in part, on water temperature data collected and analyzed by California Department of Fish and Game (CDFG) and NMFS (see Enclosure A).[3] Water temperatures downstream of Crocker-Huffman Dam have been shown to exceed the USEPA's (2003) "Water Temperature Guidelines to Protect Salmonids" for all life stages. NMFS has recommended and the Federal Energy Regulatory Commission has adopted the USEPA's (2003) guidelines as water temperature criteria in the relicensing of the FERC projects on the Merced River to protect salmonids.

Although both structures are low head dams, upstream fish passage is obviously impaired or obstructed at the Crocker-Huffman and Merced Falls facilities. The decision to terminate fishway operations was taken in 1971 when the CDFG authorized the shutdowns in favor of a new hatchery facility and "spawning channel experiment." Subsequently, the spawning channel experiment failed and was abandoned. In a letter to MID in November 2009, CDFG acknowledged the failure of the experiment and notified MID that fish passage must be resumed at Crocker-Huffman Dam.

Remedy

In light of the above circumstances, NMFS once again urges MID and PG&E to take immediate steps toward reinstating fish passage operations at Crocker-Huffman and Merced Falls dams. I invite each party to work collaboratively with NMFS technical staff, as well as with representatives of CDFG and the U.S. Fish and Wildlife Service, to plan and implement

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[3] California Department of Fish and Game (CDFG). 2010. "*CDFG Exhibit #4 to State Water Board Hearing: Effects of Water Temperature on Anadromous Salmonids.*" Prepared, February, 2010, for the Informational Proceeding to Develop Flow Criteria for the Delta Ecosystem Necessary to Protect Public Trust Resources Before the State Water Resources Control Board Beginning March 22, 2010. CDFG, Central Region, Fresno, California.

hydraulic start-up testing activities beginning in January or February of 2012. Actual fish passage operations would be expected to follow, with scheduling and necessary facility improvements being developed in consultation with the technical staff of the fisheries agencies. While additional measures may be required to promote ESA-listed species recovery, NMFS sees this action as a positive step toward better conservation of anadromous fish in the Merced River.

If you any questions concerning the technical aspects of NMFS request, please contact Mr. Richard Wantuck of my staff at 707-575-6063. Thank you for your cooperation in this matter.

Sincerely,

Rodney R McInnis

Rodney R. McInnis
Regional Administrator

Enclosures

cc: Maria Rea, Jeff McClain, Monica Gutierrez, Don Tanner – NMFS Sacramento
Jeffery Single, Ph.D., Regional Manager, CDFG
Ramon Martin, USFWS Anadromous Fish Restoration Program Manager

Enclosure A

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Merced Irrigation District **Merced River Hydroelectric Project**	))	**Project No. P-2179**

AND

Pacific Gas and Electric Company **Merced Falls Hydroelectric Project** **Merced River, California**	)))	**Project No. P-2467**

E-FILED DOCUMENTS

California Department of Fish and Game (CDFG). 2010. "*CDFG Exhibit #4 to State Water Board Hearing: Effects of Water Temperature on Anadromous Salmonids.*" Prepared, February, 2010, for the Informational Proceeding to Develop Flow Criteria for the Delta Ecosystem Necessary to Protect Public Trust Resources Before the State Water Resources Control Board Beginning March 22, 2010. CDFG, Central Region, Fresno, California.

National Marine Fisheries Service (NMFS). 2010. Letter from Richard Wantuck (NMFS) to John Sweigard (MID) and Steve Nevares (PG&E) Re: "Request for activation of fish ladders on Crocker-Huffman and Merced Falls Dams and NMFS' Technical Memorandum Regarding Evaluation of Fish Passage and Habitat Conditions in the Merced River Reach between New Exchequer Dam and Crocker-Huffman Dam." NMFS, Southwest Region, Santa Rosa, California.

Enclosure B

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Merced Irrigation District **Merced River Hydroelectric Project**	))	**Project No. P-2179**

AND

Pacific Gas and Electric Company **Merced Falls Hydroelectric Project** **Merced River, California**	)))	**Project No. P-2467**

CERTIFICATE OF SERVICE

I hereby certify that I have this day served, by first class mail or electronic mail, a letter to Secretary Bose, Federal Energy Regulatory Commission, containing the National Marine Fisheries Service concerns regarding Fish Passage and Screen Issues at Crocker-Huffman Dam and Diversion Site on the Merced River for the Merced River (P-2179) and Merced Falls (P-2467) Hydroelectric Projects. This Certificate of Service is served upon each person designated on the official P-2467 and P-2179 Service Lists compiled by the Commission in the above-captioned proceedings.

Dated this _____ day of January 2012

____
William E. Foster, M.S.
National Marine Fisheries Service

EXHIBIT D

October 20, 2017

DRAFT Final Report

on

Genetic analysis of *Oncorhynchus mykiss* in the Upper Tuolumne and Merced Rivers to evaluate ancestry and adaptive genetic variation

Submitted to:

National Marine Fisheries Service
West Coast Region California Central Valley Office
Federal Energy Regulatory Commission Branch

Prepared by:
Devon E. Pearse and Matthew A. Campbell

National Marine Fisheries Service, Southwest Fisheries Science Center, Fisheries Ecology Division, Santa Cruz, CA 95060.
Email: devon.pearse@noaa.gov Phone: 831-420-3906

Summary

California contains numerous rivers with high potential productivity for anadromous salmonids. To regain this productivity, habitat rehabilitation, mitigations, and genetic management of salmonid populations are being undertaken. Here we present a genetic analysis of *Oncorhynchus mykiss* located within the Tuolumne and Merced Rivers in the context of natural and artificial barriers to migration to inform future management decisions. Genotyping of fish revealed that although variable stocking practices have been conducted throughout the study area, many populations retain largely indigenous ancestry. Furthermore, populations located above the large dams with reservoirs in the study area potentially support adfluvial life history variants, and display genomic variation for a major chromosomal polymorphism associated with anadromy. These results support the potential to re-establish anadromous *O. mykiss* within the upper Tuolumne River and upper Merced River utilizing locally adapted gene pools.

Introduction

The Central Valley of California is both a productive agricultural region and an ecosystem and with large rivers that are home to populations of commercially-valuable Chinook Salmon, as well as rainbow trout and steelhead, the resident and anadromous forms of Rainbow Trout *Oncorhynchus mykiss* (Walbaum, 1792), respectively (Fisher 1994; Busby et al. 1996; Yoshiyama et al. 1998; McEwan 2001). However, the construction of dams and water diversions has severely restricted migratory connectivity throughout the region, resulting in extremely reduced anadromous salmonid populations in virtually all Central Valley rivers and the listing of the Central Valley steelhead Distinct Population Segment (DPS) as 'threatened' under the Endangered Species Act (Lindley et al. 2006; May & Brown 2002; NOAA 2006; Yoshiyama et al. 1998). Large barrier dams in particular prevent upstream migration of adult steelhead to spawning and rearing habitats and, like natural waterfalls, isolate populations of resident rainbow trout above them. Unlike Chinook Salmon, *O. mykiss* are able to maintain populations of freshwater rainbow trout when their ability to access the ocean as anadromous steelhead is blocked (Pearse et al. 2009; Berejikian et al. 2014; Kendall et al. 2015). These landlocked *O. mykiss* may exhibit several variations in life-history strategy, including an adfluvial migratory life-history completely within freshwaters, utilizing a newly-created reservoir as an alternative to a fully anadromous migration and returning to spawn in tributaries (Holecek & Scarnecchia 2013; Leitwein et al. 2016).These remnant populations are usually closely related to the remaining *O. mykiss* found below the dam in the same watershed (Clemento et al. 2009; Pearse & Garza 2015), although in some cases stocking of non-native hatchery rainbow trout strains into above-barrier habitats has resulted in partial or complete replacement of the native lineage (Abadía-Cardoso et al. 2016).

Even prior to the construction of the dams, the activities of the gold rush and the development of agricultural infrastructure in the Central Valley had a huge impact on the native fauna, particularly the migratory salmonids. The impacts of these early developments on salmon populations were obvious from the beginning, and fish ladders were proposed as early as 1883 for the original Wheaton Dam[1], a much smaller predecessor to Don Pedro Dam on the Tuolumne River. However, as most dams did not receive fish ladders or other mitigations, salmonid populations quickly declined. Today, intense management and hatchery supplementation maintain many salmonid populations in the Central Valley. The National Marine Fisheries Service's ("NMFS") Draft Recovery Plan10 identifies the Upper Tuolumne River above Don Pedro Reservoir as a candidate area for reintroduction of steelhead and spring-run Chinook Salmon to further recovery of these threatened species (NMFS 2014).

The Tuolumne and Merced watersheds drain a large portion of Yosemite National Park, as well as Stanislaus National Forest and other lands in the central Sierra Nevada (Figure 1). Although both rivers flow into the San Joaquin River and through the Sacramento-San Joaquin Delta on their way to the Pacific Ocean via San Francisco Bay, their upper reaches contain very different environments. The Upper Tuolumne River (UTR) is a highly impacted system, containing the three major dams and reservoirs of the Hetch Hetchy Project, as well as associated water infrastructure and small dams such as Early Intake, where water is diverted for the City of San Francisco. Cold river flows peak daily throughout the summer to create power at Holm Powerhouse and provide whitewater rafting flows from Cherry Creek down to Lake Don Pedro. The Tuolumne watershed was also the site of one of the largest wildfires in California history, the 2013 Rim Fire, which burned more than 400 square miles throughout many of the tributaries

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[1] http://www.modbee.com/news/business/agriculture/article56196215.html

in the Tuolumne River Watershed. In contrast, the Upper Merced River (UMR) is almost entirely contained within Yosemite National Park (YNP), and has enjoyed protection since the parks' establishment in 1890. It is largely unmodified above Lake McClure Reservoir, displaying a natural hydrograph and warm summer water temps in the lower elevations. Today, the tributaries of the UTR and UMR are isolated upstream of New Don Pedro Dam (Lake Don Pedro) and New Exchequer Dam (Lake McClure Reservoir), respectively (and built on top of the original Don Pedro and Exchequer dams, both dating from the 1920's). New Don Pedro Dam is upstream of La Grange Dam, which created the upper limit to anadromous migration when it was completed in 1883, as well as the former Wheaton Dam (1871) that it replaced. Similarly, New Exchequer Dam on the Merced is upstream of three smaller dams, including Crocker-Huffman Dam that limits upstream migration on that river at RM 52. Collectively these dams have prevented native salmon and steelhead from accessing their historic spawning habitats for more than a century, and few anadromous salmonids exist in the reaches below these dams today (Ford & Kirihara 2010; Cuthbert et al. 2012). Thus, in considering efforts to reconnect migratory *O. mykiss* populations below dams with their historical upriver spawning habitats, an important first step is to evaluate the genetic ancestry and adaptive potential of the fish trapped above them (Winans et al. 2010, 2014, 2017).

Expectations for Non-Native Genetic Ancestry

There is a rich history of trout stocking in YNP that has undoubtedly influenced *O. mykiss* distribution and genetics. Early visitors took a strong interest in increasing the trout populations, both for food resources and recreation (Caton 1869; Pavlik 1987). Fish planting likely began in the 1870s, initially by settlers moving locally captured fish up into the previously fishless waters above waterfalls and in high alpine lakes. The first official records of imported trout stocking occurred in the 1890s, and by 1895 there was a fish hatchery operating at Wawona that distributed both locally-sourced and imported trout throughout the area. A subsequent hatchery established at Happy Isles in 1918 and the importation of eggs from other hatcheries ensured a steady supply of Rainbow Trout, as well as non-natives such as Lahontan Cutthroat Trout (*O. clarkii henshawi*), European Brown Trout (Salmo trutta), and Brook Trout (Leitritz 1970). Although most of the eggs reared at the Happy Isles hatchery were imported from outside YNP, some were collected at an egg-taking station on Frog Creek, a historically-fishless tributary of Lake Eleanor and the UTR in northern YNP (Figure 1). These fish were descendants of those originally stocked by settlers to provide food, and in the 1930's the Civilian Conservation Corps built a fish weir and cabin to improve the ability to trap fish to obtain eggs distribute juvenile trout throughout YNP (Pavlik 1987). Thus, over the years a rich mixture of both locally-sourced *O. mykiss* and fish imported from throughout California have been planted within Yosemite. However, management of more recent stocking efforts has changed significantly, and since 2013 most trout planted in California have been sterile triploids, limiting further naturalization and spawning by hatchery strains and resulting in the current distribution of self-sustaining populations to be evaluated.

Adaptation to Residency

Under natural conditions, the diverse life history forms of *O. mykiss* interbreed freely despite the dramatic differences between them in traits related to physiology, morphology, and behavior (Quinn 2011; Phillis et al. 2016). Consequently, anadromous and resident fish within a drainage basin are typically most closely related to each other, rather than to other anadromous or resident forms found elsewhere (Olsen et al. 2006; Clemento et al. 2009; Pearse et al. 2014). Offspring of a particular life history variant may take on an alternative strategy from that of their parents (Courter et al. 2013); however, there is a great deal of evidence pointing to heritable influences on life history strategies and associated phenotypes *e.g.* (Hecht et al. 2012; Martinez et al. 2011; Nichols et al. 2008).

Surveys of genetic variation have confirmed that the isolation of *O. mykiss* into above-barrier habitat causes clear genetic changes as populations adapt to residency (Martinez et al. 2011; Pearse et al. In Prep; Pearse et al. 2014; Campbell et al. In Prep). Consistently a region of chromosome Omy5 has been identified in adaptation to residency that contains >1,000 genes is linked together in a chromosomal inversion 'supergene' complex. Alternate forms of the Omy5 inversion are associated with resident (R) and anadromous (A) life-histories, respectively (Pearse et al. 2014; Pearse et al. In Prep). However, unlike waterfalls, which exert knife-edge selection against downstream migration (Northcote 2010), barrier dams create reservoirs above them, and *O. mykiss* inhabiting streams flowing into these reservoirs may maintain an adfluvial migratory life-history, utilizing the reservoir as a rearing habitat (Holecek et al. 2012; Holecek & Scarnecchia 2013). Importantly, genetic analysis of the specific genomic region on chromosome Omy5 suggests that selection for such adfluvial migratory life-history can affect the same adaptive genomic variants as true anadromous migrations (Pearse et al. 2014; Leitwein et al. 2016). Thus, adfluvial populations isolated above dams and reservoirs represent a potential source to contribute to the recovery of migratory anadromous ecotypes through fish passage programs or following dam removal (Thrower et al. 2008; Meek et al. 2014; Leitwein et al. 2016; Winans et al. 2017; Abadía-Cardoso et al., In Prep).

The goal of this study was to determine the genetic ancestry and current population structure of *O. mykiss* populations in the Upper Tuolumne River (UTR) and Upper Merced River (UMR) (Figure 1). Thus, we evaluated the genetic relationships of *O. mykiss* in the (UTR) and (UMR) relative to other *O. mykiss* populations above and below barriers to anadromy in the Central Valley, hatchery rainbow trout strains commonly used in California, and coastal steelhead populations. In addition we assayed adaptive genomic variation known to be associated with migration and anadromous and adfluvial life-history traits in *O. mykiss* (Pearse et al. 2014; Leitwein et al. 2016; Apgar et al. 2017). We then use this information to evaluate the potential for UTR and UMR populations to contribute to the recovery of anadromous steelhead below barriers in the southern Central Valley. Populations were considered relative to the presence of barriers to fish migration and the frequencies of alleles associated with migratory behavior. Together, these data provide a baseline to inform the future management of Yosemite and other Central Valley *O. mykiss* populations and to improve our understanding of the potential for Central Valley watersheds to support the re-expression of anadromy in naturally spawning steelhead.

Projects Goals

This project funded the non-lethal collection and genetic analysis of *O. mykiss* tissue samples in order to:

1) Evaluate how dams as fish passage barriers have affected the genetic makeup of Tuolumne River and Merced River *O. mykiss* by altering the gene flow between above-barrier and below-barrier populations;

2) Understand the baseline status and origin (Natal? Hatchery? Strays?) of steelhead in the lower Tuolumne and Merced Rivers;

3) Genotype resident rainbow trout in various locations in the upper Tuolumne River and upper Merced River and evaluate their relationships and address these questions;

a. To what extent are these fish "remnants" of indigenous pre-Dam *O. mykiss*? To what extent is there hatchery influence?

b. What is the predilection of these upstream juvenile fish for exhibiting anadromous/migratory behavior (smolting)?

c. Would the upstream fish be suitable brood stock for a future program to supplement the lower Tuolumne and lower Merced steelhead populations?

Methods

Sampling

Fish were captured in 2015 and 2016 by hook-and-line or electrofishing at sites throughout the UTR and UMR watersheds, including both migratory reaches (those historically accessible to migratory steelhead; Lindley et al. 2006) and those isolated above barriers that were historically fishless (Table 1, Figure 1). All fish were measured and fin tissue samples were taken from each individual prior to release at the site of capture. All tissue samples were dried and taken to the National Marine Fisheries Service laboratory in Santa Cruz, CA, for analysis.

Genetic Data Collection

DNA was extracted from dried fin clips using the Dneasy 96 filter-based nucleic acid extraction system on a BioRobot 3000 (Qiagen, Inc.), following the manufacturer's protocols. All DNA extractions were diluted 2:1 with distilled water and used for polymerase chain reaction pre-amplification prior to TaqMan or SNPtype genotyping with 96.96 IFC chips. Genotypes were read and scored using Fluidigm SNP Genotyping Analysis software (Fluidigm, Inc.). All samples were genotyped at total of 92 SNPs for population genetic analysis following Abadía-Cardoso et al. (2013), a gender-ID SNP assay (Brunelli et al. 2008; Rundio et al. 2012), and 3 SNPs on chromosome Omy5 that have been associated with migratory life-history traits (Pearse et al. 2014; Pearse & Garza 2015; Abadía-Cardoso et al., 2016; Leitwein et al. 2016; Apgar et al. 2017; Pearse et al. In Prep).

Data analysis

The SNP genotype data were combined with published data from 21 representative wild coastal and Central Valley *O. mykiss* populations, three Central Valley steelhead hatcheries and five hatchery rainbow trout strains common in California (Pearse & Garza 2015). The genetic data were analyzed with the R statistical analysis program version 3.4.1 (R Development Core Team 2017). Genotypes were imported for use in R through *pegas* package version 0.10 (Paradis 2010) and converted to a genind object with the package adegenet version 2.0.1 for further analysis (Jombart 2008). Quality control of individual fish was undertaken with the "missingno" function of *poppr* version 2.5.0 (Kamvar et al. 2014) by specifying that both genotypes and loci were not allowed to have more than 5% missing data. From these filtered data, two separate approaches were implemented, (1) an individual approach and (2) a population approach, in which fish sampled along contiguous reaches without complete barriers to migration were combined into single sample units, resulting in a total of 20 discrete units of newly collected individuals based on local geography and barriers to migration (Table 1, Figure 1).

Individual Approach

For the individual approach, prior population assignment based on collection location was not considered, and individuals were independently assigned to inferred populations. This approach was used to verify the independence or interrelatedness of sampling locations. For example, by including hatchery reference populations, do sampled individuals show genetic similarities to any hatchery population? Both Discriminant Analysis of Principle Components (DAPC) as implemented in *adegenet* (Jombart et al. 2010) and STRUCTURE version 2.3.4 (Pritchard et al. 2000; Falush et al. 2003) were used as complementary individual analyses.

For the individual DAPC we limited our analysis to only new collections from the Tuolumne River and Merced River along with five hatchery reference populations to detect hatchery introgression or establishment within YNP. DAPC is not based on a population genetic model, and relies on the conversion of SNP data into principal components to account for linkage between SNPs and allow generic methods of individual clustering to be used. As opposed to finding axes of maximal variation as with Principal Component Analysis (PCA), DAPC maximizes between-population separations and minimizes within-population variation. We identified inferred populations with DAPC by applying the “find.clusters” function of *adegenet* followed by PCA and Discriminant Analysis (DA) within the “dapc” function of *adegenet* that utilized the packages *ade4* version 2.7-8 (Chessel and Dufour 2004; Dray et al. 2007; Dray and Dufour 2007) and *MASS* version 7.3-47 (Venables and Ripley 2002).

Unlike DAPC, STRUCTURE has an explicit population genetics model and uses the individual genotype data directly. STRUCTURE assigns fractional ancestry (q – values) to K inferred populations based on descent from a common ancestral population. For each individual, the q – values sum to 1.00 and indicate what proportion of each of K inferred populations make up the individual. Migrants and individuals of mixed ancestry can be identified with STRUCTURE without *a priori* designation of defined populations (Pritchard 2000; Pearse & Crandall 2004). We evaluated all individuals in the quality-controlled dataset with $K = \{1,\ldots,12\}$ inferred populations with four independent runs with an initial burn-in of 100,000 steps followed by a Markov Chain Monte Carlo (MCMC) of 1,000,000 steps. For most parameters, default settings were used. Results from the STRUCTURE runs were visualized with DISTRUCT version 1.1 (Rosenberg 2001).

Population Approach

Sampling units were treated as populations for identifying population genetic and phylogenetic relationships with a minimum required size of 10 individuals per sample unit (Table 1). Population genetic relationships were evaluated with DAPC using the sampling unit to predefine population genetic clusters. The same sample units were also evaluated in a Neighbor-Joining population tree generated through *poppr* version 2.4.1 using a chord distance metric (Cavalli-Sforza and Edwards 1967) and the filling of missing data by the mean of that locus. Confidence of nodes in the population tree was assessed by 1,000 bootstrap replicates.

Signatures of Migratory Adaptation

Of the three genotyped SNP loci located on chromosome Omy5, one, R04944, is known to be one of many SNPs within the inversion region that accurately identify the "R" and "A" inversion types (Pearse et al. In Prep). Based on this locus we calculated the frequencies of the "A type" allele associated with migratory behavior at this SNP locus. These data were then considered with respect to the migratory potential of each sampling site relative to historical and current barriers and reservoirs. In particular, those populations with potential for adfluvial life history variants were identified.

Results

Sample Genotyping and Population Statistics

A total of 897 *O. mykiss* samples from the UTR and UMR were genotyped, and after filtering for missing data and loci under selection linked to the Omy05 inversion the combined dataset of 20 sampling locations and 29 reference populations consisted of 2,370 individuals and 88 bi-allelic SNP loci (Table 1). Sample sizes for the UAR and UMR populations ranged from 2-103 individuals per site; sample units smaller than 10 were use for individual-based analyses, but excluded from population-level analysis.

The distribution of neutral genetic diversity among populations showed typical patterns, with most populations isolated above barriers having reduced heterozygosity relative to downstream populations (Table 1). Similarly, most hatchery rainbow trout strains had reduced levels of variation, as did populations inferred to be of primarily hatchery origin (e.g. GROS). Conversely, larger populations connected by migration (e.g. TUOL and YOSV) tended to have higher heterozygosities, similar to coastal and Central Valley steelhead populations (Table 1).

Individual Approach

DAPC of individuals from the 20 YNP sample units plus five hatchery reference strains supported the inference of eight genetic groups (Figure 2; Supplemental Figure S1). Three of these inferred clusters are composed of fish of natural genetic origin while the other five contained fish of hatchery origin or fish in genetic composition similar to hatchery fish (Figure 2). Most fish from the YNP sampling locations were not placed in clusters with significant hatchery trout contributions. However, the Grouse Creek (GROS) sampling location is entirely placed in inferred population five with the Kamloops Hatchery strain. Similarly, most individuals from the Merced River Hatchery sample (MCDH) were placed in the same inferred group as the Coleman Hatchery strain (4; Figure 2), while others were grouped with the Mt. Shasta, Eagle, and Moccasin hatchery trout lineages, supporting the mixed hatchery ancestry that has previously been inferred for lower Merced River *O. mykiss* (Pearse & Garza 2015).

Structure results showed strong convergence, verified by the highly consistent results among all four independent runs (data not shown). The distribution of STRUCTURE *q* - values in among individuals in the YNP and reference populations supported previous findings of relationships between coastal and Central Valley *O. mykiss*, and were similar to the individual DAPC results and population genetic analyses (see below). At low values of K, there were clear patterns of divergence between coastal steelhead and northern and southern Central Valley-lineage populations (K=4; Figure 3). These patterns remained evident at higher values of K (e.g. K=7), along with finer patterns of differentiation.

Population Approach

DAPC of sampling units indicated a strong geographical component, with the first and second axes of the DAPC plot roughly encompassing East-West and North-South geography (Figure 4). This pattern of divergence is concordant with previous studies showing a primary division between coastal and Central Valley steelhead and an association between geography and genetic differentiation among *O. mykiss* populations isolated above dams within the Central Valley, but not among below-barrier CV steelhead populations (Pearse & Garza 2015).

The phylogenetic tree also supported known patterns of geographic differentiation, although many nodes received less than 50% bootstrap support (bs; Figure 5). Nonetheless, well-supported relationships among several pairs and groups of populations were consistent with previous studies, indicating that the current data set has sufficient power to resolve these relationships (e.g. close similarity of Feather River and Mokelumne Hatchery steelhead, Nimbus hatchery steelhead and coastal populations, and the relationships between the new UTR and UMR samples and reference samples from those locations; Pearse & Garza 2015). Among the new UTR and UMR samples, a clade of nine Tuolumne River populations (e.g. TUOL, REED, UCLV, ROOS, FROG, etc., Figure 5) was identified with moderate support (bs = 77%), supporting their common indigenous ancestry. The The South Fork Merced sample (SFMC) appears as sister to this group, but without significant bs support. Other UTR and UMR populations on the other hand were more widely dispersed in the tree, possibly indicating more diverse sources contributing to these populations *O. mykiss*, and also reflecting the limited resolution and low bootstrap support for deeper nodes in the tree. Meaningful support (bs = 68% & 98%) was found for the relationship between the Grouse Creek (GROS) population and the Kamloops Hatchery strain, as well as a population from the McCloud River (Butcherknife Ck.) that contributed to the development of northern CV hatchery trout strains, further supporting the complete hatchery origin of this isolated above-barrier population.

Signatures of Migratory Adaptation

The frequency of Omy5 MAR A-type in the sampling units within YNP ranged from a minimum of 0.00 in GROS to maximum 0.31 in TUOL (Figure 6). Given their locations and accessibility to fish migrating from downstream reservoirs, these results support the hypothesis that the TUOL, FROG, SFMC and YOSV populations may sustain trout with an adfluvial life history. Conversely, the A-type MAR exists at relatively low frequency in other populations, notably those found above barriers to migration such as REED and CRAN (Figure 1, Figure 6). However, there was considerable variability among populations, likely reflecting a combination of factors impacting the frequency of adaptive genomic variation on chromosome Omy5 and other parts of the genome.

Discussion

Overall, the observed genetic relationships between UTR and UMR *O. mykiss* and other CV populations and hatchery trout strains indicate that a mixture of indigenous and imported *O. mykiss* lineages exists in the UTR and UMR watersheds, with primarily indigenous southern Central Valley - San Joaquin River ancestry in the reaches that were historically accessible to migratory salmonids. Thus, despite the extensive stocking with non-indigenous hatchery trout strains throughout the region, native ancestry appears to remain as the primary component of many sampling locations examined in this study. This includes the Clavey River, which has been designated as Heritage and Wild Trout populations by the California Department of Fish and Wildlife[2]. While migratory barriers can protect native trout populations from invasion by hatchery fish in some cases (e.g. Van Houdt et al. 2005; Penaluna et al. 2016), the distribution of genetic variation among YNP trout populations suggests that local adaptation has likely contributed to the persistence of these lineages.

In terms of ancestry, the primary division between coastal and CV *O. mykiss* that has previously been documented (Pearse & Garza 2015; Nielsen et al 2005) was also clear in multiple analyses of the present data set (Figures 3, 4, and 5). This is important because it confirms that, unlike some below-barrier populations in the southern Central Valley, including *O. mykiss* sampled in the lower Tuolumne River (Pearse & Garza 2015), the trout populations in the UTR and UMR have not been introgressed by coastal steelhead propagated at Nimbus Hatchery. However, the close evolutionary relationships among all Central Valley *O. mykiss*

[2] https://www.wildlife.ca.gov/Fishing/Inland/Trout-Waters

make precise inference of introgression by Central Valley-origin hatchery trout strains difficult (Pearse & Garza 2015). Within the UTR and UMR, many populations show at least some evidence of mixed ancestry, as has been observed in other regions subjected to intensive hatchery trout stocking prior to the widespread use of sterile triploids (e.g. Southern California; Abadía-Cardoso et al. 2016). It is also possible that there have been contributions from hatchery trout strains that were not included in the present study, so their contributions could not be specifically detected. Nonetheless, the relative proximities of populations shown in the DAPC analysis revealed a clear pattern of geographic divergence among populations, with the Coastal-CV division following the West-East Axis 1, and Axis 2 oriented North-South, showing divergence within the Central Valley. This is consistent with the hypothesis of Pearse & Garza (2015), who suggested that the isolated rainbow trout populations in the Sierra Nevada may better reflect their indigenous historical ancestry than the scrambled steelhead populations that persist below barriers to migration (Pearse & Garza 2015). However it is likely that some hybridization and introgression has occurred, resulting in the presence of mixed ancestry populations. Although these do not represent purely indigenous lineages, they may nonetheless have significant value as reservoirs of genetic diversity (Abadía-Cardoso et al. 2016), and the conservation of hybrid populations remains an active area of discussion (Wayne & Shaffer 2016).

Most fish sampled in UTR and UMR locations that were historically fishless due to their locations above barriers or at high elevations represent a mixture of indigenous and imported ancestries (e.g. Grand Canyon of the Tuolumne), although some appear to be either nearly pure indigenous populations (e.g. Frog Creek) or entirely descendent from hatchery rainbow trout strains (e.g. Grouse Creek). One exception is the Upper North Fork Tuolumne, which forms a genetically distinct population and does not group closely with the other, apparently indigenous UTR populations, but also does not show a clear association with any single hatchery trout strain included in the present study. This sampling site has a long history of intensive hatchery stocking due to it location near a major road (CA highway 108). In contrast, the populations in Reed Creek and Jawbone Creek show little apparent genetic differentiation from other nearby populations within the UTR genetic group, despite being isolated above large waterfalls separating them from the Clavey and Tuolumne Rivers, respectively.

Adaptive Variation and Migratory Potential

It is important to note that patterns of adaptive genomic variation like that documented on chromosome Omy5 are not independent of the factors that affect neutral genetic variation, including drift due to small population sizes and introgression by non-native lineages with highly divergent patterns of variation (Pearse 2016). In the case of hatchery rainbow trout, for example, Omy5 MAR allele frequencies vary widely among strains, so their influence on these parameters in wild populations cannot be directly determined. Thus, interpretation of such patterns cannot provide direct information about the potential for expression of adaptive traits among individuals. However, to the extent that they reflect ongoing selection, the frequencies of alleles in this genomic region provide information about the relative fitness of alternative life-history patterns in a given set of populations.

Within the UTR and UMR, the distribution of alleles associated with adaptive genomic variation on chromosome Omy5 supports the hypothesis that the populations most likely to be expressing an adfluvial life-history are those with unimpeded migratory access to downstream reservoirs such as Lake Don Pedro and Lake McClure, as well as the Frog Creek population tributary to Lake Eleanor (Figures 1 & 6). Although the maximum frequency of migration-associated alleles among the UTR and UMR populations was low relative to coastal anadromous and adfluvial populations (Pearse et al. 2014; Leitwein et al. 2016), it is similar to that seen in potentially adfluvial populations of *O. mykiss* in the Upper American River (Abadía-Cardoso et al. In Prep). In addition, recent data have shown that the genomic region of Omy5 associated with migratory life-history patterns is also influenced by temperature (Miller et al. 2012; Pearse et al. In Prep). This additional influence may also contribute to the elevate frequency of resident-associated alleles in the colder, high elevation populations. In contrast, populations of *O. mykiss* in the lower Central Valley have the highest observed frequencies of the migration-associated alleles at Omy5 likely due in part to the high environmental temperatures they experience (Abadía-Cardoso et al. In Prep; Pearse et al. In Prep). Together these results suggest that the UTR and UMR populations occupying habitat below historical barriers to migration (Lindley et al. 2006), but above reservoirs, are the most likely to express significant migratory adfluvial behavior (Holecek et al. 2012; Holecek & Scarnecchia 2013; Leitwein et al. 2016).

Conservation Implications

Conservation efforts to restore trout populations require a diverse set of approaches and cooperation among stakeholders (Penaluna et al. 2016). From an evolutionary genetic perspective, several issues must be considered in evaluating the implications of this study for the potential restoration of connectivity between UTR and UMR populations and the Central Valley DPS steelhead below the dams.

First, the present study was based on a dataset with a modest number of SNPs by today's standards, and thus has low power relative to population genetic studies that utilize many more loci (e.g. Saglam et al. 2017). While large genomic datasets based on the thousands of loci generated by high-throughput sequencing would undoubtedly refine the population genetic relationships observed here, the basic conservation conclusions regarding the distribution of indigenous *O. mykiss* within the Tuolumne and Merced watersheds are unlikely to change in biologically-significant ways. This is in part due to the history of hatchery trout stocking and fish movement in these basins that has scrambled the relationships among populations such that the weak signal of genetic differentiation reflects biological reality rather than limited resolution (Pearse & Garza 2015). Similarly, while further characterization of the distribution of adaptive genomic variation on chromosome Omy5 as well as other parts of the genome would provide insight into the evolutionary processes affecting Yosemite trout populations, such information would not necessarily impact conservation planning because the same basic principles of population genetic management will apply regardless of the underlying genomic basis of the phenotype under consideration (Pearse 2016). Nonetheless, as more examples of adaptive genomic variation associated with life-history traits are identified in *O. mykiss* and other salmonid species (Pearse et al. 2014; Barson et al. 2015; Hess et al. 2016), fisheries management practices will need to carefully consider the most appropriate ways to conserve and protect this important biodiversity (Pearse 2016).

Second, among the limited populations of *O. mykiss* that remain in the ocean-accessible river reaches below the dams, there has been moderate introgression by coastal-origin steelhead propagated at Nimbus Hatchery into the, Calaveras, Tuolumne and Stanislaus Rivers, while *O. mykiss* captured in the lower Merced River are primarily descended from hatchery rainbow trout strains derived from northern Central Valley origin (Pearse & Garza 2015). In the present study, the sample of 59 fish collected in the Lower Merced River in 2015 and spawned at the Merced

River Hatchery follow the same signal of ancestry from hatchery trout strains, especially the Eagle Lake strain, that was previously seen in for samples in the lower Merced River (Pearse & Garza 2015). Thus, the steelhead currently inhabiting either of these below barrier reaches are not ideal candidates for passage above the dams.

Third, although our data show that the *O. mykiss* trapped above the dams have both ancestry and adaptive genomic variation consistent with being descendants of indigenous migratory populations, the re-development of a truly anadromous steelhead population through downstream passage presents significant challenges. In considering such a program, evaluation of the potential for passage of migratory fish above New Don Pedro and New Exchequer dams should include directed efforts to determine the potential for trapping both upstream and downstream migrants in the mainstem Tuolumne and Merced Rivers above these barriers. If significant numbers of such migratory phenotypes exist they could be considered as potential contributors to future fish passage programs if downstream habitat issues can be addressed.

Finally, it should be acknowledged that the genetic factors considered in this study are secondary to the basic need for access to appropriate habitat to support all phases of the life-cycle of anadromous salmonids. In the absence of that, the continued existence of migratory populations in these watersheds will depend on significant efforts through hatcheries and/or fish passage projects until the dams that block their migratory paths are ultimately removed.

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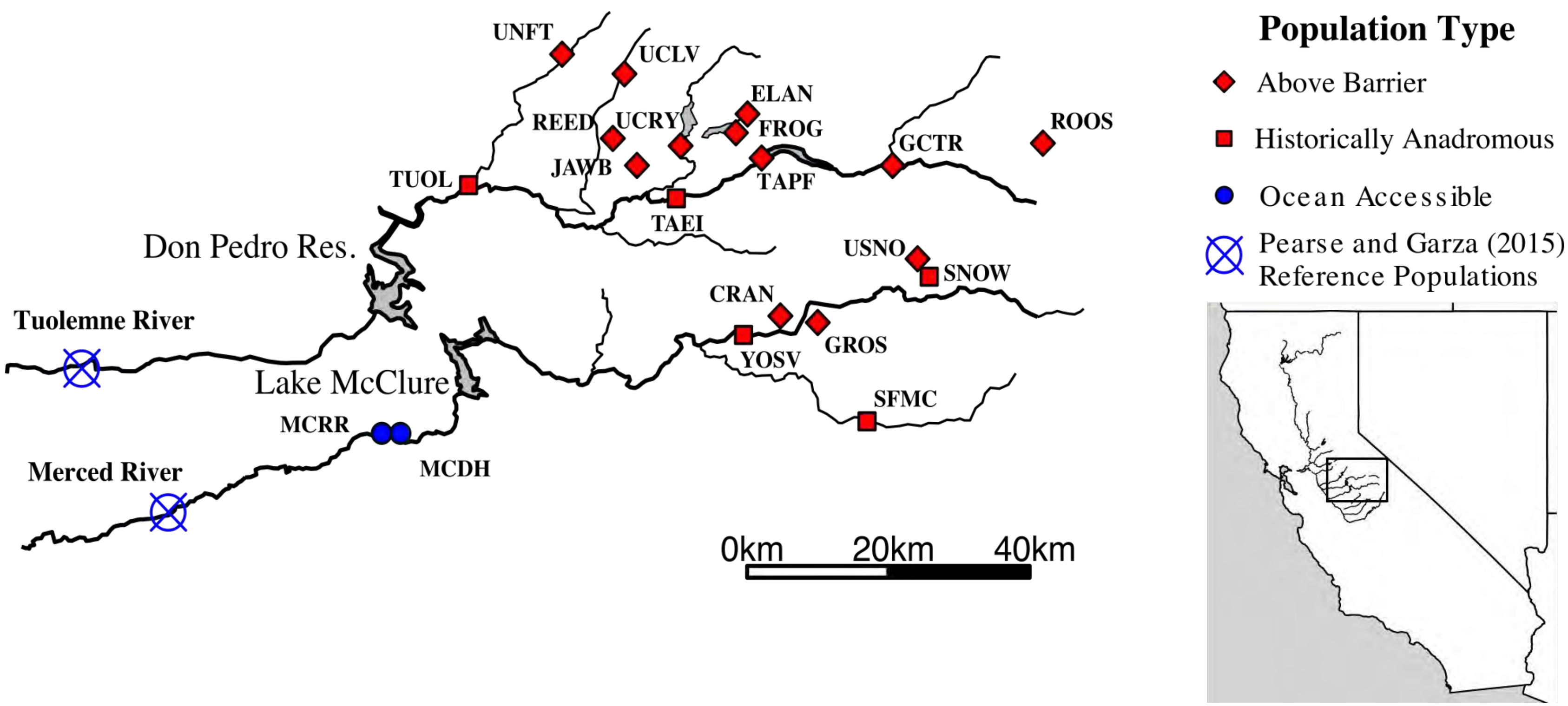


Figure 1: Map of Tuolumne River and Merced River sampling locations investigated in this study named by code found in Table 1. The inner box in the inset map of California indicates the geographic extent of the main map. Migratory potential is indicated by "Population Type" using both color and shape as indicated in the legend. Two reference populations that are ocean accessible from Pearse and Garza (2015) are also placed on the map.

