This chapter discusses the potential for the Program to affect biological resources. It describes the state and federal regulations relevant to the biological resources affected by the Program, the existing environmental conditions at the hatchery and planting sites, the key wildlife species potentially affected by the Program, the impacts of the Program on biological resources, and mitigation measures where necessary to reduce potential impacts. Several appendices support this chapter.

- Appendix E provides detailed descriptions of wildlife species addressed specifically in this chapter.

- Appendix F provides a description of the development and function of the All H Analyzer (AHA) tool used in analyzing genetic effects of fish planting on several native fish populations.

- Appendix G contains maps of each county in California, showing all DFG trout stocking and salmon and steelhead stocking locations by name.

- Appendix H provides the population structure of each salmon evolutionarily significant unit (ESU) and steelhead distinctive population segment (DPS) in California.

- Appendix J lists water bodies within California that are currently stocked or not stocked as part of the DFG trout stocking program (California Department of Fish and Game 2009c).

- Appendix K contains detailed descriptions of mitigation strategies for stocking effects on sensitive, native, or legally protected fish and wildlife species; summaries of these strategies are contained in this chapter.

Sources of Information

The descriptions and analyses presented in this chapter were prepared using a broad range of information sources, including:

- unpublished data compilations, reports, and similar documents developed by DFG;

- results of interviews and questionnaires received from hatchery and stocking program management and operations professionals, both within and outside DFG;

- published reports and analyses of many different types;

- databases providing information about hatchery releases, the biology of species of concern, water quality, hydrology, and climate;

- scientific analyses published in peer-reviewed journals and books;

- computer-based models of fish and their interactions, detailed below under the appropriate impacts; and

- professional experience with similar analyses performed for hatchery programs elsewhere in the western United States and Canada.

Specific data sources are cited in the pages below; many of these resources are available on the internet, as detailed in Chapter 10, "References Cited."

Existing Conditions

This section addresses the following aspects of the existing biological environment within the context of the Program.

- "Regulatory Setting" describes state and federal regulations relevant to the assessment of existing conditions and environmental consequences of the Program.

- "Special-Status Species" describes the regulatory classification of species of fish and wildlife addressed in this document, and briefly discusses other aquatic species known to occur in California waters.

- "Stocking Locations" describes the geographic settings within which stocking occurs and identifies the special-status fish and wildlife species that may occur in aquatic environments where trout, steelhead, and salmon stocking occurs.

- "Hatcheries" discusses the geographic setting of each hatchery included in the Program.

Regulatory Setting

A number of state and federal regulations, laws, permits, and policies are relevant to DFG's Program. These are described below.

State

California Fish and Game Code

The California Constitution establishes the California Fish and Game Commission (CA Const. Artl. 4, section 20). The California Fish and Game Code delegates the power to the FGC to regulate the taking or possession of birds, mammals, fish, amphibian and reptiles. (CFGC section 200). The FGC has adopted regulations setting forth the manner and method of the take of certain fish and wildlife in the California Code of Regulations, Title 14.

The California Fish and Game Code establishes the DFG (CFGC section 700) and states that the fish and wildlife resources of the state are held in trust for the people of the state by and through the DFG. (CFGC section 711.7(a)). All licenses, permits, tag reservations and other entitlements for the take of fish and game authorized by the California Fish and Game Commission are prepared and issued by the DFG. (CFGC section 1050 (a)).

Provisions of the California Fish and Game Code provide special protection to certain enumerated species such as:

- Section 3503 protects eggs and nests of all birds.

- Section 3503.5 protects birds of prey and their nests.

- Sections 3513 protects all birds covered under the federal Migratory Bird Treaty Act.

- Section 3511 lists fully protected birds.

- Section 5515 lists fully protected fish species.

- Section 3800 defines nongame birds.

- Section 4700 lists fully protected mammals.

- Section 5050 lists fully protected amphibians and reptiles.

California Environmental Quality Act

The California Environmental Quality Act (CEQA) was incorporated into Public Resources Code (PRC) Sections 21000–21177 in 1970. CEQA applies to development projects that are funded by, or that require permit approval from, a public agency in the state of California. Its purpose is to help inform government decision makers of potential environmental impacts caused by development projects and to aid in the selection of potentially less environmentally destructive alternatives.

- Section 15380 formally defines the terms *species*, *endangered*, *rare*, and *threatened* as they pertain to CEQA.

- Section 15065 describes situations when a mandatory finding of significance will lead to an environmental impact report.

California Endangered Species Act

The California Endangered Species Act (CESA) (CFGC Sections 2050–2116) generally parallels the main provisions of the federal Endangered Species Act (ESA) (16 U.S. Code [USC] 1531–1544) and is administered by DFG.

The CESA prohibits the "taking" of listed species except as otherwise provided in state law. Unlike the ESA, the CESA applies the take prohibitions to species under petition for listing (state candidates) in addition to listed species. Section 86 of the CFGC defines *take* as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill."

Section 2081 of the CFGC expressly allows DFG to authorize the incidental take of endangered, threatened, and candidate species if all of the following conditions are met.

- The take is incidental to an otherwise lawful activity.

- The impacts of the authorized take are minimized and fully mitigated.

- Issuance of the permit will not jeopardize the continued existence of the species.

- The permit is consistent with any regulations adopted in accordance with Sections 2112 and 2114 (legislature-funded recovery strategy pilot programs in the affected area).

- The applicant ensures that adequate funding is provided for implementing mitigation measures and monitoring compliance with these measures and their effectiveness.

The CESA provides that if a person obtains an incidental take permit under specified provisions of the ESA for species also listed under the CESA, no further authorization is necessary under CESA if the federal permit satisfies all the requirements of CESA and the person follows specified steps (CFGC section 2080.1).

Natural Community Conservation Planning Act (Fish and Game Code § 2800-2835).

The Natural Community Conservation Planning (NCCP) Act establishes a state-wide program for the development of broad-based regional conservation plans. The goals of the Act are to "provide for effective protection and conservation of the State's wildlife heritage while continuing to allow appropriate development and growth "(§ 2801). The NCCP Program is administered by the CDFG, and is a voluntary collaborative planning effort between CDFG, and other state, federal, and local governments, property owners, developers and environmental groups. NCCP plans seek to conserve ecosystems and their associated species. Some of the conserved species are currently listed as threatened or endangered, but others are considered sensitive species that are not yet listed, but may be so in the future.

Federal

Endangered Species Act of 1973

The ESA provides for the conservation of species that are endangered or threatened throughout all or a significant portion of their range, as well as the conservation of the ecosystems on which they depend. The ESA recognizes that conservation of threatened and endangered species can be facilitated through artificial propagation. Potential benefits of artificial propagation for listed species include supplementing natural populations to speed recovery, reestablishing natural populations in suitable but currently vacant habitat, or both.

Salmonid hatchery programs can be consistent with the ESA if they do not impede progress toward the recovery of listed species. Hatchery programs designed to produce fish for harvest may be compatible with the ESA provided that the programs do not jeopardize listed species or adversely affect their critical habitat.

The National Marine Fisheries Service (NMFS) is responsible for administering ESA provisions with regard to West Coast salmon and steelhead. The ESA allows listing of DPSs of vertebrates, as well as named species and subspecies, and steelhead protected under the ESA are listed according to DPS. For Pacific salmon, NMFS considers an ESU to be a DPS. Thus, Chinook and coho salmon are listed according to ESU.

Endangered Species Act Section 9

Under the ESA, it is illegal for any person, private entity, or government agency to take endangered species without federal authorization. Take of most threatened species is similarly prohibited. *Take* is defined to mean harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in such conduct. *Harm* is defined to mean an act that actually kills or injures fish or wildlife. Take may 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. For hatchery operations, take may be intentional, such as collection of brood stock, or incidental, such as interactions between hatchery and listed fish that might impair essential behavioral patterns. The incidental take of listed species can be authorized under Section 7 or Section 10 of the ESA.

Endangered Species Act Section 7

Section 7 requires federal agencies to consult with USFWS or NMFS, or both, before performing any action (including actions such as funding a program or issuing a permit) that may affect listed species or critical habitat. Section 7 applies to federal agencies that operate or fund hatcheries operated by DFG. These federal agencies include USFWS, Reclamation, and USACE. Because USFWS funds the DFG trout hatcheries addressed in this document, it will be performing an intra-agency Section 7 consultation for the effects of that funding on listed species under USFWS jurisdiction.

Endangered Species Act Section 4(d)

Incidental take of a species listed as threatened under the federal ESA may be broadly authorized under Section 4(d) of the ESA, which authorizes incidental take of such threatened species consistent with certain conditions. Section 4(d) is not applicable to species listed as endangered under the ESA. Through a Section 4(d) rule, the USFWS or NMFS may apply take prohibitions for threatened species but exempt certain programs or activities (such as hatchery operations or recreational fisheries) if they meet the requirements specified in the rule. The USFWS or NMFS may apply a Section 4(d) rule either at the time of listing or subsequently. A familiar example is the 4(d) rule that protects anglers if they accidentally catch a listed fish species, provided that they release it unharmed.

The USFWS has published a 4(d) rule regarding Lahontan and Paiute cutthroat trout, and the NMFS has published a 4(d) rule for Central Valley, central California coast, and south-central California coast steelhead DPSs and threatened salmon ESUs. These rules provide take authorization for certain activities. Under the NMFS 4(d) rule, hatchery operations conducted in accordance with an approved hatchery genetic management plan (HGMP) are exempted from the application of ESA take prohibitions.

An HGMP must:

- specify the goals and objectives for the hatchery program,
- specify the donor population's "critical" and "viable" threshold levels,
- prioritize brood stock collection programs in a manner that benefits listed fish,
- specify the protocols that will be used for spawning and raising the fish in the hatchery,
- determine the genetic and ecological effects arising from the hatchery program,
- describe how the hatchery operation relates to fisheries management,
- ensure that the hatchery facilities can adequately accommodate listed fish if they are collected for the program,
- monitor and evaluate the HGMP to ensure that it accomplishes its objectives, and
- be consistent with tribal trust obligations.

Endangered Species Act Section 10

Absent a 4(d) rule or a completed Section 7 consultation, incidental take of a listed species can only be authorized under Section 10 of the ESA. A Section 10(a)(1)(A) permit authorizes the intentional take of listed species for research or propagation that enhances the survival of the listed species in question, such as the capture of a listed species for brood stock production. Incidental take by a non-

federal entity also may be authorized through a Section 10(a)(1)(B) permit, including approval of a habitat conservation plan. However, none of the programs assessed in this EIR/EIS have or are seeking a Section 10(a)(1)(B) permit.

Endangered Species Act Recovery Planning

The USFWS and NMFS are responsible for evaluating the status of species listed under the ESA, and developing recovery plans for those species. The ESA requires that recovery plans be developed that evaluate the current status of the listed population or species, assess the factors affecting the species, identify recovery (delisting) goals, identify the entire suite of actions necessary to achieve these goals, and estimate the cost and time required to carry out those actions.

The responsibilities of the USFWS include inland salmonid species (i.e., Lahontan cutthroat trout, Paiute cutthroat trout, and Little Kern golden trout) and the associated recovery planning processes.

Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established a requirement to describe and identify "essential fish habitat" (EFH) in each fishery management plan. The act requires all federal agencies to consult with NMFS on all actions or proposed actions that are permitted, funded, or undertaken by the agency that may adversely affect EFH. Only species managed under a federal fishery management plan are covered under EFH regulations. EFH for Pacific salmon occurs in waters affected by the salmon and steelhead hatchery and stocking programs. An analysis of the effects of the Hatchery and Stocking Program on EFH will be undertaken as part of a Biological Assessment submitted to NMFS during ESA consultation.

Federal Sustainable Fisheries Act

The Sustainable Fisheries Act (Public Law 104-297) of 1996 reauthorized and amended the Magnuson Fishery Conservation and Management Act (now Magnuson-Stevens Fishery Conservation and Management Act [Magnuson-Stevens Act]), the latter of which was initially enacted in 1976 to define fisheries jurisdiction within federal waters and create the National Oceanic and Atmospheric Administration (NOAA) structure for federal fisheries management. The revisions provided in the 1996 law brought major changes to requirements for preventing overfishing and revitalizing depleted fisheries, mostly through the scientific management and reporting conducted via fisheries management reports. An analysis of the effects of the Hatchery and Stocking Program in relation to the Sustainable Fisheries Act will be undertaken as part of a Biological Assessment submitted to NMFS during ESA consultation.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) (Title 16, United States Code [USC], Part 703) enacts the provisions of treaties between the United States, Great Britain, Mexico, Japan, and the Soviet Union and authorizes the U.S. Secretary of the Interior to protect and regulate the taking of migratory birds. It establishes seasons and bag limits for hunted species and protects migratory birds, their occupied nests, and their eggs (16 USC 703, 50 Code of Federal Regulations [CFR] 21, 50 CFR 10). Most actions that result in taking of or the permanent or temporary possession of a protected species constitute violations of the MBTA. The MBTA also prohibits destruction of occupied nests. The Migratory Bird Permit Memorandum (MBPM-2) dated April 15, 2003, clarifies that destruction

of most unoccupied bird nests is permissible under the MBTA; exceptions include nests of federally threatened or endangered migratory birds, bald eagles, and golden eagles. USFWS is responsible for overseeing compliance with the MBTA.

Special-Status Species

Regulatory Classification of Special-Status Species

Most potential impacts discussed in this chapter are assessed in the context of their potential to affect special-status species, which are here defined to include all species that have been specifically identified by USFWS, NMFS or DFG as warranting some level of protection from human impacts. The following terms are used by state and federal agencies to designate special-status species. The terms are ranked approximately from the most to the least protective designation.

Fully protected (FP): species designated as fully protected under CFGC Sections 3511, 4700, 5050, or 5515. FP species may not be taken at any time unless authorized by DFG for necessary scientific research, which cannot include actions for project mitigation. Necessary scientific research includes efforts to recover fully protected, endangered, and threatened species. A notification must be published in the California Regulatory Notice Register prior to the Department authorizing take of fully protected species.

Federal endangered (FE): species designated as endangered under the ESA (described above). An FE species is one that is in danger of extinction throughout all or a significant portion of its range. Incidental take of any individual of an FE species is prohibited except with prior authorization from USFWS or NMFS (most ESA-listed species are within USFWS jurisdiction, but some marine species, including all Pacific salmon and steelhead, are regulated by NMFS).

State endangered (SE): species designated as endangered under the CESA (described above). These include native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease (CESA Section 2062). Take, as defined by FGC Section 86, of any State endangered species is prohibited unless authorized in the form of a State Incidental take permit pursuant to FGC Section 2081 or other mechanisms specified in FGC Sections 2080-2089.

Federal threatened (FT): species designated as threatened under the ESA (described above). An FT species is one that is likely to become endangered in the foreseeable future throughout all or a significant portion of its range. At the discretion of USFWS or NMFS, incidental take of any individual of an FT species may be prohibited or restricted.