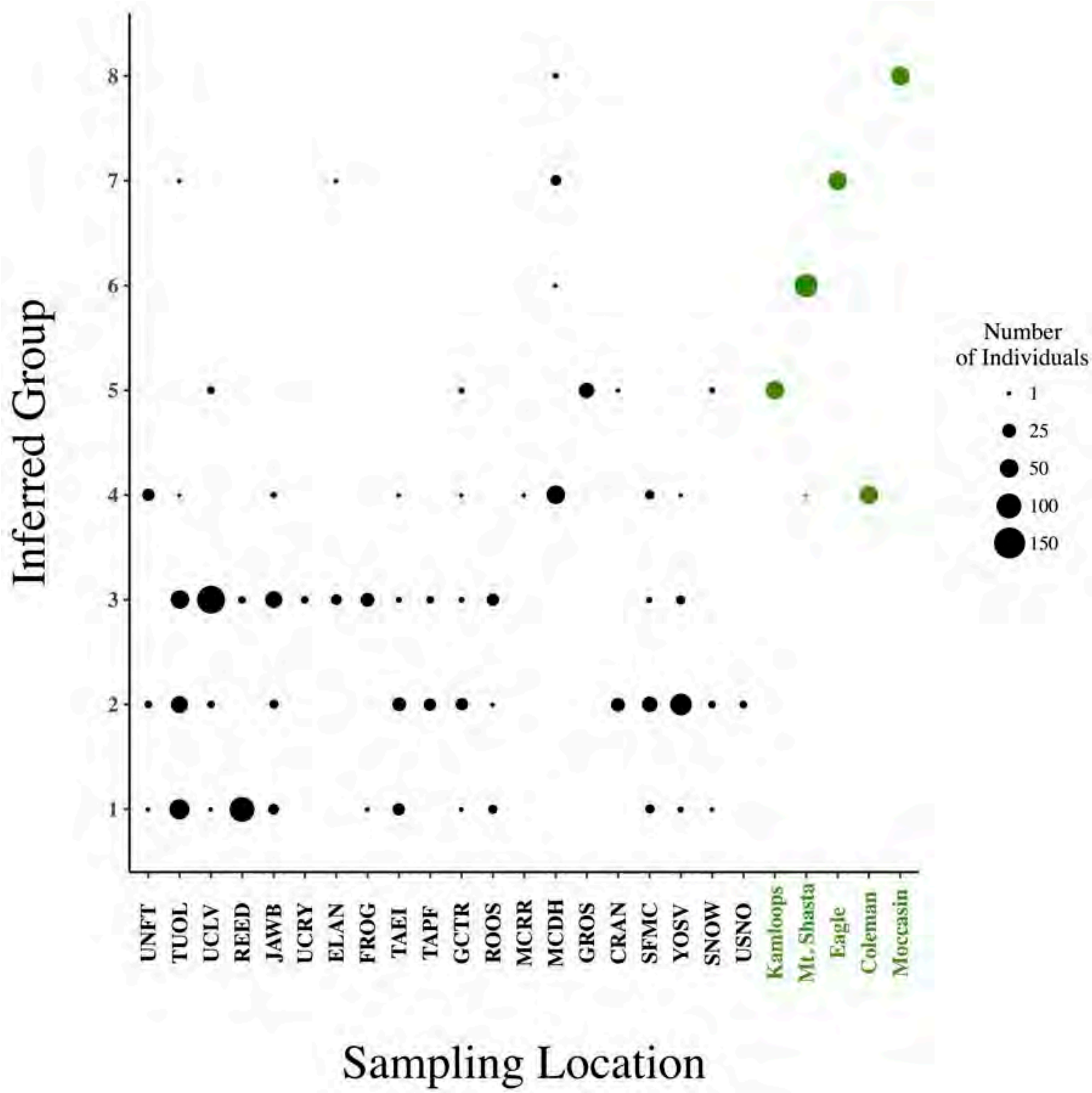


Figure 2: Discriminant Analysis of Principal Components (DAPC) of individuals from the 20 Yosemite National Park (YNP) sample units plus five hatchery reference strains. The sampling location is indicated on the *x* – axis and the eight inferred genetic groups of individuals are on the *y* – axis. Sample locations originating from the YNP are colored black and those of hatchery origin are colored green. Circles indicate the number of individuals from each sampling location assigned to a particular group.

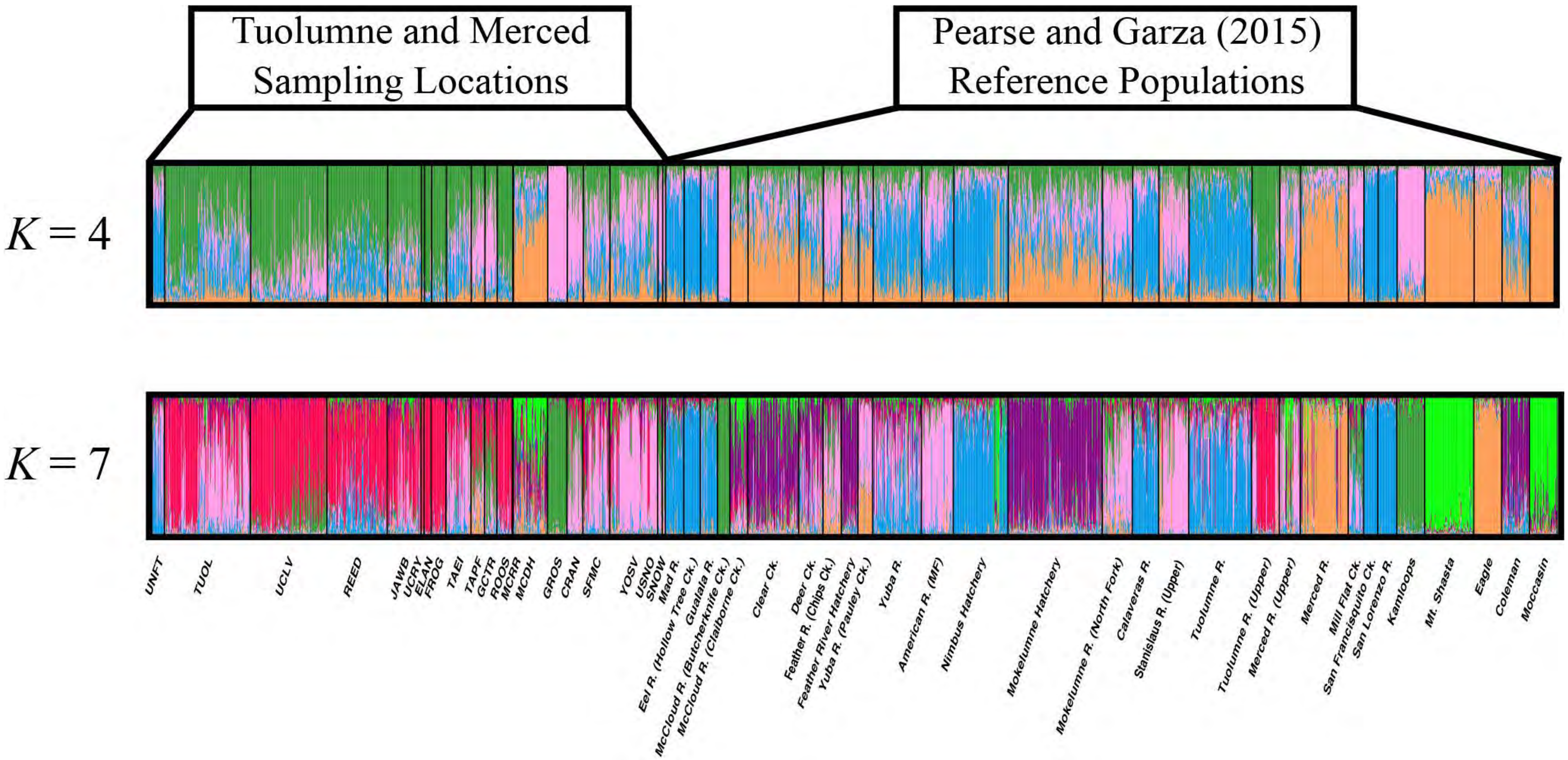


Figure 3: Individual-based plot of fractional ancestry generated by STRUCTURE with K = 4 and K = 7 shown. Sampling locations and reference populations are indicated along the bottom of the plot and described in Table 1. Every individual is represented by a vertical column, with the proportion of estimated ancestry from each of the four groups colored proportionately within the vertical column. At K = 4, native Tuolumne ancestry is shown in green, coastal ancestry in blue, Northern California hatchery ancestry in orange, and divergent outgroups in pink.

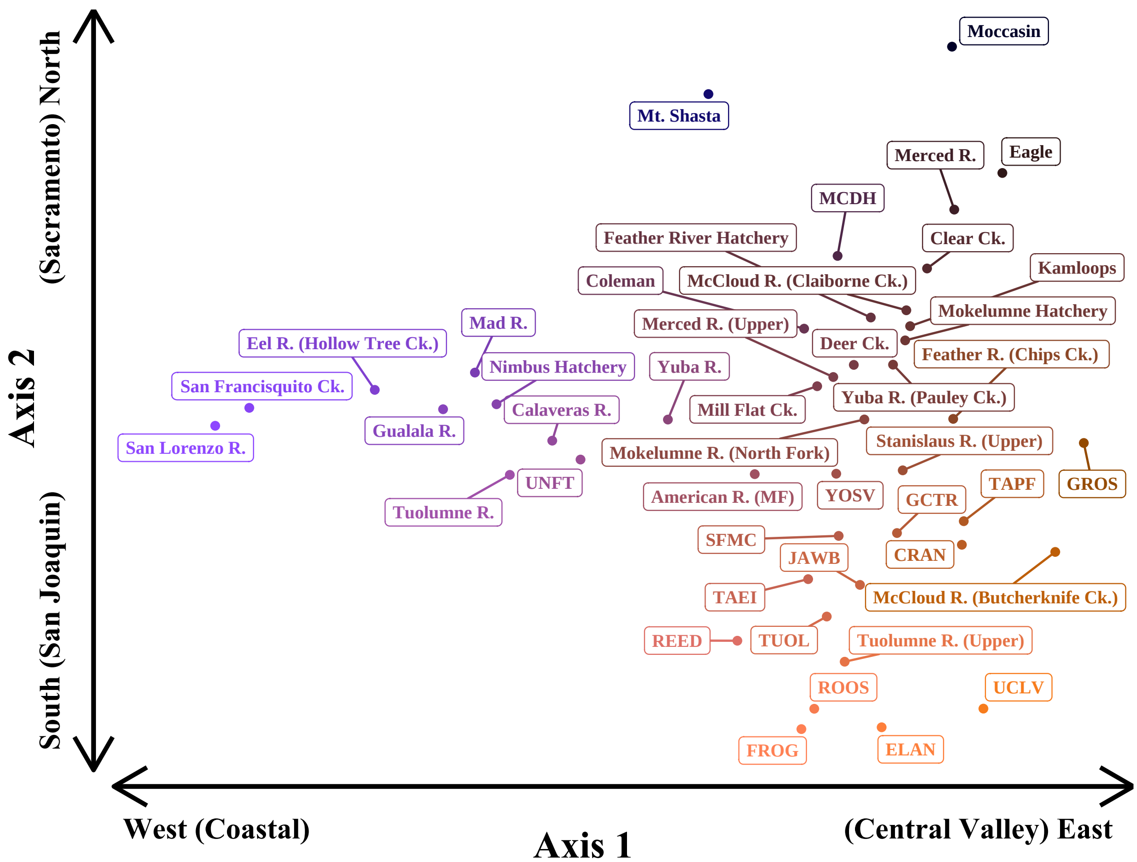


Figure 4: Population Discriminant Analysis of Principal Components (DAPC) plot showing genetic relationships among upper Tuolumne River (UTR) and upper Merced River (UMR) sampling locations relative to coastal and Central Valley reference populations. The central value for each population is indicated and with colors indicating relative positions along *x* and *y* – axes.

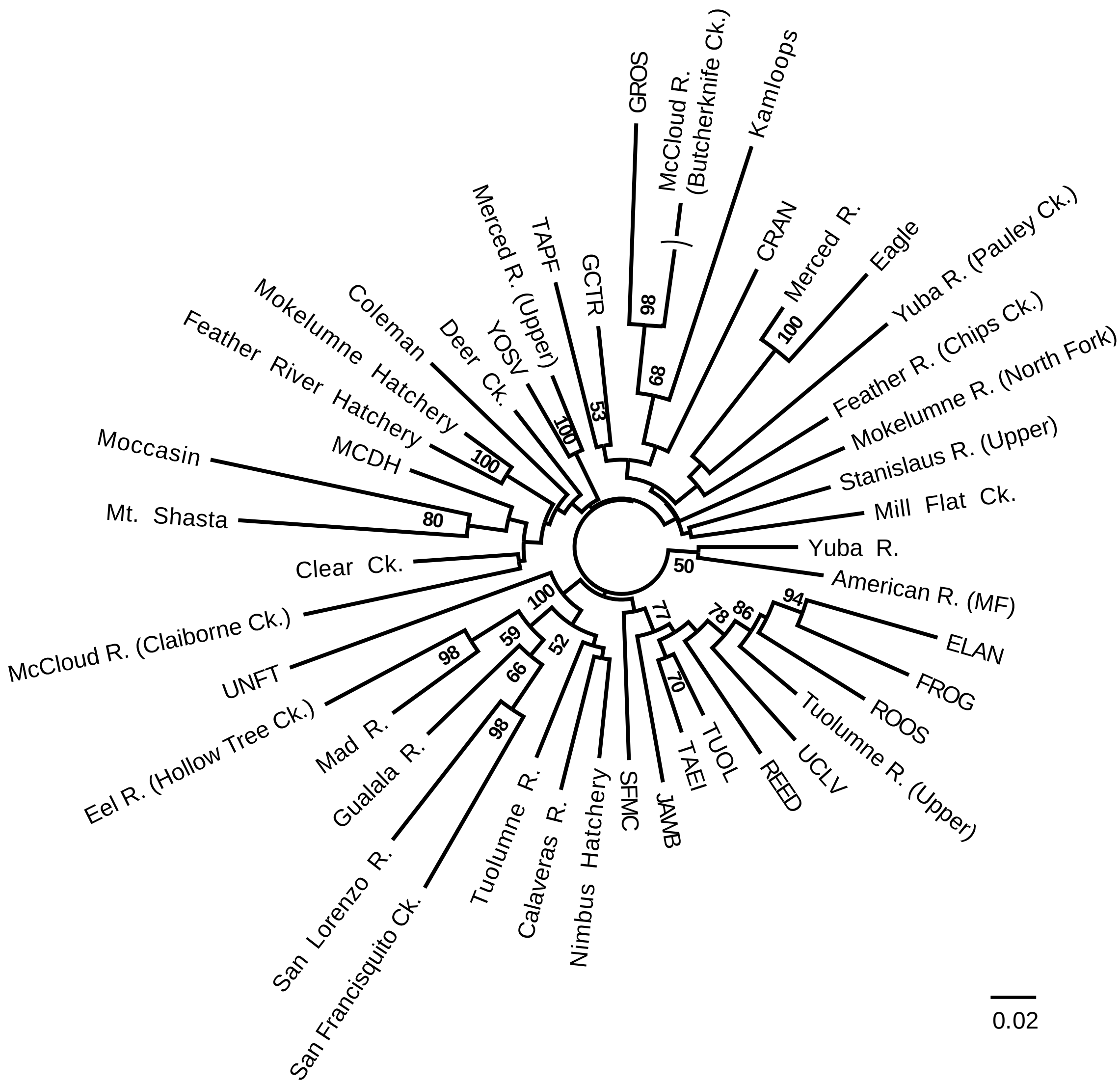


Figure 5: Neighbor Joining phylogenetic tree based on population chord distances showing relationships among sample sites within the UTR and UMR relative to other Central Valley and coastal *O. mykiss* populations. Bootstrap support, from 1,000 replicates is depicted (values of less than 50% not shown). The branch to McCloud R. (Butcherknife Ck.), indicated by a bisecting curve, has been shortened to one third of the original length for visual presentation.

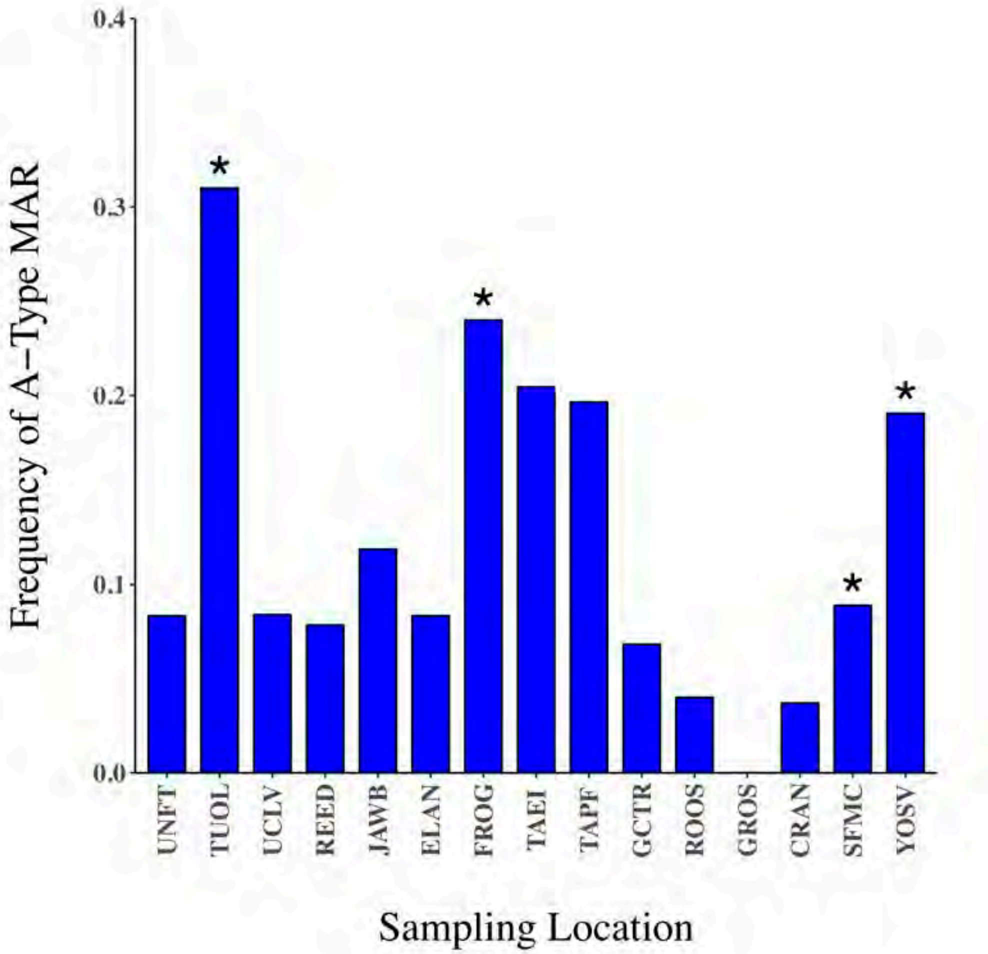


Figure 6: Frequency of A-type Migration Associated Region (MAR) estimated from Upper Tuolumne River and Upper Merced River sampling locations examined in this study. Potentially adfluvial populations are indicated by asterisks.

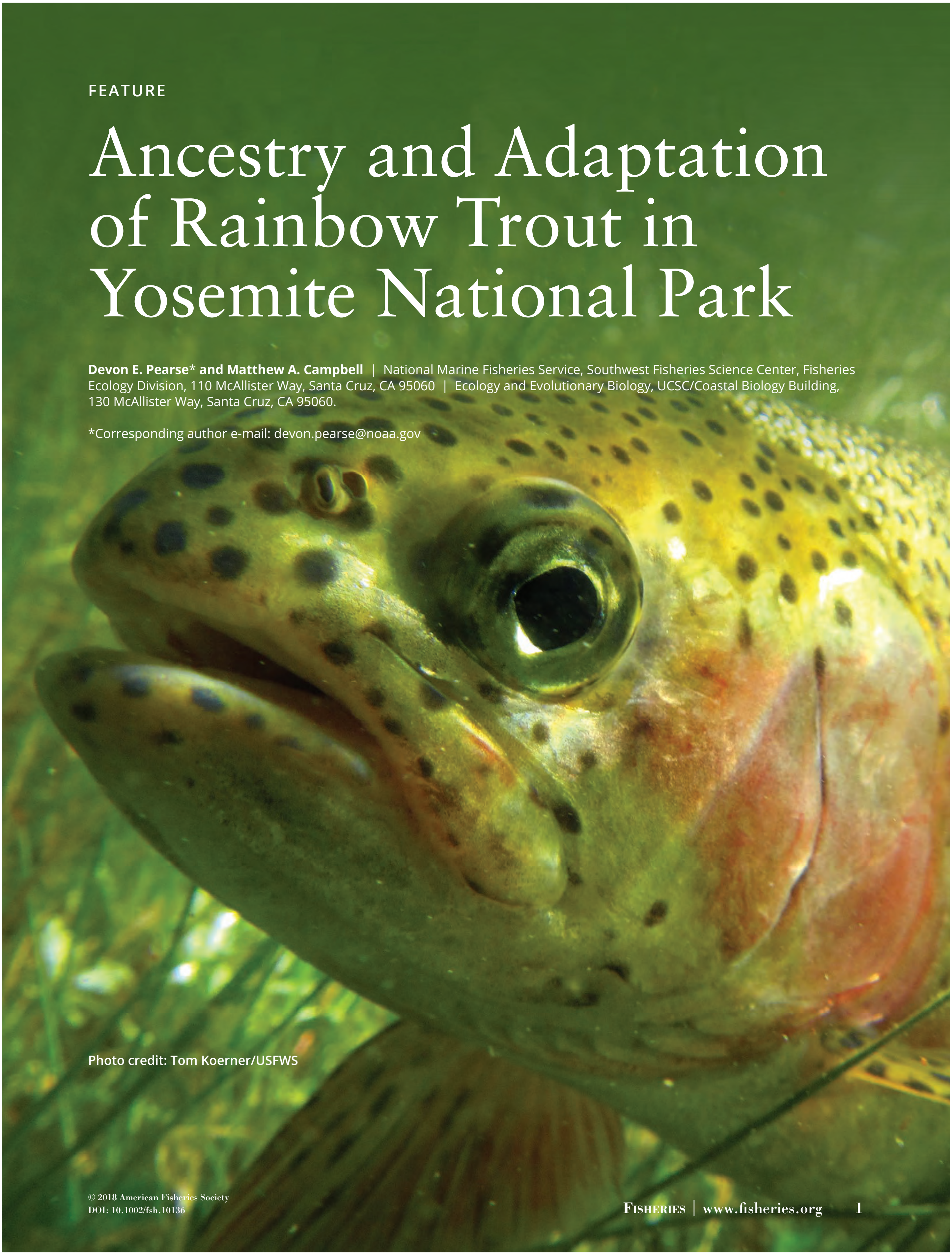
Table Captions

Table 1: Sample site information and summary statistics for genetic data analysis. The full name for sampling locations are given along with shortened codes that are used in the manuscript. The sample size for each sampling location and the categorization regarding migratory potential are also presented. For each population, the number of samples that were included in genetic analyses, expected heterozygosity (H_E) and the frequency of the anadromous type Migration Associated Region, F(A MAR) are provided. For each collection that comprised a sampling location, the major drainage basin, the dates of collection, sample size (N), and WGS 84 coordinates are indicated.

Sampling Location	Code	Sample Size	Population Type	Samples Passing QC for Genetic Analyses	H_E	F (A MAR)	Drainage Basin	Date(s)	N	Latitude	Longitude
Upper North Folk Tuolumne River	UNFT	24	Above Barrier	21	0.27	0.08	Tuolumne River	6/8/15	24	38.1	-120.11
Tuolumne River	TUOL	150	Historically Anadromous	145	0.36	0.31	Tuolumne River	5/12/15	11	37.9	-120.07
							Tuolumne River	8/27/15	3	37.9	-120.26
							Tuolumne River	10/8/15	41	37.84	-120.06
							Tuolumne River	5/12/15	31	37.84	-120.04
							Tuolumne River	6/9/15	11	37.89	-119.97
							Tuolumne River	5/15/15	36	37.89	-119.95
							Tuolumne River	5/14/15	17	37.88	-119.97
Upper Clavey River	UCLV	131	Above Barrier	129	0.30	0.08	Tuolumne River	6/9/15	68	37.99	-120.05
							Tuolumne River	6/8/15	55	38.07	-120.01
							Tuolumne River	6/8/15	8	38.09	-120.01
Reed Creek	REED	103	Above Barrier	102	0.36	0.08	Tuolumne River	5/13/15	103	37.98	-120.02
Jawbone Creek	JAWB	59	Above Barrier	57	0.35	0.12	Tuolumne River	5/13/15	59	37.93	-119.99
Upper Cherry Creek	UCRY	5	Above Barrier	5	0.31	NA	Tuolumne River	6/9/15	5	37.96	-119.92
Eleanor Creek	ELAN	12	Above Barrier	12	0.30	0.08	Tuolumne River	6/19/16	12	38	-119.83
Frog Creek	FROG	25	Above Barrier	25	0.29	0.24	Tuolumne River	6/18/16	25	37.98	-119.84
Tuolumne River - Above Early Intake	TAEI	45	Historically Anadromous	42	0.36	0.20	Tuolumne River	5/13/15	45	37.88	-119.94
Tuolumne River - Above Preston Falls	TAPF	28	Above Barrier	23	0.32	0.20	Tuolumne River	6/10/15	23	37.88	-119.88
							Tuolumne River	6/11/15	5	37.95	-119.79
Grand Canyon Tuolumne River	GCTR	22	Above Barrier	21	0.34	0.07	Tuolumne River	7/18/15	22	37.93	-119.58
Roosevelt Lake	ROOS	26	Above Barrier	26	0.32	0.04	Tuolumne River	8/13/15	26	37.964	-119.339
Merced River Ranch	MCRR	1	Ocean Accesible	1	0.39	NA	Merced River	4/9/10	1	37.52	-120.4
Merced River Hatchery	MCDH	58	Ocean Accesible	58	0.35	0.60	Merced River	12/9/14	58	37.52	-120.37
Grouse Creek	GROS	34	Above Barrier	33	0.23	0.00	Merced River	8/11/16	34	37.69	-119.7
Crane Creek	CRAN	27	Above Barrier	27	0.32	0.04	Merced River	8/10/16	27	37.7	-119.76
South Fork Merced River	SFMC	49	Historically Anadromous	45	0.34	0.09	Merced River	8/11/16	4	37.55	-119.63
							Merced River	8/11/16	43	37.539	-119.621
							Merced River	8/11/16	2	37.517	-119.667
Yosemite Valley	YOSV	85	Historically Anadromous	81	0.35	0.19	Merced River	8/11/16	3	37.671	-119.819
							Merced River	6/30/15, 8/12/16	47	37.68	-119.74
							Merced River	6/29/16	2	37.725	-119.712
							Merced River	8/11/16	4	37.725	-119.712
							Merced River	8/11/16	15	37.723	-119.557
							Merced River	6/30/2015, 8/10/2016	14	37.75	-119.54
Snow Creek	SNOW	8	Historically Anadromous	8	0.33	NA	Merced River	8/10/16	8	37.76	-119.53
Upper Snow Creek	USNO	5	Above Barrier	5	0.34	NA	Merced River	8/10/16	5	37.77	-119.54

Pearse & Garza (2015) Reference Populations				
North Coast				
Mad R.	31	Ocean Accesible	31	0.35
Eel R. (Hollow Tree Ck.)	28	Ocean Accesible	28	0.34
Gualala R.	29	Ocean Accesible	29	0.40
Central Valley				
McCloud R. (Butcherknife Ck.)	21	Historically Anadromous	21	0.17
McCloud R. (Claiborne Ck.)	33	Historically Anadromous	30	0.33
Clear Ck.	94	Ocean Accessible	86	0.34
Deer Ck.	45	Ocean Accessible	41	0.37
Feather R. (Chips Ck.)	31	Historically Anadromous	31	0.32
Feather River Hatchery	30	Ocean Accessible	28	0.37
Yuba R. (Pauley Ck.)	25	Historically Anadromous	25	0.31
Yuba R.	90	Historically Anadromous	82	0.41
American R. (MF)	58	Historically Anadromous	54	0.37
Nimbus Hatchery	98	Ocean Accessible	92	0.40
Mokelumne Hatchery	162	Ocean Accessible	159	0.37
Mokelumne R. (North Fork)	51	Historically Anadromous	51	0.33
Calaveras R.	47	Ocean Accessible	44	0.37
Stanislaus R. (Upper)	52	Ocean Accessible	51	0.34
Tuolumne R.	112	Ocean Accessible	106	0.39
Tuolumne R. (Upper)	47	Historically Anadromous	47	0.34
Merced R. (Upper)	35	Historically Anadromous	35	0.35
Merced R.	83	Ocean Accessible	81	0.29
Mill Flat Ck.	26	Historically Anadromous	26	0.36
South Coast				
San Francisquito Ck.	24	Ocean Accessible	24	0.36
San Lorenzo R.	32	Ocean Accessible	32	0.37
Hatchery Trout Strains				
Kamloops	47	NA	47	0.23
Mt. Shasta	92	NA	83	0.32
Eagle	47	NA	47	0.25
Coleman	47	NA	47	0.33
Moccasin	47	NA	46	0.25

EXHIBIT E



FEATURE

Ancestry and Adaptation of Rainbow Trout in Yosemite National Park

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California's Central Valley contains an abundance of rivers with historical and potential productivity for anadromous salmonids, which are currently limited by impacts such as dams, water diversions, and high temperatures. We surveyed genetic variation in Rainbow Trout *Oncorhynchus mykiss* within the upper Tuolumne and Merced rivers in and around Yosemite National Park to evaluate both population origins (ancestry) and the evolutionary response to natural and artificial barriers to migration (adaptation). This analysis revealed that despite extensive stocking with hatchery Rainbow Trout strains throughout the study area, most populations retained largely indigenous ancestry. Adaptive genomic variation associated with anadromy was distributed throughout the study area, with higher frequencies observed in populations connected to reservoirs that are known to support adfluvial life history variants. Fish in southern Central Valley rivers experience temperatures near the upper thermal limit for salmonids and represent an important reservoir of genomic diversity for adaptation to climate change. These results highlight the importance of local adaptation as well as the potential for resident Rainbow Trout populations above barrier dams to contribute to the recovery of steelhead (anadromous Rainbow Trout) once migratory connectivity is restored between upstream spawning and rearing habitats and the ocean.

The Central Valley of California is both a productive agricultural region and an important ecosystem in western North America that encompasses two large river systems: the Sacramento River to the north and the San Joaquin River to the south. Together, these rivers and their tributaries are home to the southernmost native populations of Chinook Salmon *Oncorhynchus tshawytscha*, Rainbow Trout *O. mykiss*, and steelhead (anadromous Rainbow Trout; Fisher 1994; Busby et al. 1996; Yoshiyama et al. 1998, 2001; McEwan 2001). However, the construction of barrier dams and water diversions has greatly restricted migratory connectivity on many rivers, resulting in extremely reduced anadromous salmonid populations throughout the Central Valley (Yoshiyama et al. 1998, 2001; May and Brown 2002; Lindley et al. 2006; NMFS 2006, 2014; Katz et al. 2013). Large barrier dams in particular prevent upstream migration of adult salmonids to their spawning habitats, as well as preventing downstream juvenile migration, thus severely impacting anadromous species. As a result, there is an increasing focus on re-connecting migratory anadromous salmonid populations with their historical spawning grounds above impassable dams through dam removal, addition of volitional passageways, or fish passage programs known as "trap and haul" (Anderson et al. 2014; NMFS 2014; Lusardi and Moyle 2017).

The Tuolumne and Merced rivers are tributaries of the San Joaquin River that drain a large portion of Yosemite National Park (hereafter, "Yosemite") in the central Sierra Nevada as well as Stanislaus National Forest lands and other lands (Figure 1). Both spring-run Chinook Salmon and steelhead historically used these waterways to access the cool refuges of the High Sierra, where they and their offspring could escape the summertime heat and dwindling river flows of the lower elevations. Both species likely spawned in the Merced River throughout Yosemite Valley up to the bases of Half Dome and the spectacular Vernal and Yosemite falls and in the Tuolumne River up to Preston Falls, just downstream of the park's boundary (Figure 1; Tuolumne River above Preston Falls [TAPF]). However, the full extent of their historical migrations is unclear (Yoshiyama et al. 2001; Lindley et al. 2006). Beginning in the mid-1800s, as happened in many Central Valley rivers, construction of a series of dams blocked anadromous salmonids' access between the ocean and the headwaters of the Tuolumne and Merced rivers. Currently, La Grange Dam (completed in 1883) and Crocker-Huffman Dam (completed in 1906) create the upper limits to anadromous migration; above these dams, the much-larger New Don Pedro and New Exchequer dams form major reservoirs on the Tuolumne and Merced rivers, respectively, providing flood control, water storage, recreation, and power generation (Figure 1). Collectively, these dams and their predecessors have prevented native salmon and steelhead from accessing historic spawning habitats for more than a century. However, even prior to the construction of the major barrier dams, the activities of the California Gold Rush in the 1850s and subsequent development of agricultural infrastructure in the Central Valley had a huge effect on the native fauna, particularly the migratory salmonids (Yoshiyama et al. 1998, 2001), and few naturally spawning anadromous salmonids exist in the reaches below these dams today (Ford and Kirihara 2010; Cuthbert et al. 2012; NMFS 2014). This situation is further exacerbated by the poor quality of downstream habitat in the Sacramento–San Joaquin Delta for both migratory and nonmigratory native fishes (Moyle et al. 2018). Today, intensive management and hatchery supplementation maintain many salmonid populations in the Central Valley, including the California Central Valley Distinct Population Segment (DPS) of steelhead, which is listed as threatened under the Endangered Species Act (ESA; NMFS 2006); however, inability to access more than 80% of its historical spawning habitat remains a critical issue for the recovery of this DPS (Yoshiyama et al. 2001; Lindley et al. 2006). The National Marine Fisheries Service's (NMFS) Central Valley Recovery Plan identifies the upper Tuolumne River (UTR) and the upper Merced River (UMR) as candidate areas for reintroduction of both steelhead and spring-run Chinook Salmon to support recovery of the southern Sierra Nevada steelhead diversity group through upstream passage of adults and downstream movement of juveniles over the dams (NMFS 2014).

With few exceptions, Chinook Salmon are strictly anadromous (but see Sard et al. 2016; Brenkman et al. 2017), whereas self-sustaining populations of freshwater resident Rainbow Trout commonly persist above barrier dams that block their ability to access the ocean (Kendall et al. 2015). Individuals in above-dam populations may exhibit several life history strategies, including a migratory adfluvial life history utilizing a reservoir as an alternative to a fully anadromous marine migration and returning to spawn in upstream tributaries (e.g., Holecek and Scarnecchia 2013; Leitwein et al. 2017). These populations are typically closely related to the remaining *O. mykiss* found below barriers in the same watershed (Narum et al. 2008; Clemento et al. 2009; but see Pearse and Garza 2015), although stocking of nonnative hatchery Rainbow Trout strains into above-barrier habitats has resulted in partial or complete replacement of the indigenous ancestry in some cases (e.g., Abadía-Cardoso et al. 2016). Importantly, only the anadromous (steelhead) life history is listed under

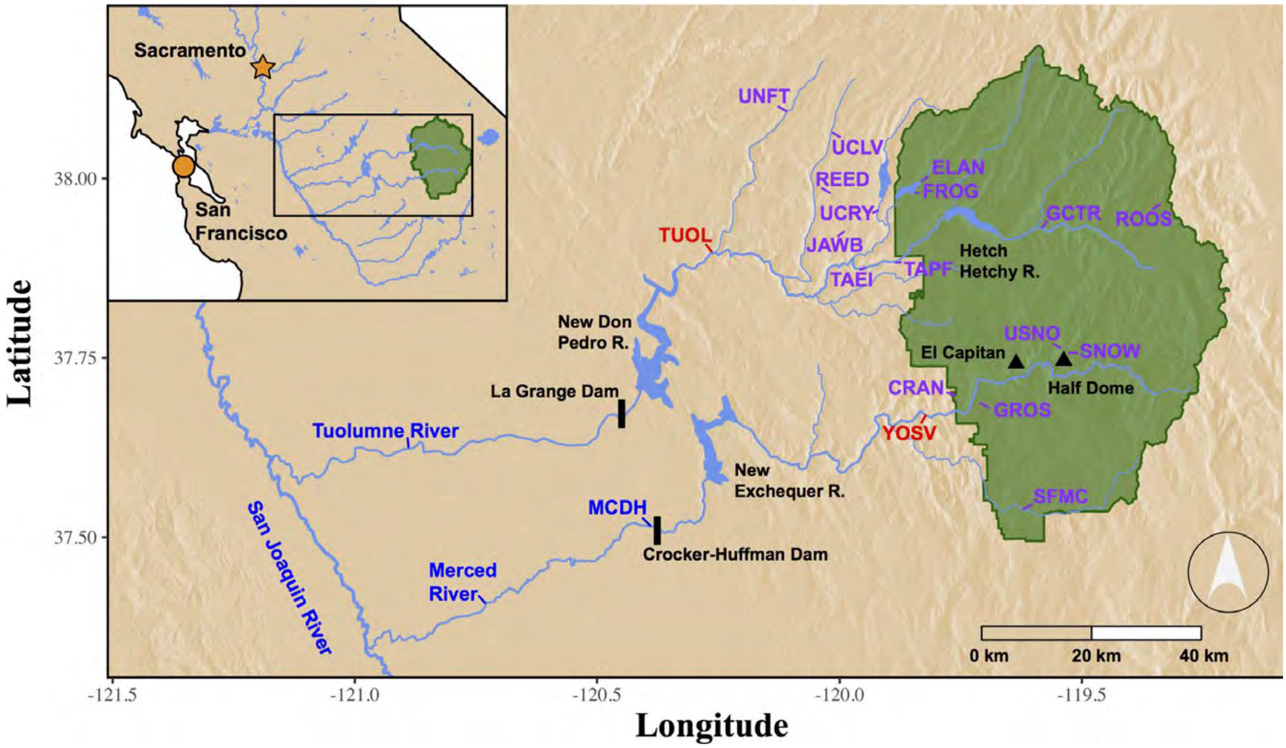

Figure 1. Map of Tuolumne and Merced river sampling locations investigated in this study, showing existing dams and reservoirs. Sampling units as described in the text are labeled following the codes in Table 1; two Pearse and Garza (2015) reference populations are indicated by "Tuolumne River" and "Merced River." Yosemite National Park is shaded green, with El Capitan and Half Dome indicated by solid black triangles. Population migratory potentials are indicated by color: potentially anadromous (blue), potentially adfluvial (red), and resident Rainbow Trout (purple). La Grange and Crocker-Huffman dams (black bars) serve as the upper limits to anadromy in the Tuolumne and Merced rivers, respectively. Inset depicts the central California region, showing the Sacramento–San Joaquin River system draining to the Pacific Ocean through San Francisco Bay. The inner box in the inset indicates the geographic extent of the main map.

the ESA, whereas even closely related above-barrier Rainbow Trout populations are not protected by the ESA (NMFS 2006). Thus, in considering efforts to reconnect migratory steelhead populations below dams with their historical upriver spawning habitats, an important first step is to evaluate the genetic ancestry and adaptive potential of the Rainbow Trout trapped above the dams (Winans et al. 2010, 2017, 2018).

ANCESTRY OF YOSEMITE TROUT

There is a rich history of fish stocking in and around Yosemite that has undoubtedly influenced the distribution and genetic composition of its Rainbow Trout. Early visitors took a strong interest in increasing the trout populations, both for food resources and recreation (Caton 1869; Pavlik 1987). Fish planting likely began in the area during the 1870s, initially by settlers moving locally captured fish up into the previously fishless waters above waterfalls and in high alpine lakes. Stocking records describing imported trout first occurred in the 1890s, and by 1895, there was a fish hatchery operating on the South Fork Merced River at Wawona that distributed both indigenous and imported trout throughout the area (Pavlik 1987). A subsequent hatchery was established in 1918 at Happy Isles on the main-stem Merced River in Yosemite Valley, and the importation of eggs from other hatcheries ensured a steady supply of Rainbow Trout as well as nonnative species, such as Lahontan Cutthroat Trout *O. clarkii henshawi*, European Brown Trout *Salmo trutta*, and Brook Trout *Salvelinus fontinalis* (Leitritz 1970). Although many of the eggs reared at the Happy Isles Fish Hatchery were imported from outside Yosemite, some were collected at an egg taking station on Frog Creek (FROG), a historically fishless tributary of the UTR above Lake Eleanor in the northern part of Yosemite (Figure 1; Pavlik 1987). Thus, over the years, a diverse mixture of both locally sourced Rainbow Trout and fish imported from throughout California have been planted within Yosemite, potentially creating admixed populations with both indigenous and hatchery ancestry. However, management of more recent stocking efforts has changed significantly, and since 2013, most trout planted in California have been sterile triploids, limiting further naturalization and spawning by hatchery fish. The current distribution of Rainbow Trout within Yosemite is therefore composed of self-sustaining populations whose ancestry remains to be evaluated through genetic analysis.

ADAPTATION TO RESIDENCY

Despite dramatic differences in traits related to physiology, morphology, and behavior, the diverse life history forms of *O. mykiss* often co-exist and interbreed, forming interrelated populations in nature (Quinn 2011). Consequently, anadromous and resident fish within a drainage basin are typically closely related to each other (Olsen et al. 2006; Narum et al. 2008; Pearse et al. 2009). Although offspring of a particular life history variant may take on an alternative strategy from that of their parents (Courter et al. 2013), there is a great deal of evidence pointing to heritable influences on life history strategies and associated phenotypes (e.g., Neave 1944; Berejikian et al. 2014; Phillis et al. 2016).

Surveys of genetic variation have found that Rainbow Trout in above-barrier habitats undergo specific genetic changes as populations adapt to residency. In particular, one region of chromosome Omy5 has shown a consistent association with resident (R) and anadromous (A) life histories, although many other genomic regions are also associated with variation in this trait (e.g., Nichols et al. 2008; Hale et al. 2013; Hecht et al. 2013). However, unlike waterfalls, which exert knife-edge selection against downstream migration (Pearse et al. 2009; Northcote 2010), barrier dams create reservoirs above them, allowing Rainbow Trout trapped above the dams to develop an adfluvial migratory life history by utilizing the reservoir as a rearing habitat and spawning in the tributary streams (e.g., Holecek et al. 2012; Holecek and Scarnecchia 2013). Importantly, despite the dramatic difference in osmotic conditions between reservoirs and the ocean, selection for an adfluvial migratory life history appears to affect the same adaptive genomic variants on Omy5 as true anadromous migrations (Pearse et al. 2014; Leitwein et al. 2017). This suggests that adfluvial Rainbow Trout populations isolated above dams and reservoirs could potentially contribute to the recovery of migratory anadromous ecotypes once migratory access to the ocean is restored through dam removal or assisted fish passage (Thrower et al. 2008; Meek et al. 2014; Winans et al. 2017).

The primary goal of this study was to determine the genetic ancestry and current population structure of *O. mykiss* populations in the UTR and UMR (Figure 1). To do so, we investigated the genetic relationships of *O. mykiss* in these rivers relative to (1) other populations above and below barriers to anadromy in the Central Valley, (2) hatchery Rainbow Trout strains commonly used in California, and (3) coastal steelhead populations. In addition, we assayed adaptive genomic variation in the region of chromosome Omy5 known to be associated with anadromous and adfluvial life history traits in *O. mykiss* to estimate the frequencies of alleles associated with migratory behavior relative to the presence of barriers to fish migration (Pearse et al. 2014; Apgar et al. 2017; Leitwein et al. 2017). We use this information to evaluate the potential for UTR and UMR populations to contribute to the recovery of anadromous steelhead below barriers in the southern Central Valley. Together, these data provide a baseline to inform future management of *O. mykiss* populations in these and other Central Valley watersheds and to improve our understanding of the potential to recover anadromous steelhead populations by restoring connectivity with *O. mykiss* populations trapped in habitats upstream of the dams.

METHODS

Sampling

Fish were captured in 2015 and 2016 at 37 sites throughout the UTR and UMR watersheds, including both migratory reaches (those historically accessible to migratory steelhead; Lindley et al. 2006) and historically fishless reaches that were isolated above barriers (Figure 1; Table 1). Due to the difficulty of accessing fish in larger rivers as well as the extremely low conductivity of Sierra Nevada streams, many sites were unsuitable for electrofishing, and most fish in the study were captured by hook and line. This "Fly Fishing for Science" had the added benefit of providing a mechanism to allow volunteer fly fishers to contribute to the project as citizen scientists (Williams et al. 2015). All fish were measured, and fin tissue samples were taken from each individual prior to release at the site of capture. Tissue samples were dried and taken to the NMFS laboratory in Santa Cruz, California, for analysis.

Genetic data collection

We extracted DNA from dried fin clips by using the DNeasy 96 filter-based nucleic acid extraction system on a BioRobot 3000 (Qiagen, Inc.) in accordance with the manufacturer's protocols. All DNA extractions were diluted 2:1 with distilled water and used for PCR pre-amplification prior to TaqMan or SNP Type (single-nucleotide polymorphism [SNP]) genotyping with 96.96 Integrated Fluidic Circuit chips (Fluidigm, Inc.). Genotypes were read and scored using Fluidigm SNP Genotyping Analysis software (Fluidigm). All samples were genotyped at total of 92 SNPs for population genetic analysis following Abadía-Cardoso et al. (2013), a gender identification SNP assay (Brunelli et al. 2008; Rundio et al. 2012), and three SNPs on chromosome Omy5 that have been associated with migratory life history traits (Pearse et al. 2014; Pearse and Garza 2015; Abadía-Cardoso et al. 2016; Leitwein et al. 2017).

Data analysis

The SNP genotype data were combined with published data from 21 representative wild coastal and Central Valley *O. mykiss* populations, three Central Valley steelhead hatcheries, and five hatchery Rainbow Trout strains common in California (Pearse and Garza 2015). The genetic data were analyzed with R version 3.4.1 (R Development Core Team 2017). Genotypes were imported for use in R and converted to a "genind" object for subsequent analyses through the package "pegas" version 0.10 (Paradis 2010). Quality control of individual fish was undertaken with the "missingno" function of "poppr" version 2.5.0 (Kamvar et al. 2014) by specifying that both genotypes and loci were not allowed to have more than 5% missing data. From these filtered data, two separate approaches were implemented: (1) an individual approach; and (2) a population approach in which fish sampled along contiguous reaches without barriers to migration were combined into "sampling units," resulting in a total of 20 discrete groups of individuals based on local geography and barriers to migration (Figure 1; Table 1).

Individual approach

For the individual approach, prior population assignment based on collection location was not considered, and individuals were independently assigned to inferred populations. This approach was used to verify the independence or interrelatedness of sampling locations. For example, when hatchery reference populations are included, do sampled individuals show genetic similarities to any hatchery population? We used discriminant analysis of principal components (DAPC) as implemented in R with the package "adegenet" version 2.0.1 (Jombart 2008; Jombart et al. 2010) and STRUCTURE version 2.3.4 (Pritchard et al. 2000; Falush et al. 2003) as complementary individual analyses.

For the individual DAPC, we limited our analysis to only new collections from the Tuolumne River and Merced River along with five hatchery trout strains as reference populations to detect hatchery introgression. The DAPC is not based on a

Table 1. Sample information and summary statistics for genetic data analysis of *Oncorhynchus mykiss*. The full name, code, and sample size for each sampling unit are given along with the categorization regarding migratory potential. For each population, the sample size included in genetic analyses (n; i.e., samples passing quality control), the expected heterozygosity (H_E), and the frequency of the anadromous-type Omy5 migration-associated region (F[A MAR]) are provided. For each collection that comprised a sampling site, the major drainage basin, dates of collection, sample size (*N*), and World Geodetic System 84 coordinates are indicated.

Sampling location	Code	Total N	Population type	*N*	H_E	F(A MAR)	Drainage basin	Date(s)	*N*	Latitude	Longitude
Upper North Folk Tuolumne River	UNFT	24	Above barrier	21	0.27	0.08	Tuolumne River	Jun 8, 2015	24	38.10	−120.11
Tuolumne River	TUOL	150	Historically anadromous	145	0.36	0.31	Tuolumne River	May 12, 2015	11	37.90	−120.07
							Tuolumne River	Aug 27, 2015	3	37.90	−120.26
							Tuolumne River	Oct 8, 2015	41	37.84	−120.06
							Tuolumne River	May 12, 2015	31	37.84	−120.04
							Tuolumne River	Jun 9, 2015	11	37.89	−119.97
							Tuolumne River	May 15, 2015	36	37.89	−119.95
							Tuolumne River	May 14, 2015	17	37.88	−119.97
Upper Clavey River	UCLV	131	Above barrier	129	0.30	0.08	Tuolumne River	Jun 9, 2015	68	37.99	−120.05
							Tuolumne River	Jun 8, 2015	55	38.07	−120.01
							Tuolumne River	Jun 8, 2015	8	38.09	−120.01
Reed Creek	REED	103	Above barrier	102	0.36	0.08	Tuolumne River	May 13, 2015	103	37.98	−120.02
Jawbone Creek	JAWB	59	Above barrier	57	0.35	0.12	Tuolumne River	May 13, 2015	59	37.93	−119.99
Upper Cherry Creek	UCRY	5	Above barrier	5	0.31	NA	Tuolumne River	Jun 9, 2015	5	37.96	−119.92
Eleanor Creek	ELAN	12	Above barrier	12	0.30	0.08	Tuolumne River	Jun 19, 2016	12	38.00	−119.83
Frog Creek	FROG	25	Above barrier	25	0.29	0.24	Tuolumne River	Jun 18, 2016	25	37.98	−119.84
Tuolumne River–above Early Intake	TAEI	45	Historically anadromous	42	0.36	0.20	Tuolumne River	May 13, 2015	45	37.88	−119.94
Tuolumne River–above Preston Falls	TAPF	28	Above barrier	23	0.32	0.20	Tuolumne River	Jun 10, 2015	23	37.88	−119.88
							Tuolumne River	Jun 11, 2015	5	37.95	−119.79
Grand Canyon Tuolumne River	GCTR	22	Above barrier	21	0.34	0.07	Tuolumne River	Jul 18, 2015	22	37.93	−119.58
Roosevelt Lake	ROOS	26	Above barrier	26	0.32	0.04	Tuolumne River	Aug 13, 2015	26	37.96	−119.34
Merced River Ranch	MCRR	1	Ocean accessible	1	0.39	NA	Merced River	Apr 9, 2010	1	37.52	−120.40
Merced River Hatchery	MCDH	58	Ocean accessible	58	0.35	0.60	Merced River	Dec 9, 2014	58	37.52	−120.37
Grouse Creek	GROS	34	Above barrier	33	0.23	0.00	Merced River	Aug 11, 2016	34	37.69	−119.70
Crane Creek	CRAN	27	Above barrier	27	0.32	0.04	Merced River	Aug 10, 2016	27	37.70	−119.76
South Fork Merced River	SFMC	49	Historically anadromous	45	0.34	0.09	Merced River	Aug 11, 2016	4	37.55	−119.63
							Merced River	Aug 11, 2016	43	37.54	−119.62
							Merced River	Aug 11, 2016	2	37.52	−119.66
Yosemite Valley	YOSV	85	Historically anadromous	81	0.35	0.19	Merced River	Aug 11, 2016	3	37.67	−119.82
							Merced River	Jun 30, 2015; Aug 12, 2016	47	37.68	−119.74
							Merced River	Jun 29, 2016	2	37.72	−119.71
							Merced River	Aug 11, 2016	4	37.72	−119.71
							Merced River	Aug 11, 2016	15	37.72	−119.56
							Merced River	Jun 30, 2015; Aug 10, 2016	14	37.76	−119.54

(continued)

Table 1. (Continued)

Sampling location	Code	Total N	Population type	*N*	H_E	F(A MAR)	Drainage basin	Date(s)	*N*	Latitude	Longitude
Snow Creek	SNOW	8	Historically anadromous	8	0.33	NA	Merced River	Aug 10, 2016	8	37.76	−119.53
Upper Snow Creek	USNO	5	Above barrier	5	0.34	NA	Merced River	Aug 10, 2016	5	37.77	−119.54
Pearse and Garza (2015) Reference Populations											
North Coast											
Mad River		31	Ocean accessible	31	0.35						
Eel River (Hollow Tree Creek)		28	Ocean accessible	28	0.34						
Gualala River		29	Ocean accessible	29	0.40						
Central Valley											
McCloud River (Butcherknife Creek)		21	Historically anadromous	21	0.17						
McCloud River (Claiborne Creek)		33	Historically anadromous	30	0.33						
Clear Creek		94	Ocean accessible	86	0.34						
Deer Creek		45	Ocean accessible	41	0.37						
Feather River (Chips Creek)		31	Historically anadromous	31	0.32						
Feather River Hatchery		30	Ocean accessible	28	0.37						
Yuba River (Pauley Creek)		25	Historically anadromous	25	0.31						
Yuba River		90	Historically anadromous	82	0.41						
American River (Middle Fork)		58	Historically anadromous	54	0.37						
Nimbus Hatchery		98	Ocean accessible	92	0.40						
Mokelumne Hatchery		162	Ocean accessible	159	0.37						
Mokelumne River (North Fork)		51	Historically anadromous	51	0.33						
Calaveras River		47	Ocean accessible	44	0.37						
Stanislaus River (upper)		52	Ocean accessible	51	0.34						
Tuolumne River		112	Ocean accessible	106	0.39						
Tuolumne River (upper)		47	Historically anadromous	47	0.34						
Merced River (upper)		35	Historically anadromous	35	0.35						
Merced River		83	Ocean accessible	81	0.29						
Mill Flat Creek		26	Historically anadromous	26	0.36						
South Coast											
San Francisquito Creek		24	Ocean accessible	24	0.36						
San Lorenzo River		32	Ocean accessible	32	0.37						
Hatchery Trout Strains											
Kamloops		47	NA	47	0.23						
Mt. Shasta		92	NA	83	0.32						
Eagle		47	NA	47	0.25						
Coleman		47	NA	47	0.33						
Moccasin		47	NA	46	0.25						

population genetic model; it relies on the conversion of SNP data into principal components to account for linkage between SNPs and allow generic methods of individual clustering to be used. As opposed to finding axes of maximal variation (e.g., using principal components analysis [PCA]), DAPC maximizes between-population separations and minimizes within-population variation. We identified inferred populations with DAPC by applying the “find.clusters” function of adegenet followed by PCA and discriminant analysis within the “dapc” function of adegenet that utilized the packages “ade4” version 2.7-8 (Chessel and Dufour 2004; Dray and Dufour 2007; Dray et al. 2007) and Modern Applied Statistics with S version 7.3-47 (Venables and Ripley 2002).

Unlike DAPC, STRUCTURE has an explicit population genetics model and uses the individual genotype data directly. STRUCTURE assigns fractional ancestry (*q*-values) to *K* inferred populations based on descent from a common ancestral population. For each individual, the *q*-values sum to 1.00 and indicate what proportion of each of the *K* inferred populations makes up the individual. Migrants and individuals of mixed ancestry can be identified with STRUCTURE without a priori designation of defined populations (Pritchard et al. 2000). We evaluated all individuals in the quality-controlled data set with $K = \{1, \ldots, 12\}$ inferred populations in four independent runs with an initial burn-in of 100,000 steps followed by 1,000,000 Markov-chain Monte Carlo steps. For most parameters, default settings were used. Results from the STRUCTURE runs were visualized with DISTRUCT version 1.1 (Rosenberg 2004).

Population approach

Sample units were treated as populations for identifying population genetic and phylogenetic relationships, with a minimum required size of 10 individuals per sample unit (Table 1). Population genetic relationships were evaluated with DAPC using the sample unit to predefine population genetic clusters. The same sample units were also evaluated in a neighbor-joining population tree generated through poppr version 2.4.1 by using a chord distance metric (Cavalli-Sforza and Edwards 1967) and the filling of missing data by the mean of that locus. Confidence in nodes of the population tree was assessed by 1,000 bootstrap replicates.

Signatures of migratory adaptation

Of the three genotyped SNP loci located on chromosome Omy5, one (R04944) is known to accurately identify the R and A haplotypes surveyed in previous studies (Pearse et al. 2014; Leitwein et al. 2017). Based on this locus, we calculated the frequencies of the A allele associated with migratory behavior in all populations. These data were then considered with respect to the migratory potential of each sampling site relative to historical and current barriers and reservoirs, and populations with potential for adfluvial life history variants were identified.

RESULTS

Sample Genotyping and Population Statistics

Overall, 897 *O. mykiss* samples from the UTR and UMR were genotyped, and after filtering for missing data and loci under selection linked to the Omy5 inversion, the combined data set of 20 sampling units and 29 reference populations consisted of 2,370 individuals and 88 bi-allelic SNP loci (Table 1). Sample sizes for the UTR and UMR populations ranged from 2 to 103 individuals per site; sample units smaller than 10 were used for individual-based analyses but were excluded from population-level analysis.

The distribution of neutral genetic diversity among populations showed typical patterns, with most populations isolated above barriers having reduced heterozygosity relative to downstream populations (Table 1). Similarly, most hatchery Rainbow Trout strains had reduced levels of variation, as did populations that were inferred to be of primarily hatchery origin (e.g., Grouse Creek [GROS]). Conversely, larger populations connected by migration (e.g., Tuolumne River [TUOL] and Yosemite Valley [YOSV]) tended to have high levels of heterozygosity, similar to coastal and Central Valley steelhead populations (Table 1; Figure 1).

Individual Approach

The DAPC of individuals from the 20 UTR and UMR sampling units plus 5 hatchery reference strains supported the inference of eight genetic groups (Figure 2). Three of these inferred clusters constituted fish of natural genetic origin, while the other five contained fish of hatchery origin or individuals with a genetic composition similar to that of hatchery fish (Figure 2). Most fish from the UTR and UMR sampling locations were not placed in clusters with significant hatchery trout contributions. However, the GROS sampling location was entirely placed in inferred group 5 along with the Kamloops Hatchery strain, while many individuals from the upper North Fork Tuolumne River (UNFT) sample were grouped with the Coleman Hatchery strain (group 4; Figure 2). Similarly, most individuals from the Merced River Hatchery (MCDH) sample were placed in group 4 with the Coleman strain, while the

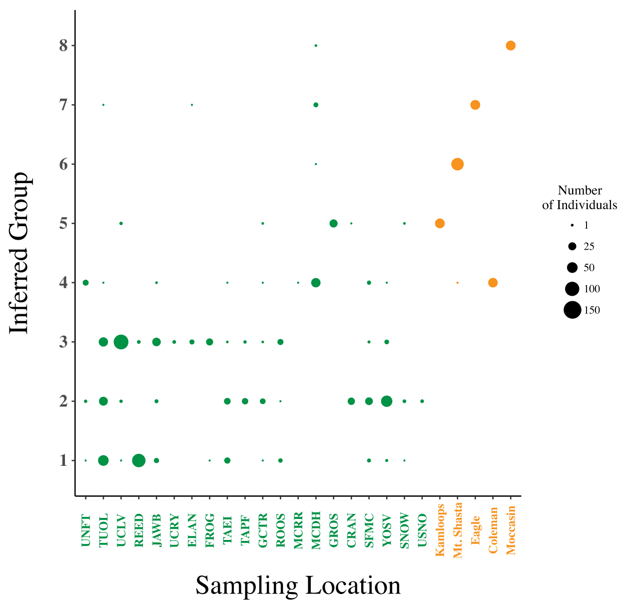

Figure 2. Individual group assignments from discriminant analysis of principal components for individual *Oncorhynchus mykiss* from the 20 upper Tuolumne River/upper Merced River sample units (Yosemite National Park; green) and five hatchery reference strains (orange). The sampling unit is indicated on the *x*-axis (codes are defined in Table 1), and the hypothesized eight genetic groups of individuals are indicated on the *y*-axis. Circle sizes indicate the number of individuals from each sampling location that were assigned to a particular genetic group.

rest were grouped with the Mt. Shasta, Eagle, and Moccasin hatchery trout lineages, supporting the mixed hatchery ancestry that had previously been inferred for lower Merced River *O. mykiss* (Pearse and Garza 2015).

STRUCTURE results showed strong convergence, verified by the highly consistent results among all four independent runs (data not shown). The distribution of STRUCTURE *q*-values in and among individuals supported previous findings of relationships between coastal and Central Valley *O. mykiss* and were similar to the individual DAPC results and population genetic analyses (see below). At low values of *K*, there were clear patterns of divergence between coastal steelhead and northern and southern Central Valley-lineage populations ($K = 4$; Figure 3). These patterns remained evident at higher values of *K*, with finer patterns of differentiation consistent with those seen by Pearse and Garza (2015).

Population Approach

The DAPC of sample units indicated a strong geographical component, with the first and second axes of the DAPC plot roughly encompassing east–west and north–south geography (Figure 4). This pattern of divergence is concordant with previous studies showing a primary division between coastal and Central Valley steelhead and an association between geography and genetic differentiation among *O. mykiss* populations isolated above dams within the Central Valley but not among below-barrier Central Valley steelhead populations (Pearse and Garza 2015).

The phylogenetic tree also supported known patterns of geographic differentiation, although many nodes received less than 50% bootstrap support (Figure 5). Nonetheless, well-supported relationships among several pairs and groups of populations were consistent with previous studies, indicating that the current data set has sufficient power to resolve these relationships (e.g., close similarity of Feather River and Mokelumne Hatchery steelhead, Nimbus Hatchery steelhead and coastal populations, and the relationships between the new UTR and UMR samples and reference samples from those locations; Pearse and Garza 2015). Among the new UTR and UMR samples, a clade of nine Tuolumne River populations (e.g., TUOL, Reed Creek [REED], upper Clavey River [UCLV], Roosevelt Lake [ROOS], FROG, etc.; Figure 5) was identified with moderate bootstrap support (77%), supporting their common indigenous ancestry. The South Fork Merced River (SFMC) sample appears as sister to this group but without significant support. Other UTR and UMR populations were more widely dispersed in the tree, possibly indicating more diverse sources contributing to these *O. mykiss* populations and also reflecting the limited resolution and low bootstrap support for deeper nodes in the tree. Meaningful support (68% and 98%) was found for the relationships between the GROS population, Kamloops Hatchery strain, and the northern Central Valley population from the McCloud River (Butcherknife Creek), further supporting the complete hatchery origin of the isolated above-barrier GROS population (Figure 5).

Signatures of Migratory Adaptation

The frequency of the Omy5 A haplotype in the sampling units within the UTR and UMR ranged from a minimum of 0.00 in GROS to a maximum of 0.31 in TUOL (Figure 6). Given their locations and accessibility to fish migrating from downstream reservoirs, the relatively high frequency of the A haplotype in the TUOL, FROG, and YOSV populations supports the suggestion that they sustain trout with adfluvial life histories. Conversely, the A haplotype exists at relatively low frequency in most other populations, particularly those found above barriers to migration (e.g., REED, Jawbone Creek [JAWB], and Crane Creek [CRAN]; Figures 1, 6). However, there was considerable variability among populations, likely reflecting a combination of selective factors impacting the frequency of adaptive genomic variation on chromosome Omy5 and other parts of the genome.

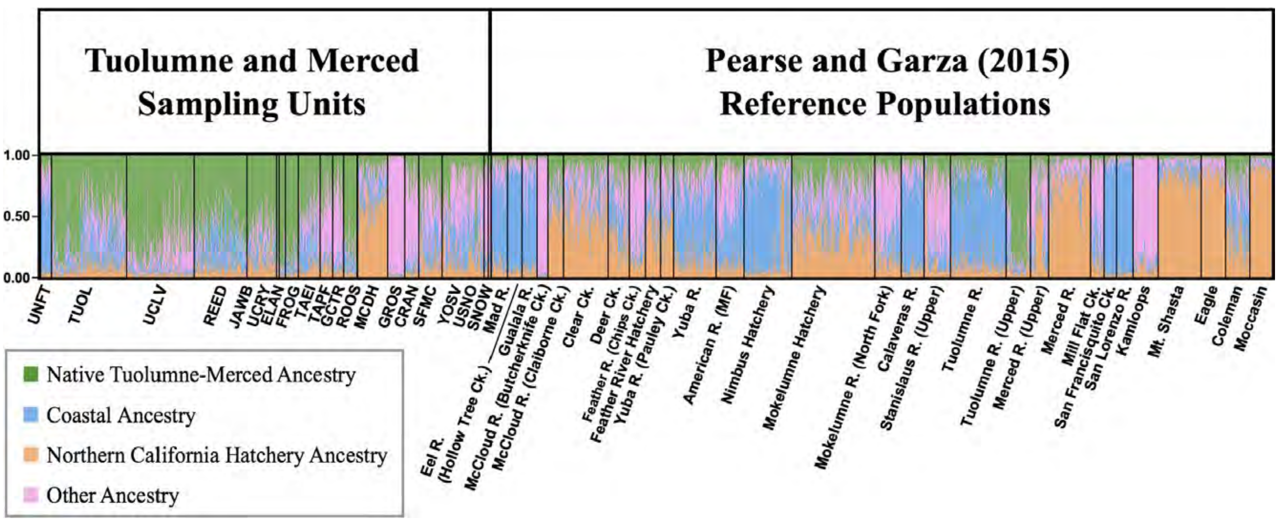

Figure 3. Individual-based plot of fractional ancestry from a hypothesized number of distinct genetic groups ($K = 4$) for *Oncorhynchus mykiss*. Sampling units and reference populations (as described and ordered in Table 1) are indicated along the bottom of the plot. Each individual is represented by a vertical line, and the proportion of estimated ancestry from each of the hypothetical genetic groups is represented by the proportionate amount of color within the vertical column (inferred ancestry: green = Yosemite National Park ancestry; blue = coastal ancestry; orange = northern Central Valley hatchery ancestry; pink = other ancestry; see text for details).

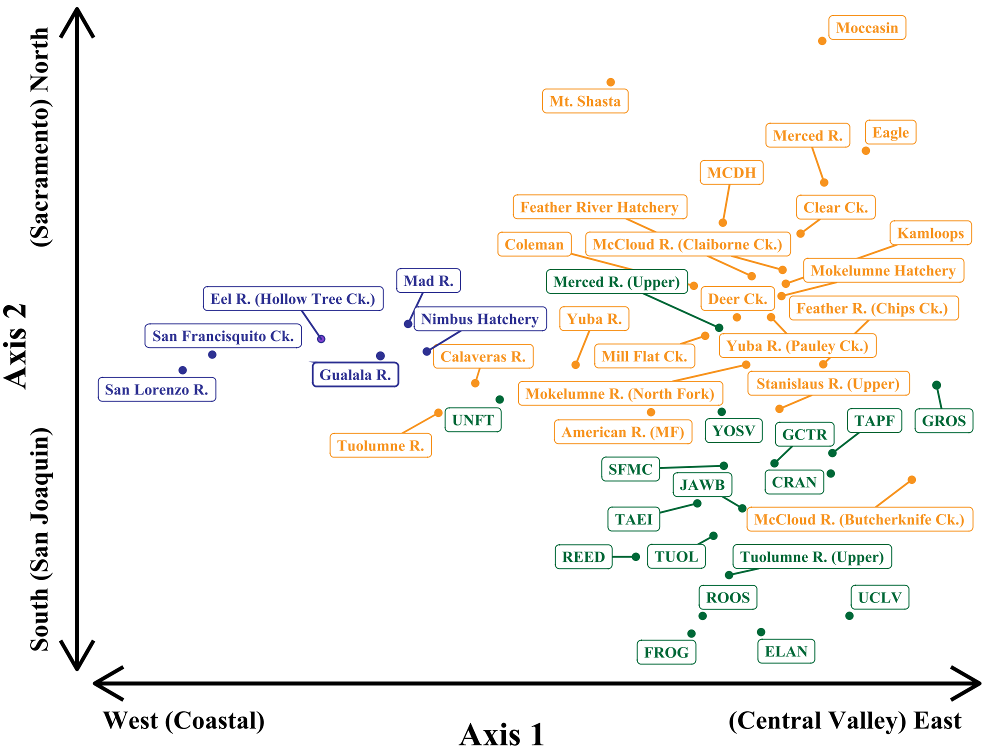

Figure 4. Population discriminant analysis of principal components plot, showing genetic relationships among *Oncorhynchus mykiss* from the upper Tuolumne River and upper Merced River sampling units (green; codes are defined in Table 1) relative to coastal reference populations (blue) and Central Valley reference populations and hatchery trout strains (orange). The central value for each population is indicated.

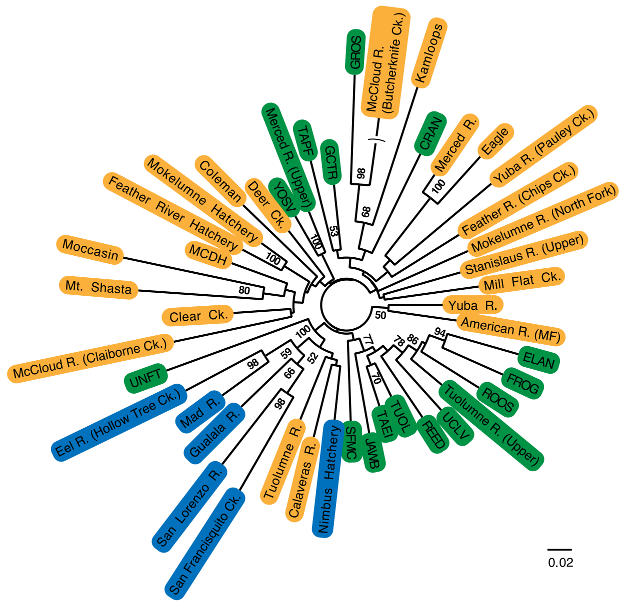

Figure 5. Neighbor-joining phylogenetic tree based on population chord distances, showing relationships among *Oncorhynchus mykiss* sampling units within the upper Tuolumne River and upper Merced River relative to other Central Valley and coastal *O. mykiss* populations. Colors highlight Yosemite National Park sampling units (green; codes are defined in Table 1), coastal reference populations (blue), and Central Valley reference populations and hatchery trout strains (orange). Bootstrap support from 1,000 replicates is depicted (values <50% are not shown). The branch to the McCloud River (Butcherknife Creek), indicated by a bisecting curve, has been shortened to one-third of the original length for visual presentation.

DISCUSSION

Overall, the observed genetic relationships between Rainbow Trout in the UTR and UMR and other Central Valley *O. mykiss* populations and hatchery trout strains indicate that a mixture of lineages exists in these Yosemite watersheds. However, despite the extensive stocking with nonindigenous hatchery trout strains throughout the region, native ancestry appears to remain as the primary component of most sampling units examined in this study, with primarily indigenous southern Central Valley–San Joaquin River ancestry in reaches that were historically accessible to migratory salmonids. This includes the Clavey River, which has been designated as one of the "Heritage and Wild Trout Waters" by the California Department of Fish and Wildlife (wildlife.ca.gov/fishing/inland/trout-waters). These results support the hypothesis that local adaptation has played a key role in the persistence of these lineages.

In terms of ancestry, the primary division between coastal and Central Valley *O. mykiss* that has previously been documented (Nielsen et al. 2005; Pearse and Garza 2015) was also clear in multiple analyses of the present data set (Figures 3, 4, 5). This is important because it confirms that unlike some below-barrier populations in the southern Central Valley, including *O. mykiss* sampled in the lower Tuolumne River (Pearse and Garza 2015), the trout populations in the UTR and UMR do not show evidence of introgression from the coastal-origin steelhead propagated at Nimbus Hatchery. However, the close evolutionary relationships among all Central Valley *O. mykiss*—including most hatchery Rainbow Trout strains commonly used in California—hinder precise inference of population relationships and admixture within the Central Valley, and the weak

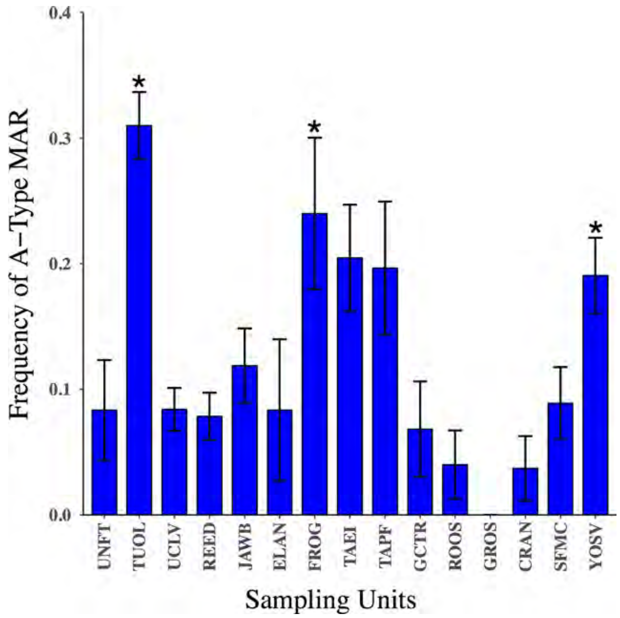

Figure 6. Frequency of the anadromous-type Omy5 migration-associated region haplotype (A-Type MAR) estimated from upper Tuolumne River and upper Merced River sampling units of *Oncorhynchus mykiss* examined in this study (codes are defined in Table 1). Potentially adfluvial populations with access to reservoirs are indicated by asterisks. Standard errors for allele frequency estimates are shown (Hartl and Clark 1997).

signal of genetic differentiation among these populations likely reflects biological reality rather than limited resolution. Nonetheless, the relative proximities of populations shown in the DAPC revealed a clear pattern of geographic divergence among populations, with axis 2 highlighting the north–south divergence within the Central Valley (Figure 4). This is consistent with the hypothesis that Rainbow Trout populations isolated above dams in the Sierra Nevada better reflect their historical geographic origins than the scrambled steelhead populations that persist below barriers to migration (Pearse and Garza 2015).

The problems with hybrids in conservation have long been recognized (Allendorf et al. 2001), and the potential conservation value of hybrid populations remains an active area of discussion (Wayne and Shaffer 2016). Within the UTR and UMR, many populations show at least some evidence of mixed ancestry, as is common in studies of *O. mykiss* above dams (e.g. Winans et al. 2017), but we did not find the complete replacement of indigenous ancestry that has been observed in some regions of California subjected to intensive hatchery trout stocking (e.g., southern California; Abadía-Cardoso et al. 2016). Although admixed populations do not represent pure indigenous lineages, they often have high genetic diversity and should not be entirely discounted when considering source populations for recovery efforts (Abadía-Cardoso et al. 2016).

Most fish sampled at sites that were historically fishless due to their positions above barriers or at high elevation represented a mixture of indigenous and imported ancestries, with some having largely indigenous ancestry (e.g., FROG) while others appeared entirely descendent from hatchery Rainbow Trout strains (e.g., GROS). The UNFT sample showed variable associations in different analyses, with genetic similarity to both the Coleman Hatchery trout strain and coastal lineage populations. The UNFT site has a long history of intensive hatchery stocking due to its location near a major road (California Highway 108), and both UNFT and GROS had low levels of heterozygosity, consistent with hatchery-strain ancestry. In contrast, the REED and JAWB populations had high heterozygosity and were genetically similar to other nearby populations within the UTR genetic group, despite being isolated above very large natural barrier waterfalls.

Adaptive Variation and Migratory Potential

It is important to note that adaptive genomic variation like that documented on chromosome Omy5 is subject to the same factors that affect the distribution of neutral genetic variation among all natural populations, including drift due to small population sizes and introgression by nonnative lineages with highly divergent patterns of variation (Pearse 2016). In the case of hatchery Rainbow Trout, Omy5 haplotype frequencies vary widely among strains, so their influence on introgressed wild populations is difficult to determine. However, to the extent that they reflect ongoing selection, the frequencies of alleles in this genomic region provide information about the relative fitness of alternative life history patterns in a given set of populations.

Within the UTR and UMR, the distribution of Omy5 haplotype variation suggests that the populations most likely to express an adfluvial life history—and therefore to retain the potential to express anadromy—are those with unimpeded migratory access to Don Pedro and McClure reservoirs (e.g., TUOL and YOSV), as well as the FROG population tributary to Lake Eleanor (Figures 1, 6). Although the maximum frequency of migration-associated alleles among the UTR and UMR populations (0.31 in TUOL) was low relative to that of coastal anadromous and adfluvial populations (typically >0.60; Pearse et al. 2014; Leitwein et al. 2017), it was similar to that seen in potentially adfluvial populations of *O. mykiss* in the upper American River (0.33; DEP, unpublished data). In addition, the genomic region of Omy5 associated with migratory life history patterns has also been associated with differences in temperature-specific development rates (Miller et al. 2012). The additional influence of temperature could contribute to the elevated frequency of resident-associated alleles in the colder, high-elevation populations, but further research is needed to better understand the factors that may influence the distribution of this adaptive genomic variation. Together, these results suggest that the UTR and UMR populations that now occupy river reaches between the reservoirs and the historical barriers to upstream migration are the most likely to express migratory adfluvial behavior and retain adaptive genomic variation associated with anadromy (Holecek et al. 2012; Holecek and Scarnecchia 2013; Leitwein et al. 2017).

Conservation Implications

Efforts to restore salmonid populations and the watersheds they inhabit will require a diverse set of approaches, investment, and cooperation among stakeholders (Phillis et al. 2013; Penaluna et al. 2016; Lackey 2017; Warren et al. 2017), particularly for migratory anadromous forms like steelhead (NMFS 2014). From an evolutionary genetics perspective, this study has several implications for the potential restoration of connectivity between the UTR and UMR populations and the California Central Valley steelhead DPS below the dams.

First, the present study was based on a data set with a modest number of SNPs by today's standards and thus has relatively low power to estimate population genetic parameters; a large genomic data set based on the thousands of loci generated by high-throughput sequencing could undoubtedly refine the results observed in the present study. For example, more than 230,000 SNP loci were recently used to accurately estimate the proportions of European, African, and Native American ancestry in admixed human populations in Colombia (Conley et al. 2017). It is also possible that hatchery trout strains that were not included in the present study have been stocked in these watersheds, so their contributions could not be specifically detected. However, the basic conclusions regarding the distribution of indigenous Rainbow Trout within the Tuolumne and Merced river watersheds and their implications for management are unlikely to change in biologically significant ways. Similarly, further characterization of the distribution of adaptive genomic variation on chromosome Omy5 and other parts of the genome will provide insight into the evolutionary processes affecting trout populations above dams. However, such information would not necessarily impact conservation planning because the basic principles of conservation genetic management to preserve genetic diversity remain the same (Pearse 2016). Nonetheless, as more examples of adaptive genomic variation associated with life history traits are identified in *O. mykiss* and other salmonid species (Barson et al. 2015; Hess et al. 2016), fisheries managers will need to carefully consider the most appropriate ways to conserve and protect this important biodiversity (Pearse 2016).

Second, Pearse and Garza (2015) detected introgression by coastal-origin steelhead propagated at Nimbus Hatchery into the limited populations of *O. mykiss* that remain in the ocean-accessible river reaches below dams in the Calaveras, Tuolumne, and Stanislaus rivers and found that *O. mykiss* captured in the lower Merced River were primarily descended from hatchery trout, especially the Eagle Lake strain. The signal of hatchery ancestry observed in the sample of 59 lower Merced River fish analyzed in the present study further confirms this result. However, recent data on the physiology of steelhead in the lower Tuolumne River have shown that they have a much higher thermal tolerance than populations from northern latitudes, demonstrating their local adaptation to the high temperatures of the southern Central Valley (Verhille et al. 2016). Thus, the *O. mykiss* currently inhabiting below-barrier reaches of the Tuolumne and Merced rivers likely represent a mixture of indigenous, hatchery, and coastal ancestry, and both admixture and local adaptation have likely influenced their current genetic composition, including the frequencies of Omy5 haplotypes and other adaptive genomic variation.

Third, although our data show that the Rainbow Trout trapped above these dams have both ancestry and adaptive genomic variation that are representative of indigenous migratory populations, the development of an anadromous steelhead population from these stocks through fish passage via two-way trap-and-haul operations or other means presents many challenges (Lusardi and Moyle 2017). Re-establishing gene flow between formerly connected populations above and below barrier dams has many potential benefits in terms of maintenance of genetic diversity and facilitating adaptation, but these must be evaluated against the possible risks and constraints within the larger reintroduction and recovery framework (Anderson et al. 2014). Nonetheless, anadromous salmonid life histories can emerge rapidly from formerly adfluvial populations after dam removal, demonstrating that such populations are capable of re-establishing their dormant ability to complete an ocean migration (Quinn et al. 2017). In this context, migratory adfluvial individuals in the Tuolumne River, Merced River, and other Central Valley watersheds could be considered as potential contributors to future fish passage programs and reintroduction efforts (Thrower et al. 2008) provided that the logistical issues associated with re-establishing connectivity can be overcome (NMFS 2014). Thus, in considering the potential for passage of migratory fish above New Don Pedro and New Exchequer dams, directed studies are needed to determine the potential for trapping downstream migrants, among other considerations, as has been undertaken in similar situations (e.g., Clancey et al. 2017; Winans et al. 2018).