State threatened (ST): species designated as threatened under the CESA (described above). These include native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts (CESA Section 2067). Take, as defined by FGC Section 86, of any State threatened species is prohibited unless authorized in the form of a State Incidental take permit pursuant to FGC Section 2081 or other mechanisms specified in FGC Sections 2080-2089.

State candidate (SC): species designated as candidates for listing under the CESA (described above). These are native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that the

California Fish and Game Commission has formally noticed as being under review by DFG for addition to either the list of endangered species or the list of threatened species, or a species for which the commission has published a notice of proposed regulation to add the species to either list (CESA Section 2068). Take, as defined by FGC Section 86, of any State candidate species is prohibited unless authorized in the form of a State Incidental take permit pursuant to FGC Section 2081 or other mechanisms specified in FGC Sections 2080–2089.

Species of special concern (SSC): a species, subspecies, or distinct population of a vertebrate animal native to California that has been determined by DFG to warrant protection and management intended to reduce the need to give the species formal protection as an SE, ST, or SC species. "Species of special concern" is an administrative designation and carries no formal legal status. However, Section 15380 of the State CEQA Guidelines clearly indicates that species of special concern should be included in an analysis of project impacts if they can be shown to meet the criteria of sensitivity outlined therein (Comrack et al. 2008). Such an analysis is presented in the following section on "How Special-Status Species Were Identified."

Federal proposed (FP): species that have been proposed by USFWS or NMFS for listing as endangered or threatened under the ESA. FP species must be evaluated in the Section 7 consultation for any federal action (described above under "Endangered Species Act Section 7") and are normally evaluated in the NEPA review of any action that may affect the species.

Federal candidate (FC): species that are candidates for listing as endangered or threatened under the ESA. Such species have not yet been proposed for listing. Consideration of FC species can assist environmental planning efforts by providing advance notice of potential listings, allowing resource managers to alleviate threats and thereby possibly remove the need to list species as endangered or threatened. Thus, FC species are normally evaluated in the NEPA review of any action that may affect the species.

Federal species of concern (FSoC): "Species of concern" are not defined or mentioned in the ESA, but some offices of both NMFS and USFWS use this term to describe special-status species that have not been designated under any of the formal federal status terms described above. Usually these are species for which the agency (NMFS or USFWS) has some concerns about status or threats, but for which there are insufficient data to indicate that the species warrants treatment as a candidate for listing. Some FSoC species are addressed in this chapter because of USFWS concerns about the possible effects of the Program on these species.

Designated critical habitat and recovery plans: Many FE and FT species have designated critical habitat or approved recovery plans, or both. There is also one adopted State Recovery Strategy (FGC Section 2112), for coho salmon. Federal regulations prohibit actions that would destroy or adversely modify designated critical habitat. One reason for designation of critical habitat is that, although such habitat may not be currently occupied, it is essential in order to achieve recovery of these species. Accordingly, for these species, the species' range is assumed to include the known range of the species plus any additional areas of designated critical habitat. Species recovery plans, including both federal plans and California's coho salmon recovery plan, identify actions that are required in order to secure recovery of a species. Accordingly, the Program is assessed with reference to the question of whether it may interfere with the implementation of recovery plans.

How Special-Status Species Were Identified

California is home to a large number of special-status species. Habitat for many of these species occurs in or near aquatic areas or associated habitats such as wetlands and riparian areas, which may be affected by the activities analyzed in this chapter.

The selection of special-status species for detailed treatment in this EIR/EIS was based on the extensive comments received during the scoping process. Those comments led to initial consideration of a list including all special-status animal species known to occur in California. Through 2008, during public scoping meetings and subject to input from USFWS and DFG staff familiar with the history and operation of hatchery and stocking programs or the biology of special-status species, various species on the initial list were determined to either require evaluation or not require evaluation in this EIR/EIS. Generally, a species was regarded as requiring evaluation if it was:

- known to occur in riparian, wetland, or aquatic habitat adjoining or within a few miles downstream of a fish hatchery evaluated in the EIR/EIS;

- known to occur in riparian, wetland, or aquatic habitat at sites where fish stocking is performed under one or more of the stocking programs described in this EIR/EIS; or

- known to be vulnerable to ecosystem-level impacts such as alteration of food webs by stocked fish, alteration of riparian and aquatic systems by the activities of anglers, or various other indirect mechanisms that have been reported in published studies of fisheries and aquatic ecosystems.

Similarly, if a species did not meet any of these criteria, it was removed from consideration for detailed evaluation within this EIR/EIS.

Decision Species

Several species that are not special-status species were added to the review list because of DFG concerns that they might be affected by stocking programs. Since the final list of species addressed in this chapter includes some species that have no special-status designation, they are cumulatively referred to as "decision species." In the course of this review process, the EIR/EIS team reviewed many documents and databases describing species range and habitat requirements. The review process identified a list of 85 species potentially affected by DFG hatchery programs (the full list appears in Table 4-1, below). These species are specifically discussed in this document in each case where a program management action could affect the species. Appendix E provides summaries of the biology of each decision species addressed in this document.

This document addresses effects on species known to occur within California. Animals not known to be extant in California are not addressed in the analysis, with one exception: Some stocked waters in California flow into Oregon or Nevada, so California stocking activities have the potential to affect special-status species within these states. This consideration affects the evaluation of two species: the Oregon spotted frog, which has not been recorded anywhere in California since 1989 (Jennings and Hayes 1994) but occupies habitat in Oregon downstream of stocked waters in the Pit River watershed; and the cui-ui, which occupies habitat in Nevada downstream of stocked Truckee River waters.

Supplemental Species

This document also considers potential impacts to a variety of bird and mammal species referred to as "supplemental species." The supplemental species are listed and potential impacts to them are analyzed in the final section of this chapter. These species are treated more briefly than the decision species because they have limited potential for interaction with stocked fish, or because the potential interactions primarily result in beneficial impacts. See the "Supplemental Species" section for further details.

Terminology for Salmonid Species

Many of the special-status species addressed in this document are salmonids (i.e., members of the family Salmonidae, which is represented in California by trout, steelhead, salmon, and kokanee). Many California salmonids have been manipulated by human activity. Examples of this manipulation include the extirpation of local populations, the stocking of native fish into waters they are not previously known to have occupied, the stocking of introduced fish species, and interbreeding between stocked and wild fish. In this analysis, the following terms are used to distinguish these types of salmonid populations.

Native vs. nonnative: Native fish are fish representing species thought to have been present in California during prehistoric times. Nonnative fishes are descended from species that were brought to California by humans and have since developed self-sustaining populations within available natural habitat. Some California fishes, such as rainbow trout, are represented by both native and nonnative populations. Many native species have been introduced into lakes and streams that were previously outside their range, usually due to the presence of impassable barriers such as waterfalls. Although humans have altered their distribution, they are still native species. California's "heritage trout," which include all trout listed in Table 4-1, are all native.

Wild, Heritage and Hatchery: Wild fish populations are comprised of fish that are spawned and reared in an aquatic ecosystem, typically a stream, lake, reservoir, or estuary. Heritage fish are a subset of wild fish defined as occurring within their historic range. Hatchery fish populations are comprised of fish that are spawned and grown to a planned size within a fish hatchery, and are then stocked into an aquatic environment. Interbreeding in a hatchery may occur if both wild and hatchery fish are used as brood stock. Outside the hatchery setting, interbreeding may occur where hatchery fish spawn with wild fish in the stream or lake. The degree of interbreeding between wild and hatchery fish can sometimes be quantified, a topic discussed in more detail in Appendix F. Both wild and hatchery fish may be either native or nonnative. The Eagle Lake trout, for instance, is a native species that depends upon a hatchery for its continued existence; whereas many California streams contain wild populations of brook trout, a non-native species.

Table 4-1. Decision Species Potentially Affected by Hatchery and Stocking Programs

Common Name	Scientific Name	Status (federal)	Status (state)
Invertebrates			
Shasta crayfish	*Pacifastacus fortis*	FE	SE
California freshwater shrimp	*Syncaris pacifica*	FE	SE
Lampreys			
River lamprey	*Lampetra ayresii*	(none)	SSC
Kern brook lamprey	*Lampetra hubbsi*	(none)	SSC
Klamath River lamprey	*Lampetra similis*	(none)	SSC
Anadromous or Estuarine Non-Salmonid Fish			
Green sturgeon (southern DPS)	*Acipenser medirostris*	FT	SSC
Delta smelt	*Hypomesus transpacificus*	FT	ST
Longfin smelt	*Spirinchus thaleichthys*	(none)	ST, SSC
Eulachon	*Thaleichthys pacificus*	FPT	SSC
Tidewater goby	*Eucyclogobius newberryi*	FE	SSC
Freshwater and Estuarine Fish			
Owens tui chub	*Gila bicolor snyderi*	FE	SE
Goose Lake tui chub	*Gila bicolor thalassina*	(none)	SSC
Arroyo chub	*Gila orcuttii*	(none)	SSC
Hardhead	*Mylopharodon conocephalus*	(none)	SSC
Owens speckled dace	*Rhinichthys osculus* ssp. 2	(none)	SSC
Santa Ana speckled dace	*Rhinichthys osculus* ssp. 3	(none)	SSC
Owens sucker	*Catostomus fumeiventris*	(none)	SSC
Modoc sucker	*Catostomus microps*	FE	SE, FP
Santa Ana sucker	*Catostomus santaanae*	FT	SSC
Cui-ui	*Chasmistes cujus*	FE	(none)
Unarmored three-spined stickleback	*Gasterosteus aculeatus williamsoni*	FE	SE, FP
Sacramento perch (within native range only)	*Archoplites interruptus*	(none)	SSC
Salmonid Fish			
Coastal cutthroat trout	*Oncorhynchus clarkii clarkii*	(none)	SSC
Lahontan cutthroat trout	*Oncorhynchus clarkii henshawi*	FT	(none)
Paiute cutthroat trout	*Oncorhynchus clarkii seleniris*	FT	(none)
California (Volcano Creek) golden trout	*Oncorhynchus mykiss aguabonita*	(none)	SSC
Eagle Lake rainbow trout	*Oncorhynchus mykiss aquilarum*	(none)	SSC
Kern River rainbow trout	*Oncorhynchus mykiss gilberti*	(none)	SSC
Goose Lake redband trout	*Oncorhynchus mykiss* ssp. 1	(none)	SSC
McCloud River redband trout	*Oncorhynchus mykiss* ssp. 2	(none)	SSC
Warner Valley redband trout	*Oncorhynchus mykiss* ssp. 3	(none)	(none)

Common Name	Scientific Name	Status (federal)	Status (state)
Little Kern golden trout	*Oncorhynchus mykiss whitei*	FT	(none)
Steelhead (Klamath Mountains Province DPS)	*Oncorhynchus mykiss irideus*	(none)	SSC
Steelhead (northern California DPS)	*Oncorhynchus mykiss irideus*	FT	SSC
Steelhead (Central Valley DPS)	*Oncorhynchus mykiss irideus*	FT	(none)
Steelhead (central California coast DPS)	*Oncorhynchus mykiss irideus*	FT	(none)
Steelhead (south/central California coast DPS)	*Oncorhynchus mykiss irideus*	FT	SSC
Steelhead (southern California DPS)	*Oncorhynchus mykiss irideus*	FE	SSC
Coho salmon (southern Oregon/northern California coast ESU)	*Oncorhynchus kisutch*	FT	ST, SSC
Coho salmon (central California coast ESU)	*Oncorhynchus kisutch*	FE	SE
Chinook salmon (Klamath-Trinity rivers spring-run ESU)	*Oncorhynchus tshawytscha*	(none)	SSC
Chinook salmon (California coastal ESU)	*Oncorhynchus tshawytscha*	FT	(none)
Chinook salmon (Sacramento River winter-run ESU)	*Oncorhynchus tshawytscha*	FE	SE
Chinook salmon (Central Valley spring-run ESU)	*Oncorhynchus tshawytscha*	FT	ST
Chinook salmon (Central Valley fall-/late fall–run ESU)	*Oncorhynchus tshawytscha*	(none)	SSC
Amphibians			
California tiger salamander	*Ambystoma californiense*	FT	SCE, SSC
Northwestern salamander	*Ambystoma gracile*	(none)	(none)
Long-toed salamander	*Ambystoma macrodactylum*	(none)	(none)
Santa Cruz long-toed salamander	*Ambystoma macrodactylum croceum*	FE	SE, FP
California giant salamander	*Dicamptodon ensatus*	(none)	(none)
Pacific giant salamander	*Dicamptodon tenebrosus*	(none)	(none)
Southern torrent salamander	*Rhyacotriton variegatus*	(none)	SSC
Rough-skinned newt	*Taricha granulosa*	(none)	(none)
Red-bellied newt	*Taricha rivularis*	(none)	(none)
Sierra newt	*Taricha torosa sierrae (=Taricha sierrae)*	(none)	(none)
Coast Range newt (Monterey County and south, only)	*Taricha torosa torosa*	(none)	SSC
Western tailed frog	*Ascaphus truei*	(none)	SSC
Western spadefoot	*Spea (=Scaphiopus) hammondii*	(none)	SSC
Western toad	*Bufo boreas*	(none)	(none)
Arroyo toad	*Bufo (=Anaxyrus) californicus*	FE	SSC
Yosemite toad	*Bufo (=Anaxyrus) canorus*	FC	SSC
Woodhouse's toad	*Bufo woodhousii*	(none)	(none)

Common Name	Scientific Name	Status (federal)	Status (state)
California treefrog	*Hyla (=Pseudacris) cadaverina*	(none)	(none)
Pacific treefrog	*Hyla (=Pseudacris) regilla*	(none)	(none)
Northern leopard frog (native populations only)	*Rana (=Lithobates) pipiens*	(none)	SSC
Lowland leopard frog	*Rana (=Lithobates) yavapaiensis*	(none)	SSC
Northern red-legged frog	*Rana aurora aurora*	(none)	SSC
California red-legged frog	*Rana draytonii*	FT	SSC
Foothill yellow-legged frog	*Rana boylii*	(none)	SSC
Mountain yellow-legged frog (southern DPS)	*Rana muscosa*	FE	SSC
Mountain yellow-legged frog (northern DPS)	*Rana muscosa (includes R. sierrae)*	FC	SSC
Cascades frog	*Rana cascadae*	(none)	SSC
Oregon spotted frog	*Rana pretiosa*	FC	SSC
Reptiles			
Western pond turtle	*Clemmys marmorata*	(none)	SSC
Common garter snake	*Thamnophis sirtalis*	(none)	(none)
Mountain garter snake	*Thamnophis elegans elegans*	(none)	(none)
Sierra (western aquatic) garter snake	*Thamnophis couchii*	(none)	(none)
Two-striped garter snake	*Thamnophis hammondii*	(none)	SSC
Giant garter snake	*Thamnophis gigas*	FT	ST
San Francisco garter snake	*Thamnophis sirtalis tetrataenia*	FE	SE, FP
South Coast garter snake	*Thamnophis sirtalis* ssp.	(none)	SSC
Birds			
Bald eagle	*Haliaeetus leucocephalus*	(none)	SE, FP
Osprey	*Pandion haliaetus*	(none)	WL
Willow flycatcher (except southwestern subspecies)	*Empidonax traillii*	(none)	SE
Southwestern willow flycatcher	*Empidonax traillii extimus*	FE	SE

Notes:

Source for species names, table order, and listing status information is the California Natural Diversity Database (CNDDB) (2009), except for species not evaluated in the CNDDB (non-special-status species), for which species names are from the California Department of Fish and Game (2008c)

FC = federal candidate for listing.
FE = federal endangered.
FP = DFG fully protected species.
FPT = federal proposed: threatened.
FT = federal threatened.
SCE = state candidate: endangered.
SE = state endangered.
SSC = DFG species of special concern.
ST = state threatened.
WL = state watch list.