Finally, it should be noted that the populations of steelhead in the southern Central Valley are likely among the most vulnerable to the impacts of climate change, so their continued persistence is far from certain. Therefore, in the context of protecting and restoring anadromous fish populations in California, genetic factors should be considered as secondary to the basic need for access to appropriate habitat to support all phases of the migratory life cycle. This includes access to suitable spawning and rearing habitats, as provided by removal of large barrier dams or via carefully monitored two-way trap-and-haul fish passage programs (Anderson et al. 2014), as well as modification or removal of smaller migration barriers (Apgar et al. 2017), adjustments to flow regimes, and other improvements in downstream habitats to support native fishes and restore viable migratory connectivity with the ocean for both out-migrating juveniles and returning adult salmonids (NMFS 2014). In the absence of these changes, the existence of migratory salmonid populations in the Central Valley will continue to depend on hatchery propagation and other interventions until the dams that block their migratory paths are modified or removed (Katz et al. 2013; Quiñones et al. 2015).

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EXHIBIT F

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
WEST COAST REGION
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4706

April 25, 2022

In response refer to:
WF: WCR: FERC P-2179 /P-2467

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

Re: NOAA's National Marine Fisheries Service, West Coast Region, Provides Technical Assistance, pursuant to the Endangered Species Act and the Magnuson-Stevens Fishery Conservation and Management Act, Regarding the Supplemental Environmental Impact Statement for the Merced River (P-2179) and Merced Falls (P-2467) Hydroelectric Projects, Merced River, California.

Dear Secretary Bose:

The U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, West Coast Region (NMFS) hereby files for consideration by the Federal Energy Regulatory Commission (FERC) Technical Assistance information, pursuant to the Endangered Species Act (ESA), towards the preparation of FERC's Supplemental Environmental Impact Statement (SEIS) for the Merced River (P-2179) and Merced Falls (P-2467) Hydroelectric Projects (Projects).

We appreciate FERC's decision to update the Environmental Impact Statement for the Projects by issuing a SEIS. Because the new licenses will be issued for 30-50 years and pursuant to the ESA, it is important to document that California Central Valley (CCV) steelhead (*Oncorhynchus mykiss*), which are ESA listed as threatened, and its critical habitat exist in the Merced River up to the Crocker-Huffman Dam (NMFS comments on FERC's EIS, April 7, 2016). To that end, NMFS provides to FERC in Enclosure A Technical Assistance documentation of past ESA Section 7 consultations in the Merced River for steelhead and its critical habitat. Pursuant to the ESA, section 7 consultation with NMFS is necessary because CCV steelhead and their critical habitat are present in the Merced River.

NMFS also requests that FERC expand its SEIS, pursuant to the ESA, to include ESA-threatened Central Valley (CV) spring-run Chinook salmon (*O. tshawytscha*) as well as an Essential Fish Habitat assessment, pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSA) for Pacific salmon, because CV spring-run salmon occur in the San Joaquin River tributaries (Frank 2014; Personal Communication w/Steven Tsao 2022).

If you have questions regarding the documents we have filed, please contact Mr. William Foster of my Staff at (916) 930-3617 or William.Foster@noaa.gov.

Sincerely,

Thomas Holley (for Steve Edmondson)
FERC Hydropower Branch Supervisor
NMFS, WCR, Central Valley Area Office

Enclosures
cc: FERC Service Lists P-2179 and P-2467.

Enclosure A

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Merced River Hydroelectric Project	**)**	**Project #P-2179**
Merced Falls Hydroelectric Project	**)**	**Project #P-2467**
Merced Irrigation District	**)**	
Merced River	**)**	

ESA/MSA TECHNICAL ASSISTANCE DOCUMENTS
E-FILED TO FERCS MERCED RIVER PROJECTS' DOCKETS ABOVE

ESA/MSA Technical Assistance documents concerning the presence of CCV steelhead (*O. mykiss*), and its critical habitat and CV spring-run Chinook salmon (*O. tshawytscha*) in the San Joaquin River tributaries has been uploaded to the FERC e-file system. NMFS urges FERC to review and assess these documents because they provide the best available information concerning FERC's ESA Section 7 and EFH consultations with NMFS for the action of issuing a license for the Projects and should be analyzed in FERC's SEIS for the Projects.

File Names:

2014-Franks 2014 Current Central Valley spring-run in SJR tribs.
2017-03-22_FERC Project 2179-047 Merced River Project Merced Irrigation District_IF
2017-05-23_Merced Irrigation District Drought Protection Water Management Model Project_IF
2017-09-06_Lower Merced River Boat Access Ramp Project (SPK-2016-00053)_IF
2019-04-22 Merced Seismic Restoration Project LOC
2019-05-22-Merced-River-Instream-and-Off-Channel-Habitat-Rehab-Project-BO-final
2021-12-09_Merced-River-Pipeline-Removal-Non-Concurrance-508-Signed

References:

Franks, S. 2014. "*Possibility of natural producing spring-run Chinook salmon in the Stanislaus and Tuolumne Rivers*." NMFS, West Coast Region, Sacramento, CA. June 2014.

National Marine Fisheries Service (NMFS). 2016. Letter from NMFS to Secretary Bose (FERC), Re: "*NMFS' Comments on the Federal Energy Regulatory Commission's Final Environmental Impact Statement for the Merced River and Merced Falls Hydroelectric Projects, Nos. 2179-043 and 2467-020, Respectively, Merced River, California*." NMFS, West Coast Region, Sacramento, CA. April 7, 2016.

NMFS. 2022. Personal Communication w/Steven Tsao (California Department of Fish and Wildlife) regarding the presence of spring-run Chinook salmon at the Merced River Fish Hatchery and in the Stanislaus and Tuolumne rivers in 2021).

Enclosure B

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Merced River Hydroelectric Project	**)**	**Project #P-2179**
Merced Falls Hydroelectric Project	**)**	**Project #P-2467**
Merced Irrigation District	**)**	
Merced River	**)**	

CERTIFICATE OF SERVICE

I hereby certify that I have this day served, by first class mail or electronic mail, a letter to Secretary Bose of the Federal Energy Regulatory Commission (FERC), the U.S. Department of Commerce's, National Oceanic and Atmospheric Administration's, National Marine Fisheries Service's Technical Assistance, pursuant to the ESA and MSA, for the above-captioned proceedings, and this Certificate of Service upon each person designated on the official service lists compiled by the FERC in the above-captioned proceedings.

Dated this 25th day of April 2022

William E. Foster
National Marine Fisheries Service

Franks, Sierra
NOAA -NMFS
November, 2012
Updated June 2014

Possibility of natural producing spring-run Chinook salmon in the Stanislaus and Tuolumne Rivers

Currently Central Valley spring-run Chinook salmon are listed as threatened under the Endangered Species Act (ESA). This species was first listed in 1999. Historically in the San Joaquin River system spring-run Chinook are thought to have been one of the most viable runs, but were not listed under the original ESA listing as it was presumed by 1950, that the entire run of spring-run Chinook salmon was extirpated from the San Joaquin River (Fry 1961). The former spring run of the San Joaquin River has been described as “one of the largest Chinook salmon runs anywhere on the Pacific Coast” and numbering “possibly in the range of 200,000-500,000 spawners annually” (CDFG 1990).

Analyzing the historic data and information provided specifically on the Tuolumne and Stanislaus rivers, there is high probability based on records coupled with current data that natural (fish that naturally spawned in river systems and whose parents did as well) occurring spring-run Chinook are still present in small numbers. Here it is discussed where spring-run originally used these river systems.

On the Tuolumne River, Clavey Falls (10-15 ft. high) at the confluence of the Clavey River, may have obstructed the salmon at certain flows, but spring-run salmon in some numbers undoubtedly ascended the mainstem a considerable distance. The spring-run salmon were most likely stopped by the formidable Preston Falls at the boundary of Yosemite National Park (~50 mi upstream of present New Don Pedro Dam), which is the upstream limit of native fish distribution (CDFG 1955 unpublished data).

Spring run Chinook also originally occurred in the Stanislaus River. Spring-run probably went up the system considerable distances because there are few natural obstacles (Yoshiyama et al. 1998). Much of the spawning occurred on the extensive gravel beds in the 23-mi. stretch from

Riverbank upstream to Knights Ferry, which is essentially on the Valley floor at approximately 213 feet in elevation. Upstream of Knights Ferry, where the river flows through a canyon, spawning was (historic observations of spring-run) and is (fall-run) concentrated at Two-mile Bar (~1 mi above Knights Ferry) but also occurs in scattered pockets of gravel (Yoshiyama et al. 1998). Historically, the spring run was the primary salmon run in the Stanislaus River, but after the construction of dams which regulated the stream flows (i.e., Goodwin Dam and, later, Melones and Tulloch dams); the fall run became predominant (CDFG 1972 unpublished report).

Recent information suggests that perhaps a self-sustaining (capable of reproducing without hatchery influence) population of spring-run Chinook is occurring in some of the San Joaquin River tributaries, most notably the Stanislaus and the Tuolumne Rivers. Snorkel surveys (Kennedy T. and T. Cannon 2005) conducted between October 2002 to October 2004 on the Stanislaus River identified adults in June 2003 and June 2004 between Goodwin and Lovers Leap. Additionally on the Stanislaus, snorkel surveys also observed Chinook fry in December 2003 at Goodwin Dam, Two Mile Bar, and Knights Ferry, which they interpreted as an indication of spawning occurring in September, which is earlier than when fall-run Chinook salmon would be spawning in the river.

FISHBIO a fisheries consultant has operated a resistance board weir coupled with a Vaki RiverWatcher video monitoring system on the Stanislaus since 2003 and on the Tuolumne since 2009. Information obtained from this monitoring indicates that adult Chinook salmon are passing upstream of these weirs at a time period that would historically indicate a spring-run timing. Looking specifically at the months from February to June almost annually since observation began, some adult Chinook are migrating upstream (Table 1). It should be noted that the weir has not always operated past December due to study design or non-conducive river conditions. For example in 2007, 11 phenotypic spring-run Chinook were observed passing the weir between May and June on the Stanislaus. Future monitoring will determine if these fish are a typical occurrence or an anomaly (Anderson et al. 2007). Further personal observations by fisheries biologist from other agencies (CDFG & USFWS) that are familiar with these systems have accounts of seeing adult Chinook holding in these river systems in summer months (CDFG & USFWS, Personal comm.). If this is the case then genetic testing would be needed to confirm that these fish are in fact naturally producing spring-run Chinook and not hatchery strays*, i.e.*

Feather River. Otolith analysis may be the best way to confirm this by matching chemical signatures specific to each river system. Additionally there is no segregation barrier in place for spring-run and fall-run and it is likely that fall-run are superimposing on spring-run redds (Wikert, Personal Comm.). A further analysis looking at these tributaries rotary screw trap (RST) data helps support the suggestion of self-sustaining spring-run by looking at length at date criteria and comparing it to known spring-run Chinook populations on Sacramento River tributaries. RST data provided by Stockton United State Fish and Wildlife Service (USFWS) corroborates with the adult timing, by indicating that there are a small number of fry migrating out of the Stanislaus and Tuolumne at a period that would coincide with spring-run juvenile emigration (Tables 2 & 3).

Additionally during snorkel and kayak surveys in April, May and June of 2013 with CDFW, USFWS and NMFS staff, the author observed a large number of adult Chinook in the upper reaches of the Stanislaus River below Goodwin Dam and potential redds in Reach 1 of the Tuolumne River.

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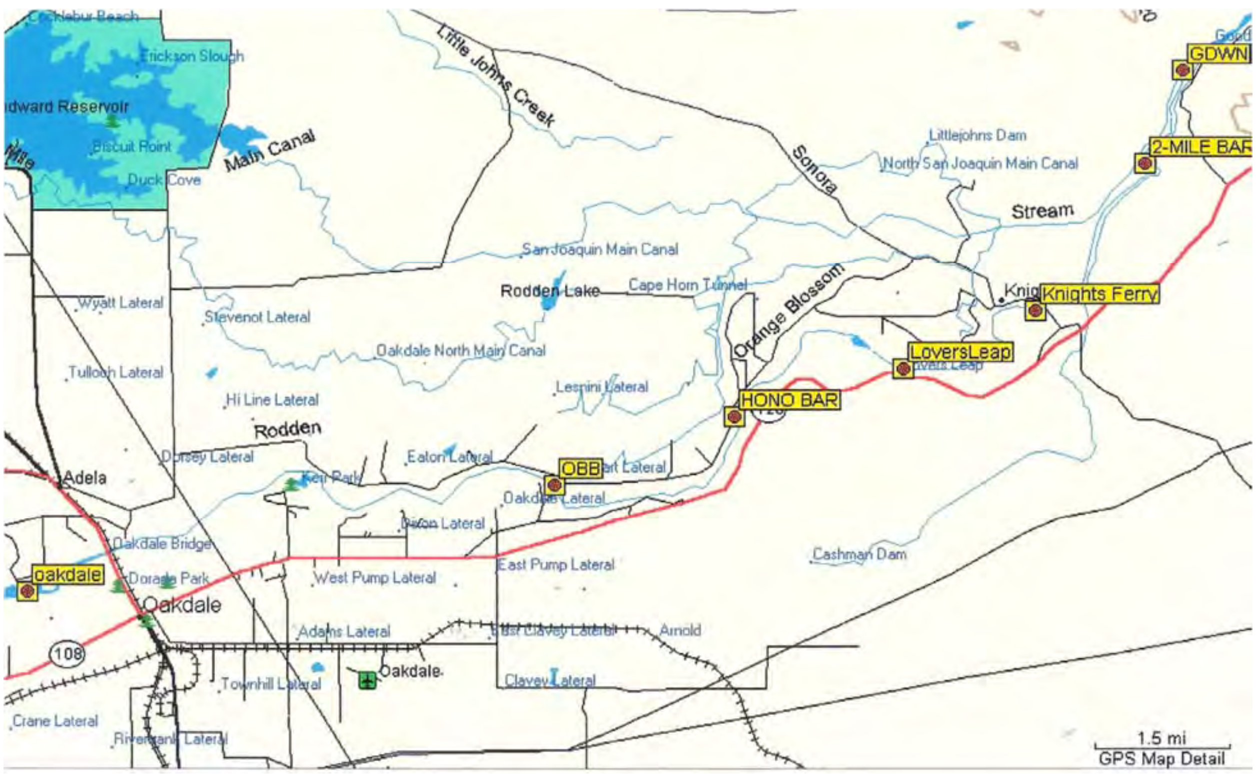

Figure 1. Displaying specific points mentioned in the text on the Stanislaus River, such as Goodwin Dam, 2-Mile Bar and Knights Ferry.

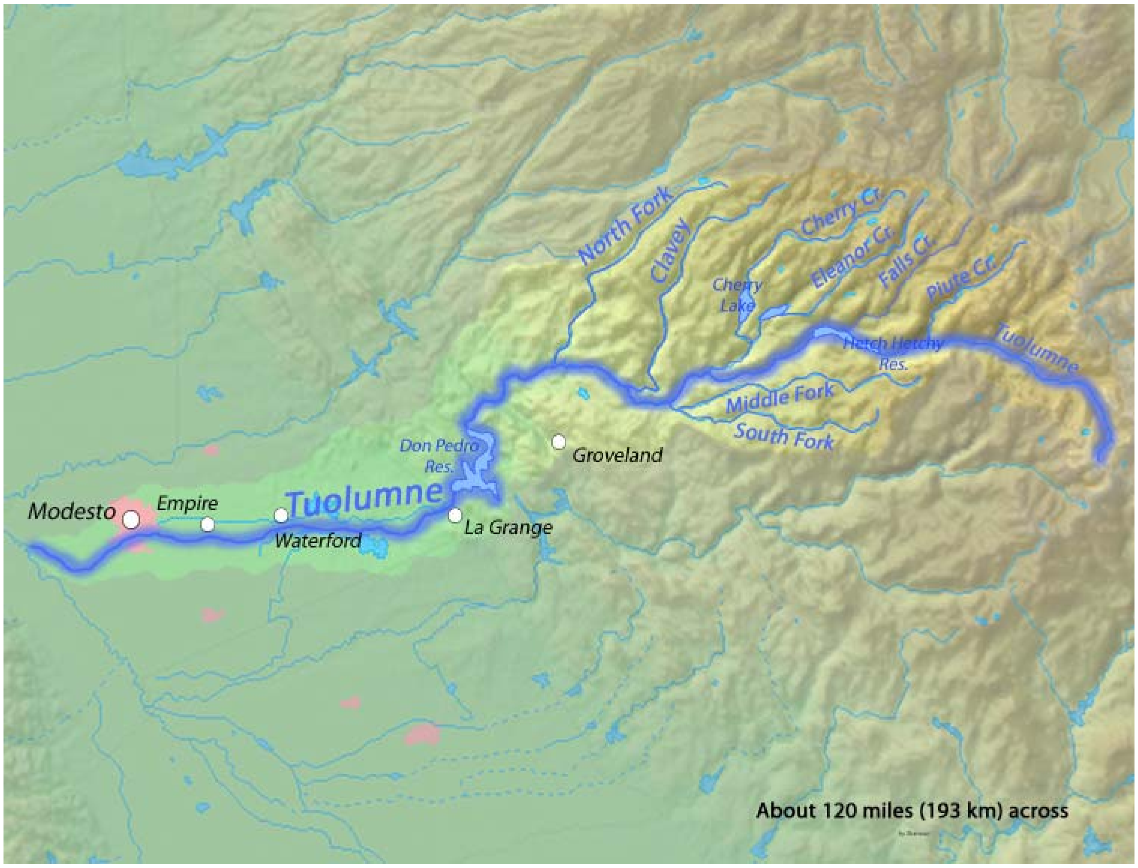

Figure 2. The Tuolumne River

Table 1. **Adult** adipose intact Chinook migrating upstream on the Tuolumne and Stanislaus Rivers (viewed by VAKI RiverWatcher weir: FISHBIO)

Tuolumne (2010, 2012)	Stanislaus (2007, 2009, 2010, 2012)
12 Confirmed adipose intact (*55 total passed)	51 confirmed adipose intact (*68 total passed)

* In 2011 the Stanislaus weir was pulled in mid-March due to flood control releases. The Tuolumne weir was not operating

* 2012 adipose clipped information not available at this time (this includes 38 total fish for the Tuolumne)

Table 2. Tuolumne RST cumulative catch 2000-2011 – matching USFWS length at date criteria for spring-run fry at Mossdale

March	245 Chinook fry -6% of TC
April	761 Chinook fry – 26% of TC
May	736 Chinook fry – 25% of TC
June	7 Chinook fry – 2% of TC

Table 3. Stanislaus (Caswell) RST cumulative catch 2000-2011 - matching USFWS length at date criteria for spring-run fry at Mossdale

March	636 Chinook fry - 9% of TC
April	911 Chinook fry - 12% of TC
May	363 Chinook fry – 6% of TC
June	4 Chinook fry - < 1% of TC

Table 4. Official Water Year Hydrologic Classification Indices from CDWR

	Year Type
2000	Above Normal
2001	Dry
2002	Dry
2003	Below Normal
2004	Dry
2005	Wet
2006	Wet
2007	Critical Dry
2008	Critical Dry
2009	Dry
2010	Above Normal
2011	Wet
2012	Dry

Table 5. Rotary Screw Trap Data on the Tuolumne, cumulative from 2000 – 2011. Data courtesy of Kes Ben, USFWS.

Chinook Salmon Length Range (5 mm intervals) by Month, Tuolumne Rotary Screw Trap Data, 2000-2011.

Length Range (mm)	January	February	March	April	May	June	December
25.1 - 30	41	60	9				2
30.1 - 35	1,835	2,336	1,473	74	17		135
35.1 - 40	2,462	2,900	1,541	37	9		39
40.1 - 45	15	67	38	2	1		
45.1 - 50	1	59	59	6	1		
50.1 - 55	4	58	144	14	1		
55.1 - 60	3	50	179	19	3		
60.1 - 65	3	35	226	58	5	2	
65.1 - 70	3	27	230	144	14	1	
70.1 - 75	7	34	199	333	61	6	
75.1 - 80	15	15	130	605	214	12	
80.1 - 85	22	8	72	658	488	25	
85.1 - 90	26	12	43	495	615	47	
90.1 - 95	12	5	20	266	679	77	
95.1 - 100	6	9	12	126	492	94	
100.1 - 105	4	16	8	26	244	47	
105.1 - 110	5	12	3	16	104	19	
110.1 - 115	2	5	2	6	33	5	
115.1 - 120		4	3	2	10	1	
120.1 - 125	2	4	3			1	
125.1 - 130	4	5	2				
130.1 - 135		3	5				
135.1 - 140	1	4	3				
140.1 - 145							
145.1 - 150			2				
150.1 - 155			1				
155.1 - 160							
160.1 - 165							
165.1 - 170		1					
175.1 - 180							
190.1 - 195							

Table 6. Rotary Screw Trap Data on the Stanislaus, cumulative from 2000 – 2011. Data courtesy of Kes Ben, USFWS.

Chinook Salmon Length Range (5 mm intervals) by Month, Stanislaus Rotary Screw Trap Data at Caswell, 2000-2011.

Length Range (mm)	January	February	March	April	May	June	July	December
20.1 - 25			2					
25.1 - 30	53	105	29					
30.1 - 35	496	967	496	4				4
35.1 - 40	413	1,227	555	6	1			3
40.1 - 45	18	395	507	2	2			
45.1 - 50	4	298	734	21	2			
50.1 - 55		181	924	109	3			
55.1 - 60		110	965	381	10			
60.1 - 65		52	928	799	69	1		
65.1 - 70		14	761	1,280	282	5		
70.1 - 75		2	602	1,509	828	22		
75.1 - 80			358	1,480	1,305	105		
80.1 - 85		1	193	1,040	1,510	162		
85.1 - 90			85	635	1,147	256		
90.1 - 95	1		26	276	677	213	2	
95.1 - 100			11	104	274	100		
100.1 - 105			1	41	89	46		
105.1 - 110				18	24	5		
110.1 - 115		1	1	7	3	2		
115.1 - 120			1		1			
120.1 - 125			3			2		
125.1 - 130			3					
130.1 - 135		1						
135.1 - 140			2					
140.1 - 145		1	1	1				
145.1 - 150	1	1	1	1				
150.1 - 155		1	2					
155.1 - 160			1					
160.1 - 165			4					
165.1 - 170								
170.1 - 175								
175.1 - 180								
180.1 - 185								
185.1 - 190			1					

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

MAR 2 3 2017

Refer to NMFS Tracking No: WCR-2017-6560

Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

Re: Endangered Species Act Section 7(a)(2) Concurrence Letter and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Federal Energy Regulatory Commission's Order Granting Temporary Variance of Minimum Pool Requirement Under Article 44 for the Merced River Project No. 2179.

Dear Secretary Bose:

On November, 28 2016, NOAA's National Marine Fisheries Service (NMFS) received your request for a written concurrence that the Federal Energy Regulatory Commission's (Commission) Order Granting Temporary Variance of Minimum Pool Requirement Under Article 44 for the Merced River Project No. 2179 (Project) and associated emergency water withdraw did not likely adversely affect (NLAA) species listed as threatened or endangered, California Central Valley (CCV) steelhead (*Oncorhynchus mykiss*), or critical habitats designated under the Endangered Species Act (ESA). For this project, the Commission is acting as the lead Federal agency on behalf of the licensee, Merced Irrigation District (MID), for this informal after-the-fact consultation following the implementation of an emergency action. This response to your request was prepared by NMFS pursuant to section 7(a)(2) of the ESA, implementing regulations at 50 CFR 402, and agency guidance for preparation of letters of concurrence.

NMFS also reviewed the action for potential effects on essential fish habitat (EFH) for Pacific Coast salmon, designated under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), including conservation measures and any determination you made regarding the potential effects of the action. This review was pursuant to section 305(b) of the MSA, implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to complete EFH consultation. Habitat areas of particular concern (HAPCs), as designated under the Pacific Coast Salmon Fishery Management Plan, include (1) complex channels and floodplain habitats, (2) thermal refugia, (3) spawning habitat, (4) estuaries, and (5) marine and estuarine submerged aquatic vegetation. The HAPCs present in the action area include (2) thermal refugia and (3) spawning habitat. In this case, NMFS concluded the action would not adversely affect EFH. This is based on the following evaluation of project effects to the ESA-listed species. Thus, consultation under the MSA is not required for this action.

Because the action modified a stream or other body of water, NMFS also provides recommendations and comments for the purpose of conserving fish and wildlife resources under the Fish and Wildlife Coordination Act (16 U.S.C. 662(a)).

This letter underwent pre-dissemination review using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The concurrence letter will be available through NMFS' Public Consultation Tracking System *https://pcts.nmfs.noaa.gov*. A complete record of this consultation is on file at the California Central Valley Office of NMFS.

Background

On June 24, 2015, the Commission issued an Order Granting Temporary Variance of Minimum Pool Requirements under Article 44 for the Merced River Project No. 2179 (Order). The Order was in response to extraordinary drought conditions at the project site in Mariposa County, California, and authorized MID to continue to allow a consumptive water withdraw (Withdraw) at Exchequer Reservoir (Lake McClure) when reservoir storage dropped below the minimum pool requirement of 115,000 acre-feet (AF). Due to the urgency of the Withdraw, and the potential effects on federally-threatened CCV steelhead, on May 26, 2015, the Commission requested that formal consultation take place under the emergency provisions of section 7 of the ESA.

On June 15, 2015, NMFS provided technical assistance to the Commission on the Order granting temporary variance of minimum pool requirements at Lake McClure, including a request for MID to conduct water temperature monitoring upstream of Crocker-Huffman Diversion Dam (CHDD). NMFS also requested that the Commission initiate formal consultation on the proposed variance.

In the Order, the Commission discussed the potential impacts of the Withdraw from Lake McClure on CCV steelhead. Due to the minor nature of the Withdraw relative to lake storage and inflows in June 2015, the Commission did not expect any significant adverse effects to aquatic resources to result from an inappreciable reduction in flows to the lower Merced River or increases in water temperature. On August 18, 2015, MID installed a remote recording thermograph a few hundred feet upstream of CHDD. The thermograph recorded once each hour, and MID maintained the thermograph through December 31, 2015. Since that time, MID had prepared several documents related to the effects of the Withdraw, conducted water temperature monitoring, and has provided an analysis of the effects of the Withdraw on CCV steelhead.

On February 23, 2016, MID provided a summary and analysis of the effects of the Withdraw to the Commission. MID stated that the Withdraw equated to a total of 170 AF from July 14, 2015 to December 31, 2015, which resulted in a reservoir drawdown of less than two inches. Due to the minor nature of the Withdraw (170 AF) in relation to the sum inflow (60,900 AF) and outflow (81,600 AF) levels, the report concludes that the Withdraw did not have any significant effect on CCV steelhead, or its critical habitat. In addition, a review of the Lake McClure storage levels for the effective variance period (July 15, 2015 to December 31, 2015) shows a minimum storage level of 63,588 AF on December 20, 2015 (Figure 1). Therefore, the sum Withdraw of 170 AF represents only a 0.27 percent reduction in storage. MID also reported, to the Commission, the results of water temperature monitoring conducted above the CHDD from August 18, 2015, to December 31, 2015. Daily average water temperatures remained between 19 degrees Celsius and 23 degrees Celsius from August 18, 2015, until the end of October, when water temperatures declined to December 31, 2015 (Figure 2).

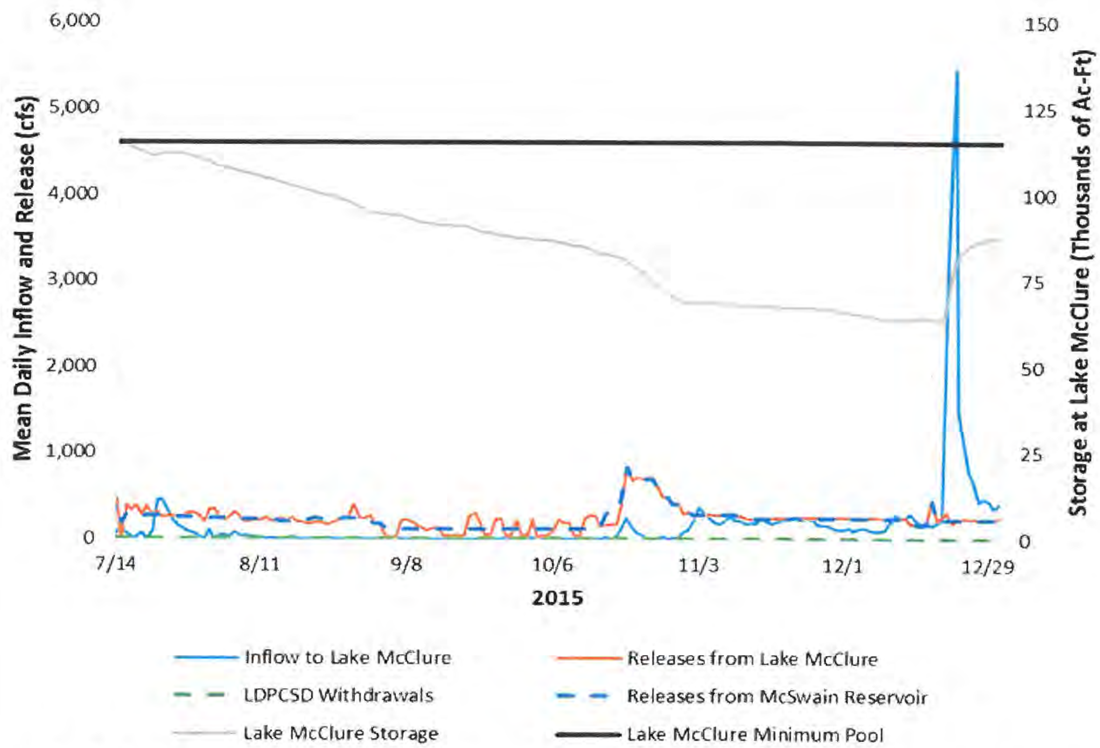

Figure 1. Estimated mean daily inflows, releases, and storage in Lake McClure from July 14, 2015 through December 31, 2015. The brief increase in releases in October 2015 is to meet the fall pulse flow requirement.

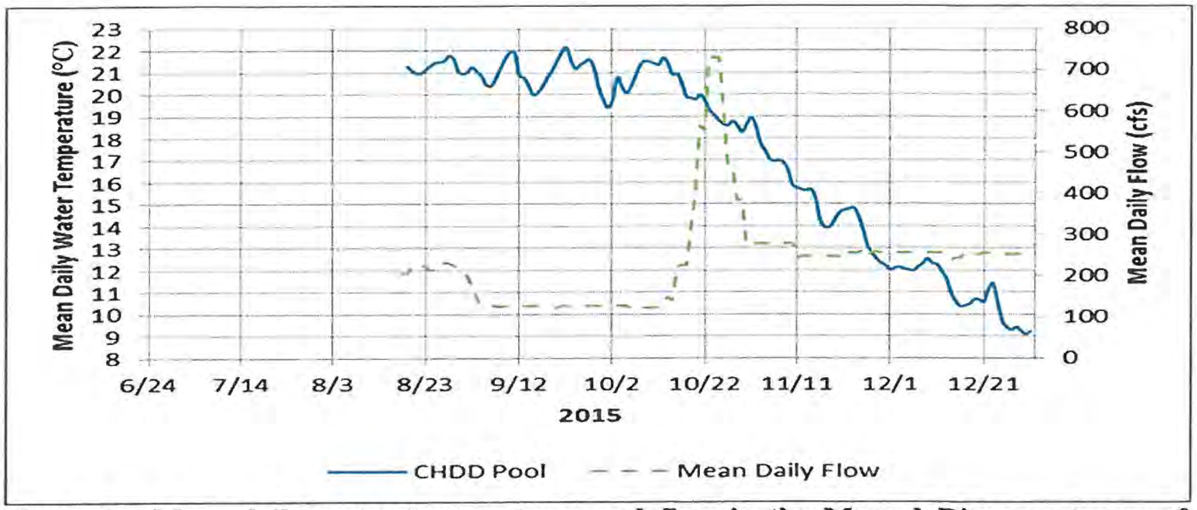

Figure 2. Mean daily water temperatures and flow in the Merced River upstream of Crocker-Huffman Diversion Dam from August 18, 2015 through December 31, 2015.

On April 6, 2016, MID issued a supplemental analysis in response to the Commission's March 7, 2016, request for additional information. The response letter provided water temperature data and analysis for the Merced River downstream of the CHDD. The report again concluded that the Withdraw under the June 24, 2015, Order had no discernable effect on CCV steelhead, or its critical habitat.

On June 10, 2016, MID provided additional information in response to NMFS' April 15, 2016, request for additional information. Specifically, MID provided reservoir water temperature data for Lake McClure and McSwain Reservoir, historical water temperature monitoring data from the lower Merced River.

Action and Action Area

The action associated with this letter is the emergency water withdraw totaling 170 AF from July 14, 2015, to December 31, 2015, at Exchequer Reservoir. The consumptive water withdrawal associated with the June 24, 2015, Order took place at Exchequer Reservoir (Lake McClure) on the lower Merced River in Mariposa County, California. The action area extends from Exchequer Reservoir downstream to the CHDD on the Merced River.

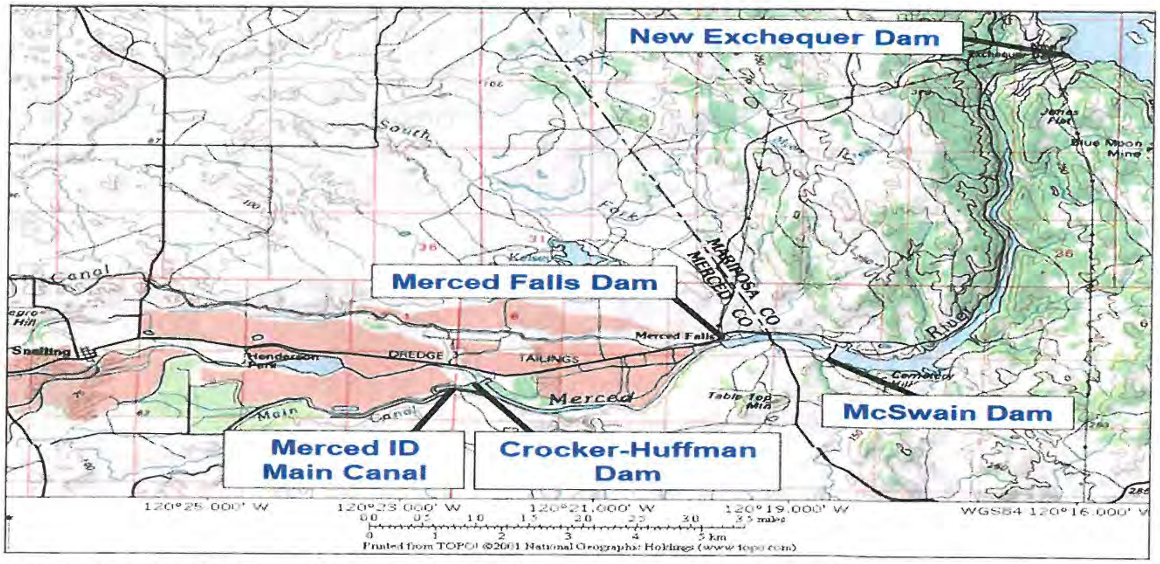

Figure 3. Action area extends from New Exchequer Dam to Crocker-Huffman Diversion Dam on the Merced River

Project Purpose

The emergency water withdrawal at Exchequer Reservoir, which totaled 170 AF from July 14, 2015, to December 31, 2015, was needed to meet health and safety needs of MID's water management plan due to extreme drought conditions in that area. Specifically, the June 24, 2015, Order allowing relaxation of the minimum pool requirement of 115,000 AF at Exchequer Reservoir, allowed diversions by the Lake Don Pedro Community Services District to offset the effect of drought conditions in 2015.

Habitat

The Project site, like most of California west of the Sierra Nevada, experiences a Mediterranean climate. Summers are hot and dry. Winters are cool and moist. Average annual precipitation in the general vicinity of the site is approximately 15 inches, most of which falls as rain between the months of October and April. Precipitation amounts vary considerably from year to year. During drought years, rainfall can be as little as 6 to7 inches. During wet winters, rainfall can exceed 20 inches.

The hydrology of the stretch of Merced River immediately downstream and in the vicinity has been substantially altered by decades of human activity in the region, such as agricultural and mining practices. This alteration has resulted in the removal of riparian vegetation, river channelization, and the installation of dams and other irrigation infrastructure.

Action Agency's Effects Determination

The Commission, acting as the lead Federal agency on behalf of MID, has reviewed the MID's analysis of the effects of the Action and supporting monitoring data, and concurs with MID's

NLAA determination for the effects of the 2015 water Withdraw on CCV steelhead, and its critical habitat. Available information indicates the following listed species (Evolutionarily Significant Units [ESU] or Distinct Population Segments [DPS]) and critical habitat under the jurisdiction of NMFS may have been affected by the Action (Table 1). The Commission has also determined that the Action did not adversely affect EFH for Pacific Coast Salmon.

Table 1. ESA listing history.

Species	ESU or DPS	Original Final FR Listing	Current Final Listing Status	Critical Habitat Designated
Steelhead (*O. mykiss*)	California Central Valley DPS	3/19/1998 63 FR 13347 Threatened	1/5/2006 71 FR 834 Threatened	9/2/2005 70 FR 52488

Consultation History

On April 22, 2015, NMFS received an email from MID requesting comments on the proposal concerning the variance in minimum pool requirements.

On May 4, 2015, NMFS provided technical assistance to the Commission requesting that MID provide data to support its assertion that the proposed variance would have minimal effects on biological resources. NMFS also requested that MID provide an evaluation of how the flow variance would affect water temperatures and anadromous fish in the Merced River. Finally, NMFS requested for the Commission to initiate formal consultation regarding the proposed variance.

On May 22, 2015, NMFS transmitted a technical assistance letter to the Commission indicating the need for a CDFW fish rescue plan to protect steelhead below CHDD, and reiterated the need for the Commission to initiate formal consultation with NMFS.

On May 26, 2015, the Commission transmitted a letter to NMFS requesting agreement on conducting consultation under the emergency provisions of the ESA.

On June 5, 2015, MID transmitted a response letter addressing NMFS's May 4, 2015, technical assistance letter. MID contended that CCV steelhead do not exist in the Merced River. MID also stated that it also conducts water temperature monitoring in conjunction with CDFW, and that the volume and depth of water released from the Project does not have the characteristics to meaningfully affect water temperatures downstream of the non-project CHDD. Rather, MID explained that water temperatures in the area are a function of ambient conditions.

On July 15, 2015, NMFS transmitted a letter to the Commission, including procedures for initiating emergency consultation under the ESA, and technical assistance recommendations to minimize the potential effects on steelhead resulting from the proposed variance. NMFS recommended that MID conduct water temperature monitoring above CHDD, and coordinate with CDFW on fish rescues below CHDD. NMFS also requested access to the water temperature monitoring and fish salvage data. Finally, NMFS renewed its request for the Commission to initiate formal consultation.

On November 28, 2016, the NMFS received a letter from the Commission requesting initiation of an informal, after-the-fact, emergency consultation regarding the 2015 reservoir variance in minimum pool requirements.

On December, 21, 2016, Thomas Yockachonis, NMFS' Fishery Biologist, was assigned as Lead Biologist for this consultation.

On January 5, 2016, NMFS and John Aedo, FERC lead, conducted a final phone conversation to clarify the action associated with the Commission's consultation request. This completed the information needed to initiate an informal, after-the-fact, emergency consultation.

ENDANGERED SPECIES ACT

Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR 402.02). The applicable standard to find that a proposed action is not likely to adversely affect listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. There is no designated critical habitat for listed anadromous fish within the action area, thus the Proposed Action will have no effect on designated critical habitat.

Operational Effects

The Don Pedro Community Services District has a preexisting water withdraw, and approval of the variance allowed the community to continue their water withdraw from Lake McClure during the 2015 drought. The Withdraw associated with the relaxation of the minimum pool requirement of 115,000 AF had the potential to affect CCV steelhead downstream of Lake McClure. Specifically, the water Withdraw had the potential to accelerate the depletion of Lake McClure during the 2015 drought conditions. Reduced storage levels can increase water temperatures, due to thermal loading in Lake McClure and the Merced River in the summer months, leading to adverse effects on fishery resources downstream of Lake McClure.

The Merced River represents the southernmost extent of self-sustaining CCV steelhead (https://www.wildlife.ca.gov/Drought/Projects/Merced-River). Adequate stream flow and cool water temperature are key to survival for juvenile steelhead rearing during the summer and fall. In a review of numerous studies, the Washington State Department of Ecology (2002) concluded that daily average temperatures of 21 degrees Celsius to 24 degrees Celsius are associated with avoidance behavior and migration blockage in steelhead trout. Monitoring by CDFW near the Merced River Hatchery recorded and showed mean daily water temperatures at the beginning of the Order (June 24, 2015) upstream and downstream of CHDD was ~20 degrees Celsius, increased to ~22 degrees Celsius by late-September, and then decreased to about 9 degrees Celsius by the end of December. However, water temperature in this area of the Merced River is a function of flow and ambient conditions, and water temperatures during these months historically reach temperatures problematic to steelhead in the absence of reservoir water withdraws (Carter and Region 2005). MID maintained minimum flow requirements under Article 40, which requires MID to maintain instantaneous flow of now less than 40 cfs at Shaffer Bridge on the Merced River; approval of the variance in minimum flow requirements associated with the Withdraw did not alter flow below Lake McClure, it merely allowed the Don Pedro Community Services District to continue with their preexisting water withdraw.

Conclusion

MID stated that the water withdrawal equated to a total of 170 AF from July 14, 2015, to December 31, 2015, which resulted on a reservoir drawdown of less than two inches. MID also provided the results of water temperature monitoring conducted above the CHDD from August 18, 2015, to December 31, 2015, and concluded that the effect of the water withdrawal on water temperature was insignificant. In addition, CDFW conducted water temperature monitoring immediately below CHDD, which aligns with the data provided by MID for upstream of CHDD. Due to the minor nature of the water withdrawal (170 AF) in relation to the sum inflow (60,900 AF) and outflow (81,600 AF) levels, any effects due to the water withdrawal on CCV steelhead are very likely insignificant and discountable. As a sum amount, the water withdrawal is negligible, but any potential effects to water quantity or temperature from the Action are further diminished when spread out over the 4.5 month variance period. Based on the magnitude of the action, NMFS concurs with the Commission's determination that the emergency water Withdraw associated with the June 24, 2015, did not cause take to occur, and is not likely to have adversely affected CCV steelhead or its critical habitat.

Reinitiation of Consultation

Reinitiation of consultation is required and shall be requested by the Commission or by NMFS where discretionary Federal involvement or control over the action has been retained or is authorized by law and (1) 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; (2) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this concurrence letter; or if (3) a new species is listed or critical habitat designated that may be affected by the identified action (50 CFR 402.16). This concludes the ESA portion of this consultation.

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. The Commission also has the same responsibilities, and informal consultation offers action agencies an opportunity to address their conservation responsibilities under section 7(a)(1). To this purpose, NMFS provides the following recommendations:

1) The Commission should make every effort to work with irrigation districts and NMFS to anticipate future scenarios and actions that might require emergency consultations concerned with ESA-listed anadromous species so that future consultations may be completed prior to actions being taken.

FISH AND WILDLIFE COORDINATION ACT

The purpose of the FWCA is to ensure that wildlife conservation receives equal consideration, and is coordinated with other aspects of water resources development (16 U.S.C. 661). The FWCA establishes a consultation requirement for Federal departments and agencies that undertake any action that proposes to modify any stream or other body of water for any purpose, include navigation and drainage (16 U.S.C. 662(a)). Consistent with this consultation requirement, NMFS provides recommendations and comments to Federal action agencies for the purpose of conserving fish and wildlife resources. The FWCA allows the opportunity to offer recommendations for the conservation of species and habitats beyond those currently managed under the ESA and MSA.

NMFS has no additional recommendations beyond the measures included in the proposed action.

This concludes the FWCA portion of this consultation.

Please direct questions regarding this letter to TJ Yockachonis, California Central Valley Office, at (916) 930-3710 or via e-mail at Thomas.Yockachonis@noaa.gov.

Sincerely,

Erin Strange

Barry Thom for
Regional Administrator

Cc: California Central Valley Office
Division Chron File: 151422-WCR2015-SA00117

Literature Cited:

Carter, K. and Region, N.C. 2005. The Effect of Temperature on Steelhead Trout, Coho Salmon, and Chinook Salmon Biology and Function by Life Stage. Implications for the Klamath River Total Maximum Daily Loads. California Regional Water Quality Control Board. North Coast Region, Santa Rosa, California.

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

MAY 23 2017

Refer to Tracking No: *WCR-2017-6914*

Mr. Richard J. Woodley
Regional Resources Manager
Bureau of Reclamation
Mid-Pacific Regional Office
2800 Cottage Way
Sacramento, California 95825-1898

Re: Request for Re-initiation of Informal Consultation Regarding the Merced Irrigation District Drought Protection Water Management Model Project (Project; NMFS Tracking No. WCR-2016-5156).

Dear Mr. Woodley:

On April 4 2017, NOAA's National Marine Fisheries Service (NMFS) received your request for written concurrence that the change in timing of the Bureau of Reclamation (Reclamation) funded Merced Irrigation District (MID) Drought Protection Water Management Model Project (Proposed Project) from 2016 to 2017 is not likely to adversely affect (NLAA) species listed as threatened or endangered or critical habitats designated under the Endangered Species Act (ESA). This response to your request was prepared by NMFS, pursuant to section 7(a)(2) of the ESA, implementing regulations at 50 CFR 402, and agency guidance for preparation of letters of concurrence.

We previously concurred with Reclamation's finding that the similar action proposed in 2016 was not likely to adversely affect the subject listed species and designated critical habitat. We recognize that the proposed change from the previously analyzed action is to implement the project in 2017 instead of 2016. In addition, it was previously indicated that the in-water work would be completed in one day. The MID contractors have now indicated that in-water work would require two days at one location, and one day at another location (three days total). The analysis of the proposed action has not changed, but is included in this letter to repeat NMFS' understanding of the proposed action, and to reinforce the included Conservation and Avoidance Measures and Best Management Practices (BMPs). In addition, while the analysis has not changed, the analysis was based on the likelihood that due to high water temperatures, "juvenile [CCV steelhead] would only be expected to be in the area during construction period when extreme wet weather conditions occur". Because the 2016/2017 winter has been extremely wet, and a high volume of water is stored as snow higher in the watershed, it is therefore no longer likely that conditions will preclude the presence of rearing juvenile CCV steelhead during the previously proposed in-water work window of between June 15 and August 30. Therefore, a new, reduced in-water work window of between July 15 and August 30, 2017, is proposed.

NMFS also reviewed the proposed action for potential effects on essential fish habitat (EFH) for Pacific Coast Salmon, designated under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), including conservation measures and any determination you made regarding the potential effects of the action. This review was pursuant to section 305(b) of the MSA, implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to complete EFH consultation. Chinook salmon have the potential to be present in the action area and are managed under the Pacific Coast Salmon Fisheries Management Plan (FMP). Habitat areas of particular concern (HAPCs), as designated under this FMP, include (1) complex channels and floodplain habitats, (2) thermal refugia, (3) spawning habitat, (4) estuaries, and (5) marine and estuarine submerged aquatic vegetation. The HAPCs present in the action area include (1) from above. In this case, NMFS concluded the action would not adversely affect EFH. This is based on the following evaluation of project effects to ESA-listed species and their designated critical habitat. Thus, consultation under the MSA is not required for this action.

This letter underwent pre-dissemination review using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The concurrence letter will be available through NMFS' Public Consultation Tracking System at https://pcts.nmfs.noaa.gov. A complete record of this consultation is on file at the California Central Valley Office of NMFS.

Proposed Action and Action Area

The Proposed Project involves the installation of two data collection stations along the lower Merced River below the Crocker-Huffman Dam, in Merced County, California. One site is located at the State Highway 59 Bridge near river mile 42.1, and the second site is located at the private Gallo Bridge near river mile 39.4. Weather stations will be constructed at the base of the bridge footings, while conduits will run to gauges that will be placed instream. The data collection stations consist of weather gauges for measuring temperature, humidity, precipitation, wind speed, and sunlight; coupled with stage (river flow). The action area includes the area approximately 50 feet to the upstream side of both the Highway 59 and Gallo Bridges, and downstream from each bridge approximately 30 feet, as far as turbidity and sedimentation effects may result from Proposed Project actions. The footprint within which the Proposed Project weather stations will be installed is approximately 0.846 acres in total. Operations and maintenance of the gaging stations, including biweekly panel cleaning and battery replacement, which will occur on the bank, are inextricably linked to the project, however not interrelated or interdependent. There are no interrelated or interdependent activities associated with this project.

Construction Activities

The Proposed Project includes the installment of two stage measurement and weather stations, concrete bases, conduit for instrumentation wires, flow gauges, and vertical staff gauges.

Weather stations will be constructed on concrete five foot by five foot concrete pads within ten feet of the bridge footings and above the high water mark. The stations will each use a pole mounted solar panel measuring approximately two feet by three feet and a sealed 12-volt battery to generate and store power. Stations will be housed in locked, four foot by four foot by eight foot metal buildings at both installation sites.

The existing ground contains only herbaceous vegetation (i.e., no woody vegetation), and will be prepared using a skid steer track loader. The concrete footings will be precast offsite. Station equipment will be housed and fenced entirely on the platform to prevent vandalism.

Flow measurements will be made using a bubble gauge system. To connect the pressure sensor in the station housing to the orifice mechanism in the stream flow, two-inch diameter conduit will house 3/8-inch air lines. The conduit will be buried eight to ten inches deep at the point it leaves the concrete base.

Installation of the data collection stations is anticipated to take a crew of two to three people a total of five 10-hour workdays to complete. The proposed in-water work is expected to take two days at the Highway 59 Bridge Site and one day at the Gallo Bridge Site. Work will only occur in periods of no rain following dry periods of at least 24 hours. ork will be completed between July 15 and August 30, 2017. Ground disturbance activities below the high water mark will occur after July 15, 2017.

Gallo Bridge Site - At the Gallo Bridge site, the conduit will continue underground approximately five to ten feet, then angle upwards from the ground and attach to the base of the bridge at the footing. It will run along the left upstream edge of the base to the first pylon, and will then angle down the pylon to the orifice in the water. The conduit and orifice will be bolted to the base of the bridge and fixed to the first pylon with metal strapping. Other than wading or the use of a small floatation device (e.g., cataraft), no disturbance to the streambed will be made.

Along with the bubble gauge, a staff gauge will also be strapped to the bridge pylon. A staff gauge is basically a four-inch-wide porcelain and metal measuring stick that can be read from the river bank. It is used for calibration purposes and ensures that bubble gauge measurements are accurate.

Because the access road to the Gallo Bridge is private, all work vehicles will remain on the dirt road. Likewise, the staging of all project materials will remain along the road.

Highway 59 Bridge Site - At the Highway 59 Bridge site, the conduit also will angle down off of the concrete base to a buried depth of eight to ten inches. However, it will not run along the bridge, but instead will be buried for a length of about 230 feet until it emerges at a point that is instream during low flows. The conduit will continue approximately nine feet into the low-flow stream to the expected anchor point for the bubbler orifice.

A staff gauge will be anchored instream, and the bubbler orifice will be attached to it. A three-foot high concrete cylinder with a diameter of about three feet will be used to anchor the instrumentation. A small anchor plate, four to six inches in diameter, will be used to hold the staff gauge vertical, and will be bolted to the concrete anchor. The concrete anchor will be buried approximately two to three feet in the streambed. To minimize potential problems caused by instream debris, the staff gauge will be limited to approximately five feet in height. However, to cover the full range of flow up to the ordinary high water mark, a second staff for higher flows will be anchored directly to the bridge pylon. As with the Gallo Bridge site, the staff will be anchored with metal straps around the pylon.

A mini-excavator will be used to bury conduit, as well as the anchor for the low-flow staff gauge. No vegetation below the bridge will be removed. Only the bucket of the excavator will enter the water. A turbidity curtain will be installed from the left bank, around the proposed staff anchor site, and back to the left bank. In all, the turbidity curtain will be installed in approximately a 20-foot length of the stream, and approximately 85 percent of the stream flow will be left unrestricted. The curtain will be removed once there are no visible signs of turbidity following the anchor and staff installation. Work below the high water mark is expected to be completed in one day. Staging of equipment and materials will occur along Highway 59.

Conservation and Avoidance Measures and Best Management Practices

The following measures will be followed as part of the proposed action to minimize or avoid potential impacts, resulting from implementation, to listed fish:

1. Staging and storage areas will be located at least 500 feet from the ordinary high water mark of the river, and will be limited to existing roads and disturbed areas. Hazardous material containment areas will be installed at the staging areas for fueling and maintenance of stationary equipment to ensure any spill will not enter the water, contaminate sediments that may come in contact with the water, or damage wetland or riparian vegetation.

2. All ground-disturbing activities below the high water mark and in-water activities at the Highway 59 Bridge site will be conducted between July 15 and August 30, 2017.

3. Except for the bucket of the mini-excavator under the Highway 59 Bridge, heavy machinery or construction equipment will not enter the waterway. All excavation work will be done from dry land.

4. A turbidity curtain will be installed in the in-channel work area under the Highway 59 Bridge to isolate turbidity from moving across or downstream of the action area. The turbidity curtain will be removed upon completion of all in-water activities and when no visible signs of turbidity remain.

5. Known BMPs will be implemented (such as fiber rolls and silt fence) to minimize sediment and erosion as a result of the construction activities from entering the water ways.

6. Construction will follow typical spill prevention and control plan measures implemented to minimize effects from spills of hazardous, toxic, or petroleum substances used in project related construction activities.

7. No standing woody vegetation will be trimmed or removed during Proposed Project actions.

8. Upon completion of project activities, all construction debris will be removed and, wherever feasible, disturbed areas will be restored to pre-project conditions. All disturbed areas above the ordinary high water mark will be reseeded with a native seed mix.

Action Agency's Effects Determination

Reclamation has determined that the proposed action may affect but is not likely to adversely affect ESA-listed species and their designated critical habitats, under the jurisdiction of NMFS, based on project measures to avoid and minimize potential impacts, such as project timing, practices to reduce sediment and turbidity effects, and avoiding removal of standing woody vegetation. Available information indicates the following listed species (Evolutionarily Significant Units [ESU] or Distinct Population Segments [DPS]) and critical habitat under the jurisdiction of NMFS may be affected by the proposed project (Table 1). Reclamation has determined that the proposed action would not adversely affect EFH for Pacific Coast Salmon.

Status of Species and Critical Habitat in the Action Area

The designation(s) of critical habitat for (species) use(s) the term primary constituent element or essential features. The new critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). This shift in terminology does not change the approach used in conducting our analysis, whether the original designation identified primary constituent elements, physical or biological features, or essential features. In this letter of concurrence, we use the term PBF to mean primary constituent elements or essential feature, as appropriate for the specific critical habitat.

Table 1. ESA listing history.

Species	ESU or DPS	Original Final FR Listing	Listing Status Reaffirmed	Critical Habitat Designated
Steelhead (*Oncorhynchus mykiss*)	California Central Valley DPS	3/19/1998 63 FR 13347 Threatened	1/5/2006 71 FR 834 Threatened	9/2/2005 70 FR 52488

Consultation History

During January and February, 2016, NMFS exchanged multiple email correspondence discussing this potential consultation, and to coordinate a site visit.

On March 22, 2016, NMFS, Reclamation, and MID performed a site visit to both locations.

On May 23, 2016, NMFS received a letter from Reclamation for the Proposed Project, requesting consultation.

On June 10, 2016, NMFS requested additional information from Reclamation via email regarding the Proposed Project activities.

On June 10, 2016, Reclamation provided the requested additional information to NMFS via email, but some additional clarification was required.

On June 13, 2016, NMFS requested additional information from Reclamation via email regarding the Proposed Project activities.

On June 13, 2016, Reclamation provided the requested additional information to NMFS via email. This completed the information needed for NMFS to initiate consultation.

On March 1, 2017 Dan Cordova of Reclamation contacted Jeff Abrams by email to ask if reinitiation was required to conduct work in 2017 instead of 2016. Jeff indicated that it was.

On April 4, 2017, NMFS received a letter from Reclamation requesting reinitiation of informal consultation.

On April 25, 2017, after evaluating conditions based on the expected 2017 water year type, NMFS proposed, by email, a reduced in-water work window.

On April 26, 2017, Reclamation agreed to the reduced in-water work window, but indicated that the MID contractors now anticipated an extra two days of in-water work to complete the project.

Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR 402.02). The applicable standard to find that a proposed action is not likely to adversely affect listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur.

Listed species potentially in the action area during time of construction (July 15 through August 30) include rearing juvenile California Central Valley (CCV) steelhead. Juvenile CCV steelhead rear in the Merced River year-round. However, adult and juvenile migration occur outside of the in-water work window. The potential effects of the proposed action include impacts to listed rearing juvenile CCV steelhead. Potential impacts include: injury or death due to construction work, mobilized sediment and increases of turbidity, reduced riparian vegetation, and effects to critical habitat.

Injury or Death due to Construction Work- Direct injury or death may occur to rearing juvenile salmonids during in-water construction activities. During the installation of the data collection stations, fish can be impacted from construction related activities. However, there is a low likelihood that rearing juvenile CCV steelhead will be present in the action area due to low flows and warm water temperatures during the in-water construction timing (July 15 through August 30). The proposed in-water work is expected to be completed in three days. During this time of the year, average daily water temperatures in the action area typically are in the upper 70 to mid 80 degrees Fahrenheit (F). Optimal water temperatures for juveniles range from 59 to 68 degrees F (McCullough et al. 2001, Spina et al. 2006). However, because the 2016/2017 winter has been extremely wet, and a high volume of water is stored as snow higher in the watershed, it is likely that water temperatures in the action area will be lower than normal. An examination of water temperatures in the action area during the last very wet year, 2011, suggested a work window of July 15 to August 30 was more appropriate than the previously proposed in-water work window. During the new authorized in-water work window, rearing juvenile CCV steelhead are more likely to be present in the upper reaches of the lower Merced River where higher quality habitat exists during this time of the year. Therefore, impacts to juvenile salmonids are expected to be discountable and juvenile CCV steelhead are not expected to be directly affected by the proposed construction work.

Mobilized Sediment and Increases of Turbidity - Turbidity and suspended sediment levels associated with the installation of the data collection stations may negatively impact fish populations temporarily through reduced availability of food, reduced feeding efficiency, exposure to toxic sediment released into the water column, and damage to gills. Fish response to increased turbidity and suspended sediment can range from behavioral changes (alarm reactions, abandonment of cover, and avoidance) to sublethal effects (e.g., reduced feeding rate), and, at high suspended sediment concentrations for prolonged periods, lethal effects. The construction activities will occur during low flow period (June 1 through August 30), when fish are not likely to be present in the action area. In addition, the installation of a silt fence and fiber rolls, and an in-channel turbidity curtain, is expected to minimize potential across stream and downstream effects to an insignificant level.

Water Quality Degradation - All construction equipment and machinery will be on land and will not enter the waterway. Only the bucket of the mini-excavator will disturb the substrate and water column. However, the use of construction equipment near the waterway has the potential to impair water quality if hazardous chemicals (e.g., fuels and petroleum-based lubricants, hydraulic fluids, degreasers, etc.) are spilled and directly or indirectly entered the river. Additionally, construction-related activities could impact waterways through erosion, sediment, and storm water runoff. These potential effects are expected to be discountable because of the BMPs and measures described above.

Reduced Riparian Vegetation - Riparian vegetation provides cover, shade, and food resources required by adult and juvenile life stages. Removal of shaded riverine aquatic habitat could result in a decrease in the amount of food supply entering the river as well as an increase in water temperatures due to loss of shading. Decreasing the amount of cover may also increase the likelihood of predation. However, no standing woody vegetation will be trimmed or removed during Proposed Project actions, all disturbed areas above the ordinary high water mark will be reseeded with a native seed mix, and disturbed ground in the riparian areas will be restored to pre-project conditions. Therefore, impacts to riparian vegetation as a result of the construction activities will be insignificant.

Effects to Critical Habitat - The Proposed Project likely will result in some increased turbidity and reduced riparian vegetation due to the excavation necessary to bury the conduit. The increases in turbidity and sediment will be insignificant due to the implementation of BMPs and the turbidity curtain. Impacts to riparian vegetation will be minimal as no standing woody vegetation will be affected and disturbed areas will be restored.

Conclusion

Based on this analysis, NMFS concurs with Reclamation that the proposed action is not likely to adversely affect the subject listed species and designated critical habitat.

Reinitiation of Consultation

Reinitiation of consultation is required and shall be requested by Reclamation or by NMFS where discretionary Federal involvement or control over the action has been retained or is authorized by law and (1) 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; (2) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this concurrence letter; or if (3) a new species is listed or critical habitat designated that may be affected by the identified action (50 CFR 402.16). This concludes the ESA portion of this consultation.

Please direct questions regarding this letter to Jeff Abrams, California Central Valley Office, at (916) 930-3614 or via e-mail at Jeff.Abrams@noaa.gov.

Sincerely,

Erin Strange for

Barry A Thom
Regional Administrator

Cc: California Central Valley Office
Division Chron File: ARN-151422-WCR2016-SA00246

References

McCullough, D., S. Spalding, D. Sturdevant, and M. Hicks. 2001. Issue Paper 5. Summary of Technical Literature Examining the Physiological Effects of Temperature on Salmonids. Prepared as Part of U.S. EPA, Region 10 Temperature Water Quality Criteria Guidance Development Project.

Spina, A. P., M. R. McGoogan, and T. S. Gaffney. 2006. Influence of Surface-Water Withdrawal on Juvenile Steelhead and Their Habitat in a South-Central California Nursery Stream. California Fish and Game 92(2):81-90.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

SEP 6 2017

Melissa France
California North Section Office
Regulatory Division, Sacramento District
U.S Army Corps of Engineers
1325 J Street, Sacramento, CA 95814

Subject: Lower Merced River Boat Access Ramp Project (SPK- 2016-00053)

Dear Ms. France:

This letter is in response to your letter of August 8, 2017, requesting initiation of informal consultation under section 7 of the Endangered Species Act (ESA) with NOAA's National Marine Fisheries Service (NMFS) in support of the issuance of a Department of the Army Permit (SPK-2016-00053) for the Lower Merced River Boat Access Ramp Project located on the Merced River, in Merced County, California. Specifically, the U.S. Army Corps of Engineers has determined that the project is not likely to adversely affect federally listed threatened California Central Valley (CCV) steelhead *(Oncorhynchus mykiss)* or designated critical habitat.

The Merced Irrigation District (MID) proposes to construct a recreational river access and non-motorized boat launching facility on the north bank of the Merced River. Installation of the boat ramp and rock slope protection (RSP) may alter approximately 0.035-acre within the bank, of which 0.014-acre occurs below the ordinary high water mark (OHWM). Permanent impacted areas will encompass a total of 0.175-acre. The boat launch will consist of a 20-foot-wide ArmorFlex 50s mat constructed of pre-formed concrete cinder blocks. The proposed project includes a parking area, bathroom facility, along with the boat launch. This project will replace an existing, dirt boat launch and social trail.

Due to regulations governing interagency consultation (50 CFR §402.14), NMFS is unable to complete consultation as we do not concur with your determination. A determination of "not likely to adversely affect" is appropriate only when it is clearly demonstrated that the effects of the proposed project on listed species are expected to be discountable (*i.e.*, extremely unlikely to occur), insignificant (*i.e.*, the impacts of the proposed project should never reach the scale where take of listed species occurs), or completely beneficial (*i.e.*, contemporaneous positive effects without any adverse effects to listed species). The information provided with your letter does not support a "not likely to adversely affect" determination. Specifically, the project description will permanently destroy an occupied stream channel, which may result in harm to the species by eliminating critical habitat that may be used for spawning and early juvenile rearing for CCV steelhead. In addition, juvenile CCV steelhead have the potential to be using the area as rearing habitat during the time of the project construction.

The ESA consultation process for this project will not be initiated until: 1) information necessary for us to concur with your determination of not likely to adversely affect has been received; or 2) we receive all of the information necessary to initiate formal consultation, or a statement explaining why that information cannot be made available. Once we receive all of the information necessary to complete consultation, we will review it and contact you with a determination of our findings on this project. You will be notified of the dates within which consultation should be completed and our biological opinion delivered for the proposed project.

Please contact Abbie Moyer at (916) 930-3707, or by e-mail at Abbie.Moyer@noaa.gov, if you have any questions regarding this letter.

Sincerely,

Erin Strange for

Maria Rea
Assistant Regional Administrator

Cc: California Central Valley Office
Division Chron File: 151422-WCR2017-SA00366

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

Refer to NMFS No: WCRO-2019-00352

April 22, 2019

Ms. Dena Gonzalez
Chief, Central Region Biology Branch
California Department of Transportation, District 6
1352 West Olive Ave
Fresno, California 93728

Re: Endangered Species Act Section 7(a)(2) Concurrence Letter and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Merced Seismic Restoration Project in Merced County

Dear Ms. Gonzalez:

This letter responds to your April 11, 2019, request for concurrence from NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act (ESA) for the subject action. Your request qualified for our expedited review and concurrence because it met our screening criteria and contained all required information on your proposed action and its potential effects to listed species and designated critical habitat.

We reviewed your consultation request document and related materials. Based on our knowledge, expertise, and the materials you provided, we concur with your conclusions that the proposed action is not likely to adversely affect the California Central Valley (CCV) steelhead distinct population segment (DPS) and/or designated critical habitat, nor will the proposed action jeopardize the non-essential experimental population (NEP) of Central Valley spring-run Chinook salmon.

This letter underwent pre-dissemination review using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The concurrence letter will be available through the NMFS' Public Consultation Tracking System. A complete record of this consultation is on file at the California Central Valley Office in Sacramento, California.

Reinitiation of consultation is required and shall be requested by California Department of Transportation (Caltrans) or by NMFS, where discretionary Federal involvement or control over the action has been retained or is authorized by law and (1) 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; (2) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this concurrence letter; or if (3) a new species is listed or critical habitat designated that may be affected by the identified action.

NMFS also reviewed the proposed action for potential effects on essential fish habitat (EFH) designated under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), including conservation measures and any determination you made regarding the potential effects of the action. This review was pursuant to section 305(b) of the MSA, implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to complete EFH consultation. In this case, NMFS concluded the action would not adversely affect EFH. Thus, consultation under the MSA is not required for this action.

Please contact Abbie Moyer, in the NMFS California Central Valley Office, at Abbie.Moyer@noaa.gov or 916.930.3707 if you have any questions concerning this letter or if you require additional information.

Sincerely,

Erin Strange

Erin Strange
Branch Chief
San Joaquin River Branch

cc: To the file 151422-WCR2018-SA00439

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
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Sacramento, California 95814-4700

Refer to NMFS No: WCRO-2018-00238

May 22, 2019

Rain L. Emerson
Chief, Environmental Compliance Branch
South-Central California Area Office
Bureau of Reclamation
1243 N Street
Fresno, California 93721

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Merced River Instream and Off-Channel Habitat Rehabilitation Project.

Dear Mr. Emerson:

Thank you for your letter on November 8, 2018, requesting initiation of consultation with the National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.) for the Merced River Instream and Off-Channel Habitat Rehabilitation Project.

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)) for this action.

NMFS also reviewed the likely effects of the proposed action on EFH, pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)), and concluded that the action would adversely affect the EFH of Pacific Coast Salmon. Therefore, we have included the results of that review in Section 3 of this document.

The enclosed biological opinion, based on the biological assessment, and the best available scientific and commercial information, concludes that the project is not likely to jeopardize the continued existence of the federally listed threatened California Central Valley steelhead distinct population segment (*Oncorhynchus mykiss*) and is not likely to destroy or adversely modify their designated critical habitats. NMFS has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed species associated with the project.

Please contact Savannah Bell at savannah.bell@noaa.gov or at (916)930-3721 if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Maria Rea

Maria Rea
Assistant Regional Administrator
California Central Valley Office

Enclosure

cc: To the file 151422-WCR2018-SA00487

Ms. Kathy Norton
Ecologist/Sr. Project Manager
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Mr. Mike Morris
Associate Engineer
Merced Irrigation District
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Ms. Kirsten Sellheim
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UNITED STATES DEPARTMENT OF COMMERCE
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Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

Merced River Instream and Off-Channel Habitat Rehabilitation Project

National Marine Fisheries Service Public Tracking Consultation Number: WCRO-2018-0238

Action Agency: Bureau of Reclamation

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
California Central Valley steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	Yes	No

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

Maria Rea
Assistant Regional Administrator

Date: **May 22, 2019**

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file at the Sacramento NMFS office.

1.2 Consultation History

On November 8, 2018, NMFS received a letter requesting formal consultation from the Bureau of Reclamation for the Merced River Instream and Off-Channel Habitat Rehabilitation Project (Project).

On November 28, 2018, NMFS requested more information from Reclamation on length of the action agency.

On November 29, 2018, Reclamation replied to request for more information. This was sufficient information to initiate consultation.

NMFS initiated consultation on November 29, 2018, however, the consultation was held in abeyance for 38 days due to a lapse in appropriations and resulting partial government shutdown. Consultation resumed on January 28, 2019

1.3 Proposed Federal Action

“Action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

The overall vision of the Proposed Project is to restore (rehabilitate/enhance) habitat for native fish species particularly during drought conditions, emphasizing spawning and rearing habitat for CV salmonids. The Proposed Project aims to protect, improve, and restore riverine habitat, including benefits to fish, wildlife, vegetation, and water quality, includes several components, and incorporates multiple strategies to meet goals of the USFWS Anadromous Fish Restoration Program (AFRP). These goals include long-term habitat restoration for CV fall-run salmonid populations in the Merced River, including augmenting appropriate spawning substrate for these species, and recovering side channel and floodplain habitats that support juvenile salmonid growth and survival (USFWS 2001). The specific goals and objectives of this restoration project are to: 1) augment, rehabilitate, and enhance productive lower Merced River juvenile salmonid rearing habitat and adult spawning habitat that is resilient to drought conditions, 2) enhance juvenile salmonid access to historic floodplain habitat, 3) reduce main channel habitats potentially conducive to invasive fish species, 4) create additional flooding capacity, improving flood management in wet years, and 5) determine whether the implemented project had the desired effect on target species and overall system health.

1.3.1 Project Construction

The Proposed Project would take place in the Merced River approximately 1,500 feet below Crocker-Huffman Diversion Dam, which is the extent of anadromy, over a two year period. The Proposed Project would re-grade and rehabilitate 6.74 acres of tailings pile upland habitat, 7.49 acres of main channel salmonid rearing and spawning habitat, and 3.35 acres of seasonally inundated juvenile rearing habitat within the Action Area of the Merced River. Pre-project sediment surveys within the site determined that the dredger tailings piles adjacent to the river channel contained large quantities of gravel and cobble that could be obtained by sorting the excavated material. The sorted gravel and cobble could then be used for river channel rehabilitation including salmonid spawning gravel augmentation.

Approximately 65,000 yd3 (~49,696 m3) of native gravel and cobble obtained by excavating and sorting dredger tailings adjacent to the river channel would be used to rehabilitate the channel morphology within the site including gravel bar creation and to create or enhance salmonid spawning riffles. The river rock would be placed in select areas in the main channel to enhance/create 1.7 acres (0.69 ha) of salmonid spawning habitat and increase water surface elevation to facilitate inundation of the floodplain and side channels created through removal of the dredger tailings piles. The enhanced/created spawning riffles would consist of 5 – 10 inch diameter (12.7 – 25.4 centimeter [cm]) cobbles used to build up base layer and stabilize the toe of spawning riffles and 1⁄4 – 5 inch diameter (0.6 – 12.7 cm; per AFRP specifications) gravel that would be placed 2 – 3 ft (0.6 – 0.9 m) deep.

An approximately 2.33-acre perched floodplain area on the north side of the river would be re-graded by 1-10 ft (0.3 – 3.0 m) in elevation, allowing it to inundate at flows greater than 900 cubic feet per second (cfs). A total of 1.22 acres and 1,030 ft (314 m) of side channels would be created on the reclaimed north floodplain. Side channels totaling 1.02 acres and 1,000 ft (304.8 m) would be created on the south side of the river through the remnant point bar. The floodplain and side channel excavation would require no in-channel work, as construction would occur when flows are lower than the features are designed to inundate.

Gravel and cobble would be deposited in-stream and placed by rubber-tired front-end loaders (Caterpillar 950 Loader). To minimize any potential negative effects on salmonids, in-stream gravel placement activities would occur during summer/early fall (15 July to 15 October) when flows are low (approximately 200 cfs) and active salmonid spawning is not occurring.

Construction would occur over two seasons and would require approximately 16 weeks per season, with in-stream construction requiring approximately 10 to 20 days per season. Work would occur Monday – Friday from 7:00 am to 5:00 pm to ensure minimal disturbance to the environment.

The strategy for instream gravel replenishment is based on an understanding of the existing channel bed topography and is intended to re-create channel bedforms to enhance salmonid spawning. Gravel would be placed using designs from the Spawning Habitat Integrated Rehabilitation Approach (SHIRA) developed by the University of California at Davis (Wheaton et al. 2004 a, b, Pasternack 2008, Sawyer et al. 2009), and general rearing habitat components. Any trees removed during restoration activities would be used within the created floodplains and side channels as large woody material habitat elements. The trees would be strategically placed in the floodplains and side channels to provide cover and habitat complexity for rearing juvenile salmonids.

Native trees, such as Fremont cottonwood (*Populus fremontii*), oak (*Quercus* spp.), and willow (*Salix* spp.) with a diameter at breast height (dbh) of at least 12 in (15.2 cm) would be protected with buffers that extend to the canopy edge to avoid ground disturbance within the tree’s drip line. To compensate for the removal of riparian shrubs and trees during implementation, the plans would identify tree and shrub species that would be planted, how, where, and when they would be planted, and measures taken to ensure a performance criteria of 70% survival of planted trees for a period of three consecutive years. The tree plantings would be of native tree species compensated for in the following manner:

- Oaks having a dbh of three to five inches would be replaced in-kind, at a ratio of 3:1, and planted during the winter dormancy period in the nearest suitable location to the area where they were removed. Oaks with a dbh greater than five inches would be replaced in-kind at a ratio of 5:1.

- Native riparian trees having a dbh of three to five inches would be replaced in-kind on site at a ratio of 3:1 and planted in the nearest suitable location to the area where they were removed.

After floodplain grading and gravel augmentation activities have been completed the disturbed areas would be revegetated with native riparian plants. Planting would occur in late November, which is the likely beginning of the winter storm season, to maximize survival rates. Exotic species present in the riparian area, including Himalayan blackberry (*Rubus armeniacus*), yellow starthistle (*Centaurea solstitialis*) and milk thistle (*Silybum marianum*), would be eradicated where possible.

The Proposed Project would excavate habitat features on the floodplain and use gravel and cobble sediments to rebuild the river bed. The floodplain design would create side channels where possible, and seek to preserve existing high quality biological resources such as wetlands and riparian trees. Once excavated sediments from the floodplain are sorted they would be used to rescale the current river channel geometry to better match the managed flow regime. The river bed would be graded to create mosaic alluvial river mesohabitat units (e.g. riffles, pools and bars) to increase main channel spawning, rearing, and holding habitat, while concurrently raising low-flow water levels to inundate the newly graded floodplain for off channel rearing habitat. The Proposed Project would increase the area of main channel bar edges, which juvenile salmonids use for rearing, particularly during drought years (Beechie et al. 2005). In drought years, when floodplains, side channels, and other off-channel rearing habitats are generally not inundated, juvenile salmonids use main channel bar edges for rearing (Beechie et al. 2005, Sellheim et al. 2015).

Spawning habitat increases are anticipated from rescaling the channel size to the current flow regime, as well as building riffles using appropriately-sized spawning gravels. Rescaling river geometry to better match the managed flow regime is a common enhancement approach in California's regulated rivers. The Proposed project seeks to install greater topographic variation in created channel forms beyond a uniform bankfull channel, including riffles, pools and bars. These features would create the hydraulic conditions that vary considerable about average bankfull dimensions that are needed to support geomorphic and ecological processes (Brown et al., 2015; Brown and Pasternack, 2017).

1.3.2 Project Monitoring

A detailed monitoring plan would be implemented with the primary goal of defining the current state of the system before restoration and determining whether the implemented project had the desired effect on target species and overall system health.

The monitoring program consists of four monitoring stages: 1) pre-project site description, 2) implementation, 3) effectiveness, and 4) validation. Pre-project monitoring helps identify the baseline for the project including the identification of deficiencies in ecosystem health and for detecting change over time. Implementation monitoring would determine if the project was constructed according to the design standards. Hydrology, topography and bathymetry, sediment dynamics, and vegetation would be assessed. Effectiveness monitoring would determine if the project was effective in meeting target physical and biological objectives. A range of physical and biological traits would be tracked before and after restoration to assess ecosystem function. Pre-project monitoring is essential for effectiveness monitoring because it establishes an objective baseline of ecosystem function with which to evaluate change caused by project implementation. Finally, validation monitoring would be conducted to substantiate the underlying assumptions of the restoration work and determine if restoration projects, like the Proposed project, recover productive habitat that promotes juvenile salmon salmonid growth and riparian vegetation recruitment. The monitoring efforts described in this plan would improve understanding of restored ecosystem function and the potential of restoring off-channel and floodplain rearing habitat to enhance salmonid populations within streams impacted by dam flow regulation and channel modification. Fish abundance, habitat use, and community composition would be determined at the site of the project and at control sites using field methods described below.

Hydrology and Geomorphology

Evaluating the changes in the Action Area's hydrology and geomorphology will be predominantly done using digital elevation models and 2 dimensional hydraulic models. Data needed to parameterize these models include topography and bathymetry surveys, riverbed substrate composition, and water surface elevations. Collecting these data will require in-water wading by staff to conduct survey work with survey-grade GPS equipment. Wading activities will likely be restricted during low-flow periods in late summer (i.e., July through September) when the presence of juvenile and adult salmonids is minimized due to the timing of their life cycles.

Spawning Surveys

Information on adult Chinook salmon spawning would be provided by ongoing CDFW escapement surveys in the Merced River and additional coordinated surveys by Crammer Fish Sciences (CFS). The CDFW surveys provide information on abundance and distribution of spawning fall-run Chinook salmon throughout the Merced River. The CFS team would conduct more focused redd and spawning surveys within the Action Area, in coordination with CDFW, which would include redd size and depth measurements and ambient conditions. These data would be used to map Chinook salmon spawning density and redd locations within the sampling sites before and after restoration. This information is critical to addressing hypotheses regarding enhanced spawning habitat productivity. Spawning surveys would be conducted every other week during the fall-run Chinook salmon spawning season (mid-October to January). GPS coordinates would be recorded using a GPS unit (Trimble GeoXT) for individual Chinook salmon redds.

Snorkel Surveys

Snorkel surveys would assess juvenile and adult salmonid abundance and use of the enhanced sites. Snorkeling methods would be consistent with other studies (Edmundson et al. 1968, Dolloff et al. 1996, Cavallo et al. 2004, Sellheim et al. 2016). Sample units would consist of transects that are approximately 35 to 75 meters long and distributed throughout the Action Area to capture the available habitat types within the Action Area and at upstream and downstream control locations. Units would be snorkeled by two or three divers moving upstream adjacent to each other for channel margin habitats and downstream for mid-channel habitats. Fish would be observed, identified, and enumerated as divers proceed through each sampling unit. Counts would be compiled for all divers and recorded as a total for each sample unit. Fish would be categorized by species and fork length size classes. Juvenile salmonid snorkel surveys would be conducted monthly from February through May. All surveys would be led by a crew member with training and experience conducting snorkel surveys. To minimize fish disturbance, surveyors attempt to limit fast or sudden movements and wear mud brown colored StreamCount drysuits. During snorkel surveys, two depth and velocity transects would be recorded along each channel margin at one third and two thirds of the unit length to represent conditions within each sample unit. At all locations where individuals or groups of juvenile salmonids are observed to be rearing, GPS coordinates would be taken using a GPS unit and the average water column velocity would be recorded.

Video Surveys

Video surveys would be used to assess habitat use, abundance, and behavior of juvenile salmonids in shallow water habitats such as side channels and channel margins. GoPro waterproof video cameras on a camera mount would be deployed within the Action Area and at unrestored control sites. The GoPro would be set to record for a specific amount of time and would then be retrieved. The recorded video would be reviewed in the lab.