Stocking Locations

California may be divided into eight regions according to physiographic characteristics (e.g., topography and hydrography) (Bunn et al. 2007). The descriptions of these regions, presented below, address the general physical landscape (Figure 4-1) and major stressors affecting wildlife and habitats within each of eight regions at a scale that is appropriate to analyze the potential effects of the proposed programs. The eight regions are:

- Mojave Desert Region,

- Colorado Desert Region,

- South Coast Region,

- Central Coast Region,

- North Coast–Klamath Region,

- Modoc Plateau Region,

- Sierra Nevada and Cascades Region, and

- Central Valley and Bay-Delta Region.

Full accounts for each region are provided by Bunn et al. (2007), which, except as noted otherwise, was the source for the summaries presented below.

Mojave Desert Region

The 32-million-acre Mojave Desert extends into four states: California, Nevada, Arizona, and Utah. The majority of the landscape is a moderately high plateau at elevations between 2,000 and 3,000 feet. Variations in elevation and soil composition and different orientations to the sun and wind provide topographic and climatic diversity. Aquatic, wetland, and riparian habitat is associated with seeps, springs, and several perennial streams (Surprise Canyon and Cottonwood Creek in the Panamint Range, as well as the Amargosa and Mojave Rivers).

The federal government manages about 80% of the Mojave Desert Region in California. The largest land manager is the Bureau of Land Management (BLM), overseeing 8 million acres. The National Park Service (NPS) manages another 5 million acres, including the Mojave National Preserve and Death Valley and Joshua Tree National Parks, and the Department of Defense manages five military bases that cover the remaining 2.5 million acres of federal land. In contrast, the State Park System and DFG manage only 0.32% of the region.

There are 439 vertebrate species that inhabit the Mojave Desert Region at some point in their life cycle, including 252 birds, 101 mammals, 57 reptiles, 10 amphibians, and 19 fish. Of the total vertebrate species that inhabit this region, there are three special-status species specifically addressed in this document and five additional special-status vertebrate species potentially found in areas of Program influence.

Major stressors affecting wildlife and habitats in the Mojave Desert Region include multiple uses conflicting with wildlife on public lands, growth and development, solar energy development, fire, groundwater overdrafting and loss of riparian habitat, inappropriate off-road vehicle use, excessive livestock grazing, excessive burro and horse grazing, invasive plants, non-native fish, military lands management conflicts, illegal harvest or illegal commercialization, and mining operations.

Figure 4-1
California Physiographic
Regions

Iron Gate Hatchery
Mount Shasta Hatchery
Mad River Hatchery
Crystal Lake Hatchery
Trinity River Hatchery
Darrah Springs Hatchery
Coyote Valley Fish Facility
Thermalito Afterbay Annex
Feather River Hatchery
Warm Springs Hatchery
Silverado Fisheries Base
American River Hatchery
Nimbus Hatchery
Mokelumne River Hatchery
Moccasin Creek Hatchery
Merced River Hatchery
Hot Creek Hatchery
San Joaquin Hatchery
Fish Springs Hatchery
Black Rock Rearing Ponds
Mount Whitney Hatchery
Kern River Planting Base
Fillmore Hatchery
Mojave River Hatchery

Modoc
Plateau

North Coast
and Klamath

Sierra
Nevada
and Cascades

Central
Valley and
Bay Delta

Central Coast

Mojave Desert

South Coast

Colorado Desert

Legend

- Salmon Hatchery
- Trout Hatchery

California Physiographic Regions

- Central Coast
- Central Valley and Bay Delta
- Colorado Desert
- Modoc Plateau
- Mojave Desert
- North Coast and Klamath
- Sierra Nevada and Cascades
- South Coast

0   25   50   100 Miles

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Colorado Desert Region

The 7 million acres of the Colorado Desert Region extend from the Mojave Desert in the north to the Mexican border in the south and from the Colorado River in the east to the Peninsular Ranges in the west. The majority of the landscape lies below 1,000 feet elevation, but elevations range from 275 feet below sea level in the Salton Trough to nearly 10,000 feet in the Peninsular Ranges. These mountain ranges block most coastal air, which produces an arid climate. The region experiences higher summer daytime temperatures than higher-elevation deserts do and almost never has frost. There are two rainy seasons, one in winter and one in late summer. The common habitats of the Colorado Desert Region are creosote bush scrub; mixed scrub, including yucca and cholla cactus; desert saltbush; sandy soil grasslands; and desert dunes. Higher elevations are dominated by pinyon pine and California juniper, with areas of manzanita and Coulter pine.

In the Colorado Desert region's arid climate, aquatic and wetland habitats are uncommon but critical to wildlife. Springs and runoff from seasonal rains form alluvial fans, arroyos, fan palm oases, freshwater marshes, brine lakes, washes, ephemeral and perennial streams, and riparian vegetation communities dominated by cottonwood, willow, and invasive tamarisk. The region's two largest water systems are the Salton Sea and the Colorado River.

The largest land manager of the region is the Bureau of Land Management (BLM), overseeing 2.9 million acres. Department of Defense land accounts for 500,000 acres. A number of other public landholdings occur around the Salton Sea. Slightly less than half of the Joshua Tree National Park lies within the Colorado Desert Region. Anza Borrego Desert State Park encompasses more than 600,000 acres. Santa Rosa Wildlife Area encompasses about 100,000 acres.

Some 481 vertebrate species, including 282 birds, 82 mammals, 66 reptiles, 16 amphibians, and 35 fish, inhabit the Colorado Desert Region at some point in their life cycle. Of these, three are special-status species specifically addressed in this document, and there are 15 additional special-status vertebrate species potentially found in areas of Program influence.

Although the Colorado Desert remains one of the least populated regions in California, human activities have had a substantial impact on the region's habitat and wildlife. Some of the greatest human-caused effects on the region have resulted from water diversions and flood control measures along the Colorado River. In addition, portions of the region are experiencing substantial growth and development pressures, most notably within the Coachella Valley.

Major stressors affecting wildlife and habitats in the Colorado Desert Region include water management conflicts and water transfer effects, inappropriate off-road vehicle use, loss and degradation of dune habitats, growth and development, solar energy development, and invasive species.

South Coast Region

The 8 million acres of California's South Coast Region extend along the coast from the middle of Ventura County in the north to the Mexican border in the south. Inland, the region is bounded by the Peninsular Ranges and the transition to the Mojave and Colorado Deserts on the east and by the Transverse Ranges on the north. The landscape varies from wetlands and beaches to hillsides, rugged mountains, arid deserts, and densely populated metropolitan areas. The region's coastal habitats include coastal strand, lagoons, and river-mouth estuaries that transition from riparian wetlands to freshwater and saltwater marshes. Inland, the predominant hillside and bluff

communities are coastal sage scrub and chaparral. Low- to mid-elevation uplands often feature oak woodlands, while coniferous forests dominate higher-elevation mountainous areas.

The region's largest river drainages include the Tijuana, San Diego, San Luis Rey, Santa Margarita, Santa Ana, San Gabriel, Los Angeles, Santa Clara, and Ventura Rivers. Pine forests occur along the high-elevation stream reaches, and mountain drainages support mountain yellow-legged frog, California red-legged frog, arroyo toad, arroyo chub, Santa Ana sucker, and Santa Ana speckled dace. In urbanized coastal areas, many sections of the region's river corridors are channelized with concrete.

There are 476 vertebrate species, including 287 birds, 87 mammals, 52 reptiles, 16 amphibians, and 34 fish, that inhabit the South Coast Region at some point in their life cycle. Seven special-status species are specifically addressed in this document, and 19 additional special-status vertebrate species are potentially found in areas of Program influence.

Major stressors affecting wildlife and habitats in the South Coast Region include growth and development, water management conflicts and degradation of aquatic ecosystems, invasive species, altered fire regimes, and recreational pressures.

Central Coast Region

The 8 million acres of California's Central Coast Region extend from the southern boundary of Los Padres National Forest north to the San Francisco Bay lowlands. Inland, the region is bounded on the east by the Diablo and Temblor mountain ranges. A rugged coastline characterizes the landscape, with small mountain ranges that roughly parallel the coast, river valleys with rich alluvial soils, and arid interior valleys and hills. Across the region, differences in climate, geography, and soils result in widely varying ecological conditions, supporting diverse coastal, montane, and desert-like natural communities. The region's coastal habitats include river mouth estuaries, lagoons, sloughs, tidal mudflats, marshes, coastal scrub, and maritime chaparral. Coastal scrub and grasslands extend inland along river valleys. The outer coastal ranges support mixed coniferous forests and oak woodlands.

The region's largest drainages include the Santa Ynez, Santa Maria, Carmel, Salinas, and Pajaro watersheds. The outer coastal ranges, including the Santa Cruz and Santa Lucia mountains, run parallel to the coastline.

There are 482 vertebrate species, including 283 birds, 87 mammals, 42 reptiles, 25 amphibians, and 45 fish, that inhabit the Central Coast Region at some point in their life cycle. Twelve are special-status species specifically addressed in this document, and 26 additional special-status vertebrate species are potentially found in areas of Program influence.

Major stressors affecting wildlife and habitats in the Central Coast Region include population growth, expansion of intensive types of agriculture, invasions by exotic species, and overuse of regional water resources.

North Coast–Klamath Region

The 14-million-acre North Coast–Klamath Region extends along the Pacific coast from the Oregon-California border to the San Francisco Bay watershed. The region's inland boundary is formed by the Cascade Ranges along the north and by the transition to the Sacramento Valley in the south. The region is characterized by large expanses of rugged, forested mountains that range in elevation from

3,000 feet to 8,000 feet. The climate features high precipitation in the coastal areas and dry conditions in some inland valleys. The region's coastal habitats include sandy beaches, rocky shorelines, estuaries, lagoons, marshes, open-water bays, grasslands, coastal shrub, pine forests, mixed evergreen forests, and redwood forests. The inland ecological communities include moist inland forests dominated by Douglas fir, ponderosa pine, and sugar pine mixed with a variety of other conifers and hardwoods.

The region's major inland waterways are part of the Klamath River system, which includes the Klamath, Scott, Shasta, Salmon, and Trinity Rivers. River systems draining the Coast Ranges include the Eel, Russian, Mattole, Navarro, Smith, Mad, Little, and Gualala Rivers, and Redwood Creek. The majority of California's rivers with state or federal "wild and scenic river" designations are in the North Coast–Klamath Region, including portions of the Klamath, Trinity, Smith, Scott, Salmon, Van Duzen, and Eel Rivers. In addition to rivers, creeks, and streams, the North Coast–Klamath region contains more than 1,000 HMLs.

Some 501 vertebrate species, including 282 birds, 104 mammals, 26 reptiles, 30 amphibians, and 59 fish, inhabit the North Coast–Klamath Region at some point in their life cycle. Of these, 18 are special-status species specifically addressed in this document, and 31 additional special-status vertebrate species are potentially found in areas of Program influence.

Major stressors affecting wildlife and habitats in the North Coast–Klamath Region include water management conflicts, in-stream gravel mining, forest management conflicts, altered fire regimes, agriculture and urban development, excessive livestock grazing, non-native fishes, and invasive species. The introduction of nonnative fish to formerly fishless lakes and streams has substantially affected the aquatic life of the region, particularly in the subalpine and alpine ecosystems. Decades of stocking fish to create and maintain a recreational fishery have contributed to the decline of some native species in the region.

Modoc Plateau Region

The Modoc Plateau Region is framed by and includes the Warner Mountains and Surprise Valley along the Nevada border on the east and the edge of the southern Cascade Ranges on the west. The region extends north to the Oregon border and south to include the Skedaddle Mountains and the Honey Lake Basin. Elevations range from 4,000 to 5,000 feet. The region is situated on the western edge of the Great Basin and supports high-desert plant communities and ecosystems similar to that region, including shrub-steppe, perennial grasslands, sagebrush, antelope bitterbrush, mountain mahogany, and juniper woodlands. Conifer forests dominate the higher elevations. Wetland, spring, meadow, vernal pool, riparian, and aspen communities are scattered throughout the rugged and otherwise dry desert landscape. The region's major waterway is the Pit River and its tributaries.

Sixty percent of the region is federally managed: The Forest Service manages 30%, the BLM manages 26%, and USFWS and Department of Defense manage about 2% of the land in the region. DFG manages 1% of the land, while about 37% is privately owned or belongs to municipalities.

The 3-million-acre Pit River watershed is the major drainage of the Modoc Plateau, providing 20% of the water to the Sacramento River. The upper reaches of the watershed are in creeks of the Warner Mountains that drain into Goose Lake. The north fork of the Pit River flows from Goose Lake southwest and merges with the south fork of the Pit River, which drains the southern Warner Mountains. Several endemic aquatic species, including Modoc sucker, Goose Lake redband trout, Goose Lake tui chub, Goose Lake lamprey, and Shasta crayfish, inhabit the watershed (Moyle 2002).

Creeks of the northern Modoc Plateau (or Lost River watershed) drain to Clear Lake. The outlet of Clear Lake is the Lost River, which circles north into Oregon farmland and then joins the Klamath River system. The Lost River watershed has its own endemic aquatic fish and invertebrates.

There are 399 vertebrate species, including 235 birds, 97 mammals, 23 reptiles, six amphibians, and 38 fish, that inhabit the Modoc Plateau Region at some point in their life cycle. Six special-status species are specifically addressed in this document, and 17 additional special-status vertebrate species are potentially found in areas of Program influence.

Major stressors affecting wildlife and habitats in the Modoc Plateau Region include excessive livestock grazing, excessive feral horse grazing, altered fire regimes, Western juniper expansion, invasive plants, forest management conflicts, and water management conflicts and degradation of aquatic ecosystems. The introduction of exotic aquatic species (e.g., largemouth bass and nonnative trout to lakes; and bullheads, catfishes, and signal crayfish to rivers and streams) has reduced or extirpated populations of native amphibians and fish and affected invertebrates in many segments of the rivers, creeks, and lakes of the region.