Juvenile Salmonid Seine Sampling

A crew of two to four members would conduct beach seining for juvenile salmonids following the methods of Merz et al. (2015). Typically, three 50-m long seine hauls are performed at each sampling location, and up to 12 locations would be seined. A 4 ft x 50 ft beach seine with 0.125-inch mesh attached to 1 inch x 5 ft wood poles would typically be used; however, seine length and mesh size would vary depending on monitoring objectives and site-specific habitat characteristics. Lead weights would be used along the bottom line of the seine to keep in contact with the bottom, and floats would be attached to the top line to keep it near the waters' surface. Once the lead line approaches the shore it would be withdrawn up the shore so that fish are corralled in the bag of the seine and the lead line is on the shore. Fish from each beach seining haul would be stored in separate buckets filled with river water. Water in the buckets would be monitored to ensure that temperature remains within 2°C of the river water and dissolved oxygen (DO) is above 5 mg/l. Water would be replaced and aerators used, as necessary. Fish would be released at the capture location after all seine passes at the location have been performed and the fish have been processed and have recovered from processing. No seining would occur if water temperatures exceed 18°C. All non-target fish would be identified to species, enumerated, and released. All salmonids with a fork length greater than 50 mm would be anesthetized, measured, and weighed, while salmonids with a fork length less than or equal to 50 mm would only be anesthetized and measured.

Fyke-Net Sampling

Fyke-net sampling would only be performed during periods when the floodplain and/or side channels are inundated during the time period when juvenile salmonids would be present. Therefore, fyke nets would be deployed sometime between February and May. Floodplains are typically only inundated for several days to four weeks during flow events on the Merced River. The fyke net would be "fished" continuously during the period of floodplain/side channel inundation and then removed when the floodplain/side channel was no longer inundated. The fyke-net sampling would be used to test hypotheses related to whether floodplains and side channels provide habitat that is utilized by juvenile salmonids and other native fish, whether salmonids rearing on the floodplain experience measureable growth and whether stomach content is greater in the floodplain relative to the main channel. A 4-ft x 5-ft fyke made of 0.25 inch nylon mesh or a 3-ft x 4-ft fyke made of 0.125 inch nylon mesh, both with 25-ft wings, would be used for trapping. The cod end of the fyke net would be connected to a live box that is 4 ft long, 2.5 ft wide, and 2.5 ft high. A velocity break would be inserted into the live box to ensure that captured fish are not impinged on the back of the live box. The fyke net would be placed in the floodplain spanning an exit channel or in the exit to one of the side channels, and the wings would be extended as necessary by adding additional 0.25 or 0.125 inch nylon mesh to cover the width of the floodplain exit or side channel. The live boxes would be checked at twice a day, typically in the morning and afternoon to process fish in the live boxes and to clean debris from the traps and live boxes. During each trap check, the fyke trap would be cleaned of debris and all fish in the live box would be netted out using aquarium nets and placed in five-gallon buckets of fresh river water. Larger, piscivorous fish would be placed in separate buckets from juvenile salmonids and other smaller fish to prevent predation. Bucket water would be monitored to ensure that temperature remains within 2°C of the river water and DO is above 5 mg/l. Water would be replaced and aerators used, as necessary. All non-target fish would be identified to species, enumerated, and released. All salmonids with a fork length greater than 50 mm would be anesthetized, measured, and weighed, while salmonids with a fork length less than or equal to 50 mm would only be anesthetized and measured. After processing, the fish would be immediately placed in a recovery bucket with a battery powered aerator. Once all fish in the recovery bucket are behaving normally, they would be released immediately downstream of the live box.

1.3.3 Interrelated actions

"Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). There are no interrelated or interdependent activities associated with this project.

2 ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of" a listed species, which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.
This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214).

The designation(s) of critical habitat for CCV steelhead use(s) the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ''destruction or adverse modification'' analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.

- Integrate and synthesize the above factors by: (1) Reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.
- If necessary, suggest a RPA to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

The descriptions of the status of species and conditions of the designated critical habitats in this BO are a synopsis of the detailed information available on NMFS' West Coast Regional website.

The following federally listed species ESUs or DPSs and designated critical habitat occur in the action area and may be affected by the proposed action (Table 1):

Table 1. ESA Listing History

Species Name	ESU or DPS	Current Final Listing Status	Critical Habitat Designated
steelhead (*O. mykiss*)	California Central Valley DPS	1/5/2006 71 FR 834 Threatened	9/2/2005 70 FR 52488

2.2.1 Species Listing and Critical Habitat Designation History for CCV Steelhead

CCV steelhead were originally listed as threatened on March 19, 1998 (63 FR 13347). Following a new status review (Good et al. 2005) and after application of the agency's hatchery listing policy, NMFS reaffirmed the status of CCV steelhead as threatened and also listed the FRFH and Coleman NFH artificial propagation programs as part of the DPS on January 5, 2006 (71 FR 834). In doing so, NMFS applied the DPS policy to the species because the resident and anadromous life forms of steelhead remain "markedly separated" as a consequence of physical, ecological, and behavioral factors, and may therefore warrant delineation as separate DPSs 24 (71 FR 834; January 5, 2006). In May 2016, NMFS completed a 5-year status review of the CCV steelhead DPS. Based upon a review of available information, NMFS (2016) recommended that the CCV steelhead DPS remain classified as a threatened species. However, NMFS (2016) also indicated that the biological status of the DPS has declined since the previous status review in 2011. Their continued low numbers in most hatcheries, domination by hatchery fish, and relatively sparse monitoring makes the continued existence of naturally reproduced steelhead a concern. Due to this declining trend, NMFS (2016) suggests that the DPS is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

On February 16, 2000 (65 FR 7764), NMFS published a final rule designating Critical Habitat for CCV steelhead. This Critical Habitat included all river reaches accessible to CCV steelhead in the Sacramento and San Joaquin rivers and their tributaries in California. NMFS proposed new Critical Habitat for CCV steelhead on December 10, 2004 (69 FR 71880) and published a final rule on September 2, 2005 (70 FR 52488). This Critical Habitat includes the Merced River from the confluence with the lower San Joaquin River upstream to Crocker-Huffman Diversion Dam, as well as the San Joaquin River downstream of the Merced River, and the Delta. Habitat from Crocker Huffman Diversion Dam to the Merced Falls Diversion Dam is not accessible.

2.2.2 Critical Habitat and Physical or Biological Features for CCV Steelhead

Critical habitat for CCV steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba rivers and the Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the San Joaquin River, including its tributaries; and the waterways of the Delta.

Currently, the CCV steelhead DPS and critical habitat extends up the San Joaquin River to the confluence with the Merced River. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent would be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series) (Bain and Stevenson 1999) (70 FR 52488; September 2, 2005). The following subsections describe the status of the Physical or Biological Features (PBFs) of CCV steelhead critical habitat, which are listed in the critical habitat designation (70 FR 52488; September 2, 2005).

Spawning Habitat

The PBFs of CCV steelhead critical habitat include freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, egg incubation, and larval development. Most of the available spawning habitat for steelhead in the Central Valley is located in areas directly downstream of dams due to inaccessibility to historical spawning areas upstream and the fact that dams are typically built at high gradient locations. These reaches are often impacted by the upstream impoundments, particularly over the summer months, when high temperatures can have adverse effects upon salmonids spawning and rearing below the dams (NMFS 2014). Even in degraded reaches, spawning habitat has a high value for the conservation of the species as its function directly affects the spawning success and reproductive potential of listed salmonids.

Freshwater Rearing Habitat

The PBFs of CCV steelhead critical habitat include freshwater rearing sites with 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 woody material (LWM), log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids (NMFS 2014). Some complex, productive habitats with floodplains remain in the system such as the lower Cosumnes River, Sacramento River reaches with setback levees primarily located upstream of the City of Colusa and flood bypasses like the Yolo and Sutter bypasses (Summer et al 2004; Jeffries 2008). However, the 25 channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators (NMFS 2014).

Freshwater rearing habitat also has a high value for the conservation of the species even if the current conditions are significantly degraded from their natural state. Juvenile life stages of salmonids are dependent on the function of this habitat for successful survival and recruitment.

Freshwater Migration Corridors

The PBFs of CCV steelhead critical habitat include freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging LWM aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival. Migratory corridors are downstream of the spawning areas and include the lower mainstems of the Sacramento and San Joaquin rivers and the Delta. These corridors allow the upstream and downstream passage of adults and the emigration of smolts. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (i.e., hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration (NMFS 2014). For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. Stranding of adults has been known to occur in flood bypasses and associated weir structures (Vincik and Johnson 2013), and a number of challenges exist on many tributary streams. For juveniles, unscreened or complex in-river cover have degraded this PBF (NMFS 2014). However, since the primary freshwater migration corridors are used by numerous listed fish populations, and are essential for connecting early rearing habitat with the ocean, even the degraded reaches are considered to have a high intrinsic value for the conservation of the species.

Estuarine Areas

The PBFs for CCV steelhead critical habitat include estuarine areas free of obstruction and excessive predation with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and saltwater; natural cover such as submerged and overhanging LWM, aquatic vegetation, large rocks and boulders, side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation (50 CFR 226.211(c)).

The remaining estuarine habitat for this species is severely degraded by altered hydrologic regimes, poor water quality, reductions in habitat complexity, and competition for food and space with exotic species (NMFS 2014). Regardless of the conditions, the remaining estuarine areas are considered to have a high value for the conservation of the species because they provide features that function to provide predator avoidance, as rearing habitat, and as a transitional zone to the ocean environment.

2.2.3 Life History

Egg to Parr

The entire egg incubation life stage encompasses the time from when adult CCV steelhead spawn through the time when fry emerge from the gravel (CALFED and YCWA 2005). The length of time it takes for eggs to hatch depends mostly on water temperature. CCV steelhead eggs can reportedly survive at water temperature ranges of 35.6°F to 59°F (Myrick and Cech 2001), and have the highest survival rates at water temperature ranges of 44.6°F to 50.0°F (Myrick and Cech 2001). steelhead eggs hatch in 3 to 4 weeks at 50°F (10°C) to 59°F (15°C) (Moyle 2002). Studies conducted at or near 54.0°F report high survival and normal development of CCV steelhead incubating embryos (RMT 2010b). Relatively low mortality of incubating CCV steelhead embryos is reported to occur at 57.2°F, and a sharp decrease in survival has been reported for CCV steelhead embryos incubated above 57.2°F (RMT 2010b). After hatching, alevins remain in the gravel for an additional 2 to 5 weeks while absorbing their yolk sacs and emerge in spring or early summer (Barnhart 1986). A compilation of data from multiple surveys has shown that steelhead prefer a range of substrate sizes between approximately 18 and 35 mm (Kondolf and Wolman 1993). CCV steelhead embryo development requires a constant supply of well oxygenated water. This implies a loose gravel substrate allowing high permeability, with little silt or sand deposition during the development time period. Merz et al. (2004) showed that spawning substrate quality influenced a number of physical parameters affecting egg survival including temperature, DO, and substrate permeability. Coble (1961) noted that a positive correlation exists between dissolved oxygen levels and flow within redd gravel, and Rombough (1988) observed a critical threshold for egg survival between 7.5 and 9.7 mg/L. Fry emerge from the gravel usually about 4 to 6 weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954). Upon emergence, fry inhale air at the stream surface to fill their air bladders, absorb the remains of their yolks in the course of a few days, and start to feed actively, often in schools (Barnhart 1986, NMFS 1996).

The newly emerged juveniles move to shallow, protected areas such as stream margins and low gradient riffles, and forage for zooplankton in open areas, using cobble and gravel as cover (Hartman 1965, Everest et al. 1986, Fontaine 1988, Bradford and Higgins 2001). As steelhead parr increase in size and their swimming abilities improve, they increasingly exhibit a preference for higher velocity and deeper midchannel areas (Hartman 1965, Everest and Chapman 1972, Fontaine 1988). Growth rates have been shown to be variable and are dependent on local habitat conditions and seasonal climate patterns (Hayes et al. 2008).

Productive juvenile rearing habitat is characterized by complexity, primarily in the form of cover, which can be deep pools, woody debris, aquatic vegetation, or boulders. Cover is an important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (Meehan and Bjornn 1991). Optimal water temperatures for growth range from 59°F (15°C) to 68°F (20°C) (McCullough et al. 2001, Spina et al. 2006). Cherry et al. (1975) found preferred temperatures for rainbow trout (*O. mykiss*) ranged from 51.8°F (11°C) to 69.8°F (21°C) depending on acclimation temperatures (Myrick and Joseph J. Cech 2001).

Smolt Migration

Most juvenile steelhead spend 1 to 3 years in fresh water before emigrating to the ocean as smolts (Shapovalov and Taft 1954). During their downstream migration, juvenile CCV steelhead undergo a process referred to as smoltification, which is an adaptive physiological change to allow for movement from fresh to saltwater. Juvenile steelhead will often migrate downstream as parr in the summer or fall of their first year of life, but this is not a true smolt migration (Loch et al. 1988). CCV steelhead successfully smolt at water temperatures in the 43.7°F to 52.3°F range (Myrick and Cech 2001). The optimum water temperature range for successful smoltification in young CCV steelhead has been reported as 44.0°F to 52.3°F (Rich 1987 as cited in NMFS 2009b). Wagner (1974) reported that smolting ceased rather abruptly when water temperatures increased to 57°F to 64°F. NMFS (2009a) reported that water temperatures under 57°F are considered best for smolting. Smolt migrations occur in the late winter through spring, when juveniles have undergone a physiological transformation to survive in the ocean, and become slender in shape, bright silvery in coloration, with no visible parr marks. The primary period of CCV steelhead smolt outmigration from rivers and creeks to the ocean generally occurs from February to April (NMFS 2009b), though emigration appears to be more closely associated with size than age, with 6 in. to 8 in. being most common size range for downstream migrants. In the Sacramento River, juvenile CCV steelhead reportedly migrate to the ocean in spring and early summer at 1 to 3 years of age with peak migration through the Delta in March and April (Reynolds et al. 1993 as cited in NMFS 2014). Hallock et al. (1961) found that juvenile CCV steelhead in the Sacramento River Basin migrate downstream during most months of the year, but the peak emigration period occurred in the spring, with a much smaller peak in the fall (NMFS 2014).

Ocean Behavior

Most CCV steelhead spend 1 to 3 years in the ocean. Smolts arriving to the ocean that are smaller tend to remain in salt water longer than larger smolts (Shapovalov and Taft 1954, Chapman 1958, Behnke 1992). Larger smolts have been found to experience higher ocean survival rates (Ward and Slaney 1988). steelhead grow more rapidly in the ocean than in freshwater rearing habitats (Shapovalov and Taft 1954, Barnhart 1991). Unlike Pacific salmon, steelhead do not appear to form schools in the ocean (Behnke 1992). steelhead in the southern part of their range appear to migrate close to the continental shelf, while more northern populations may migrate throughout the northern Pacific Ocean (Barnhart 1986). It is possible that CCV steelhead may not migrate to the Gulf of Alaska region of the North Pacific as commonly as more northern populations such as those in Washington and British Colombia. Burgner (1993) reported that no coded-wired-tagged steelhead from California hatcheries were recovered from the open ocean surveys or fisheries that were sampled for steelhead between 1980 and 1988. Only a small number of disk-tagged fish from California were captured. This behavior might explain the small average size of CCV steelhead relative to populations in the Pacific Northwest, as food abundance in the nearshore coastal zone may not be as high as in the Gulf of Alaska.

Pearcy et al. (1990) found that the diets of juvenile steelhead caught in coastal waters of Oregon and Washington were highly diverse and included many species of insects, copepods, and amphipods, but by biomass the dominant prey items were small fishes (including rockfish and greenling) and euphausids.

There are no commercial fisheries for steelhead in California, Oregon, or Washington, with the exception of some tribal fisheries in Washington waters.

Spawning

CCV steelhead generally enter freshwater from August to November (with a peak in September) (Hallock et al. 1961), and spawn from December to April (with a peak in January through March) in rivers and streams where cold, well-oxygenated water is available (Hallock et al. 1961, McEwan and Jackson 1996, Williams 2006). The timing of upstream migration is correlated with high flow events, such as freshets, and the associated change in water temperatures (Workman et al. 2002). Adults typically spend a few months in freshwater before spawning (Williams 2006), but very little is known about where they hold between entering freshwater and spawning in rivers and streams.

The female CCV steelhead selects a site with good intergravel flow, digs a redd with her tail, usually in the coarse gravel of the tail of a pool or in a riffle, and deposits eggs while an attendant male fertilizes them (NMFS 2014). Spawning occurs mainly in gravel substrates (i.e., particle size range of about 0.2−4.0 in.). Sand-gravel and gravel-cobble substrates are also used, but these must be highly permeable and contain less than 5 percent sand and silt for the water to be able to provide sufficient oxygen to the incubating eggs. Adults tend to spawn in shallow areas (i.e., 6−24 in. deep) with moderate water velocities (i.e., ~1 to 3.6 ft/s) (Bovee 1978 as cited in McEwan and Jackson 1996, Hannon and Deason 2007 as cited in Reclamation 2008). The optimal temperature range for spawning has been reported to range from 39° to 52°F (Bovee 1978, Reiser and Bjornn 1979, Bell 1986 all as cited in McEwan and Jackson 1996). Egg mortality begins to occur at 56°F (McEwan and Jackson 1996).

Few direct counts of fecundity are available for CCV steelhead populations, but because the number of eggs laid per female is highly correlated with adult size, adult size can be used to estimate fecundity with reasonable precision. Adult steelhead size depends on the duration of and growth rate during their ocean residency (Meehan and Bjornn 1991). CCV steelhead generally return to freshwater after 1 or 2 years at sea (Hallock et al. 1961), and adults typically range in size from 2 to 12 pounds (Reynolds et al. 1993). Steelhead about 55 cm (fork length) long may have fewer than 2,000 eggs, whereas steelhead 85 cm (FL) long can have 5,000 to 10,000 eggs, depending on the stock (Meehan and Bjornn 1991). The average for Coleman NFH since 1999 is about 3,900 eggs per female (USFWS 2011).

Unlike Pacific salmon, steelhead are iteroparous, meaning they are capable of spawning multiple times before death (Busby et al. 1996). However, it is rare for steelhead to spawn more than twice before dying; and repeat spawners tend to be biased towards females (Busby et al. 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby et al. 1996). Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners were relatively numerous (17.2 percent) in Waddell Creek. Null (2013) found between 36 percent and 48 percent of kelts released from Coleman NFH in 2005 and 2006 survived to spawn the following spring, which is in sharp contrast to what Hallock (1989) reported for Coleman NFH in the 1971 season, where only 1.1 percent of adults were fish that had been tagged the previous year. Most populations have never been studied to determine the percentage of repeat spawners. Hatchery steelhead are typically less likely than wild fish to survive to spawn a second time (Leider et al. 1986).

Kelts

Post-spawning steelhead (kelts) may migrate downstream to the ocean immediately after spawning, or they may spend several weeks holding in pools before outmigrating (Shapovalov and Taft 1954). Recent studies have shown that kelts may remain in freshwater for an entire year after spawning (Teo et al. 2011), but that most return to the ocean (Null 2013).

2.2.4 Description of Viable Salmonid Population Parameters

As an approach to determining the conservation status of salmonids, NMFS has developed a framework for identifying attributes of a VSP. The intent of this framework is to provide parties with the ability to assess the effects of management and conservation actions and ensure their actions promote the listed species' survival and recovery. This framework is known as the VSP concept (McElhany et al. 2000). The VSP concept measures population performance in terms of four key parameters: abundance, population growth rate, spatial structure, and diversity.

2.2.4.1 Abundance

Historic CCV steelhead run sizes are difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s, the CCV steelhead run size had declined to about 40,000 adults (McEwan 2001). Hallock et al. (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River upstream of the Feather River. Steelhead counts at the RBDD declined from an average of

11,187 from 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations. Comprehensive steelhead population monitoring has not taken place in the Central Valley since then, despite 100 percent marking of hatchery steelhead smolts since 1998. Efforts are underway to improve this deficiency, and a long-term adult implementation monitoring plan has been formulated (Eilers et al. 2010, Fortier et al. 2014).

There is very little monitoring focused on CCV steelhead; as a result, population trends and status are largely unknown. However, analyses of CCV steelhead abundance across the DPS indicate that naturally reproducing stocks are suffering severe and long-term declines, rangewide, within the San Joaquin River watershed. In the San Joaquin River tributaries, the CCV steelhead populations are very small, with most fish apparently demonstrating the resident phenotype (Zimmerman et al. 2009). Chipps Island trawl data also suggests that natural CCV steelhead production is very low (NMFS 2016). The apparent CCV steelhead population declines have been attributed to longstanding human induced factors that exacerbate the adverse effects of natural environmental variability (NMFS 1996). Important factors in this decline include habitat destruction and degradation of freshwater spawning and rearing habitat, river flow regulation, over-fishing, and the introduction of non-native piscivorous fish species (62 FR 43937). In particular, impassable dams block access to 80 percent of historically available CCV steelhead habitat and block access to all historical CCV steelhead spawning habitat for about 38 percent of historical populations (Lindley et al. 2006).

Current abundance data are limited to returns to hatcheries and redd surveys conducted on a few rivers. The hatchery data are the most reliable, as redd surveys for steelhead are often made difficult by high flows and turbid water usually present during the winter-spring spawning period.

Coleman NFH operates a weir on Battle Creek, where all upstream fish movement is blocked August through February, during the hatchery spawning season. Counts of steelhead captured at and passed above this weir represent one of the better data sources for the CCV DPS. However, changes in hatchery policies and transfer of fish complicate the interpretation of these data. In 2005, per NMFS request, Coleman NFH stopped transferring all adipose-fin clipped steelhead above the weir, resulting in a large decrease in the overall numbers of steelhead above the weir in recent years. In addition, in 2003, Coleman NFH transferred about 1,000 clipped adult steelhead to Keswick Reservoir, and these fish are not included in the data. The result is that the only unbiased time series for Battle Creek is the number of unclipped (wild) steelhead since 2001, which have declined slightly since that time, mostly because of the high returns observed in 2002 and 2003.

Prior to 2002, hatchery- and natural-origin steelhead in Battle Creek were not differentiable, and all steelhead were managed as a single, homogeneous stock, although USFWS believes the majority of returning fish in years prior to 2002 were hatchery-origin. Abundance estimates of natural-origin steelhead in Battle Creek began in 2001. These estimates of steelhead abundance include all CCV steelhead, including resident and anadromous fish.

Steelhead returns to Coleman NFH increased from 2011 to 2014. After hitting a low of only 790 fish in 2010, 2013 and 2014 have averaged 2,895 fish. Since 2003, adults returning to the hatchery have been classified as wild (unclipped) or hatchery-produced (adipose fin clipped). Wild adults counted at the hatchery each year represent a small fraction of overall returns, but their numbers have remained relatively steady, typically 200 to 300 fish each year. Numbers of wild adults returning each year have ranged from 252 to 610 from 2010 to 2014.

Redd counts are conducted in the American River and in Clear Creek (Shasta County). An average of 143 redds have been counted on the American River from 2002 to 2015 (Hannon et al. 2003, Hannon and Deason 2008, Chase 2010). Surveys were not conducted in some years on the American River due to high flows and low visibility. An average of 178 redds have been counted in Clear Creek from 2001 to 2015. The Clear Creek steelhead population appears to have increased in abundance since Saeltzer Dam was removed in 2000, as the number of redds observed in surveys conducted by the USFWS has steadily increased since 2001. The average redd index from 2001 to 2011 is 178, representing a range of approximately 100 to 1,023 spawning adult steelhead on average each year, based on an approximate observed adult-to-redd ratio in Clear Creek (USFWS 2015). The vast majority of these steelhead are wild fish, as no hatchery steelhead are stocked in Clear Creek.

The East Bay Municipal Utilities District (EBMUD) has included steelhead in their redd surveys on the Lower Mokelumne River since the 1999-2000 spawning season, and the overall trend is a slight increase. However, it is generally believed that most of the steelhead spawning in the Mokelumne River are resident fish (Satterthwaite et al. 2010), which are not part of the CCV steelhead DPS. Recent genetic studies have shown that Mokelumne River Hatchery steelhead are now closely related to Feather River Hatchery fish, because these fish are considered to be native Central Valley stock (Pearse and Garza 2015). Thus in the most recent 5-year status review, NMFS recommended that steelhead originating from the Mokelumne River Hatchery be included as part of the CCV steelhead DPS population (NMFS 2016).

The returns of CCV steelhead to the FRFH experienced a sharp decrease from 2003 to 2010, with only 679, 312, and 86 fish returning in 2008, 2009, and 2010, respectively. In recent years, however, returns have experienced an increase with 830, 1,797, and 1,505 fish returning in 2012, 2013, and 2014, respectively. Almost all these fish are hatchery fish, and stocking levels have remained fairly constant, suggesting that smolt and/or ocean survival was poor for age classes that showed poor returns in the late 2000s.

Catches of steelhead at the fish collection facilities in the southern Delta are another source of information on the relative abundance of the CCV steelhead DPS, as well as the proportion of wild steelhead relative to hatchery steelhead (CDFG 2018). The overall catch of steelhead at these facilities has been highly variable since 1993. Variability in catch is likely due to differences in water year types as Delta exports fluctuate. The percentage of unclipped steelhead in salvage has also fluctuated, but has generally declined since 100 percent clipping started in 1998. The number of stocked hatchery steelhead has remained relatively constant overall since 1998, even though the number stocked in any individual hatchery has fluctuated.

The years 2009 and 2010 showed poor returns of steelhead to the FRFH and Coleman NFH, probably due to three consecutive drought years in 2007 to 2009, which would have impacted parr and smolt growth and survival in the rivers, and possibly due to poor coastal upwelling conditions in 2005 and 2006, which strongly impacted fall-run Chinook salmon post-smolt survival (Lindley et al. 2009). Wild (unclipped) adult counts appear not to have decreased as greatly in those same years, based on returns to the hatcheries and redd counts conducted on Clear Creek, and the American and Mokelumne rivers. This may reflect greater fitness of naturally produced steelhead relative to hatchery fish, and certainly merits further study.

Overall, steelhead returns to hatcheries have fluctuated so much from 2001 to 2015 that no clear trend is present, other than the fact that the numbers are still far below those seen in the 1960s and 1970s, and only a tiny fraction of the historical estimate. Returns of natural origin fish are very poorly monitored, but the little data available suggest that the numbers are very small, though perhaps not as variable from year to year as the hatchery returns.

2.2.4.2 Productivity

An estimated 100,000 to 300,000 naturally produced juvenile steelhead are estimated to leave the Central Valley annually, based on rough calculations from sporadic catches in trawl gear (Good et al. 2005). The Mossdale trawls on the San Joaquin River conducted annually by CDFW and USFWS capture steelhead smolts, although usually in very small numbers. These steelhead recoveries, which represent migrants from the Stanislaus, Tuolumne, and Merced rivers, suggest that the productivity of CCV steelhead in these tributaries is very low.

Spatial Structure

About 80 percent of the historical spawning and rearing habitat once used by anadromous steelhead in the Central Valley is now upstream of impassible dams (Lindley et al. 2006). The extent of habitat loss for steelhead most likely was much higher than that for salmon because steelhead were undoubtedly more extensively distributed. Due to their superior jumping ability, the timing of their upstream migration, which coincided with the winter rainy season, and their less restrictive preferences for spawning gravels, steelhead could have utilized at least hundreds of miles of smaller tributaries not accessible to the earlier-spawning salmon (Yoshiyama et al. 1996).

Many historical populations of CCV steelhead are entirely above impassable barriers and may persist as resident or adfluvial rainbow trout, although they are presently not considered part of the DPS. Steelhead were found as far south as the Kings River (and possibly Kern River systems in wet years) (McEwan 2001). Native American groups, such as the Chunut people, have had accounts of steelhead in the Tulare Basin (Latta 1977). Steelhead are well-distributed throughout the Central Valley below the major rim dams (Good et al. 2005, NMFS 2016). Zimmerman et al. (2009) used otolith microchemistry to show that steelhead of anadromous parentage occur in all three major San Joaquin River tributaries, but at low levels, and that these tributaries have a higher percentage of resident steelhead compared to the Sacramento River and its tributaries.

Most of the steelhead populations in the Central Valley have a high hatchery component, including Battle Creek (adults intercepted at the Coleman NFH weir), the American River, Feather River, and Mokelumne River. This is confounded, of course, by the fact that most of the dedicated monitoring programs in the Central Valley occur on rivers that are annually stocked. Clear Creek and Mill Creek are the exceptions.

The low adult returns to the San Joaquin tributaries and the low numbers of juvenile emigrants typically captured suggest that existing populations of CCV steelhead on the Tuolumne, Merced, and lower San Joaquin rivers are severely depressed. The loss of these populations would severely impact CCV steelhead spatial structure and further challenge the viability of the CCV steelhead DPS.

Efforts to provide passage of salmonids over impassable dams have the potential to increase the spatial diversity of Central Valley steelhead populations if the passage programs are implemented for steelhead. In addition, the San Joaquin River Restoration Program (SJRRP) calls for a combination of channel and structural modifications along the San Joaquin River below Friant Dam, releases of water from Friant Dam to the confluence of the Merced River, and the reintroduction of spring-run and fall-run Chinook salmon. If the SJRRP is successful, habitat improved for spring-run Chinook salmon could also benefit CCV steelhead (NMFS 2016).

2.2.4.3 Diversity

Genetic Diversity

The CCV steelhead abundance and growth rates continue to decline, largely the result of a significant reduction in the amount and diversity of habitats available to these populations (Lindley et al. 2006). Recent reductions in population size are also supported by genetic analysis (Nielsen et al. 2003).

Garza and Pearse (2008) analyzed the genetic relationships among CCV steelhead populations and found that unlike the situation in coastal California watersheds, fish below barriers in the Central Valley were often more closely related to below barrier fish from other watersheds than to steelhead above barriers in the same watershed. This pattern suggests the ancestral genetic structure is still relatively intact above barriers, but may have been altered below barriers by stock transfers.

The genetic diversity of CCV steelhead is also compromised by hatchery-origin fish, which likely comprise the majority of the annual spawning runs, placing the natural population at a high risk of extinction (Lindley et al. 2007). There are four hatcheries (Coleman NFH, FRFH, Nimbus Fish Hatchery, and Mokelumne River Fish Hatchery) in the Central Valley which combined release approximately 1.6 million yearling steelhead smolts each year. These programs are intended to mitigate for the loss of steelhead habitat caused by dam construction, but hatchery-origin fish now appear to constitute a major proportion of the total abundance in the DPS. Two of these hatchery stocks (Nimbus and Mokelumne River Hatcheries) originated from outside the DPS (primarily from the Eel and Mad rivers) and are not presently considered part of the DPS. However, during the recent NMFS 5-year status review for CCV steelhead, NMFS recommended including the Mokelumne River Hatchery steelhead population in the CCV steelhead DPS due to the close genetic relationship with FRFH steelhead that are considered part of the native Central Valley stock (NMFS 2016).

Life-history Diversity

Steelhead in the Central Valley historically consisted of both summer-run and winter-run Chinook salmon migratory forms, based on their state of sexual maturity at the time of river entry and the duration of their time in freshwater before spawning. Only winter-run (ocean-maturing) steelhead currently are found in CCV rivers and streams (McEwan and Jackson 1996, Moyle 2002). Summer-run steelhead have been extirpated due to a lack of suitable holding and staging habitat, such as cold water pools in the headwaters of CV streams, presently located above impassible dams (Lindley et al. 2006).

Juvenile steelhead (parr) rear in freshwater for 1 to 3 years before migrating to the ocean as smolts (Moyle 2002). The time that parr spend in freshwater is inversely related to their growth rate, with faster-growing members of a cohort smolting at an earlier age but a smaller size (Seelbach 1993, Peven et al. 1994). Hallock et al. (1961) aged 100 adult steelhead caught in the Sacramento River upstream of the Feather River confluence in 1954 and found that 70 had smolted at age-2, 29 at age-1, and one at age-3. Seventeen of the adults were repeat spawners, with three fish on their third spawning migration, and one on its fifth. Age at first maturity varies among populations. In the Central Valley, most steelhead return to their natal streams as adults at a total age of 2 to 4 years (Hallock et al. 1961, McEwan and Jackson 1996).

2.2.5 Climate Change

One major factor affecting the range-wide status of the threatened and endangered anadromous fish in the Central Valley, and aquatic habitat at large is climate change. Lindley et al. (2007) summarized several studies (Hayhoe et al. 2004; Dettinger et al. 2004; Dettinger 2005; VanRheenen et al. 2004; Knowles and Cayan 2002) on how anthropogenic climate change is expected to alter the Central Valley, and based on these studies, described the possible effects to anadromous salmonids. Climate models for the Central Valley are broadly consistent in that temperatures in the future would warm significantly, total precipitation may decline, the variation in precipitation may substantially increase (i.e., more frequent flood flows and critically dry years), and snowfall would decline significantly (Lindley et al. 2007). Climate change is having, and would continue to have, an impact on salmonids throughout the Pacific Northwest and California (Battin et al. 2007).

Warmer temperatures associated with climate change reduce snowpack and alter the seasonality and volume of seasonal hydrograph patterns (Cohen et al. 2000). Central California has shown trends toward warmer winters since the 1940s (Dettinger and Cayan 1995). An altered seasonality results in runoff events occurring earlier in the year due to a shift in precipitation falling as rain rather than snow (Roos 1991; Dettinger et al. 2004). Specifically, the Sacramento River basin annual runoff amount for April- to July has been decreasing since about 1950 (Roos 1987, 1991). Increased air temperatures influence the timing and magnitude patterns of the hydrograph.

The magnitude of snowpack reductions is subject to annual variability in precipitation and air temperature. The large spring snow water equivalent (SWE) percentage changes, late in the snow season, are due to a variety of factors including reduction in winter precipitation and temperature increases that rapidly melt spring snowpack (VanRheenen et al. 2004). Factors modeled by VanRheenen et al. (2004) show that the melt season shifts to earlier in the year, leading to a large percent reduction of spring SWE (up to 100 percent in shallow snowpack areas). Additionally, an air temperature increase of 3.8°F (2.1°C) is expected to result in a loss of about half of the average April snowpack storage (VanRheenen et al. 2004). The decrease in spring SWE (as a percentage) would be greatest in the region of the Sacramento River watershed, at the north end of the Central Valley, where snowpack is shallower than in the San Joaquin River watersheds to the south. Modeling indicates that stream habitat for cold water species declined with climate warming and remaining habitat suitable may only exist at higher elevations (Null et al. 2013). Climate warming is projected to cause average annual stream temperatures to exceed 24°C (75.2°F) slightly earlier in the spring, but notably later into August and September. The percentage of years that stream temperatures exceeded 24°C (for at least 1 week) is projected to increase, so that if air temperatures rise by 6°C, most Sierra Nevada rivers would exceed 24°C for some weeks every year.

Warming is already affecting CV Chinook salmon. Because the runs are restricted to low elevations as a result of impassable rim dams, if climate warms by 9°F (5°C), it is questionable whether any CV Chinook salmon populations can persist (Williams 2006). Based on an analysis of an ensemble of climate models and emission scenarios and a reference temperature from 1951 to 1980, the most plausible projection for warming over Northern California is 4.5°F (2.5°C) by 2050 and 9°F (5°C) by 2100, with a modest decrease in precipitation (Dettinger 2005). Chinook salmon in the Central Valley are at the southern limit of their range, and warming would shorten the period in which the low elevation habitats used by naturally producing Chinook salmon are thermally acceptable. This should particularly affect fish that emigrate as fingerlings, mainly in May and June, and especially those in the San Joaquin River and its tributaries. Central Valley salmonids are highly vulnerable to drought conditions. The increased in-river water temperature resulting from drought conditions is likely to reduce the availability of suitable holding, spawning, and rearing conditions in Clear Creek and in the Sacramento, Feather, and Yuba rivers. During dry years, the availability of thermally suitable habitats in spring-run Chinook salmon river systems without major storage reservoirs (e.g., Mill, Deer, and Butte creeks) is also likely to be reduced. Multiple dry years in a row could potentially devastate Central Valley salmonids. Prolonged drought due to lower precipitation, shifts in snowmelt runoff, and greater climate extremes could easily render most existing spring-run Chinook salmon habitat unusable, either through temperature increases or lack of adequate flows. The drought that occurred from 2007 to 2009 was likely a factor in the recent widespread decline of all Chinook salmon runs (including spring-run Chinook salmon) in the Central Valley (Williams et al. 2011).

The increase in the occurrence of critically dry years also would be expected to reduce abundance, as, in the Central Valley, low flows during juvenile rearing and outmigration are associated with poor survival (Kjelson and Brandes 1989; Baker and Morhardt 2001; Newman and Rice 2002). In addition to habitat effects, climate change may also impact Central Valley salmonids through ecosystem effects. For example, warmer water temperatures would likely increase the metabolism of predators, reducing the survival of juvenile salmonids (Vigg and Burley 1991). In summary, climate change is expected to exacerbate existing stressors and pose new threats to Central Valley salmonids, including CCV steelhead, by reducing the quantity and quality of inland habitat (Lindley et al. 2007).

Since 2005, there has been a period of widespread decline in all CV Chinook salmon stocks. An analysis by Lindley et al. (2009) that examined fall-run Chinook salmon found that unusual oceanic conditions led to poor growth and survival for juvenile salmon entering the ocean from the Central Valley during the spring of 2005 and 2006 and most likely contributed to low returns in 2008 and 2009. This reduced survival was attributed to weak upwelling, warm sea surface temperatures, low prey densities, and poor feeding conditions in the ocean. When poor ocean conditions are combined with drought conditions in the freshwater environment, the productivity of salmonid populations can be significantly reduced. Although it is unclear how these unusual ocean conditions affected CCV steelhead, it is highly likely they were adversely impacted by a combination of poor ocean conditions and drought (NMFS 2011).

Although CCV steelhead would experience similar effects of climate change to Chinook salmon, as they are also blocked from the vast majority of their historic spawning and rearing habitat, the effects may be even greater in some cases, as juvenile CCV steelhead need to rear in the stream for one to two summers prior to emigrating as smolts. In the Central Valley, summer and fall temperatures below the dams in many streams already exceed the recommended temperatures for optimal growth of juvenile steelhead, which range from 57°F to 66°F (14°C to 19°C). Several studies have found that steelhead require colder water temperatures for spawning and embryo incubation than salmon (McCullough et al. 2001). In fact, McCullough et al. (2001) recommended an optimal incubation temperature at or below 52°F to 55°F (11°C to 13°C). Successful smoltification in steelhead may be impaired by temperatures above 54°F (12°C), as reported in Richter and Kolmes (2005). As stream temperatures warm due to climate change, the growth rates of juvenile steelhead could increase in some systems that are currently relatively cold, but potentially at the expense of decreased survival due to higher metabolic demands and greater presence and activity of predators. Stream temperatures that are currently marginal for spawning and rearing may become too warm to support wild steelhead populations.

In summary, observed and predicted climate change effects are generally detrimental to all of the species addressed in this appendix (McClure 2011; Wade et al. 2013), so unless offset by improvements in other factors, the status of the species and critical habitat is likely to decline over time. The climate change projections referenced above cover the time period between the present and approximately 2100. While there is uncertainty associated with projections, which increase over time, the direction of change is relatively certain (McClure et al. 2013).

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The Action Area for proposed actions that involve instream construction work must include the Proposed Project footprint and the area downstream, where instream construction activities can temporarily decrease water quality. The effects of increased turbidity would attenuate downstream as suspended sediment settles out of the water column. Instream projects with a larger footprint than the Proposed Project have created turbidity plumes of 25-75 nephelometric turbidity units (NTUs) extending up to 1,000 ft (304.8 m) downstream as a result of instream construction activities (NMFS 2006). Therefore, a conservative definition of the Action Area for restoration projects with instream activities includes the project boundary and the segment of river extending from the edge of the project boundary to 1,000 ft (304.8 m) downstream. The Action Area for this Proposed Project includes adjacent biological monitoring control sites, that are located both upstream and downstream of the Proposed Project footprint, to collect baseline information before implementation to enable hypothesis testing following restoration, using a BACI study design (CFS 2018). However, the downstream control site is shared with the Merced River Ranch and Henderson Park Restoration projects and monitoring "take" coverage for CCV steelhead at the downstream control site has been and is currently covered by 4(d). Therefore, the Action Area for the Proposed Project includes the stretch of the Merced River from the upstream control site to the downstream boundary and extending downstream for 1,000 ft. This is the area in which the Proposed Project could result in direct or indirect effects on federally listed species.

Figure 1 shows the Proposed Project and Action Area boundaries.