Sierra Nevada and Cascades Region

The Sierra Nevada and Cascade Ranges form the spine of California's landscape, extending 525 miles from north to south. The southern Cascades extend from north of the Oregon border southeastward to Mount Lassen, where they merge with the Sierra Nevada range. The Sierra Nevada range extends to the south to the Mojave Desert, where it curves south to link with the Tehachapi Mountains. The region includes the oak woodland foothills on the western slope of the Sierra Nevada and Cascade Ranges and, on the east, the Owens Valley and edges of the Great Basin. On the west side, elevations gradually increase from near sea level at the floor of the Central Valley to ridgelines ranging from 6,000 feet in the north to 14,000 feet in the south. The east slope of the Sierra Nevada drops off sharply, and the east side of the Cascade Range slopes gradually. As elevations increase from west to east, habitats transition from chaparral and oak woodlands to lower-level montane forests of ponderosa and sugar pine to upper montane forests of firs, Jeffrey pine, and lodgepole pine and above timberline to alpine plant communities.

Sixty-one percent of the Sierra Nevada and Cascade Ranges are managed by federal agencies: The Forest Service manages 46%, the National Park Service manages 8%, and BLM manages 7%. State parks and wildlife areas account for 1% of the region, while the remaining area is privately owned.

The hundreds of creeks and streams on the western slope of the Sierra Nevada and Cascade Ranges drain via major river basins to merge with the Sacramento River in the north and the San Joaquin River in the south. The southern streams drain into the Tulare Basin via the Kaweah, Kern, and Kings rivers, while the streams east of the Sierra Nevada crest drain into the Great Basin via the Lahontan, Mono, and Owens drainages. Many of the creeks and streams of northeastern California drain via the Pit River, which joins the Sacramento River at Lake Shasta. Besides creeks and streams, there are approximately 10,000 HMLs.

There are 67 aquatic habitat types in the region. Major riparian habitats include valley foothill riparian, montane riparian, wetland meadow, and aspen. Numerous invertebrate and vertebrate species are associated with these moist habitats. Other wildlife species, including some raptors and numerous songbirds, live in drier plant communities and rely on nearby aquatic and riparian habitats for hunting, foraging, cover, and resting. Of the 67 aquatic habitat types, nearly two-thirds

are in decline. Ecosystem functions have been disrupted in thousands of riparian areas, and more than 600 miles of river habitat have been submerged under reservoirs.

There are 572 vertebrate species, including 293 birds, 135 mammals, 46 reptiles, 37 amphibians, and 61 fish, that inhabit the Sierra Nevada and Cascades Region at some point in their life cycle. Seventeen special-status species are specifically addressed in this document, and 20 additional special-status vertebrate species are potentially found in areas of Program influence.

Major stressors affecting wildlife and habitats in the Sierra Nevada and Cascades Region include growth and land development, forest management conflicts, altered fire regimes, excessive livestock grazing, invasive plants, recreational pressures, climate change, and introduced nonnative fish.

The introduction of nonnative fish to formerly fishless lakes and streams has significantly affected the aquatic life of the region, particularly in the subalpine and alpine ecosystems and in the Owens Valley. Decades of stocking fish for recreational fishing have contributed to the decline of native fish, amphibian and reptile species in the region (Matthews et al. 2002). Stocking of trout into historically fishless HMLs has contributed to the extirpation of native amphibians in some basins, with particularly severe consequences for the once-common mountain yellow-legged frog (Knapp and Matthews 2000; Vredenburg 2004). By consuming native amphibians and aquatic insects, the predatory trout also contribute to the decline of the western terrestrial garter snake and some birds that depend on these prey species (Matthews et al. 2001; Knapp 2005;Bunn et al. 2007). Introduced non-native fish are also a major stressor in waters previously occupied only by native fish.

DFG is conducting a field study of fish, amphibians, and reptiles in the HMLs of the Klamath, Cascade, and Sierra Nevada mountains. The multiyear project, begun in 1995, has collected data on three-fourths of the Sierra Nevada's 10,000 HMLs, and on nearly all HMLs in the Klamath and Cascade mountains of California. The results of the study are serving to inform aquatic biodiversity management plans (ABMPs) that are being prepared for the high-mountain watersheds of the Sierra Nevada. The goal of these plans is to protect and restore native amphibians and other fauna while maintaining thriving recreational fisheries.

Central Valley and Bay-Delta Region

The Central Valley and Bay-Delta Region comprises most of the low-lying lands of central California. Forty percent of the state's water falls as either rain or snow over much of the northern and central parts of the state and drains into the Sacramento or San Joaquin Rivers, which feed into the Sacramento–San Joaquin Delta (Delta). The Delta and the San Francisco Bay together form California's largest estuary (1,600 square miles of waterways). The region has four subregions, each with its own unique climate, topography, ecology, and land use: the San Francisco Bay area, the Delta, the Sacramento Valley, and the San Joaquin Valley.

The **San Francisco Bay** area is the most densely populated area of the state of California outside of the southern California metropolitan region. The region consists of low-lying baylands, aquatic environments, and watersheds that drain into the San Francisco Bay. The region is bounded on the east by the Delta, on the west by the Pacific Ocean, in the north by the North Coast–Klamath Region, and on the south by the Central Coast Region. Low coastal mountains surround the region, with several peaks rising above 3,000 feet. The climate is characterized by relatively cool, often foggy summers, and cool winters. The area receives 15–25 inches of rain annually from October to April, leaving most of the smaller streams dry by the end of summer. The topography of the San Francisco Bay area allows for a variety of habitats, including deep and shallow estuarine environments in the

bay itself. The bay also supports many marine species. Along the shoreline are coastal salt marshes, coastal scrub, tidal mudflats, and salt ponds. Ninety percent of the surface water from the Sacramento and San Joaquin Rivers and their tributaries is received via the Delta. Other major river drainages include the Napa and Petaluma Rivers and the Sonoma, Petaluma, and Coyote Creeks.

The Great Central Valley contains the **Sacramento Valley, the San Joaquin Valley, and the Delta.** Together they form a vast, flat valley, approximately 450 miles long and averaging 50 miles wide, with elevations almost entirely below 300 feet. The Sutter Buttes (2,000 feet) are the only topographic feature that exceeds that height. The Central Valley is surrounded by the Sierra Nevada on the east, the Coast Ranges on the west, the Tehachapi Mountains on the south, and the Klamath and Cascade mountains on the north. The Central Valley has hot, dry summers, and foggy, rainy winters. Annual rainfall averages from 5 to 25 inches, with the least rainfall occurring in the southern portions and along the west side (in the rain shadow of the coastal mountains). Agriculture dominates land use in the Central Valley. The major natural upland habitats are annual grassland, valley oaks on floodplains, and vernal pools on raised terraces.

The **Delta** is a low-lying area that contains the tidally influenced portions of the Sacramento, San Joaquin, Mokelumne, and Cosumnes Rivers. The Delta was once a huge marsh formed by the confluence of the Sacramento and San Joaquin Rivers but has been extensively drained and diked for flood protection and agriculture.

The **Sacramento Valley** contains the largest river in the state, the Sacramento River. The Sacramento River and its numerous tributaries support winter-run, spring-run, and fall-/late fall–run Chinook salmon populations; steelhead; green sturgeon; and hardhead. The lower 180 miles of the river are contained by levees, and excess floodwaters are diverted into large bypasses to reduce risks to human populations.

The **San Joaquin Valley** has two distinct, or separate, drainages. In the northern portion, the San Joaquin River flows north toward the Delta. It captures water from the Stanislaus, Tuolumne, and Merced Rivers and supports fall-/late fall–run Chinook salmon populations, steelhead, and hardhead populations. The southern portion of the valley is isolated from the ocean, except in very wet years when it overflows to the San Joaquin River, and otherwise drains into the closed Tulare Basin. Lakes and vast wetlands in this region are now dry most of the time because water has been dammed and diverted to upland agriculture.

There are 490 vertebrate species, including 279 birds, 88 mammals, 40 reptiles, 18 amphibians, and 65 fish, that inhabit the Central Valley and Bay-Delta Region at some point in their life cycle. Thirteen special-status species are specifically addressed in this document, and 30 additional special-status vertebrate species are potentially found in areas of Program influence.

Major stressors affecting wildlife and habitats in the Central Valley and Bay-Delta Region include urban, residential, agricultural, and solar energy growth and development; water management conflicts; water pollution; invasive species; and climate change.

Hatcheries

Characteristics of the individual trout, salmon, and steelhead hatcheries are summarized in Tables 2-2 and 2-5 in Chapter 2, and in Appendix A. The location of each hatchery is shown in Figure 2-1, which also shows the various DFG management regions within which the hatcheries are located. Note that the Fillmore Hatchery is within DFG Region 5 but is managed by DFG Region 6. The

following sections briefly describe the location and setting for each hatchery. For detailed descriptions of each hatchery's watersheds, water usage, and impacts on water quality, refer to Chapter 3, "Hydrology, Water Supply, and Water Quality." Appendix A gives a more detailed description of each hatchery's structures and operations.

American River Hatchery

This 20-acre hatchery complex is sited on the south bank of the American River, approximately 1,000 feet downstream from Nimbus Dam in Sacramento County. It is located in the Central Valley and Bay-Delta Region in a residential setting with remnant oak and riparian woodland along the American River.

Black Rock Rearing Ponds

Black Rock Rearing Ponds, an annex to Mount Whitney Hatchery, is about 10 miles north of the Mount Whitney Hatchery. It is located in the Sierra Nevada and Cascades Region in a rural setting dominated by sagebrush scrub.

Coyote Valley Fish Facility

The Coyote Valley Fish Facility, located on the east branch of the Russian River near the town of Ukiah, provides seasonal support to Warm Springs Hatchery by providing a facility for holding and imprinting, prior to release, steelhead produced at Warm Springs. It is located in the North Coast–Klamath Region in a rural setting dominated by agricultural lands and oak-conifer forest.

Crystal Lake Hatchery

The Crystal Lake Hatchery is on the south shore of Baum Lake, in eastern Shasta County. It is located in the Sierra Nevada and Cascades Region in a rural setting dominated by sagebrush and oak-pine woodland.

Darrah Springs Hatchery

The Darrah Springs Hatchery is approximately 25 miles northeast of Red Bluff, near Manton, in Tehama County. It is located in the Sierra Nevada and Cascades Region in a rural setting dominated by oak-pine woodland.

Feather River Hatchery

The Feather River Hatchery is located on the north side of the Feather River, 4 miles downstream from the Oroville Dam. It is located in the Central Valley and Bay-Delta Region in a residential area with some remnant riparian vegetation along the Feather River and an abandoned orchard on the bluffs above the hatchery.

Fillmore Hatchery

Fillmore Hatchery is located in Ventura County, 1 mile east of the town of Fillmore. It is located in the South Coast Region in a rural setting dominated by agricultural lands, grasslands, and chaparral. This location is within DFG Region 5, but the hatchery is administered by Region 6.

Fish Springs Hatchery

Fish Springs Hatchery is located on the eastern slope of the Sierra Nevada approximately 5 miles south of Big Pine, California. It is located in the Sierra Nevada and Cascades Region in a rural setting dominated by sagebrush scrub and agricultural lands.

Hot Creek Hatchery

The facility is located approximately 7 miles east of the town of Mammoth Lakes, California. It is located in the Sierra Nevada and Cascades Region in a rural setting dominated by sagebrush scrub.

Iron Gate Hatchery

The Iron Gate Hatchery is downstream from the Iron Gate Dam on the Klamath River in Siskiyou County. It is located in the North Coast–Klamath Region in a rural setting dominated by sagebrush and oak-pine woodland. River flows at the hatchery are highly regulated by releases from Iron Gate Dam.

Kern River Planting Base

This facility is located 1 mile north of Kernville, California. It is located in the Sierra Nevada and Cascades Region in a rural setting dominated by oak-pine woodland and riparian woodland along the Kern River.

Mad River Hatchery

The Mad River Hatchery is south of the town of Blue Lake in Humboldt County. It is located in the North Coast–Klamath Region in a rural setting dominated by coniferous forest. River flows at the hatchery are not significantly affected by releases from upstream dams.

Merced River Hatchery

The Merced River Hatchery is located immediately downstream from the Crocker-Huffman Dam on the Merced River, a tributary to the San Joaquin River. It is located in the Sierra Nevada and Cascades Region in a rural setting dominated by grassland and riparian woodland along the Merced River

Moccasin Creek Hatchery

The Moccasin Creek Hatchery is located between Lake Tahoe and the Yosemite Valley in the town of Moccasin. It is located in the Sierra Nevada and Cascades Region in a rural setting dominated by oak-pine woodland.

Mojave River Hatchery

This hatchery is located near Victorville in the Mojave Desert Region in an urban setting with some remnant desert scrub habitat.

Mokelumne River Hatchery

The Mokelumne River Hatchery is located in Clements, San Joaquin County. It is located in the Central Valley and Bay-Delta Region in a rural setting dominated by grassland, oak savannah, and riparian woodland.

Mount Shasta Hatchery

The Mount Shasta Hatchery is on the west side of Mount Shasta, in Siskiyou County. It is located in the Sierra Nevada and Cascades Region in a rural residential setting dominated by pine forest.

Mount Whitney Hatchery

The facility is located 2 miles north of the town of Independence, California. It is located in the Sierra Nevada and Cascades Region in a rural setting dominated by sagebrush scrub and riparian vegetation along the adjacent creek.

Nimbus Hatchery

The Nimbus Hatchery is located adjacent to the American River near Sacramento, downstream from Nimbus Dam. It is located in the Central Valley and Bay-Delta Region in a residential setting with remnant oak and riparian woodland along the American River. Flows in this stretch of the lower American River are highly regulated by the flood control and water storage regimens of Folsom Dam operations.

San Joaquin Hatchery

This hatchery is located in the town of Friant, near Fresno. It is located in the Sierra Nevada and Cascades Region in a rural setting dominated by grasslands, agricultural lands, and riparian vegetation along the San Joaquin River.

Silverado Fisheries Base

The Silverado Fisheries Base is located near Silverado Trail adjacent to DFG's headquarters office near Yountville, Napa County. It is located in the Central Valley and Bay-Delta Region in a rural setting dominated by agricultural lands and oak woodland.

Thermalito Annex

The Feather River Hatchery Thermalito Annex is located east of Richvale and west of Oroville. It is located in the Central Valley and Bay-Delta Region in a rural setting and is surrounded by agricultural lands and the Thermalito Afterbay.

Trinity River Hatchery

The Trinity River Hatchery is adjacent to the Trinity River near Lewiston, Trinity County. It is located in the North Coast–Klamath Region in a rural setting dominated by coniferous forest. River flows at the hatchery site are highly regulated by discharges from the Trinity Dam, immediately upstream.

Warm Springs Hatchery

The Warm Springs Hatchery is located just below Warm Springs Dam on Lake Sonoma. It is located in the North Coast–Klamath Region in a rural setting dominated by agricultural lands and oak-conifer forest.

Environmental Consequences

Methods

Appropriate methods for investigating environmental consequences were determined by review of the array of potential environmental impacts identified during scoping. The potential environmental consequences can broadly be assigned to each of the seven programs: the trout hatchery program, the trout stocking program, the salmon and steelhead hatchery program, the salmon and steelhead stocking program, the Classroom Aquarium Education Project (CAEP), the Fishing in the City program, and the private stocking permit program. Each program potentially affects biological resources via different mechanisms, though there are many similarities between the programs.

The trout hatchery program and the salmon and steelhead hatchery program both have the potential to affect biological resources via hatchery operations. Environmental consequences associated with hatchery operations are related to the physical and biological interaction of a hatchery facility with its surrounding environment. Two impacts concern the effects of water withdrawals for hatchery use; all others concern the effects of routine and accidental discharges from the hatchery. Types of impact discussed in this analysis include the biological effects of the following:

- release of nutrients to surface waters via hatchery water discharges;

- changes in salinity, pH, and dissolved oxygen (DO) in surface waters caused by hatchery water discharges;

- suspended solids delivered to surface waters in hatchery water discharges;

- release of aquaculture treatment chemicals and drugs in hatchery water discharges;

- release of nonnative, potentially invasive species via hatchery water discharges (such releases are unlawful and would only occur by accident);

- release of pathogens via hatchery water discharges (these are pathogens that may harm aquatic organisms, but not humans; such releases are unlawful and would only occur by accident);

- changes in stream flow due to diversion of surface water into hatcheries or due to hatchery water discharges;

- entrainment of aquatic organisms due to diversion of surface water into hatcheries;

- effects of predator control performed at the hatchery on native fish and wildlife; and

- effects on aquatic food webs.

Fish stocking programs also can affect biological resources. These effects arise from stocking activity itself, as well as from the presence and behavior of stocked fish within aquatic ecosystems, and can arise due to various mechanisms of effect, including direct interaction between hatchery and native

fish and wildlife by predation, competition, or interbreeding; and effects on ecosystem functions. These effects are assigned to the following potential impact mechanisms:

- effects due to predation by stocked fish and competition for food and space between stocked fish and native fish and wildlife;

- effects on native fish and wildlife from potential accidental release of invasive species during the stocking program;

- effects on native fish and wildlife from potential accidental release of water-borne pathogens (none of which pose a direct threat to human health but may afflict aquatic organisms) or of diseased fish;

- effects on food webs resulting from general changes in aquatic ecosystems;

- effects on the genetic fitness and diversity of native salmonids due to interbreeding between hatchery and wild origin salmonids;

- effects on native fish and wildlife due to unauthorized or inappropriately authorized releases of hatchery fish;

- effects on native fish and wildlife resulting from non-target harvest; and

- effects on aquatic and riparian ecosystems due to activity by anglers.

The principal tool used to screen for potential impacts associated with hatchery operations or fish stocking was a GIS-based evaluation of whether impacts and sensitive resources occur in close proximity to each other. Impact potential was identified using GIS databases showing the location of hatcheries and the DFG stocking locations (Hatchery Information System),and sensitive resource locations were identified using databases (cited on the species range maps) showing the known range of each decision species. GIS shape files for trout, steelhead and salmon stocking locations between 2004 and 2008 were overlain on GIS shape files for the decision species ranges. The text in this chapter indicates the numbers of these intersections. These numbers are not exact. The stocking database may contain minor additions or exclusions when compared to actual stocking activity. In addition, the stream stocking locations are represented by stream segments that, in some cases, extend beyond the likely range of effects associated with the actual stocking site. DFG staff familiar with actual stocking locations and local information on the distribution of these sensitive species reviewed the GIS analysis and in some cases provided information that was used to modify the assessment of which locations represented a potential for hatchery operations or stocking activities to affect individual decision species.

Significance Criteria

The State CEQA Guidelines (Title 14, Chapter 3 of the California Code of Regulations [CCR]), at Section 15064.7, encourage public agencies to develop thresholds of significance to use in determining the significance of environmental effects when complying with CEQA. In this same section, the State CEQA Guidelines define a threshold of significance as "an identifiable quantitative, qualitative or performance level of a particular environmental effect, non-compliance with which means the effect will normally be determined to be significant by the agency and compliance with which means the effect normally will be determined to be less than significant."

The significance criteria used to evaluate impacts on biological resources are based on and incorporate the mandatory findings of significance, as listed in Section 15065 of the State CEQA Guidelines (Title 14, Chapter 3 of the CCR); criteria contained in Appendix G, "Environmental Checklist Form," of the State CEQA Guidelines; and guidance contained in Section 1508.27 of the Council on Environmental Quality (CEQ) NEPA regulations regarding significance determinations. The criteria have been applied to all determinations of effect for each impact mechanism discussed in following pages. All aspects of the Program are subject to these criteria, including the trout hatchery program, the salmon and steelhead hatchery program, the trout stocking program, the salmon and steelhead stocking program, the private stocking permit program, the Fishing in the City program, and the CAEP. The Program would have a significant effect on biological resources if it would:

- have a substantial adverse effect, either directly or through habitat modifications, including designated critical habitat, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by DFG or USFWS, including substantially reducing the number or restricting the range of an endangered, rare, or threatened species;

- have a substantial adverse effect on any sensitive natural community identified in local, state, or federal regional plans, policies, or regulations, including long-term degradation of a sensitive plant community because of substantial alteration of a landform or site conditions;

- have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (CWA), including marsh, vernal pool, and coastal wetlands, through direct removal;

- substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, or threaten to eliminate a plant or animal community; or

- conflict substantially with goals set forth in an approved recovery plan for a federally listed species, or with goals set forth in an approved State Recovery Strategy (FGC Section 2112) for a state listed species.

Impacts and Mitigation Measures

Impacts of the Hatchery Operations

Background

This section of the biological resources analysis considers the effects of operating both the trout and the salmon and steelhead hatcheries managed by DFG. The trout and the salmon and steelhead operations were analyzed together because of the similarities of their effects on the environment. Information collected into a Program-specific geographic information system (GIS) database has been used to identify instances where hatchery operations might affect special-status fish and wildlife species or sensitive habitats. Potential effects are considered within the "hatchery vicinity," defined to extend 0.25 mile upstream and 3.0 miles downstream of a hatchery (see Figures 4-2 through 4-24). (Figures 4-2 through 4-67 are located at the end of this chapter.)

The hatchery vicinity was chosen to provide a conservative estimate of potential impacts arising from hatchery operations. Hatchery effluents are discharged into rivers or river tributaries (except for the Fillmore Hatchery, for which discharge water is used for irrigation of nearby fields) and therefore potential effects will be focused on downstream aquatic communities. Literature reviews on the environmental effects due to hatchery waste loadings reported high levels of variability in downstream effects. This variability is a reflection of the difficulty to develop a uniformly clear picture of aquaculture effluents and environmental impacts. This difficulty stems from differences in culture systems, production rates and timing, quantity and quality of source and recipient waters, hydraulic retention time, fish species and age, feed types and feeding rates, and management procedures such as cleaning and effluent treatment (Westers 2003). Few articles were reviewed that found impacts to the aquatic communities at distances greater than 3 miles (Westers 2002), while the majority of literature reviewed on hatchery effluent impacts suggest that the influence of hatchery effluents tends to be localized in the immediate downstream reach (Camargo 1992; Doughty and McPhail 1995; Loch 1996; Selong and Helfrich 1998; Fries and Bowles 2002; Stephens 2003). In a comprehensive study on the quality and fate of fish hatchery effluents during the summer low flow season it was reported that while hatchery effluents do cause changes in downstream aquatic communities, in most cases recovery was observed within 0.2 miles downstream (Kendra 1989). The downstream hatchery vicinity of 3 miles therefore is a conservative value that will capture any significant impacts arising due to hatchery operations. The analysis of hatchery operation effects on upstream communities was limited to 0.25 miles upstream of most hatcheries. This is a reasonable approach as many of the hatcheries are isolated from upstream waters due to the presence of dams, are located at the source waters of a spring, or are fed by groundwater. In some cases, the upstream hatchery vicinity was increased if 1) non-effluent-related hatchery operation impacts were identified and 2) the water body allowed the potential for these impacts to propagate to communities at a distance greater than 0.25 miles.

Multiple sources of information were sought on the ranges and critical habitat for special-status species that might be affected by hatchery discharges, hatchery water diversions, or escape of hatchery fish; this information was overlain with the hatchery vicinity to determine the potential for effects. A potential for effect was assumed if any of the special-status species identified in Table 4-1 was known to occur in the hatchery vicinity. Occurrence of these species in the vicinity of each hatchery is summarized in Table 4-2.

Table 4-2. Special-Status Species in the Hatchery Vicinity[a] for Each Fish Hatchery

Species	American River	Black Rock	Coyote Valley	Crystal Lake	Darrah Springs	Feather River	Fillmore	Fish Springs	Hot Creek	Iron Gate	Kern River	Mad River	Merced River	Moccasin Creek	Mojave River	Mokelumne River	Mount Shasta	Mount Whitney	Nimbus	San Joaquin	Silverado	Thermalito	Trinity River	Warm Springs
Shasta crayfish				X																				
River lamprey	X					X										X					X			
Green sturgeon						X				X													X	
Eulachon												X												
Owens tui chub									X															
Arroyo chub							X								X									
Hardhead	X		X	X		X					X	X	X			X	X			X	X			X
Owens speckled dace									X															
Owens sucker		X						X	X									X						
Santa Ana sucker							X																	
Tidewater goby																								
Steelhead (Klamath Mountains Province DPS)										X													X	
Steelhead (northern California DPS)							X					X												
Steelhead (Central Valley DPS)	X			X	X								X			X								
Steelhead (central California coast DPS)			X																		X			X
Coho salmon (south Oregon / north California coast ESU)										X		X											X	
Coho salmon (central California coast ESU)			X																					X
Chinook salmon (Klamath-Trinity Rivers spring-run ESU)										X													X	
Chinook salmon (California coastal ESU)			X									X												X
Chinook salmon (Central Valley spring-run						X																		

Species	American River	Black Rock	Coyote Valley	Crystal Lake	Darrah Springs	Feather River	Fillmore	Fish Springs	Hot Creek	Iron Gate	Kern River	Mad River	Merced River	Moccasin Creek	Mojave River	Mokelumne River	Mount Shasta	Mount Whitney	Nimbus	San Joaquin	Silverado	Thermalito	Trinity River	Warm Springs
ESU)																								
Chinook salmon (Central Valley fall-/ late fall–run ESU)	X					X							X			X								
California tiger salamander	X																							
Northwestern salamander												X												
Long-toed salamander																								
California giant salamander																					X			X
Pacific giant salamander			X									X											X	
Southern torrent salamander												X												
Rough-skinned newt			X		X							X					X				X		X	X
Red-bellied newt			X																					X
Sierra newt						X																		
Coast Range (California) newt			X			X								X										
Western spadefoot	X					X	X						X		X					X		X		
Western toad	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
California treefrog						X																		
Pacific treefrog	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
Northern red-legged frog												X												
California red-legged frog				X			X									X					X			X
Foothill yellow-legged frog			X	X							X	X	X				X				X		X	X
Mountain yellow-legged frog (northern DPS)									X									X						
Cascades frog																	X							
Western pond turtle	X		X	X	X	X	X			X	X	X	X	X			X			X	X	X	X	X
Common garter snake	X		X	X	X	X	X			X	X	X	X	X		X	X			X	X	X	X	X

Species	American River	Black Rock	Coyote Valley	Crystal Lake	Darrah Springs	Feather River	Fillmore	Fish Springs	Hot Creek	Iron Gate	Kern River	Mad River	Merced River	Moccasin Creek	Mojave River	Mokelumne River	Mount Shasta	Mount Whitney	Nimbus	San Joaquin	Silverado	Thermalito	Trinity River	Warm Springs
Mountain garter snake	X	X	X		X	X		X	X	X		X		X		X	X			X	X	X	X	X
Sierra (western aquatic) garter snake				X	X				X					X										
Two-striped garter snake							X																	
Giant garter snake	X															X						X		
Bald eagle	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X
Osprey	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X		X	X	X	X	X
Willow flycatcher (includes Southwestern willow flycatcher)				X	X		X		X			X						X						

a The hatchery vicinity is defined to extend 0.25 mile upstream and 3.0 miles downstream of a hatchery.

Numerous studies have related downstream water quality degradation to salmonid fish cultures. Examples of observed impacts include increases in suspended solids, nutrients, and biological oxygen demand (Hinshaw 1973). Impacts on biological resources dependent on aquatic environments may occur because of the daily discharge of hatchery wastewater. Wastewaters may include uneaten food, fecal matter, soluble metabolites, algae, parasitic microorganisms, drugs, and other chemicals. All have the potential to disrupt the receiving environment. Other hatchery-related impacts on water quality can include decreases in dissolved oxygen (DO) levels due to metabolic activity by the hatchery fish, and increased water temperature fluctuations. Many of these changes in water quality parameters are problematic in environments suitable for salmonids and other species highly sensitive to water quality impairments, such as aquatic insects. Wild salmonids typically require low water temperatures and spawning gravels that are relatively free of fine sediments. Furthermore, impaired water quality has been associated with increased risk of viral and bacterial fish diseases and impacts on other aquatic vertebrates (Svobodová 1993).

The potential for significant water quality changes as a result of hatchery operations at each of the 24 DFG hatchery facilities is evaluated in Chapter 3, "Hydrology, Water Supply, and Water Quality." This evaluation considers whether natural waste products associated with hatchery production, chemotherapeutics associated with hatchery operations, and increases in stream temperatures due to hatchery water use are of a sufficient magnitude to significantly degrade local waters. Although no hatchery operations are determined to cause significant impacts on water quality, some infrequent NPDES violations have been observed. Although these discharge violations have been infrequent and of a small enough magnitude not to significantly affect water quality, the potential for these exceedances to affect biological resources remains and, therefore, is also evaluated within this section.

Risks to local native aquatic communities exist because of the infrequent, unintentional release of hatchery-raised fish into local waters. These risks include pathogen and invasive species transmission, interbreeding, competition for limited resources, predation, and establishment of naturally reproducing hatchery-origin stocks. For most of these adverse impacts to occur, hatchery fish would have to escape in sufficient numbers to outcompete native populations or survive long enough to interbreed with native populations. Although the frequency of escape from hatcheries is very low, escaped salmonids most likely would survive because DFG hatcheries exist in aquatic settings suitable for salmonids. The principal causes of escape from hatchery facilities are equipment failure, operational errors, and flooding. The magnitude of unintentional fish-release events during the past 5 years has been evaluated using DFG records of operations and through discussions with DFG regional hatchery supervisors. Potential impacts on biological resources from unintentional hatchery fish releases were evaluated in this chapter when both of the following were true.