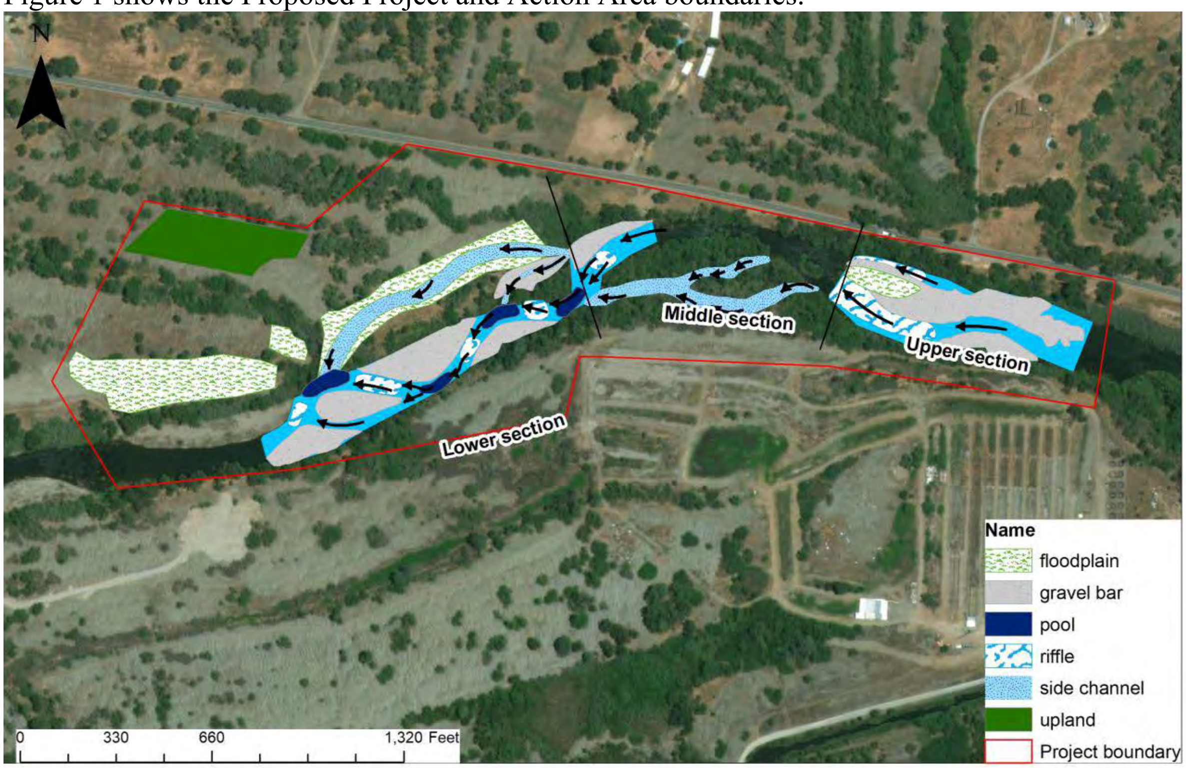

Figure 1. Proposed Project conceptual design with grading for side channels and floodplains and gravel addition areas indicated.

The river corridor in the Action Area is partly confined with a meandering channel. The channel is confined by Merced Falls road along the upstream half of the north bank as well as dredger tailings along both the north and south banks. These channel confinements substantially reduce the amount of floodplain and other off channel features available to be inundated during high flow events. There is a remnant vegetated bar terrace in the middle of the Action Area on the south bank. However, channel incision resulting from flow regulation and reduction in sediment supply has isolated this bar terrace from the channel during commonly occurring flow events. The bar terrace starts to inundate at approximately 2,000 cfs (ESA Associates 2017). The river channel within the Action Area can generally be characterized with three primary sections, separated by a series of bedrock steps at a bend in the river. The average river bed slope is 0.0028, which is slightly steeper than the average bed slope of the downstream river corridor through the town of Snelling. This is due to the bedrock outcrop producing a slope break that controls bed elevations. In the upper section of the Action Area above the bedrock outcrops, the channel is uniform and straight with very little variation in the channel topography. The north bank is confined by Merced Falls Road; south of the road it is vegetated with a narrow band of trees and shrubs. The south bank also has a narrow band of vegetation and is bounded to the south by a tailings pile. The Calaveras Trout Farm (private trout farm) and the Merced River Fish Hatchery (Chinook salmon hatchery operated by the CDFW) are located south of the tailings. The salmon hatchery receives piped water from Crocker Huffman Diversion Dam impoundment and water is diverted from the Crocker Huffman Diversion Dam impoundment to the trout farm via a combination of canals and pipes (Vogel 2007). Bed materials in this area are mostly large cobbles and bedrock, although there is lateral sorting in the channel with finer sediments present near the channel banks. At the very upstream limit there are some gravels in the channel, presumably from CDFW gravel augmentation.

The bedrock exposed middle section of the Action Area is characterized by several river islands and steps in the riverbed profile followed by a narrower channel meander that is adjacent to Merced Falls Road. The channel in this area is very complex with multiple islands and bedrock steps. The overall channel topography slopes to the north in this location, where flow appears to be directed to the north bank. The north bank shows signs of erosion adjacent to Merced Falls Road. The south bank is relatively low relief due to the presence of a large vegetated bar-terrace. Within the terrace there are several side channels adjacent to the main river channel. In the lower most section the channel returns to a uniform state, with little to no variation in the cross sectional or longitudinal profile. Both banks are confined by a narrow band of vegetation and dredger tailings. The lowest section of the Action Area is roughly 1,000 ft long transitions from a river island and bedrock step into a long uniform channel. The upper channel of the river island does not appear to convey much flow, but there are several small (e.g. 5-10') channels that flow to the south. Adjacent to the northern edge of the river island is a river bed step. Downstream of the river island both the river bed and cross section topography are very simple, resulting in homogenous hydraulic conditions. The banks have a 20- 50' wide riparian corridor before transitioning into tailing piles. At the southern boundary of the middle and lower sections is a culvert that appears to provide drainage from the trout hatchery.

2.4 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). CCV steelhead have experienced declines in abundance in the past several decades.

The Merced River is a tributary to the San Joaquin River in the southern portion of the CCV. The river, which drains an approximately 1,273 square mile (mi^2) (3,297 square kilometer [km^2]) watershed, has three forks; main, north and, south, which each originate in the Sierra Nevada mountain range. The north and south forks flow into the main Merced River before it enters Lake McClure. Elevations in the watershed range from 13,000 ft (4,000 m) at the crest of the Sierra Nevada to 50 ft (15 m) at the confluence with the San Joaquin River.

Factors that currently may limit steelhead populations in the lower Merced River include impedance of passage during critical life stages, high water temperatures, and reduced quality and availability of habitat (NOAA Fisheries 1996a). Due in part to the long-term scarcity or absence of *0. mykiss* in the entire San Joaquin Basin (DFG 1993), no distinct steelhead run is thought to inhabit the Merced River, although large adult *0. mykiss* enter Merced River Hatchery from time to time (DFG 1993; Moyle et al. 1996; NOAA Fisheries 1996b). Little or no historic record of escapement is available.

2.4.1 Factors Affecting the Species and Habitat in the Action Area

The Merced River has been affected by a range of human activities, including dam construction for water storage and diversion, land use conversion, introduction of exotic plant and animal species, gold and aggregate mining, and bank protection (Stillwater Sciences 2002). These kinds of modifications are known to change habitat such as water temperature, flow, and availability of spawning and rearing habitat that are critical to CV steelhead (NOAA Fisheries 1996a).

Barriers Water Diversions and Unscreened Diversions

There are four major permanent barriers on the Merced River. New Exchequer Dam (RM 65) was built in 1967 to enlarge a pre-existing dam that was built in the 1926, while McSwain Dam (RM 56) was completed in 1966. These dams were built for irrigation, flood control, and power production. Merced Falls (RM 55) and Crocker-Huffman (RM 52) dams are the two other dams, which are low diversion dams and located below McSwain Dam. Collectively, these dams are known as the Merced River Development Project, owned and operated by Merced Irrigation District, and licensed by the Federal Energy Commission (FERC; Stillwater Sciences 2002). New Exchequer Dam has the capacity to store 1,024.6 thousand acre-feet (T AF) of water. McSwain Dam adds 9.73 TAF of storage, whereas Merced Falls and Crocker-Huffman dam have a capacity of 0.9 TAF and 0.2 TAF, respectively. The existence of dams is one of the major factors contributing to the decline CV steelhead by limiting access to historical habitat (NOAA Fisheries 1996a). Historical accounts suggest that salmon occurred up to an elevation of approximately 2,000 feet near El Portal on the Merced River (Yoshiyama 1999). By 1925, Crocker-Huffman, Merced Falls, and Exchequer dams limited access to upstream salmon and steelhead habitats. Currently, only the reach downstream of Crocker-Huffman Dam is accessible to these species. Crocker-Huffman and Merced Falls dams are equipped with fish ladders to allow upstream passage of adult salmon and steelhead. However, these ladders were shut down when the Merced River Hatchery was constructed and are no longer in use (Stillwater Sciences 2002).

Since most of the Merced River corridor is privately owned below Crocker-Huffman dam, there are several diversion dams owned and operated by Merced ID or riparian water rights diverters, as well as several unaccountable diversions along the river. Many of the diversions are unscreened or inadequately screened. From Crocker-Huffman dam to Shaffer Bridge, there are seven riparian rights small diversions. Downstream of Shaffer Bridge, 238 diversions have been identified, which are typically pumps to supply water for agricultural use (Odenweller 2004; Witts and Raquel 2004). Studies have shown that water diversions reduce survival of emigrating juvenile salmonids through direct losses at unscreened or inadequately screened diversions, and indirect losses resulting from reduced stream flows. Fish losses at diversions can result from physical injury, impingement, entrainment, or predation. Delayed passage, increased stress, and increased vulnerability to predation may contribute to indirect mortality at diversions (NOAA Fisheries 1996a, Odenweller 2004). In one of DFG's pre-screening evaluations of salmonid entrainment on a small riparian diversion on the Merced River near Snelling, DFG found that the existing screen was inadequate to effectively keep fish from being entrained in the diversion canal. DFG captured rainbow trout, Chinook salmon, hardhead (Mylopharodon conocephalus), Sacramento pikeminnow (Ptychocheilus grandis), etc. in the canal during their evaluation (DFG 2002).

Flow

Flow conditions in the Merced River are affected by storage, diversion, and flood control due to the presence of the dams mentioned above. The river is approximately 150 miles in length and drains 1,276 square miles of watershed originating in Yosemite National Park. The Merced River is heavily allocated for agricultural water use from the dams that are owned and controlled by Merced ID. Merced ID diverts an average of 522 TAF of water annually from the mainstem Merced River at Merced Falls Dam and Crocker-Huffman Dam. This represents 52 percent of the average unimpaired discharge from the watershed. Merced ID also is required to release 94 T AF annually from Crocker-Huffman Dam for the Merced River riparian water users (Stillwater Sciences and EDAW 2001).

In addition to flow storage and diversion for agricultural supply, the U.S. Army Corps of Engineers limits flow in the Merced River for flood control. A total of 350 T AF of storage space in New Exchequer Dam reservoir is reserved for flood control between October 31 and March 15, and an additional 50 TAF is reserved for forecasted spring snowmelt between March and May 15. The flood control release rules limit the maximum flow release from the Merced River Development Project to 6,000 cubic feet per second (cfs) as measured at the U.S. Geological Survey (USGS) gauge Merced River at Stevinson, which is located near the confluence with the San Joaquin River (Stillwater Sciences 2002).

Flow regulation and flood control have reduced the frequency and magnitude of 1.5-, 2-, 5-, and 10-year floods in the Merced River by 80 to 84 percent, resulting in changes to geomorphology of the river and habitat downstream of Crocker-Huffman dam. Flows equivalent to the pre-dam channel-forming flow have not occurred since completion of New Exchequer Dam. In addition, flow regulation has shifted the timing of peak flows from spring to winter. This shift from spring peaks to winter peaks likely affects riparian vegetation establishment along the river corridor because native riparian species germinate in spring, and plants germinating in areas inundated in spring are vulnerable to drowning and scour during the following fall and winter. Currently, the distribution of Merced River riparian vegetation downstream of Crocker-Huffman Dam generally is fragmented and narrow compared to historical accounts (Stillwater Sciences 2002). Such conditions have reduced the amount of shaded riverine aquatic habitat available to lower water temperatures in the summer and provide refugia for rearing juvenile CV steelhead. In addition, changes in the magnitude and timing of reservoir releases can influence the timing of steelhead migration. Relatively early attraction of steelhead into tributaries can be triggered by occasional reservoir releases of cold water or the occurrence of high flows early in the fall. Conversely, low flows and higher water temperatures can inhibit or delay migration to spawning areas. Unnatural and/or rapid flow fluctuations downstream of reservoirs can cause dewatering of redds and stranding of juveniles. Because rearing steelhead may be present year-round, suitable flows are necessary throughout the year. In many streams, flows and water temperatures are most critical during the summer. The stream reaches that are presently accessible to steelhead often lack the summer habitat conditions needed to sustain juvenile steelhead through their freshwater rearing period. These unsuitable conditions, which are exacerbated by reservoir operations and water diversions that reduce summer flows, and can be particularly severe in drought years (NOAA Fisheries 1996a, Dennis McEwan, DFG, pers. comm. 2001, 2002).

Water Temperature

Water temperature is a primary factor limiting natural steelhead production in many Central Valley streams. Although cold water releases occur below some dams, the amount and quality of habitat available for steelhead rearing below these dams is a fraction of what was once available. Most of the time cold water releases are not available below many migration barriers, or are only possible when reservoirs are at capacity. Appropriate water temperature regimes below many dams cannot be maintained at levels comparable to temperatures achieved naturally in the 11pper watersheds that once provided habitat (NOAA Fisheries 1996a).

Water Quality

The Merced River has been identified by the Central Valley Regional Water Quality Control Board as impaired due to the usage of agricultural pesticides diazinon, chlorpyrifos, and group A pesticides (i.e., aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor eposide, hexachlorocyclohexane, lindane, endosulfan, and toxaphene. The U.S. Environmental Protection Agency (EPA) considers diazinon and chlorpyrifos to be of a higher priority than Group A pesticides in controlling the usage of these pesticides and improving the water quality in the Merced River (EPA 2000a and 2000b).

Diazinon is applied during the winter rainy season to control woodboring insects in dormant almond orchards (Dubrovsky et al. 1998). Because it is applied during the rainy season, diazinon can be transported to the river by rain and run-off when CV steelhead may be present. Diazinon is moderately mobile and persistent and is highly toxic to birds, mammals, terrestrial insects, freshwater fish, and aquatic insects (EPA 2000a). Studies have have shown that exposure of salmonids to diazinon can result in diminished responsiveness to predators and reduced homing responses (EPA 2000a). The EPA currently is evaluating the need to discontinue and phase out diazinon usage in the United States (EPA 2000a).

Chlorpyrifos is used to protect grain and a variety of orchard and row crops during the March to September inigation season (e.g., to control worms in alfalfa and sugarbeets, and codling moths and twig borers in walnuts and almonds) (Stillwater Sciences 2002). Ecological risk assessment indicates that risks to birds, fish (i.e., salmonids), and mammals are high and risks to aquatic invertebrates are very high (EPA 2000b). Fish and aquatic invertebrate mortality can result from application rates as low as 0.01 pounds/acre. In addition, chlorpyrifos bioaccummulates in the tissues of aquatic organisms and, due to its acute toxicity and persistence in sediments, is hazardous to bottom feeding species (Extoxnet 2001).

Hatchery Operations

The Merced River Hatchery, located below Crocker-Huffman Dam, was built in 1970 by Merced ID with funds provided by the California Department of Water Resources (DWR), and is operated by DFG. This is the only salmon hatchery on the San Joaquin River south of the Delta (DFG 1993). Hatchery production is small relative to the Mokelumne River Hatchery and Feather River Hatchery. Its primary objective is to supplement natural production and help restore and maintain a healthy salmon run that supports sport and commercial fisheries. Revised hatchery production protocols utilize best management practices such as non-selective mating procedures and maintaining genetic diversity by spawning fish over the entire duration of the natural run to ensure expression of full run-time. The Merced River Hatchery produces and provides juvenile salmon for sustaining and supplementing salmon runs on the Merced, Tuolumne, and Stanislaus rivers, as well as providing juvenile salmon for study purposes throughout the San Joaquin basin. Its production success led to the closure of the ladders at the Crocker-Huffman and Merced Falls Dams resulting in more limited access by CV steelhead to their habitat in the upper reaches of the Merced River (Stillwater Sciences 2002).

Spawning Gravels

Spawning success (i.e., egg hatching and fry emergence) is highly dependent on flow, temperature, and dissolved oxygen levels during the development of embryos and growth of the fry (Kondolf and Wolman 1993, Barnard and McBain 1994). Barnhart (1986) noted the existence of gravels with high permeability and few fines (less than five percent sand and silt by weight) in highly productive steelhead spawning streams.

In the Merced River, sediment supply from the upper 81 percent of the watershed is intercepted by New Exchequer Dam. Because the dam intercepts the sediment supply from the upper watershed, erosion of the river bed and banks and input from Dry Creek are currently the only sources of coarse sediment to the river. Dry Creek joins the Merced River at RM 31.7 and is the only major tributary to the river downstream of Crocker-Huffman Dam. Sediment supplied from Dry Creek consists primarily of sand but includes some gravel. The creek enters at an in-channel mining pit, which captures most of the sediment delivered from the Dry Creek watershed. At the same time, bedload stored in the river channel and floodplain downstream of the dams has been removed by gold dredging and aggregate mining. Based on Stillwater Sciences baseline evaluation report, bedload sediment supply from the upper watershed was estimated to be roughly 11 to 21 thousand tons per year between 1926 and 1946. Downstream of the dams, an estimated 7 to 14 million tons of bedload, or 350 to 1,350 times the natural annual bedload supply from the upper watershed, has been removed from the channel by mining. Sediment transport continuity through the Merced River is interrupted by a series of gold dredging and aggregate mining pits. At these pits, channel slope, depth, and width have been modified to the extent that all bedload being transported from upstream reaches is deposited into the pits.

Reaches downstream of the pits are deprived of upstream bedload supply, causing scour of the bed and banks to restore the bedload supply (Stillwater Sciences 2002). This indicates that the Merced River is deprived of sediment/gravel below dams and downstream of instream aggregate mining pits. This lack of bedload supply includes gravels that may be utilized as spawning gravel by CCV steelhead.

2.4.2 Occurrence of Listed Species and Critical Habitat

The number of juvenile CV fall-run Chinook salmon and CCV steelhead observed during pre-project snorkel surveys are shown in Table 2. Juvenile CV fall-run Chinook salmon were captured during 2016 pre-construction seine sampling in the main channel of the Merced River within the Action Area. No juvenile CCV steelhead were captured during 2016 pre-project seine sampling (Table 3). As predicted, juvenile salmonid density within the Proposed Project was relatively low because of its low suitability for juvenile rearing. Enhancing areas within the Action Area by adding gravel and cobble, including areas which already support spawning, is predicted to result in increased spawning utilization and higher quality incubation habitat for salmonids.

Table 2: Total number of juvenile Chinook and steelhead observed during pre-project snorkel surveys within the Action Area from 2011-2016

Year	Months	Number of Surveys	Fall-run Chinook salmon	CCV steelhead
2011	Jun.	2	23	3
2012	Mar.-Jun.	4	384	28
2013	Feb., Apr.	2	1676	151
2014	Feb., Apr., May	3	3145	0
2015	Feb., Apr., May	3	1	0
2016	Feb., Apr., May	3	0	1

Table 3: Total number of juvenile Chinook salmon and steelhead captured during pre-construction seine surveys for the Proposed Project in 2016

Year	Months	Number of Surveys	Fall-run Chinook salmon	CCV steelhead
2016	March	1	26	0

As part of a lower San Joaquin River study as described in Brown (2000), the author collected fish at four locations in the lower Merced River: 1) near Snelling Road Bridge (site RM 45 described by Brown); 2) near McConnell State Park (RM 27.0); 3) near Hagaman County Park (RM 12.2); and 4) at River Road (RM 1.2). Samples were collected by a combination of electrofishing or seining, or fish were observed by snorkeling. Brown collected CCV steelhead only at the Snelling Road Bridge site. From 2006 through 2008, EMRCD and Stillwater Sciences sampled fish in the main stem of the Merced River at 17 sites located from Crocker Huffman Diversion Dam to near the confluence of the Merced River with the San Joaquin River.

Depending on the year, sampling occurred between March and October, and methods included snorkeling surveys, seining, backpack electrofishing, and boat electrofishing. CCV steelhead were found only at the two upper DTR sites within 3.2 mi of Crocker-Huffman Diversion Dam, and none exhibited signs of smolting (M. Ardohain, pers. comm. 2005, as cited in Stillwater Sciences 2008). PG&E conducted a suite of fisheries study above and below Merced Falls Dam as part of relicensing. Sampling occurring above Merced Falls Dam was only within impounded water and lacustrine methodologies (i.e. boat electrofishing and gillnetting) were employed, while downstream sampling was a mixture of both stream and lacustrine sampling methods (i.e. snorkeling and backpack shocking with limited boat electrofishing). Researchers reported that all CCV steelhead captured appeared to be resident and of hatchery origin. Some of the collected fish showed fin scarring and wear from rearing in raceways. In addition, fish scales were collected and reviewed for 25 fish. Growth patterns indicated a stable rate with no indication of rapid increases generally associated with saltwater residency. During its evaluation of rearing habitat in the lower Merced River in 2012 and 2013, Merced ID surveyed by snorkeling 243 sites from Crocker Huffman Diversion Dam to Shaffer Road Bridge. Twenty-seven juvenile CCV steelhead were observed at 9 sites during 2012 and 14 juvenile CCV steelhead were observed at 10 sites during 2013. More than half of the CCV steelhead were observed within 5 mi of Crocker-Huffman Diversion Dam, with only 4 CCV steelhead observed within about 8 mi of the Shaffer Road Bridge. CDFW conducted snorkel surveys within the lower Merced River from April 20 through May 30, 2014, to document the distribution and abundance of CCV steelhead. Water temperature was also monitored. Surveys were part of a plan prepared by CDFW in preparation of a potential rescue of salmonids at risk of exposure to warm water conditions resulting from consecutive critically dry water years, including one of the driest years on record (2014) (Dean Marsten pers. comm.; June 2, 2014). Snorkeling occurred twice each week between Crocker Huffman Diversion Dam and the “G” Street Bridge. Fish count tallies were provided for sequential designated areas (i.e. alpha-numeric riffle units) per CDFW’s salmon spawning distribution maps. The purpose of conducting this monitoring was two-fold: 1) identify where CCV steelhead and salmon occur; and 2) identify the water temperature conditions that exist where the CCV steelhead and salmon are located. During the first 6 weeks of the surveys (through May 29, 2014), CDFW observed as many as 78 CCV steelhead within a survey week. Most observations were in the uppermost 1 RM (44%), with nearly 80% of the observations occurring in the upper 3 RM. Most observed CCV steelhead were larger than 12 in.; less than 4% of the observations were of young-of-the-year CCV steelhead.

Snorkel surveys conducted by CFS from February through June for monitoring associated with the Merced River Ranch and Henderson Park Restoration projects from 2010 to 2016 generally observed the first CCV steelhead fry (fork length ≤ 50 mm) in April. This fry observation timing is similar to the nearby Stanislaus River when the first CCV steelhead fry are typically observed between mid-March and early April (Kennedy and Cannon 2005). By June almost all observed CCV steelhead had fork lengths greater than 50 mm. CCV steelhead observed in the Merced River have ranged in fork length from less than 50 mm to greater than 400 mm. However, the majority of CCV steelhead observed have been less than or equal to 50 mm fork length. Rotary screw traps operated in the lower Merced River between 2007 and 2009 captured no CCV steelhead (Montgomery et al. 2009). A majority of outmigrating CCV steelhead smolts leave the nearby Stanislaus River during the late winter and early spring. Based on recoveries of CCV steelhead in the Caswell and Oakdale rotary screw traps, approximately 70% of CCV steelhead smolts have exited the Stanislaus River by the end of March (NMFS 2014). Recent genetic analysis of CCV steelhead in the lower Merced River suggests that the population is largely comprised of a resident CCV steelhead hatchery strain (Pearse and Garza 2015). In general, the quality and quantity of salmonid spawning habitat throughout the lower Merced River, including within the Action Area, has been degraded by anthropogenic impacts (NMFS 2014). The Merced River below Crocker Huffman Dam to the confluence with the San Joaquin River has low channel complexity and is lacking in floodplains and side channels that inundate regularly, resulting in limited juvenile salmonid rearing habitat (NMFS 2014). Many of the juvenile Chinook salmon and CCV steelhead rearing within the Merced River are observed holding in association with submerged vegetation and woody material. Juvenile CCV steelhead which are older than 1 year are observed holding in deeper riffles or runs with substrate consisting of a combination of gravel, cobble, and boulders/bedrock. Various types of fish cover are present within the Action Area, including submerged terrestrial vegetation and roots, instream woody material, bedrock, and overhead cover provided by lowgrowing riparian vegetation. Some locations support aquatic macrophytes that also provide cover for fish.

The physical or biological features (PBFs) of CCV steelhead Critical Habitat present in the Action Area are freshwater rearing habitat, spawning habitat, and freshwater migration corridors. As described above, the Merced River has been converted from a multi-channel system to a single, incised and constricted channel. Features such as floodplains and other off-channel salmonid rearing habitat within the Action Area only function at high flows (2,000 cfs or greater). Instream habitats and adjacent riparian/floodplain areas within the Merced River downstream of Crocker Huffman Diversion Dam have been modified or converted for uses such as agriculture, rural residential, gravel and gold mining. These major actions and other events have led to the deterioration of riparian and aquatic habitat conditions for salmonids. The Merced River is lacking in floodplain areas that inundate regularly and in channel complexity, which has resulted in very limited juvenile salmonid rearing habitat (NMFS 2014). The cover that is present includes: submerged terrestrial vegetation and roots, aquatic macrophytes, instream woody material, and overhead cover provided by low-growing riparian vegetation. Despite the anthropogenic impacts that have reduced the quality and quantity of juvenile salmonid rearing habitat in the Merced River, a limited number of CCV steelhead juveniles have been observed rearing during snorkel surveys within the Action Area.

Spawning habitat for CCV steelhead is likely present within the Action Area. However, CCV steelhead have not been observed spawning within the Action Area. CV fall-run Chinook salmon spawning has been observed within the Action Area and there is overlap in their preferred spawning habitat characteristics (Zeug et al. 2014a). Gravel augmentation is expected to improve the quality and quantity of CCV steelhead spawning habitat within the Action Area. The Merced River within the Action Area could be used as a migration corridor for adult and juvenile CCV steelhead.

2.5 Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

The following is an analysis of the potential direct and indirect effects to listed fish species that may occur as a result of implementing the proposed action in the Merced River. For our analysis on the effects of the proposed action to listed species, we have used the presence of species in the action area to determine the risk each the species and life stage may face if exposed to project impacts. The effects of the proposed action components that were analyzed include: (1) sediment and turbidity, (2) contaminants, (3) noise exposure, (4) habitat modification, and (5) monitoring activities.

Our assessment considers the nature, duration, and extent of the proposed actions relative to the spawning, rearing, and migration timing, behavior, and habitat requirements of all life stages of federally listed fish in the action area. Effects of the restoration project on aquatic resources include direct and indirect effects. When the project is complete, the Proposed Project would provide long-term beneficial impacts to the listed species and critical habitat. Potential impacts from specific monitoring actions related to each restoration activity are also described below.

2.5.1 Construction Activities

NMFS expects that rearing juvenile CCV steelhead may be present in the action area during in-water construction activities (July 15 to October 15), potentially exposing juvenile steelhead to construction related adverse impacts such as increased sedimentation and turbidity, release of contaminants from construction equipment, increased noise and disturbance and modification of habitat.

Impacts to adult migration and spawning, egg incubation, and emergence would be avoided because construction activities would occur outside of the timing of those life stages. Therefore, no adverse effects to those life stages are expected during construction activities.

Sediment and Turbidity

Construction activities related to restoration actions would temporarily disturb soil and riverbed sediments as well as riparian vegetation, resulting in the potential for temporary increases in turbidity and suspended sediments in the Merced River within the Action Area. Restoration-related increases in sedimentation and siltation above the background level could potentially affect fish species and their habitat.

High concentrations of suspended sediment can have both direct and indirect effects on salmonids. The severity of these effects depends on the sediment concentration, duration of exposure, and sensitivity of the affected life stage. Based on the types and duration of proposed in-water construction methods, short-term increases in turbidity and suspended sediment may disrupt feeding activities or result in avoidance or displacement of fish from preferred habitat. Juvenile salmonids have been observed to avoid streams that are chronically turbid (Lloyd 1987) or move laterally or downstream to avoid turbidity plumes (Sigler et al. 1984). Bisson and Bilby (1982) reported that juvenile Coho Salmon (*Oncorhynchus kisutch*) avoid turbidities exceeding 70 NTUs. Sigler et al. (1984) found that prolonged exposure to turbidities between 25 and 50 NTUs resulted in reduced growth and increased emigration rates of juvenile Coho Salmon and steelhead compared to controls. These findings are generally attributed to reductions in the ability of salmon to see and capture prey in turbid water (Waters 1995). Chronic exposure to high turbidity and suspended sediment may also affect growth and survival by impairing respiratory function, reducing tolerance to disease and contaminants, and causing physiological stress (Waters 1995). Berg and Northcote (1985) observed changes in social and foraging behavior and increased gill flaring (an indicator of stress) in juvenile Coho Salmon at moderate turbidity (30-60 NTU). In this study, behavior returned to normal quickly after turbidity was reduced to lower levels (0-20 NTU). In addition to direct behavioral and physical effects on fish, increased sedimentation can alter downstream substrate conditions, as suspended sediment settles and increases the proportion of fine particles in the system. Adult salmonids require coarse substrate (gravel and small cobbles) to construct redds, and deposition of fine substrate may reduce egg and alevin survival and lead to decreased production of the macroinvertebrate prey of juvenile salmonids (Wu 2000, Chapman 1988, Phillips et al. 1975, Colas et al. 2013). Deposited fine sediment can impair growth and survival of juvenile salmonids (Suttle et al. 2004, Harvey et al. 2009). However, minor accumulations of deposited sediment downstream of construction are generally removed during normal annual high flow events (Anderson et al. 1996).

Impacts to CCV steelhead would be minimized by conducting all in-water restoration activities during the dry season between July 15 and October 15. Weekly redd surveys would be performed within the Action Area and in-water restoration work would cease immediately for the remainder of the season if evidence of salmon spawning is observed. The number of juvenile salmonids potentially residing in the Action Area during in-water restoration is expected to be very low because of the time of year and low quality of existing habitat. Individual fish that encounter increased turbidity or sediment concentrations would be expected to move laterally, downstream, or upstream of the affected areas. For juveniles, this may increase their exposure to predators if they are forced to leave protective habitat. Turbidity plumes would be expected to affect only a portion of the channel width and extend up to 1,000 ft downstream of the Action Area. Turbidity would be monitored in accordance with the Section 401 Water Quality Certification for the Proposed Project, and if turbidity exceeds the thresholds identified in the certification, work would cease until levels return to background levels.

The Proposed Project may have direct effects on rearing CCV steelhead by reducing water quality during project construction. Impacts to rearing CCV steelhead would be minimized by the water quality conservation measures. In addition, juvenile steelhead are highly mobile and would likely avoid the Proposed Project impacts by swimming away and rearing in highly suitable habitats of the river. Because water quality impacts are temporary and short in duration, in addition to their highly mobile behavior, adverse direct and indirect effects of sediment and turbidity on CCV steelhead would be avoided or minimized to the extent that the effects would be insignificant and not likely to reach a level that causes injury or death.

Contaminants

During restoration activities, the potential exists for spills or leakage of toxic substances that could enter the Merced River. Refueling, operation, and storage of construction equipment and materials could result in accidental spills of pollutants (e.g., fuels, lubricants, sealants, and oil).

High concentrations of contaminants can cause direct (sub-lethal to lethal) and indirect effects on fish. Direct effects include mortality from exposure or increased susceptibility to disease that reduces the overall health and survival of the exposed fish. The severity of these effects depends on the contaminant, the concentration, duration of exposure, and sensitivity of the affected life stage. A potential indirect effect of contamination is reduced prey availability; invertebrate prey survival could be reduced following exposure, therefore making food less available for fish. Fish consuming infected prey may also absorb toxins directly. For salmonids, potential direct and indirect effects of reduced water quality during construction would be addressed by avoiding construction during times when salmonids are most likely to be present, utilization of vegetable-based lubricants and hydraulic fluids in equipment operated in the wet channel, and a Spill Prevention and Response Plan to avoid, and if necessary, clean up accidental releases of hazardous materials. Implementation of conservation measures would minimize adverse effects to juvenile CCV steelhead such that impacts would be discountable and would not likely to reach a level that causes injury or death.

Noise Exposure

Noise generated by heavy equipment and personnel during restoration activities could adversely affect fish and other aquatic organisms. The potential direct effects of underwater noise on fish and other organisms depend on a number of biological characteristics (e.g., fish size, hearing sensitivity, behavior) and the physical characteristics of the sound (e.g., frequency, intensity, duration) to which fish and invertebrates are exposed. Potential direct effects include behavioral effects, physiological stress, physical injury (including hearing loss), and mortality. The loudest noise generated at the Action Area is expected from the sediment sorting equipment. This equipment would not come in contact with aquatic habitat. Diesel engines are the second greatest noise expected at the Action Area. No diesel engines or their exhaust systems would come in contact with the flowing channel. No indirect effects are anticipated as a result of construction noise.

Exposure of adult and juvenile salmonids to noise and disturbance would be minimized by conducting all instream activities during a single construction season between July 15 and October 15 when minimal numbers of adult and juvenile Chinook salmon and CCV steelhead are likely to be present in the Action Area.

Noise and disturbance would be limited to the immediate Action Area and, at any given time, the area immediately surrounding the restoration activity. Once construction is underway, individual fish approaching the Action Area from upstream or downstream are likely to detect the sounds/vibrations and avoid the Action Area.

By avoiding contact with flowing water from the sediment transport equipment and diesel engines that could generate noise, along with restricting the time period during which restoration activities would occur, the potential noise impacts would be minimized such that the impacts would be insignificant to CCV steelhead and not likely to reach a level that causes injury or death.

2.5.2 Habitat Modification

Restoration activities would result in the disturbance of an estimated 2.33 acres of perched floodplain habitat. Approximately 65,000 cubic yards (yd3) of material would be excavated during floodplain lowering and side channel creation. Gravel would be deposited in-stream and placed by rubber-tired front-end loaders (Caterpillar 950 Loader). Creation of side channels and minor drainage channels would modify bank habitat; however, islands of native plants and trees would be preserved within the restoration area. Wetland areas on site would not be impacted or reduced in size, but minor channels would be created downstream to allow drainage at high flows. Habitat restoration would cause short-term adverse impacts and long-term beneficial impacts to steelhead.

Gravel and cobble placement in the main channel to create bar features, enhance salmonid spawning habitat, and increase water surface elevation to facilitate inundation of the side channel would alter channel habitat. Channel habitat would be temporarily disturbed when side channel connections with the main channel are created and may result in a short-term decrease in natural cover for salmonids. Side channel and floodplain excavation would change the hydrodynamics of the channel to provide more complex habitat in the Action Area. The amount of shallow water edge habitat used by rearing juvenile salmonids would increase along with frequency of floodplain and side channel inundation.

Bar feature creation and spawning gravel augmentation in the main channel has the potential to impact juvenile salmonids through disturbance and displacement. Cobble and gravel addition to the main channel would occur during a time period (July 15 to October 15), when few juvenile and adult salmonids are present within the Action Area. Gravel augmentation would temporarily impact CV fall-run Chinook salmon spawning riffles. However, gravel augmentation would occur before the spawning season and would increase the quality and quantity of spawning habitat within the Action Area. Juvenile CCV steelhead that may be present in locations where gravel and cobble addition would occur are expected to be able to avoid and temporarily or permanently relocate away from the area. Juvenile CCV steelhead are highly mobile and will rapidly move away from an area when they are disturbed. When heavy equipment enters the river to place gravel, fish in the vicinity are expected to be spooked and move rapidly away from the area of disturbance and thus avoid being injured or killed through crushing by the vehicle or gravel placement. Fish that are spooked are likely to endure short-term stress from being forced to migrate away from their current holding/rearing area and needing to temporarily or permanently locate a new holding/rearing location. When gravel is being repeatedly added to an area, then fish are likely to temporarily or permanently relocate from the area. Juvenile fish may be subject to increased predation risk while they are locating a new holding/rearing area. Displaced juvenile fish are likely to find a new holding/rearing location that is suitable as juvenile fish density, particularly CCV steelhead, in the Merced River within the Action Area has been observed to be low (CFS 2018). During creation and/or enhancement of spawning habitat that would also serve as juvenile salmonid rearing habitat (see Sellheim *et al.* 2016), juvenile salmonids are likely to avoid the construction area during the day and return to the new habitat when construction activities have ceased for the day to use the habitat over the night until construction starts again the next day. Juvenile salmonids feeding has been observed immediately downstream of gravel placement activity and returning to placement sites immediately after equipment activity has ceased. Relatively few juvenile salmonids are expected to be impacted by instream restoration activities as juvenile salmonid density has been observed to be low in the Merced River within the Action Area, particularly during the summer. The temporary displacement of fish and the stress they have to endure is not expected to affect the survival chances of individual fish based on the size of the area that would likely be affected and the small number of juvenile CCV steelhead likely to be displaced.

Instream restoration activities are expected to cause benthic aquatic macroinvertebrates to be killed, displaced, or their abundance reduced when they are covered with coarse sediment added to the channel to enhance salmonid spawning habitat. However, effects to aquatic macroinvertebrates from displacement and sediment smothering would be temporary because restoration activities would be relatively short lived and rapid recolonization (about one to two months) of the new sediment is expected (Merz and Chan 2005). The benthic macroinvertebrate production within the Action Area is expected to increase when construction is complete as there would be an increase in area of perennial riffle habitat. The amount of food available for juvenile salmonids and other native fishes is therefore expected to increase.

To the maximum extent practicable, existing riparian habitat would be retained and disturbance of riparian habitat would be minimized. All large gallery trees present in the site would be retained. However, riparian vegetation that cannot be avoided would be replanted as stated in the project description.

Following restoration activities, all disturbed or exposed soils would be stabilized and planted with native woody and herbaceous vegetation to control erosion and offset any unavoidable losses of vegetation. Non-native plant species would be replaced with native riparian plants. Some short-term losses of mature riparian vegetation may occur during restoration which may result in a short term reduction in natural cover for salmonids. However, plantings and natural riparian vegetation recruitment would establish and mature following project completion thereby resulting in an increase in the amount and extent of riparian habitat within the Project area.

Overall, completion of the project is expected to have beneficial impacts by increasing the quality and quantity of spawning and rearing habitat for CV fall-run Chinook salmon and CCV steelhead. Existing low-lying areas associated with relict side channel and floodplain topography would be enhanced to activate more frequently and at depths and velocities more appropriate for rearing salmonids. Creation of side channel habitat and enhancement of existing riffles would improve and increase area of spawning and rearing habitat for salmonids. Imported coarse material would be used to enhance in-channel features for spawning, incubation, and rearing habitat. Although some short-term disturbance may occur when coarse sediment is placed into the river channel to improve spawning, incubation, and rearing habitat, these effects would be minimized through implementation of the salmonid protection measures described above.

Disturbance to benthic macroinvertebrates would be temporary as they would rapidly colonize the newly added substrate. Riparian vegetation, including native trees and plants, would be retained and managed to maintain the vital ecological roles it currently provides within the community. Due to the timing of construction activities and mitigation measures that would be implemented, potential impacts from habitat modifications would be insignificant to CCV steelhead and not likely to reach a level that causes injury or mortality of CCV steelhead. Lastly, there would be long-term beneficial impacts from the Proposed Project for all life stages of CCV steelhead.

2.5.3 Monitoring Activities

The long-term monitoring efforts accompanying the Proposed Project's aim to measure changes in the Action Area's hydrology, geomorphology, and river ecosystem as it relates to CCV steelhead and CV fall-run Chinook salmon life cycles (CFS 2017).

Hydrology and Geomorphology

Collecting data on hydrology and geomorphological changes would require in-water wading by staff to conduct survey work with survey-grade GPS equipment. Wading activities would likely be restricted during low-flow periods in late summer (i.e., July through September) when the presence of juvenile and adult salmonids is minimized due to the timing of their life cycles. Alterations to the riverbed topography and substrate from wading are trivial, and wading is generally considered a low-level and short-term disturbance to juvenile and adult salmonids. If juvenile or adult salmonids are observed during survey work then all effort would be made to avoid disturbing them by not wading or surveying in their vicinity. Therefore, impacts to juvenile and adult CCV steelhead are considered to be discountable.

Stream Temperature

Changes in stream temperature would be evaluated during and after the Proposed Project is implemented. These evaluations would require the installation of water temperature recorders within the Action Area. Installation of these temperature recorders may require minimal wading. However, the installation of the water temperature recorders would be in locations and at times of the year when presence of juvenile or adult salmonids is minimized. The installation and presence of these recorders would not have measureable biological impacts to the Action Area and impacts to CCV steelhead individuals would be discountable.

Juvenile Salmonid Prey Base

Changes to juvenile salmonid prey-base would be assessed before and after implementation. These assessments would require sampling of macroinvertebrates present in the drift and benthos. Sampling efforts may require minor disturbance of benthic substrate through wading and to dislodge macroinvertebrates. The total area of benthic substrate disturbed during sampling (using a Hess sampler) is small (< 10 ft2 [0.93 m^2]) and time spent wading is short-term (minutes). Care would be taken to avoid areas being used by salmonids (e.g., active redds). Juvenile salmonids can easily avoid staff and equipment associated with these sampling activities. Juvenile and adult salmonids that are spooked away from their holding/rearing area during invertebrate sampling would return to the area when the disturbance from sampling has ceased. If juvenile or adult salmonids are observed during macroinvertebrate sampling, effort would be made to avoid disturbing them by not sampling or wading in their vicinity. Biological impacts from macroinvertebrate sampling are considered temporary and minor and therefore insignificant to juvenile and adult CCV steelhead.

Salmonid Snorkel and Video Surveys

Snorkel surveys would require survey staff to observe and enumerate rearing juvenile salmonids within the Action Area and record the GPS coordinates and depth and velocity in the locations in which juvenile salmonids are observed. Snorkel surveys would require a day to complete and would typically be performed monthly from February through May, the time period when rearing juvenile salmonids are present. If present in the system, adult CCV steelhead may be observed during juvenile salmonid snorkel surveys during February through April, as these months overlap with the migration, holding, and spawning of CCV steelhead in the Merced River. Effort would be made to avoid actively spawning adult CCV steelhead during snorkel surveys by not wading or surveying in their vicinity. The presence of individuals conducting the snorkel surveys would have short-term impacts on fish behavior and habitat use. Performing snorkel surveys is likely to result in "take" of CCV steelhead through observation and harassment, if they are present.

Two types of video surveys would be used, shallow water and deep pool. Both survey types would take a day to complete, with shallow water video occurring up to monthly from February to May and deep pool video up to twice a year. During shallow water video, disturbing adult CCV steelhead would be avoided by not placing the cameras or wading in the vicinity of where actively spawning or holding adult CCV steelhead are observed. Juvenile and adult CCV steelhead may be observed during deep pool video surveys and the presence of the camera and boat may have short-term impacts on fish behavior and habitat use.

Direct observation is the least disruptive method for determining a species' presence/absence and estimating their relative abundance. Its effects are also generally the shortest-lived and least harmful of the research activities discussed in this section. A cautious observer can effectively obtain data while only slightly disrupting the fishes' behavior. Juvenile salmonids frightened by the turbulence and sound created by observers, are likely to seek temporary refuge in deeper water, behind or under rocks, or riparian vegetation. In extreme cases, some individuals may leave a particular pool or habitat type and then return when observers leave the area. At times, the research involves observing adult fish—which are more sensitive to disturbance. During some of the research activities, redds may be visually inspected, but would easily avoid trampling redds. Harassment is the primary form of take associated with these observation activities, and few if any injuries (and no deaths) are expected to occur. Because these effects are so small, there is little a researcher can do to mitigate them except to avoid disturbing sediments, gravel, and, to the maximum extent possible, the individual fish themselves, and allow any disturbed fish the time they need to reach cover. Performing video surveys is likely to result in take of CCV steelhead through observation and harassment, if they are present.

Juvenile Salmonid Seine and Fyke-Net Sampling

Monitoring juvenile salmonid habitat use within the main channel, side-channel, and floodplain in the Action Area may require seine sampling. Seine sampling may occur monthly from February through May. Seine sampling would be used when water turbidity (i.e. visibility) precludes snorkel surveys. Seining would require wading by individuals operating the seine net and the net would possibly agitate stream bottom substrate where it is deployed. Negative effects of seining include, small fish can be gilled in the mesh of a seine, scales and dermal mucus can be abraded by contacting the net, fish can be suffocated if they are not quickly removed from the net after the net is removed from the water to process the fish, and the fish can be crushed by the handler when removing the net from the water.

The fyke-net sampling would be used to determine if juvenile salmonids are using and benefitting from the floodplain and side channel areas that were rehabilitated as part of the Proposed Project. The fyke-nets would be checked twice a day to process fish in the live boxes and to clean debris from the traps and live boxes. Use of these nets can cause abrasion to fish from shaking fish down into the end prior to removal. Furthermore, these nets can result in mortality when small fish are gilled in the mesh of the nets. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared regularly.

Captured fish would be held in cool, oxygenated freshwater and anesthetized prior to any handling. Captured juvenile CV fall-run Chinook salmon and CCV steelhead would be weighed and measured and then placed in an aerated recovery bucket. Once fish in the recovery buckets are behaving normally then the fish would be returned to a proper release location within the area from which they were captured.

Any physical handling is known to be stressful to fish (Sharpe et al. 1998). The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the river and wherever the fish are held in buckets/live boxes), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18º Celsius or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps if the traps are not emptied regularly. Decreased survival of fish can result when stress levels are high because stress can be immediately debilitating and may also increase the potential for vulnerability to subsequent challenges (Sharpe et al. 1998). The Proposed Project contains measures that mitigate the factors that commonly lead to stress and trauma from handling, and thus minimize the harmful effects of capturing and handling fish. When these measures are followed, fish typically recover fairly rapidly from handling.

Seine and fyke sampling is expected to result in the take of CCV steelhead through capture and handling, if present in the system. However, no CCV steelhead were captured during pre-project seine sampling surveys performed within the Action Area in March 2016. If fish mortality occurs during seining or fyke-net sampling, then the sampling would cease immediately and NMFS would be contacted. Sampling would only be performed again with the approval of NMFS.

2.5.4 Effects on Critical Habitat

The proposed restoration project is expected to cause direct short and long-term effects on critical habitat for CCV steelhead. The project is expected to temporarily cause adverse impacts to several PBFs of critical habitat for CCV steelhead. Potential project effects include temporary water quality degradation from localized increases in turbidity and suspended sediment, temporary disturbance to spawning riffles during gravel augmentation, temporary channel disturbance during connection of side channels to the main channel, short-term reduction of natural cover resulting from channel and riparian disturbance, and potential discharges of contaminants in the Merced River during restoration activities. The effects of these short-term impacts would be mitigated by the measures discussed above.

Long-term direct effects on designated critical habitat would be beneficial, including: increased channel complexity, reduced sedimentation and turbidity, increased side channel, floodplain, incubation, and spawning habitat, and improved riparian vegetation quality.

Project modifications would result in a beneficial change to freshwater incubation, rearing, and spawning PBFs because of the existing low quality rearing and spawning habitat in the action area and the increased quality and quantity of the restored habitat. The action area would also continue to function as a freshwater migration corridor by providing adequate passage for adult and juvenile salmonids. Therefore, the Proposed Project would have long-term benefits to critical habitat.

2.6 Cumulative Effects

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

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the Action Area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the status of the species (Section 2.2).

Agricultural Practices

Agricultural practices in the action area may adversely affect riparian habitats through upland modifications of the watershed that lead to increased siltation, reductions in water flow, or agricultural run-off. Grazing activities from cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which can flow into the receiving waters of the associated watersheds. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may adversely affect listed salmonids reproductive success and survival rates (Dubrovsky 1998, Daughton 2002).

Increased Urbanization

Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. Increased growth would place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those which are situated away from waterbodies, would not require Federal permits, and thus would not undergo review through the ESA section 7 consultation process with NMFS. Increased urbanization also is expected to result in increased recreational activities in the region. Among the activities expected to increase in volume and frequency is recreational boating. Boating activities typically result in increased wave action and propeller wash in waterways.

This potentially would degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially re-suspending contaminated sediments and degrading areas of submerged vegetation. This in turn would reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids and green sturgeon moving through the system. Increased recreational boat operation is anticipated to result in more contamination from the operation of gasoline and diesel powered engines on watercraft entering the associated water bodies.

Rock Revetment and Levee Repair Projects

Depending on the scope of the action, some non-federal riprap projects carried out by state or local agencies do not require federal permits. These types of actions and illegal placement of riprap occur within the watershed. The effects of such actions result in continued degradation, simplification and fragmentation of riparian and freshwater habitat.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the Proposed Project. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the Proposed Project is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) Appreciably diminishes the value of designated or proposed critical habitat for the conservation of the species.

Status of the CCV Steelhead DPS

The Status of Species and Environmental Baseline sections show that past and present impacts to the San Joaquin River basin have caused significant salmonid habitat loss, fragmentation and degradation. This has significantly reduced the quality and quantity of freshwater rearing sites and the migratory corridors within the lower valley floor reaches of the San Joaquin River and the south Delta for these listed species. Additional loss of freshwater spawning sites, rearing sites, and migratory corridors have also occurred upstream of the south Delta in the upper main stem and tributaries of the San Joaquin River. The 2016 status review (NMFS 2016) concluded that overall, the status of CCV steelhead appears to have changed little since the 2011 status review when the Technical Recovery Team concluded that the DPS was in danger of extinction. Further, there is still a general lack of data on the status of wild steelhead populations. There are some encouraging signs, as several hatcheries in the Central Valley (such as Mokelumne River), have experienced increased returns of steelhead over the last few years. There has also been a slight increase in the percentage of wild steelhead in salvage at the south Delta fish facilities, and the percent of wild fish in those data remains much higher than at Chipps Island. Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show an overall very low abundance, and fluctuating return rates.

Status of the Environmental Baseline and Cumulative Effects in the action area

CCV steelhead use the action area as a spawning, rearing, egg incubation, and migratory corridor. Within the action area, the essential features of freshwater spawning, egg incubation, rearing and migration habitats for steelhead have degraded over time due to agriculture, rural residential, gravel and gold mining, water impoundments, increased water diversions, decreased instream flows, and levees. The construction of New Exchequer Dam and gold mining has resulted in an essentially static channel in the lower river reach accessible to anadromous salmonids. The change in ecosystem as a result of halting the lateral migration of the river channel, the loss of floodplains, the removal of riparian vegetation, loss of gravel and instream woody material have likely affected the functional ecological processes that are essential for growth and survival of CCV steelhead in the action area.

Summary of Project Effects on CCV Steelhead

<u>Construction-related Effects</u>

During construction, some injury or death to individual fish is possible to result from placement of the gravel, or predation related to displacement of individuals away from the shoreline or at the margins or turbidity plumes. These construction type actions would occur during the summer and early fall months, when the abundance of individual steelhead is low and avoids adult and incubation periods, which would result in correspondingly low likelihood of injury or death. Alignment of a new channel is likely to result in increased turbidity, although this effect would be temporary in nature. These construction effects may result in injury or death to salmonids due to physiological damage from avoidance activity, reduced foraging capability, and increased predation related to displacement of individuals away from the shoreline or at the margins or turbidity plumes. Depending on the life stage of the listed species, impacts from increased turbidity would vary. Juvenile and adult salmonids would have adjacent suitable habitat to temporarily move to if needed. Incubating eggs would be at the highest risk. However, with the timing of instream work during summer when eggs would not be present and weekly redd surveys to monitor for redds, this effect can be considered discountable.

As a result of channel realignment, floodplain restoration, and placement of instream habitat structures, spawning and rearing habitats are expected to increase and improve for CCV steelhead. A long-term benefit of the continued project is that population abundances are expected to increase.

Monitoring-related Effects

During monitoring activities, some injury or death to individuals is likely to occur as a result of capture and handling of fish. However, proper care and precautions would be taken during the monitoring activities to minimize stress and mortality to individual fish.

Summary of Project Effects on CCV Steelhead Critical Habitat

Within the action area, the relevant PBFs of the designated critical habitat for listed salmonids are spawning, egg incubation, rearing, and migration.

The PBFs for the above habitats is expected to be affected by the temporary removal of vegetation, short-term channel modifications, temporary increases in turbidity, and wading and seining during monitoring activities. These activities are expected to temporarily decrease the quality of habitat. The minor disturbances to habitat as part of monitoring efforts are expected to have insignificant effects to the habitat. Long-term impacts to critical habitat would be beneficial as it would increase the quality and quantity of habitat for all life stages of CCV steelhead.

Summary

Although there are some direct short-term impacts from the Proposed Project, when added to the environmental baseline and cumulative effects, the adverse impacts from the Proposed Project in the action area are minimal. Overall, the project would result in long-term beneficial effects to the individual steelhead and their critical habitat as it would result in an increase in quality and quantity of spawning and rearing habitat in the action area.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of CCV steelhead or destroy or adversely modify its designated critical habitat.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. “Take” is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. “Harm” is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). “Incidental take” is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.9.1 Amount or Extent of Take

NMFS anticipates incidental take of CCV steelhead through the implementation of the proposed monitoring efforts in the action area. NMFS determined that incidental take is reasonably certain to occur as follows: incidental take of juvenile and adult CCV steelhead in the proposed action area. NMFS anticipates that juveniles and adults would be observed, harassed, captured, handled, or killed as a result of the proposed monitoring activities that would be occurring between February through December, up to three years. Specifically, incidental take is expected to occur during beach seining, snorkel surveys, spawning surveys, video monitoring, and fyke-net sampling activities, up to three years.

Table 4. Take of CCV steelhead for monitoring activities associated with the Proposed Project

Method	Take Action	Life Stage	Expected Annual Take	Indirect Mortality
Beach Seine	Capture/ Handle/ Release Fish	Juvenile	150	1
Snorkel Surveys	Observe/Harass	Juvenile	250	0
Snorkel Surveys	Observe/Harass	Adult	10	0
Video Monitoring	Observe/Harass	Juvenile	50	0
Video Monitoring	Observe/Harass	Adult	1	0
Fyke-net Sampling	Capture/ Handle/ Release Fish	Juvenile	250	2

2.9.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.10 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02). At this time, no conservation recommendations have been identified.

2.10.1 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1. Measures shall be taken to ensure that all activities minimize, to the maximum extent practicable, any adverse effects on CCV steelhead.

2. Measures shall be taken by Reclamation to monitor incidental take of CCV steelhead and provide NMFS with a report following each monitoring season.

2.10.2 Terms and Conditions

The terms and conditions described below are non-discretionary, and Reclamation or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). The Reclamation or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:

   a. ESA-listed fish must be handled with extreme care and keep them in cold water to the maximum extent possible during sampling and processing procedures. When fish are transferred or held, a healthy environment must be provided; e.g., the holding units must contain adequate amounts of well-circulated water. When using gear that captures a mix of species, the applicant must process ESA-listed fish first to minimize handling stress.

   b. Handling must stop (i.e. no sedation, measurements, weighing procedures, etc.) of ESA-listed fish if the water temperature exceeds 70 degrees Fahrenheit at the capture site. Under these conditions, listed fish may only be identified and counted.

   c. If ESA-listed fish are anesthetized to avoid injuring or killing them during handling, the fish must be allowed to recover before being released. Fish that are only counted must remain in water and not be anesthetized.

d. When using anesthesia, extreme care shall be taken to use the minimum amount of substance necessary to immobilize ESA-listed salmonids for handling and sampling procedures. It is the responsibility of the researcher to determine when anesthesia is necessary to reduce injuries to ESA-listed salmonids during handling and sampling activities.

e. In the event that debris (rocks, logs, abundant vegetation, etc.) are trapped within the beach seine, researchers will remove debris before fish are centralized in the net to prevent harm. Researchers will select the smallest mesh-size seine-net or dip-net that is appropriate to achieve sampling objectives while reducing the probability that smaller fish will become gilled in the net.

f. If any ESA-listed adult fish is unintentionally captures while sampling for juveniles, the adult fish must be released without further handling and such take must be reported.

g. Care must be exercised during spawning ground surveys to avoid disturbing ESA-listed adult salmonids and redds when they are spawning. Visual observation must be used instead of intrusive sampling methods, especially when just determining fish presence.

h. Approval from NMFS must be obtained before changing sampling locations or research protocols.

i. NMFS must be notified as soon as possible but no later than two days after any authorized level of take is exceeded or if such an event is likely. A written report detailing why the authorized take level was exceeded or is likely to be exceeded must be submitted.

j. Any NMFS employee or representative will be allowed to accompany field personnel while they conduct monitoring and evaluation activities.

k. Any NMFS employee or representative must be allowed to inspect any records or facilities related to the authorized monitoring and evaluation activities.

   a. Reclamation shall submit a riparian planting plan for on-site plantings prior to restoration activities. Measures would be taken to ensure the performance criteria of 70 percent survival of plantings, for a period of three consecutive years.

2. The following terms and conditions implement reasonable and prudent measure 2:

   a. On or before January 31st of every year, Reclamation must submit to NMFS a post-season report in the prescribed form describing the research activities, the number of listed fish taken and the location, the type of take, the number of fish intentionally killed and unintentionally killed, the take dates, and a brief summary of the research results. The report must be submitted electronically on our permit website, and the forms can be found at *https://apps.nmfs.noaa.gov/*. Falsifying annual reports or records is a violation of this authorization.

b. Reports shall be sent to:
   Erin Strange
   San Joaquin River Basin Branch Chief
   NOAA Fisheries
   650 Capitol Mall, Suite 5-100,
   Sacramento, California 95814
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2.11 Reinitiation of Consultation

This concludes formal consultation for the Merced River Instream and Off-channel Habitat Rehabilitation Project.

As 50 CFR 402.16 states, 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 taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the Action Agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by Reclamation and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

EFH designated under the Pacific Coast Salmon FMP may be affected by the Proposed Action. Additional species that utilize EFH designated under this FMP within the action area include fall-run/late fall-run Chinook salmon. Habitat Areas of Particular Concern (HAPCs) that may be either directly or indirectly adversely affected include (1) complex channel and floodplain habitat, (2) spawning habitat, and (3) thermal refugia.

3.2 Adverse Effects on Essential Fish Habitat

Effects to the HAPCs listed above are discussed in context of effects to critical habitat PBFs as designated under the ESA in section 2.2.2. A list of adverse effects to EFH HAPCs is included in the EFH consultation. Affected HAPCs are indicated by number corresponding to the list in section 3.1:

1. Sediment and Turbidity
    a. Degraded water quality (1, 2, 3)
    b. Reduce habitat complexity (1, 2, 3)

2. Contaminants
    a. Degraded water quality (1)

3. Modification of Physical Habitat and Riparian Habitat
    a. Temporary loss of riparian habitat which provide shade, cover, nutrients, and habitat complexity due to vegetation removal or trimming (1, 3)

3.3 Essential Fish Habitat Conservation Recommendations

1. NMFS recommends the following measures in order to mitigate for sediment and turbidity:

   a. Reclamation shall implement erosion control measures such as silt fencing or fiber rolls to trap sediments and erosion control blankets on exposed slopes.

      a. Reclamation shall appropriately screen and clean gravel prior to placement in the main channel and side channels to avoid introduction of additional fine material into the Merced River.

   b. Grade and stabilize spoils sites to minimize erosion and sediment input to surface waters.

   c. Stream bank impacts shall be isolated and minimized to reduce bank sloughing. The banks would be stabilized following project activities.

2. NMFS recommends the following measures in order to mitigate for contaminants:

   a. Reclamation shall implement construction-site housekeeping practices, including prohibitions on discharging or washing potentially harmful materials into areas that could lead to waterways. Vehicles and equipment would be washed/cleaned only at approved off-site areas. All equipment would be steam cleaned prior to working within the stream channel to remove contaminants that may enter the river or adjacent lands.

   b. All equipment working within the stream corridor would be inspected daily for fuel, lubrication, and coolant leaks; and for leak potentials (e.g., cracked hoses, loose filling caps, stripped drain plugs); and, all equipment must be free of fuel, lubrication, and coolant leaks. All equipment would be fueled and lubricated in designated staging area located outside the stream channel and banks. Only vehicles serviced with vegetable-based lubricants would work in the active channel to reduce the potential for water quality impacts to the Merced River.

   c. A Spill Prevention and Response Plan that identifies any hazardous materials to be used during restoration work; describes measures to prevent, control, and minimize the spillage of hazardous substances; describes transport, storage and disposal procedures for these substances; and outlines procedures to be followed in case of a spill of a hazardous material. The Spill Prevention and Response Plan would require that hazardous and potentially hazardous substances stored onsite be kept in securely closed containers located away from drainage courses, agricultural areas, storm drains, and areas where stormwater is allowed to infiltrate. It would also stipulate procedures, such as the use of spill containment pans, to minimize hazard during onsite fueling and servicing of construction equipment. Finally, the Spill Prevention and Response Plan would require that the County be notified immediately of any substantial spill or release.

3. NMFS recommends the following measures in order to mitigate for the modification of physical and riparian habitat:

    a. During r estoration a ctivities, a s m uch unde rstory brush a nd a s many t rees as possible would be retained. The emphasis would be on retaining shade-producing and bank-stabilizing vegetation.

    b. Any disturbed and decompacted areas outside the restoration area would be revegetated with locally native species.

    c. There would be no impacts on heritage size trees (i.e. greater than 16 inches diameter breast height).

    d. Sensitive vegetation in the near vicinity of restoration areas would be flagged or fenced.

    e. All contractors and equipment operators would be given instructions to avoid impacts and be made aware of the ecological value of the site.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, approximately 7.2 acres of designated EFH for Pacific Coast salmon.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, Reclamation must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the Action Agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

Reclamation must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Bureau of Reclamation. Other interested users could include Merced Irrigation District. Individual copies of this opinion were provided to the Bureau of Reclamation. The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and EFH contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

Refer to NMFS ECO #: WCRO-2021-03146

December 09, 2021

Ms. Kathy Norton
Senior Project Manager
U.S. Army Corps of Engineers, Regulatory Division
California South Section
1325 J Street, Room 1350
Sacramento, California 95814-2922

Re: Non-concurrence with action agency's determination of "Not Likely to Adversely Affect" for Endangered Species Act Section 7(a)(2) Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Merced River Pipeline Removal Project (SPK-2021-00413).

Dear Ms. Norton:

On November 10, 2021, NOAA's National Marine Fisheries Service (NMFS) received your request for a written concurrence that the issuance of a Department of the Army Corps of Engineers' (Corps) Permit (SPK-2021-00413) for the Merced River Pipeline Removal Project is not likely to adversely affect (NLAA) the federally listed threatened California Central Valley (CCV) steelhead (*Oncorhynchus mykiss*) or designated critical habitat.

Upon review of the proposed project description and the biological assessment for the proposed action, NMFS has determined that the information provided for the proposed action does not support a "not likely to adversely affect" determination as proposed project activities have a potential to cause harm or take of federally listed fish species, and are likely to adversely affect or destroy designated critical habitat. In order for NMFS to concur with a determination that a project is "not likely to adversely affect" listed species, the consultation package must demonstrate that the effects upon the listed species will be "discountable", "insignificant", or completely beneficial. Discountable effects are those that are extremely unlikely to occur. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Beneficial effects are contemporaneous positive effects without any adverse effects to species. Based on best judgment, one would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur. Therefore, a determination of "likely to adversely affect" is an appropriate finding if any adverse effects to listed species or critical habitat may occur as a result of the proposed action, and the effect is not discountable, insignificant, or beneficial. A "likely to adversely affect" determination requires the initiation of formal section 7 consultation. The following information describes why NMFS does not concur with the Corps' determinations, and identifies further analyses and information needed to initiate formal consultation under the ESA for the proposed action.

The proposed action area occurs within the Merced River channel (37.3995, -120.7424), which is designated critical habitat for CCV steelhead and is also designated as EFH for Pacific Coast salmon. The proposed action includes: (1) excavating a pit within the river channel to allow access to the gas pipeline (2) construction of a sheet pile cofferdam and dewatering a portion of the wetted channel (3) trenching and removal of the gas pipeline (4) permanent stabilization activities and (5) removal of riparian vegetation.

The biological assessment lacked a detailed analysis of the potential impacts to CCV steelhead, their designated critical habitat, and EFH from the trenching of the riverbed, removal of riparian vegetation, and permanent stabilization activities. Since the proposed action includes activities that would permanently alter designated critical habitat, NMFS cannot concur that the proposed action is NLAA critical habitat for CCV steelhead, and formal consultation will be required.

Additionally, the proposed action includes the development of a sheet pile cofferdam, pile driving, dewatering, and fish relocation plans, in the event that flowing water is in the Merced River channel during construction months July 1 through October 15. The term “take” means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (50 CFR 402.02). Potential incidental take of a listed species as a result of the proposed action includes capture and collection, which would be integral to a fish capture and relocation effort. In addition, potential incidental take of a listed species as a result of the proposed action includes harass, harm, or kill, which would be a result of pile driving efforts in constructing a sheet pile cofferdam. As such, NMFS cannot concur that the proposed action is NLAA for CCV steelhead, and formal consultation will be required for this reason as well.

In summary, the materials accompanying your consultation request do not provide all of the information necessary to initiate consultation under the ESA as described in the regulation governing interagency consultations 50 CFR §402.14(c)). In order to continue ESA and EFH consultation, please provide the following information:

1) An effects analysis on critical habitat for CCV steelhead from the trenching of the Merced River channel and clarification on total area that is would be trenched;

2) A description of what permanent stabilization activities would be and an effects analysis on critical habitat for CCV steelhead from construction of permanent bank stabilization;

3) An effects analysis on critical habitat for CCV steelhead from the removal of riparian trees and vegetation, and clarification on if any riparian trees will be planted within the action area to replace those removed. NMFS recommends native riparian trees be planted in the footprint of the area where removal was necessary to mitigate for removal of riparian trees for construction at a 3:1 ratio. For any mitigation for effects to NMFS’ species, ensure proposed purchase of mitigation bank credits are at NMFS approved mitigation banks;

4) Please incorporate potential impacts to Central Valley (CV) spring-run Chinook salmon into your analysis. Recently, CV spring-run carcasses have been identified in the San Joaquin River tributaries and it is reasonable to assume that they are present in the river.

5) Please clearly identify the entire area that would be disturbed both temporarily and permanently by the proposed action. Also, please keep in mind that we require mitigation for any permanent adverse modifications to critical habitat at a 3:1 ratio.

6) There is mention of revegetating a disturbed area. How much will be removed or disturbed and how much will be replanted? How many trees will need to be removed?

7) The proposed action includes the construction of two sheet pile cofferdams, but there is no description of how the cofferdam would be constructed, or if pile driving would occur for construction. A detailed description of sheet pile cofferdam construction and pile driving will be needed. In addition, an effects analysis on CCV steelhead from pile driving and cofferdam construction will be needed as well.

8) A detailed map of staging areas.

9) How many days are anticipated for in-water work? Will this project occur over a single season?

NMFS believes the proposed action is "likely to adversely affect" for CCV steelhead and their designated critical habitat. NMFS has therefore closed out your consultation request for concurrence on your NLAA determination. NMFS recommends that the Corps request formal consultation once the additional information is developed.

Please contact Jake Rennert by email at jake.rennert@noaa.gov or by phone at (916) 217-5060, if you would like technical assistance while preparing the consultation request and determining the content for the consultation, if you have any questions concerning this letter, or if you require additional information.

Sincerely,

Monica Gutierrez
Branch Chief
California Central Valley Office

cc: To the File ARN 151422-WCR2021-SA00136

Document Content(s)

EXHIBIT G

NOTICE OF CLAIM

California Government Code 910

August 29, 2022

By Email and Express Mail

TO:	MERCED IRRIGATION DISTRICT 744 W 20th St, Merced, CA 95340
CLAIMANT:	WATER AUDIT CALIFORNIA A California Public Benefit Corporation 952 School Street PMB 316 Napa, CA 94559 707.681.5111 Legal@WaterAuditCA.org
CLAIMANT'S ATTORNEYS:	WILLIAM McKINNON CA Bar No. 129329 530.575.5335 WMcKinnon@WaterAuditCA.org 303 Sacramento St Fl 2 San Francisco, CA 94111-3613 ADAM KEATS CA Bar 191157 415-430-9403 AKeats@WaterAuditCA.org 303 Sacramento St Fl 2 San Francisco, CA 94111-3613

August 29, 2022

The Board of Directors of the Merced Irrigation District
744 W 20th St,
Merced, CA 95340

Cc. Angela Cartisano, Secretary
John Sweigard, General Manager
Jon Parnell, Manager of Water Operations
Phillip R. McMurray, Staff General Counsel

RE: The operation of the fishways on the Crocker-Huffman and Merced Falls Dams is in violation of the law and requires immediate attention and repair and new operating protocols.

To all concerned:

Water Audit California, a public benefit corporation, uses the best scientific, technical, and legal practices to review and analyze potentially unlawful injuries to the environment. Based upon this review, Water Audit pursues remediation utilizing all available resources. Certain aspects of Merced Irrigation District ("District") dam operations have been brought to Water Audit's attention.

It is our understanding that the District is a water district organized pursuant to *Water Code § 20500 et seq.* The District is a "political subdivision" of the State of California ("State") pursuant to *Public Resource Code § 1502*.

It is elementary that the District is obliged to obey the law. *East Bay Mun. Utility Dist. v. Department of Forestry Fire Protection* (1996) 43 Cal.App.4th 1113, 1132. Additionally, the District has duties under the public trust doctrine as a trustee of the public trust to measure and monitor its conduct to ensure that it is not causing unnecessary or avoidable harm to the environment.

The District owns and operates four dams[1] on the Merced River. Identified from downstream they are: (1) the Crocker-Huffman, built 1910; (2) the Merced Falls, built 1901; (3) the McSwain, built 1966; and (4) the New Exchequer, built 1967.

We have concluded, subject to receipt of new exculpatory information, that the District is in breach of its duties under the *Fish & Game Code* and the public trust doctrine. Specifically, the District has unlawfully obstructed the fishways on the Crocker-Huffman and Merced Falls dams or alternatively has allowed the fishways to be blocked by third parties and has failed to remove the obstructions. More generally, the District has failed to keep the fishways in repair and free from obstructions to the passage of fish at all times and failed to provide sufficient bypass flows.

[1] *Fish & Game Code § 5900*

For over a decade, the District has failed to respond to requests by state and federal regulators to repair and reopen the fishways.

As a preliminary comment, it is one of the foremost duties of a public trust trustee to ensure that *its* conduct is not causing unnecessary injury to the public trust.

FGC § 5901 states:

> Except as otherwise provided in this code, it is unlawful to construct or maintain in any stream in Districts 1, 1 3/8, 1 1/2, 1 7/8, 2, 2 1/4, 2 1/2, 2 3/4, 3, 3 1/2, 4, 4 1/ 8, 4 1/2, 4 3/4, 11, 12, 13, 23, and 25, any device or contrivance that prevents, impedes, or tends to prevent or impede, the passing of fish up and down stream.

The aforesaid dams are located in California Department of Fish and Wildlife ("CDFW") District 2, and *prima facie* prevent, impede, or tend to prevent or impede the passing of fish up and downstream. Therefore, the continued existence of the dams is unlawful *unless authorized under the Fish & Game Code.* The disinclination of the CDFW to enforce legal obligations does not diminish the dam owners' obligation to comply.

There is no statute of limitations barring this action, as each day is renewing a continuing injury. There is no "home free" for a long-term offender. The California Supreme Court has held that property held in public trust cannot be lost through adverse possession: "More than a century ago … we articulated the rule that property held by the state in trust for the people cannot be lost through adverse possession. The statute of limitations is of no effect in an action by the state to recover such property from an adverse possessor whose use of the property for private purposes is not consistent with the public use." *People v. Shirokow* (1980) 26 Cal.3d 301, at p. 311. *See also Marin Healthcare Dist. v. Sutter Health* (2002) 103 Cal.App.4th 861, at p. 883-84

Nor is the pre-1914 construction of the lower two dams a defense, as Water Audit established in *Water Audit v. Department of State Hospitals,* litigation over an 1880-era dam that resulted in the State reluctantly coming into compliance with the dictates of the contemporary public trust doctrine.

Reiterating the necessity of dam owners and/or operators to comply with the *FGC* permitting process, *FGC § 5948* states:

> **No person shall cause or having caused, permit to exist an**y log jam or debris accumulation or **any** other **artificial barrier, except a dam for the storage or diversion of water**, public bridges and approaches thereto, groins, jetties, seawalls, breakwaters, bulkheads, wharves and piers **permitted by law,** and debris from mining operations, in any stream in this State, which will prevent the passing of fish up and down stream or which is deleterious to fish as determined by the commission, subject to review by the courts.

The blockage of the fishways is clearly by artificial barriers, and our review indicates that they are not "permitted by law." We understand that barriers were *first installed with permission* in approximately 2007 to facilitate a fish passage experiment, but that the experiment failed, and in 2010 CDFW sought to have the barriers removed. In other words, permission for the barriers was withdrawn about four thousand days ago. In response to Water Audit's public records request earlier this year, the District admitted that it had done *nothing* in the last decade to address to the problem.

Addressing the District breach of law more specifically, FGC §§ 5935, 5936, and 5937 are unambiguous in stating that the District has a ministerial duty to provide the maintenance necessary to reopen fish ladders and to bypass sufficient water to keep fish downstream in good condition.

FGC § 5935:

> The owner of any dam upon which a fishway has been provided shall keep the fishway in repair and open and free from obstructions to the passage of fish at all times.

FGC § 5936:

> It is unlawful to willfully destroy, injure, or obstruct any fishway.

FGC § 5937 states:

> **The owner of any dam shall allow sufficient water at all times to pass through a fishway**, or in the absence of a fishway, allow sufficient water to pass over, around or through the dam, **to keep in good condition any fish that may be planted or exist below the dam.** During the minimum flow of water in any river or stream, permission may be granted by the department to the owner of any dam to allow sufficient water to pass through a culvert, waste gate, or over or around the dam, to keep in good condition any fish that may be planted or exist below the dam, when, in the judgment of the department, it is impracticable or detrimental to the owner to pass the water through the fishway.

Further, the District is in violation of its duties to bypass sufficient water to keep fish downstream in good condition. Fish that have been identified as present downstream, but that are not receiving sufficient bypass, include fall-run Chinook, the Central Valley spring-run Chinook salmon environmentally significant unit ("ESU"), and California Central Valley steelhead distinct population segment ("DPS"). The latter two species are on the Federal List of Endangered and Threatened Wildlife (50 CFR 1711). Because of their life cycle, steelhead are particularly injured by the failure to provide sufficient flows to keep summer temperatures within a livable range.

The reopening of the fishways is a ministerial act. A ministerial act is defined as "one that a public functionary 'is required to perform in a prescribed manner in obedience to the mandate of legal authority,'" without regard to his or her own judgment or opinion concerning the propriety of such act. *Ridgecrest Charter School v. Sierra Sands Unified School Dist.* (2005) 130 Cal.App.4th

986, 1002. “Thus, ‘[w]here a statute or ordinance clearly defines the specific duties or course of conduct that a governing body must take, that course of conduct becomes mandatory and eliminates any element of discretion.’ ” (*Carrancho v. California Air Resources Bd.* (2003) 111 Cal.App.4th 1255, 1267, as cited in *Ellena v. Department of Insurance* (2014) 230 Cal.App.4th 198, 205).

The initial determination of the quantum of “sufficient” bypass flows is a discretionary act within the jurisdiction of the District, subject to review and amendment by regulatory authorities. Please note, while mandamus will not force a public entity to exercise discretionary powers in any particular manner, if the entity refuses to act, mandate is available to compel the exercise of those discretionary powers in some way. *Ballard v. Anderson* (1971) 4 Cal.3d 873, 884; *See also Ellena, supra*, 205.

REQUEST FOR REMEDY:

We respectfully request that within ten days the District acknowledge in writing to the Claimant:

1. That the District has a duty pursuant to FGC §§ 5935 and 5936 to keep the fishways on the Crocker-Huffman and Merced Falls dams in repair and open and free from obstructions to the passage of fish at all times;
2. That on or before November 1, 2022, the District will complete the maintenance necessary to reopen the fishways at the Crocker-Huffman and Merced Falls dams;
3. That on or before November 1, 2022, the District will begin and continuously thereafter continue to bypass sufficient water to keep fish downstream in good condition.
4. That the District has a duty under the public trust doctrine to manage all of its dams in a manner that protects public trust resources.

TAKE NOTICE:

If the Claimant is not in receipt of the acknowledgments and undertakings set forth above on or before 5 p.m. September 8, 2022, the Claimant will seek judicial relief without further notice. This short period is made necessary by the proximity to attraction flows and spawning runs.

In this matter, where the FGC “"... clearly defines the specific duties or course of conduct that a governing body must take, that course of conduct becomes mandatory and eliminates any element of discretion."' *Ellena, supra,* at p. 205.

It is our sincere wish that your organization recognize and perform its legal duties without the necessity of judicial intervention, however non-performance will cause immeasurable and unacceptable injury to the environment. The work must be done.

If any aspect of this Demand is unclear, or if a discussion is required on the timing and manner of remedy, please contact the undersigned at your earliest opportunity.

Respectfully,

William McKinnon
Attorney for Water Audit California

EXHIBIT H

MERCED IRRIGATION DISTRICT
WATER & POWER

September 8, 2022

VIA E-MAIL legal@waterauditca.org

William McKinnon
General Counsel
Water Audit California
952 School Street #316
Napa CA 94559

Re: August 29, 2022 Letter to Merced Irrigation District

Dear Mr. McKinnon:

I am General Counsel of the Merced Irrigation District (MID). This letter responds to your August 29, 2022 correspondence, entitled "Notice of Claim".

Your letter addresses and raises issues which are currently the subject of relicensing processes currently being conducted by the Federal Energy Regulatory Commission (FERC) in connection with certain dams owned and operated by MID. These proceedings are the Merced River Hydroelectric Project, FERC Project No. 2179, and the Merced Falls Hydroelectric Project, FERC Project No. 2467. Information on these proceeding can be found through the FERC elibrary online (https://elibrary.ferc.gov/eLibrary/search).

We are not able to respond to the claims and arguments in your letter, pending further action by FERC. We instead expect FERC, and other agencies with jurisdiction, will address the issues you raise, including issues related to "fishways," "bypass flows," and MID's duties under the Fish and Game Code and other provisions of State and Federal law, in those proceedings.

You also threaten "to seek judicial relief" against MID related to the issues addressed in your letter. We do not believe that a state or federal court would have the authority to address or consider the issues raised in your letter in light of the ongoing FERC relicensing process involving MID's federally licensed facilities. We believe any lawsuit involving the issues raised in your letter would be preempted by the FERC proceeding, or at the very least would be premature and unripe pending further action by FERC in connection with the relicensing process.

We also note that although you identify your letter as a "claim," and refer to California Government Code Section 910, it does not appear that you have presented an actual, cognizable or proper claim under the Government Code, and specifically Government Code Section 910.

(209) 722-5761 744 West 20th Street Merced, California 95340
Administration / FAX (209) 722-6421 • Finance / FAX (209) 722-1457 • Water Resources / FAX (209) 726-4176
Energy Resources / FAX (209) 726-7010 • Customer Service (209) 722-3041 / FAX (209) 722-1457

Your letter does not identify "the date, place and other circumstances of the occurrence or transaction which gave rise to the claim asserted," provide a "general description of the indebtedness, obligation, injury, damage or loss incurred so far as it may be known at the time of presentation of the claim," or provide "the name or names of the public employee or employees causing the injury, damage, or loss, if known," as required by Government Code Section 910. Your letter also does not identify any "amount claimed," "the estimated amount of any prospective injury, damage, or loss," or whether the amount claimed exceeds or totals less than ten thousand dollars ($10,000) as of the date of presentation of the claim.

This letter shall therefore constitute written notice of insufficiency, pursuant to Government Code Sections 910.8 and 915.4, that your purported August 29, 2022 claim "as presented fails to comply substantially with the requirements of Sections 910 and 910.2,"

If you have any questions or wish to discuss any of the issues raised in this letter, please give me a call.

Phillip A. McMurray
General Counsel