- A review of existing information revealed that unintentional releases occurred within the past 5 years.

- A special-status species, community, or movement corridor determined through GIS mapping exists within 3 miles downstream or 0.25 mile upstream of the hatchery location.

In cases where large or frequent unintentional hatchery releases have been identified, qualitative evaluations describe the potential effect on biological resources using information obtained from hatchery managers and published literature, as cited in the text.

The diversion of natural stream flow for hatchery operational water supply poses some risk to biological resources downstream of the diversion. The location and size of each hatchery water source extraction was reviewed in the context of total stream or spring flow to determine whether a substantial change in water availability was being created by the diversion.

Effects from Nutrient Releases to Rivers and Streams

It was concluded in Chapter 3, "Hydrology, Water Supply, and Water Quality," that discharges from DFG hatcheries into waters of the state cause a less-than-significant impact on water quality because of nutrient biostimulation. All Regional Water Quality Control Board (RWQCB) basin plans contain a narrative objective for biostimulation that specifies that receiving waters will not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause a nuisance or adversely affect the water for beneficial uses. The nutrients evaluated included nitrate, total nitrogen (TN), orthophosphate, total phosphorus, and ammonium.

Impact BIO-1: Effects of Nitrate and Total Nitrogen Releases to Rivers and Streams (Less than Significant)

Based on the analysis of nitrate and TN discharges from DFG hatcheries into waters of the State, it was concluded that nitrate discharges would not cause significant impacts on water quality. Although less-than-significant impacts were determined for water quality impacts, infrequent nitrate exceedances were observed at the Hot Creek and Mojave River Hatcheries.

In addition to the biostimulation effects associated with elevated nitrate levels, nitrate can be toxic to aquatic animals. Nitrate toxicity increases with increasing nitrate concentrations and exposure times. The main toxic action of nitrate is due to the conversion of oxygen-carrying pigments to forms that are incapable of carrying oxygen. Studies have shown that a nitrate concentration of 10 milligrams (mg) nitrate per liter(the Environmental Protection Agency [EPA] federal maximum level for drinking water) can adversely affect freshwater invertebrates (*E. toletanus*, *E. echinosetosus*, *Cheumatopsyche pettiti*, and *Hydropsyche occidentalis*), fishes (*Oncorhynchus mykiss*, *Oncorhynchus tshawytscha*, and *Salmo clarki*), and amphibians (*Pseudacris triseriata*, *Rana pipiens*, *Rana temporaria*, and *Bufo bufo*), at least during long-term exposures. Levels below this concentration are recommended to protect sensitive freshwater animals from nitrate pollution (Camargo et al. 2005).

A single nitrate exceedance in the Mojave River Hatchery effluent was detected in one of the seven quarterly water samples taken between January 2008 and August 2009. The nitrate level was measured at 5.2 mg/L. This detected level is greater than the Lahontan RWQCB basin plan's specific nitrate objective of 5 mg/L N for the West Fork Mojave River, which is applicable for the Mojave River Hatchery. Discharges from the Mojave River Hatchery run across the Victor Valley College property through a wetland area used by avian, terrestrial, and aquatic organisms prior to reaching the Mojave River. It is well documented that wetlands are capable of significantly reducing nitrates from effluent waters (Adams n.d.; Iovana et al. 2008). Considering the presence of the wetlands, the infrequency of nitrate exceedances, and the magnitude of the one exceedance, the effect on biological resources is less than significant.

Although the magnitude and frequency of the Hot Creek Hatchery's instantaneous discharge exceedances of maximum nitrate and TN objectives have been low, little information exists on the duration of exceedances. A study completed in 2007, using multiple benthic macroinvertebrate indices, found that Hot Creek Hatchery's discharge was adversely affecting the biotic integrity below the facility (Jellison et al. 2007). The study concluded that the primary influence on downstream

benthic populations was due to nutrient enrichment from the phosphorus- and nitrogen-rich spring used for source waters. However, it was further concluded that hatchery metabolic waste products also contributed to nitrogen enrichment in downstream waters. This hatchery-related addition of nitrogen is a secondary cause of the observed impacts, and of a magnitude that is likely sufficient to cause impacts on biotic integrity in absence of the primary cause.

A time schedule order (TSO) issued by the Lahontan RWQCB (NO R6V-2009-0016) on May 11, 2009, established a schedule for DFG to develop and implement an acceptable compliance plan to address these water quality issues at the Hot Creek Hatchery. The TSO requires the hatchery to achieve compliance with all requirements of its NPDES permit by April 28, 2014. Because the TSO compliance period extends beyond 1 year, the TSO also establishes interim performance-based effluent limitations for nitrate + TN. The TSO also contains quarterly assessment reporting to track the DFG's compliance with the TSO and progress toward returning the facility to compliance with its NPDES permit effluent limitations.

Jellison et al. (2007) identified the Hot Creek Hatchery's settling ponds as inadequate at reducing nutrient levels and total suspended solids (TSS) in hatchery discharges. Inadequate water clarification was the result of waste accumulation in its settling ponds, reducing the depth of the ponds. This limited the water retention time. To increase the settling ponds' effectiveness in reducing nutrient and TSS discharges, DFG conducted a pilot project that involved pumping the settling pond sludge into tankers and then transporting the sludge into an empty raceway to dry. Roughly 15%–20% of one pond was cleaned. At this point, DFG anticipates hiring a contractor to design and implement a cost-effective and timely approach to removing the sludge from the hatchery's settling ponds.

Assuming that Hot Creek Hatchery successfully meets the schedule and performance requirements of the TSO, biological impacts associated with nitrate and TN releases to rivers and streams at all DFG hatcheries would be less than significant.

Impact BIO-2: Effects of Orthophosphate and Total Phosphorus Releases to Rivers and Streams (Less than Significant)

Based on the analysis of orthophosphate and total phosphorus discharges from DFG hatcheries into waters of the state, phosphorous discharges do not cause significant impacts on water quality (see Chapter 3, "Hydrology, Water Supply, and Water Quality"). Although phosphorus in the aquatic environment can be toxic, toxicity rarely occurs and is generally not a concern. Of more concern are the increases in organic matter that arise in the presence of elevated phosphorus levels. This organic matter will eventually decompose and subsequently use DO during this process. Based on a review of the discharger monitoring report (DMR) data for the 10 hatcheries that record visual observations of potential nuisance growth conditions in the receiving water, the hatcheries typically do not cause nuisance biostimulatory responses such as discoloration, bottom deposits, visible films/sheens, or objectionable growth (i.e., fungi/slimes). The one exception has been observed at the Hot Creek Hatchery. Increases in benthic algae growth downstream of the Hot Creek Hatchery have been observed when compared with upstream conditions. Although this increase in algae production is a significant effect on the general ecological condition of Hot Creek below the hatchery, it has not been directly attributed to phosphorus derived from hatchery-related operations. The majority of phosphate in hatchery discharge water (i.e., greater than 75%) is contributed by the naturally elevated phosphate concentrations in the Hot Creek spring source water supply. These natural phosphate concentrations are present at sufficient concentrations to

not limit aquatic algae growth (Jellison et al. 2007). Maximum orthophosphate and concentrations are similar in the source water and hatchery water. It is therefore unlikely that phosphorus enrichment due to hatchery operations is responsible for the observed differences in biotic integrity in the vicinity of the hatchery (Jellison et al. 2007).

Assuming that Hot Creek Hatchery meets the schedule and performance requirements of the TSO (detailed in the analysis of Impact BIO-1), biological impacts associated with orthophosphate and total phosphorus releases to rivers and streams at all DFG hatcheries would be less than significant.

Impact BIO-3: Effects of Ammonia Releases to Rivers and Streams (Less than Significant)

Based on the analysis of ammonia discharges from DFG hatcheries into waters of the state, ammonia discharges would not cause significant impacts on water quality (see Chapter 3, "Hydrology, Water Supply, and Water Quality"). This evaluation was based on the maximum ammonia values recorded for hatcheries with available data and concluded that ammonia values would not exceed the lowest EPA-recommended chronic aquatic life criteria.

Effects of Salinity, pH, and Dissolved Oxygen Changes in Rivers and Streams

Potential impacts on water quality due to hatchery operations' influence on pH, DO, and salinity in receiving waters are analyzed in Chapter 3, "Hydrology, Water Supply, and Water Quality." Hatchery effluent NPDES permit limitations for these three water quality parameters reflect the RWQCBs' interpretation of appropriate numerical concentrations that are consistent with basin plans. DO and pH changes were evaluated against the most stringent basin plans, which contain specific numeric water quality objectives for the protection of aquatic life. Salinity limitations for most hatchery discharges are controlled by agricultural beneficial use criteria, because they are the most restrictive for this water quality parameter.

Impact BIO-4: Effects of Salinity Changes in Rivers and Streams (Less than Significant)

The analysis of salinity data for undiluted DFG hatchery discharges into waters of the state found that electrical conductivity (EC) and total dissolved solids (TDS) concentrations do not exceed the applicable agricultural EC goal or secondary drinking water maximum contaminant levels (MCLs). However, information in the NPDES permits for the Feather River Hatchery and the Thermalito Annex indicate that chloride in the undiluted hatchery discharges exceeds the 106 mg/L chloride agricultural goal. Even though discharges from the Thermalito Annex discharge to the Thermalito Afterbay and not directly to the Feather River at the Feather River Hatchery, an analysis of the combined discharges on the Feather River was conducted (see Chapter 3, "Hydrology, Water Supply, and Water Quality"). With the dilutions available even under low flow conditions in the Feather River, the maximum incremental increase in receiving water chloride was calculated to be 32 mg/L. Water quality data collected for the Oroville Facilities Relicensing program (California Department of Water Resources 2004) support this worst-case analysis of chloride. This worst-case salinity concentration of 32 mg/L is more than 125 times lower than published results that indicate that *Daphnia magna* will survive and reproduce well in water with salinities below 4,000 mg/L (Schuytema et al. 1998) and is nine times lower than published data for effects on wetland plants, which have a no-observable-effects level of 280 mg/L (Siegel 2007). Additional studies have found that acute toxicity values for stream macroinvertebrates exposed to saline waters range from 2,000 to 13,000 mg/L (Benbow and Merritt 2004). Invertebrate species are generally more sensitive to chloride than are vertebrate species. Fish have reported sodium chloride tolerances between 400

and 30,000 mg/L depending on whether they are freshwater or saltwater species (Seigel 2007). Therefore, no significant effect on downstream benthic or fish populations is anticipated from such exposures.

Impact BIO-5: Effects of pH Changes in Rivers and Streams (Less than Significant)

It was concluded in Chapter 3, "Hydrology, Water Supply, and Water Quality," that discharges from DFG hatcheries into waters of the state cause a less-than-significant impact on receiving water pH. The pH changes were evaluated against the most stringent basin plans that contain specific numeric water quality objectives for the protection of aquatic life.

The preferred pH range of trout is between 6.4 and 8.4, with a pH between 7.0 and 7.5 (without rapid fluctuations) being optimal. Most fish, including trout, generally are not seriously affected by a pH between 6.0 and 7.0. As values dip below 6.0, however, problems with all stream life become noticeable (Cincotta 2002). A study of the effects of aquatic acidity on Sierra Nevada amphibians found no correlation between the presence or absence of amphibians in field sites with pH levels as low as 5.4 (Air Research Board 1995). High pH levels are relatively toxic to aquatic species in the same way that relatively low levels of ammonia become dangerously toxic to aquatic organisms (Department of Fisheries Western Australia 2005).

Although less-than-significant impacts due to pH were determined for water quality within Chapter 3, pH exceedances were observed at the Thermalito Annex and the Moccasin Creek Hatchery. It is important to note that each hatchery experienced occurrences of pH of <6.5 or >8.5 at the downstream monitoring site. The pH exceedance at the Thermalito Annex was observed twice in 28 samples taken on a monthly basis, while the exceedance at Moccasin Creek Hatchery was observed only once in 60 samples taken on a weekly basis. At both hatcheries the incremental change in pH levels between source and effluent waters for both hatcheries is less than 0.5 unit. The small change in downstream versus upstream pH suggests these changes have little to do with hatchery operations. In addition, the frequency of pH exceedances detected at both hatcheries was very low. There was one observed exceedance at the Moccasin Creek Hatchery, and there were two observed exceedances at Thermalito Annex. Therefore, in the highly unlikely scenario that pH exceedances at either of these two hatcheries would affect biological resources, the impacts would be transient, quickly dissipating in the downstream environment, thus allowing any displaced organism to quickly repopulate any affected areas. This impact would be less than significant.

Impact BIO-6: Effects of Dissolved Oxygen Changes in Rivers and Streams (Less than Significant)

It was concluded in Chapter 3, "Hydrology, Water Supply, and Water Quality," that discharges from DFG hatcheries into waters of the state cause a less-than-significant impact on DO levels. DO changes were evaluated against the most stringent basin plans, which contain specific numeric water quality objectives for the protection of aquatic life.

DO is needed by nearly all aquatic organisms. Algae require DO for many chemical reactions that are essential for normal function. Fish and aquatic insects need oxygen to live and have developed gills to transfer DO from the water into their bodies. Like any other gas diffusion process, the transfer is efficient only above certain concentrations. In other words, oxygen can be present in the water but at too low a concentration to sustain aquatic life. DO depletion occurs when oxygen consumption exceeds oxygen production. This usually occurs when nutrients or organic matter enter the water in sufficient amounts to trigger rapid growth of oxygen-consuming algae or microorganisms, or it can

be caused by certain chemicals (e.g., formalin) that remove oxygen directly from the water column. If values of DO fall below about 5 mg/L for extended periods of time, trout and many other organisms become very stressed (Klamath Resource Information System 2009a). Concentrations below 5 mg/L may adversely affect function and survival of biological communities, and concentrations below 2 mg/L can lead to death for most fishes (Deas and Orlob 1999). In summer, warm water worsens the problem because increased metabolism requires more oxygen, but oxygen is less soluble in warm water.

Infrequent DO exceedances have been observed in discharges from six DFG hatcheries (Iron Gate, Warm Springs, Nimbus, Mokelumne River, Darrah Springs, and Hot Creek Hatcheries). As discussed in Chapter 3, DO levels monitored directly below hatcheries most likely are not representative of concentrations encountered by biological resources downstream of these hatcheries. Aeration, mixing of hatchery discharges with receiving water, and dilution with groundwater (in the case of the Nimbus Hatchery) serve to ameliorate DO changes associated with hatchery discharges. At most hatcheries, DO exceedances are infrequent, and even then the DO of discharge waters remains above 5 mg/L. If the DO conditions are always above the chronic criterion for growth (4.8 mg/L), the aquatic life at that location is not expected to be adversely affected. If the DO conditions at a site are below the juvenile/adult survival criterion of 2.3 mg/L, there is not enough DO to protect aquatic life. When persistent DO conditions are between these two values, further evaluation of duration and intensity of low DO is needed to determine whether the level of oxygen can support a healthy aquatic life community.

San Joaquin Hatchery had the most frequent DO exceedances, with four of 28 monthly sampling events detected below 7.0 mg/L. These exceedances all occurred in the months of June through August, The duration of each of the exceedances is not known. The lowest DO level detected was 6.4 mg/L. Although it is not optimal for coldwater fish conditions, this level of DO is not lethal to the aquatic communities (North Coast Regional Water Quality Control Board 2005).

At two hatcheries, the Black Rock Rearing Ponds and the Mojave River Hatchery, DO levels below 5.0 mg/L were detected. The exceedance of DO limitations at the Black Rock Rearing Ponds occurred once. The observed DO level in effluent, however, was only 0.5 mg/L lower than source waters. This suggests that the observed low DO value was primarily a response to low DO in the source waters, rather than an effect of hatchery operations. Moreover, water from the Black Rock Rearing Ponds is discharged into the Los Angeles Aqueduct, which does not support any of the enumerated special-status species.

Quarterly sampling of the Mojave River Hatchery discharge found DO levels consistently below the 7.0 mg/L screening value. DO was less than the minimum instantaneous basin plan objective of 4.0 mg/L on two samples taken during 12 monthly measurements. The duration of these DO exceedances is not known; however, they are most likely a result of the low DO groundwater that is used for hatchery water. To maintain a healthy fish culture environment, source water in this hatchery is passed through aerators to ensure adequate DO levels. However, DO exceedances are routinely observed (Table 3-9).

Special-status species having habitat ranges that overlap with the Mojave River Hatchery include the arroyo chub, western toad, Pacific treefrog, and California red-legged frog. In a worst-case scenario where the DO levels measured at the settling pond discharge point were representative of levels measured in the main flow of the Mojave River, the arroyo chub would remain unaffected because of its exceptional tolerance for low DO concentrations (Castleberry and Cech 1986). Little direct impact

on the adult form of the amphibians would be expected because they breathe air and are not dependent on DO in water for life. Some amphibian tadpoles rely on DO as their principal oxygen source and could be affected by exposure to low DO levels. However, this effect is minimized by several factors.

- Tadpoles of all frogs can exchange atmospheric gases through their skin (Ultsch et al. 1999).

- Older tadpoles of the California red-legged frog develop lungs and can breathe air; all tadpoles are likely to be relatively old, or to have achieved metamorphosis, by the time the reduced DO conditions are achieved during late summer.

- Toad and frog tadpoles in general have good tolerance of low DO conditions; for example, *Rana sphenocephala* predominately occurs at DO concentrations of less than 3 mg/L in water temperatures of 10°C to 30°C, and *Bufo terrestris* prefers higher DO concentrations but will tolerate DO levels of less than 3 mg/L over the same temperature range (Noland and Ultsch 1981 in Ultsch et al. 1999).

Thus, seasonally reduced DO levels such as are currently observed at the Mojave River Hatchery would produce a less-than-significant impact on sensitive biological resources. Low DO concentrations have not been observed in the discharge from any other DFG hatcheries, so biological impacts associated with DO concentration in discharges to rivers and streams at all DFG hatcheries would be less than significant.

Effects of Suspended Solids Increases in Rivers and Streams

Impact BIO-7: Effects of Suspended Solids Increases in Rivers and Streams (Less than Significant)

High concentrations of suspended solids degrade water quality by reducing water clarity and decreasing light available to support photosynthesis. Reduction in photosynthesis and the subsequent reduction in plant matter may then lead to decreased food and habitat for herbivorous aquatic organisms, such as snails, insects, and fish. Furthermore, as photosynthesis slows, less oxygen is released into the water during daytime. These impacts can culminate in the death and decay of aquatic plants, resulting in further DO depletion and exacerbating already reduced DO levels (Angino and O'Brien 1967).

As stream velocities decrease, suspended solids may be deposited within the streambed and alter aquatic habitat for fish, macrophytes, and benthic organisms. Settling sediments also fill spaces between rocks and thereby can reduce habitat value for benthic organisms. In addition, deposited sediment is available for future re-suspension and subsequent transport during periods of increased stream discharge. Reduced water clarity due to suspended sediment also can affect predator-prey interactions, clog or abrade sensitive fish and insect gills, abrade soft tissues, and abrade or smother algal and microbial "mats" growing on rocks (Lakesuperiorstreams 2009).

Potential impacts on water quality due to increased turbidity or the release of TSS within hatchery effluent are analyzed in Chapter 3. Hatchery NPDES permit effluent limitations for turbidity and TSS reflect the RWQCBs' interpretation of appropriate numerical concentrations that are consistent with basin plans. Basin plan objectives for turbidity and TSS, however, are not specific for the protection of any single beneficial use.

Turbidities in the 10–25 nephelometric turbidity units (NTU) range and TSS concentrations near 35 mg/L have been shown to have deleterious effects on fish. TSS values between 18 and 35 mg/L can reduce fish feeding and abundance. TSS values in the range of 50 to 66 mg/L can result in reduced weight gain rates and avoidance behavior in adult rainbow and cutthroat trout (Garton n.d.).

Exceedances of turbidity or TSS have infrequently been observed at six of the DFG hatcheries. Potential impacts on downstream biological resources are moderated by: the infrequency of exceedance events, the biodegradable nature of hatchery solids, and the effects of the discharges being largely localized to mixing zones within receiving waters. It is of particular interest that both the Nimbus and Mokelumne River Hatcheries, with the highest net TSS concentrations, were not observed to have any turbidity exceedances. This finding suggests that the use of settling ponds with gravel bed percolation (at the Nimbus Hatchery) and effluent and stream flow mixing (at the Mokelumne River Hatchery) are substantially ameliorating changes in downstream water quality.

The highest net TSS concentration of 29.0 mg/L observed at the Mokelumne River Hatchery is of concern because this area provides habitat for the western pond turtle, the California Central Valley steelhead, and the Central Valley fall-/late fall–run Chinook salmon. However, biological observations in 2001 approximately 0.75 kilometer (km) downstream of the Mokelumne River Hatchery found little evidence of elevated TSS levels. These observations, made before and after a gravel habitat enhancement study, indicated low TSS and turbidity in both conditions. During the 2-year study, the enhanced spawning habitat for Chinook salmon 0.75 km downstream of the Mokelumne River Hatchery maintained suitable fish rearing habitat (Merz and Setka 2004).

Although the magnitude and frequency of TSS exceedances at the Hot Creek Hatchery were low, a study completed in 2007 concluded that Hot Creek Hatchery's discharge was adversely affecting the biotic integrity below the facility (Jellison et al. 2007). Downstream impacts were evaluated using multiple benthic macroinvertebrate indices. The primary cause of the observed low biotic integrity was associated with the geothermal springs that are the source water supply for the hatchery and Hot Creek. However, Jellison et al. (2007) also concluded that increased nutrient enrichment and TSS loading due to hatchery operations contributed significantly to the observed changes in biotic integrity.

Assuming that Hot Creek Hatchery meets the schedule and performance requirements of the TSO (detailed in the analysis of Impact BIO-1), biological impacts associated with suspended solids increases in rivers and streams at all DFG hatcheries would be less than significant.

Effects of Aquaculture Chemicals and Drugs in Rivers and Streams

Impact BIO-8: Effects of Aquaculture Chemicals and Drugs in Rivers and Streams (Less than Significant with Mitigation)

The water quality analysis (see Chapter 3) concluded that DFG hatchery discharges containing aquaculture treatment chemicals and drugs cause less-than-significant impacts on water quality. This evaluation, conducted for the majority of the treatment chemicals and drugs used at the hatcheries, was based on the lowest guidance concentration values identified by the RWQCBs for the protection of aquatic life.

Table 3-11 in Chapter 3 shows that copper sulfate, hydrogen peroxide, and potassium permanganate were each observed to exceed aquatic toxicity thresholds at least once during the monitoring periods. As is discussed within Impact HYD-8, "Water Quality Effects of Hatchery Discharges

Containing Aquaculture Treatment Chemicals and Drugs," both hydrogen peroxide and potassium permanganate have short half lives and are expected to dissipate and degrade rapidly in the receiving waters. Treatment applications are typically of short duration, and thus the potential exposure period in the receiving water is intermittent and of short duration. For example, hydrogen peroxide label use outlines dosing methods that dictate that the drug is to be used for 1 hour on alternating days or 15 minutes on consecutive days. Furthermore, as the material released in hatchery effluent is diluted, any sensitive benthic communities affected would be able to return to normal growth or repopulate the temporarily affected area. Aquatic invertebrates are known to repopulate after a temporary depletion; therefore, the actual acute risk to an environmentally significant freshwater invertebrate population as a result of hydrogen peroxide and potassium permanganate would be transient (Schmidt et al. 2006).

The short half lives of both hydrogen peroxide and potassium permanganate, along with dilution in the main stream flow will mitigate potential downstream impacts on biological resources, however, the copper sulfate discharge exceedances at the Darrah Springs Hatchery have the potential to cause a substantial adverse effect on downstream biological resources. The Darrah Springs Hatchery discharge is overseen by the Central Valley RWQCB. Most of the hatchery discharge is collected into a large pipe/canal system owned and operated by Pacific Gas and Electric Company (PG&E), called the PG&E canal. After Darrah Springs Hatchery discharge, the water goes through a siphon pipe to a canal and through a penstock and then ends up at Coleman National Fish Hatchery. Coleman National Fish Hatchery then uses the water to rear its fish (Radford, L. pers. comm). Use of copper sulfate is allowed per the NPDES permit.

Copper sulfate is toxic to many species of fish at or near the concentration necessary for its use in algae control (Dorzab and Arkoh 2005). Copper is a micronutrient and toxin. It strongly adsorbs to organic matter, carbonates, and clay, which reduces its bioavailability. Copper is highly toxic in aquatic environments and has effects in fish, invertebrates, and amphibians, with all three groups equally sensitive to chronic toxicity (U.S. Environmental Protection Agency 1993; Horne and Dunson 1995). Copper is highly toxic to amphibians (including mortality and sodium loss), with adverse effects in tadpoles and embryos (Horne and Dunson 1995; Owen 1981). Bioaccumulation of copper is higher in plants and animals than in the water or sediments in which they live and is particularly high in animals found in the sediments at the bottom of a water body and in shellfish, such as oysters, that can filter materials from large volumes of water. However, copper does not biomagnify in food webs (Solomon 2009).Copper sulfate and other copper compounds are effective algaecides (free copper ions are the lethal agent). Single-cell and filamentous algae and cyanobacteria are particularly susceptible to the acute effects, which include reductions in photosynthesis and growth, loss of photosynthetic pigments, disruption of potassium regulation, and mortality. Sensitive algae may be affected by free copper at low (parts per billion [ppb]) concentrations in fresh water. There is a moderate potential for bioaccumulation in plants and no biomagnification (USEPA 2008).

Much of the copper in aquatic systems is bound to particulate matter and settles out. The toxicity of copper is largely attributed to divalent ionized copper(Sylva 1976; Luoma 1983)and monovalent copper hydroxide(Luoma 1983), which is only present in small quantities in fresh water (Boyle 1979) The cupric form of copper speedily forms complexes with inorganic and organic substances and can be adsorbed onto particulate matter. As a result, free copper ions rarely occur freely in water, except in acidic soft waters (Alabaster and Lloyd 1980). The toxicity of copper is related to water quality characteristics such as hardness, alkalinity, pH, and dissolved organic carbon. Increases in these water quality variables result in decreased copper toxicity (Straus and Tucker 1993). The exceedances of $CuSO_4$ in Darrah Springs Hatchery discharge may cause a significant

decrease in populations of aquatic invertebrates, plants, and fish in the receiving water (Extoxnet 1994) and could have similar effects on amphibians, which are comparably vulnerable to dissolved copper.

To address this impact and reduce it to less than significant, DFG will implement Mitigation Measure BIO-8.

Mitigation Measure BIO-8: Implement Alternative Technologies for Reducing Copper Concentrations in Discharges from Darrah Springs Hatchery as Required in Order R5-2004-0113

As a result of the Darrah Springs Hatchery copper exceedances, the Central Valley RWQCB issued Order No. R5-2004-0113. This order required DFG to cease and desist from discharging copper from the Darrah Springs Hatchery in contradiction of requirements. Since 2004, the hatchery has pursued the development of alternative treatments. In the meantime, it has determined the minimum concentrations of copper necessary to control parasites and bacteria. The hatchery also has implemented changes in its treatment practices to minimize the concentration of copper in the discharge. For example, it treats a single raceway at a time. In accordance with Monitoring and Reporting Program No. R5-2004-0112, DFG shall monitor copper during treatments and shall comply with an interim effluent limitation of 207 µg/L, which is based on the current operations and treatment practices.

Since September 2004, the Darrah Springs Hatchery has been decreasing the amount of copper sulfate used at the facility to control fish parasites and bacteria. The annual copper sulfate usages ranged from 291 pounds in 2003 and had been decreased to 91 pounds by 2008. Currently, Darrah Springs Hatchery copper discharge levels are complying with cease-and-desist order No. R5-2004-0113. Copper sufate is still being used but with decreased frequency as a 1-hour dip treatment in place of flush treatments. This method lowered copper effluent to an average of 35 µg/L at the point of discharge

Alternative chemicals that have replaced copper sulfate are hydrogen peroxide, potassium permanganate, and Chloramine-T. Additional methods have been implemented to reduce the prevalence of diseases that are treated with copper and therefore reduce the need for copper sulfate. Examples of such approaches include reduction of fish in the spring supply waters. These fish are carriers and vectors of pathogens, in particular the gill fluke *Sanguinicola* sp., which are transmitted to hatchery fish. The pathogen causes a gill pathology which makes potassium permanganate (the preferred treatment at the hatchery) toxic during certain periods. The only safe effective treatment during these periods has been copper sulfate. DFG has developed alternative treatments to copper sulfate, and the hatchery has stopped using copper sulfate as of September 1, 2009, in compliance with Central Valley RWQCB Order No. R5-2004-0113. Hatchery plans also include the installation of an oxygen supplementation system and the construction of a new retention pond for copper abatement.

Effects of Escaped Hatchery Fish

Impact BIO-9: Effects of Escaped Hatchery Fish (Less than Significant)

All DFG hatchery culture and holding systems are designed, operated, and maintained in a manner intended to prevent escape. Prevention measures include the installation of screens of appropriate size and strength at the intake from the hatchery water source and at the outlet of the hatchery

discharge. At some hatcheries, concrete barrier walls and shallow water levels at the discharge point make fish escape difficult. In many cases, the distribution boxes and aerators at the heads of hatcheries provide barriers to minimize the unintentional release of hatchery fish, DFG personnel perform daily surveys of hatchery screens to ensure they are well maintained. Nonetheless, fish escape is a perennial phenomenon, customarily involving small numbers of fish that escape the raceways to the settling ponds and thence to receiving waters (Starr pers. Comm.). Apart from this chronic escape, during the 5-year baseline period, there were no accidental fish releases in the Region 2 fish hatcheries (Quinones pers. comm.), Region 3 hatcheries (Wilson pers. comm.), or Region 4 hatcheries (Vance pers. comm.). The only recorded release in Region 6 occurred at the Mount Whitney Hatchery during a major flood in 2008. This flood resulted in the destruction of hatchery fish and evidently did not result in the release of fish into downstream waters (Starr pers. comm).

Some escape events were recorded prior to the 2004-2008 baseline period and are discussed here to give some example scenarios of this very uncommon event. Escape of hatchery trout into the source waters of Hot Creek Hatchery was observed on at least one occasion in 1986. McEwan (1990) found that a small population of trout in one of the hatchery's headsprings was being augmented by escape of trout from six small raceways that are adjacent to the spring and discharge directly into it. This is of particular concern because these source waters are designated as critical habitat for the Owens tui chub. The escapes were believed to be the result of small hatchery trout getting around the raceway screens and going directly into the spring. McEwan (1990) determined that prey requirements overlap between the trout and the chubs and suggested that some degree of competition is likely occurring; since that time, hatchery personnel have observed predation of tui chub by trout at the hatchery (Parmenter pers. comm.). In response to this observation, Hot Creek Hatchery stopped the use of the six small raceways adjacent to the headspring for raising fingerling-sized trout until they were adequately screened. This action has prevented further escape of fish into the source springs. To ensure protection of the Owens tui chub habitats in the source springs, DFG biologists periodically remove trout from the tui chub designated critical habitat area via electrofishing, gill net, and fish traps; recent recoveries included adult brown trout in 2007 and juvenile rainbow trout in 2008 (Parmenter pers. comm.).

A flood event was recorded at the San Joaquin Hatchery in 1997 (prior to the 2004-2008 baseline period), during which approximately one-third of the inventory fish was lost. This was an exceptionally large flood. At this time, and historically, the San Joaquin River located adjacent to this facility has been stocked with trout from this facility. Various measures are constantly employed to prevent unintentional releases; however, because of the large resident population of hatchery-derived fish already present in these waters, unintentional escape would not cause increased ecological pressure. In the future, if/when this river becomes accessible to anadromous salmonids, additional control measures will implemented to prevent escapement during any flood event (Kollenborn pers. comm). No other recorded incidents in DFG hatchery records suggest that floods have caused overflow of ponds or raceways and resulted in escape of hatchery fish. Therefore, this potential impact is less than significant.

Effects from the Spread of Invasive Species

Impact BIO-10: Effects Due to the Spread of Invasive Species through Hatchery Discharge (Less than Significant with Mitigation)

Hatchery facilities provide suitable habitat for various forms of aquatic invasive species (AIS). Two species that have affected hatchery operations within the United States are the New Zealand mud snail (*Potamopyrgus antipodarum*) (NZMS) and the quagga mussel (*Dreissena rostriformis bugensis*). These species are able to colonize hard surfaces within the hatcheries, and the quagga mussel may clog water intake structures, aeration devices, pipes, and screens. Once established within hatcheries, these species may be released downstream with effluent waters and in transport water with fish stocking. These species demonstrate the potential for AIS to affect hatchery operations, and the potential for hatchery operations to spread them.

There are many other potential AIS whose spread can be accelerated by hatchery and aquaculture activities, including zebra mussel (*Dreissena polymorpha*), crayfish, channeled apple snail (*Pomacea canaliculata*), plants such as *Egeria densa* and Eurasian water milfoil (*Myriophyllum spicatum*), and algae such as *Didymosphenia geminata*.

NZMS, quagga mussels, and zebra mussels are all known to dramatically alter aquatic communities in which they establish themselves. Both quagga and zebra mussels are prodigious water filterers, capable of removing substantial amounts of phytoplankton and suspended particulate matter from the water. This, in turn, reduces the food source for zooplankton, affecting the aquatic food web. Impacts associated with the filtration of water include increased water transparency that could potentially lead to a proliferation of aquatic plants that could alter the entire ecosystem. Pseudofeces, a byproduct of the animals' water filtering, could accumulate and decompose, lowering both DO levels and water pH. NZMS colonies disrupt the base of the food chain by consuming algae in the stream and competing with native bottom-dwelling invertebrates (small aquatic insects). A population decline of invertebrates could reduce fish forage. A decrease in food availability could result in a decline of fish populations (Benson 2006).

Currently, the NZMS is the only identified invasive species (non-fish pathogen) within DFG hatcheries. The NZMS was first discovered in California in 2000 in the Owens River in Mono County. Since then, it has been found in other bodies of water, including Hot Creek (Mono County), Bishop Creek Canal (Inyo County), Lone Pine Creek (Inyo County), Medea Creek (Los Angeles County), Lindero Creek (Los Angeles County), Malibu Creek (Los Angeles County), Solstice Creek (Los Angeles County), Segunda Descheca Creek (Orange County), Trabuco Creek (Orange County), Piru Creek (Ventura County), Putah Creek (Yolo County), Lower Calaveras River (Calaveras/San Joaquin County), Mormon Slough (San Joaquin County), Lower Mokelumne River (San Joaquin/Sacramento County), lower American River (Sacramento County), Rush Creek (Mono County), Lower Napa River (Napa County), San Lorenzo River (Santa Cruz County), West Antioch Creek (Contra Costa County), and Alameda Creek (Alameda County) (California Department of Fish and Game 2009b). The NZMS has also been found in Shasta Lake and at more northern locations in Humboldt and Del Norte Counties, including Big Lagoon, Lake Earl, lower Smith River, lower Klamath River, and Redwood Creek (Benthin pers. comm.).

DFG minimizes the spread of the invasive snails and mussels by sampling to determine whether they are present in a hatchery and, if present, by stocking only in waters that also support these invasive species. Sampling is conducted on a quarterly basis at hatchery intake structures, raceway head

boxes, settling ponds, and any other areas of concern. Samples are labeled and examined by staff. Many hatcheries use strategically placed substrate that is checked and documented monthly for invasive mussels. Reports are submitted to the regional senior hatchery supervisor. If suspect or questionable snails or mussels are found, suspect specimens are sent to the regional invasive species scientist for identification. Hatchery staffs are trained in the sampling protocols by DFG invasive species specialists. Ongoing sampling for the presence of invasive species occurs at the Iron Gate, Darrah Springs, Crystal Lake, Mad River, Mount Shasta, Trinity River, Nimbus, American River, Warm Springs, Moccasin Creek, Merced River, San Joaquin, Fillmore, Fish Springs, Hot Creek, Mojave River, and Mount Whitney Hatcheries; Silverado Fisheries Base; Kern River Planting Base; and the Black Rock Rearing Ponds. Sampling at hatcheries is initiated as the occurrence of the any of these invasive species becomes more prevalent in the hatchery vicinity (Starr pers. comm.). The Mokelumne River and Feather River Hatcheries currently plan to begin sampling in the near future.

In 2005, DFG initiated NZMS surveys at Hot Creek Hatchery in response to the discovery of NZMS in downstream waters. No NZMS were found in Hot Creek Hatchery until December 2006, when they were detected in the AB Supply spring source. Sampling in January 2007 revealed the snail also was present in a second water supply source, production raceways, and two settling ponds. In April 2007, the snail was confirmed to be present in a third spring water source. As of August 2009, the NZMS had been found in the AB and CD spring supplies, which provide water for the production ponds. Also, the snails had been found in Hatchery I/Brood I spring areas (see Appendix A for hatchery details). The one remaining clean spring is Hatchery II/ Brood II spring supply (Carr pers. comm).

It is unclear how the NZMS was transferred into the hatchery source waters. However, it appears the infestation occurred initially downstream of the hatchery, and subsequently in the spring source waters. Thus the NZMS is already established in waters receiving hatchery discharge. Nonetheless, there remains a risk that NZMS originating within the hatchery may yet invade the Hatchery II / Brood II spring supply. This is a potentially significant impact. Moreover, the current invasive species management approach at DFG hatcheries is not consistent between hatcheries. In particular, some hatcheries have adopted formal plans to monitor and respond to invasive species threats, while others have not done so. These plans, are known as hazard analysis and critical control point (HACCP) plans.

HACCP plans provide a measured and appropriate response to the need for invasive species monitoring and control. Invasive species constitute a potentially significant risk to sensitive biological resources at every DFG hatchery. To address this impact DFG will implement Mitigation Measure BIO-10. With implementation of this mitigation measure, the potential impact of invasive species dissemination through hatchery discharges would be less than significant.

Mitigation Measure BIO-10: Develop and Implement Hazard Analysis and Critical Control Point Plans at Each DFG Hatchery

Development and implementation of hatchery-specific HACCP Plans must include methods to prevent the introduction of AIS into the hatchery, and operational practices that prevent the spread of AIS within and outside of the hatchery, should prevention efforts fail. BMPs/HACCP Plans have the flexibility to address many potential AIS species and methods are also effective for a variety of AIS. BMPs/HACCP Plans must be implemented irrespective of the perceived imminence of threat, as many AIS introductions are unpredictable. Accordingly, each DFG

hatchery shall, by December 31, 2010, develop and commence implementation of an HACCP plan that contains the following elements:

- A description of the product produced by each hatchery, identifying hatchery name and address, species of fish cultured, fish source (wild or hatchery), harvest method, method of distribution and storage, and intended use of the product.

- A flow diagram showing how the hatchery produces fish.

- A listing of all aquatic nuisance species and pathogens known to occur or potentially present at the hatchery.

- A hazard analysis worksheet detailing how the hatchery will respond to each nuisance species or pathogen risk.

- A plan form prescribing implementation requirements to avoid or minimize the identified hazards.

The HACCP that is currently being implemented at the Hot Creek Hatchery (California Department of Fish and Game 2008b) provides an example of such a document. As a result of the discovery of NZMS within Hot Creek Hatchery source waters and the Hot Creek Hatchery facility, DFG implemented an HACCP plan to address this problem, as well as other nuisance species and disease concerns. The goal of the HACCP plan is to reduce or eliminate the spread of aquatic nuisance species within the facilities' waters or to any water currently free of potential aquatic nuisance species.

Effects from the Spread of Pathogens through Hatchery Discharge

Impact BIO-11: Pathogen Effects on Native Fish Populations (Less than Significant)

Bacteria viruses, and parasites disperse between fish via direct contact or via contaminated water. Disease transfer between hatchery and wild salmonids can result in mortality (Hatchery Scientific Review Group 2004). Hatcheries are a potential source of infection for fish downstream when disease is present, although wild fish are more resistant to pathogens than their hatchery conspecifics (National Marine Fisheries Service 2005). With rare exceptions, pathogens found in most waters are endemic to the basin. Brannon et al. (2004) concluded there was very little evidence to suggest that hatcheries routinely transmit disease to wild fish.

In the hatchery environment, stress associated with captivity and the close proximity of rearing conditions is known to increase fish vulnerability to infection and to increase the opportunity for disease transmission. This, in turn, may result in pathogen amplification, followed by the release of these aquatic pathogens within hatchery effluents. The potential for hatchery effluents to serve as a vector of pathogen transfer to downstream biological resources likely varies based on pathogen type, the characteristics of both the effluent and receiving waters, and the presence of susceptible downstream aquatic organisms. The magnitude and frequency of epizootics attributable to pathogens derived from hatchery effluent is not known. The potential for such events at DFG hatcheries during the 2004–2008 baseline period was qualitatively evaluated through discussions with DFG staff and literature reviews. Neither literature review nor communication with DFG personnel suggested disease events simultaneously occurring both within and directly downstream of DFG hatcheries.

Although the transmission of disease from hatchery to wild fish populations is thought to occur primarily due to hatchery fish releases in adjacent waters or stocking, the detection of high levels of infectious pancreatic necrosis (IPN) virus in hatchery rearing trough water and observations of high *Aeromonas salmonicida* densities within the effluent from a tank of infected brown trout demonstrates the potential for fish pathogens to exist in hatchery discharge waters (MacKelvie and Desautels 1975; Bullock and Stuckey 1977). In addition, the viral hemorrhagic septicemia (VHS) and infectious hematopoietic necrosis virus (IHNV) both have been isolated from waters that receive hatchery effluent, demonstrating that these pathogens can persist in water for several days (Leong 1980; McCallister 1996). Although none of these observations was made in DFG hatcheries, the ability of certain fish pathogens to survive for a considerable time in the absence of a suitable host and the potential for high densities of fish pathogens to be produced within hatchery waters raises concern about the release of fish pathogens within hatchery effluent. Fish diseases that have been detected and treated within the DFG hatcheries, and that presumably have the potential to affect downstream biological communities, are identified in Table 4-3.

Evidence regarding the transfers of fish diseases from hatchery to wild populations, however, suggests wild fish themselves are the natural hosts and reservoirs for infection. The pathogens that occur in cultured fish are also present in the free-ranging fishes in the region, so it is difficult to determine whether hatchery effluent is a source of pathogens. Many native fish populations have coevolved with certain pathogens, and research has shown in these cases that there is not a high risk of transmission of certain fish diseases from hatchery to wild fish populations (Amos and Thomas 2002). For example, in a USFWS California-Nevada Fish Health Center study, a sample of wild Chinook salmon was exposed to the Nimbus strain of infectious hematopoietic necrosis (IHN) found at Coleman National Fish Hatchery in the upper Sacramento River basin for different time intervals. Results found no evidence of horizontal viral transmission. This finding is consistent with other studies that assessed the risk for IHN transmission (Keefe and Harza 2002).

Table 4-3. Fish Diseases and Pathogens in California

	Disease/Pathogens Found in California			Presence		Common Legal Veterinary Treatments for Internal and External Infections	
	Common/Acronym Name	Scientific Name	Host	+/- in Hatcheries	+/- in Wild Fish	Hatcheries	Wild
Bacteria	Bacterial hemorrhagic septicemia	*Aeromonas* spp. *Pseudomonas* ssp.	All finfish	+	+	Oxytetracycline, Perox-Aid[e], $CuSO_4$, $KMnO_4$	None
	Bacterial gill disease/BGD	*Flavobacterium branchiophilum*	Salmonids	+	+	Oxytetracycline, Chloramine-T, Perox-Aid, $CuSO_4$, $KMnO_4$	None
	Columnaris	*Flavobacterium columnare*	All freshwater fish	+	+	Oxytetracycline, Perox-Aid, $CuSO_4$, $KMnO_4$	Water temperature management
	Coldwater disease/CWD	*Flavobacterium psychrophilum*	Salmonids	+	+	Oxytetracycline, florfenicol, Pen-G, Perox-Aid, $CuSO_4$, $KMnO_4$	None
	Enteric red mouth disease/ERM	*Yersinia ruckeri*	Salmonids	+	+	Oxytetracycline, florfenicol, vaccine	None
	Furunculosis[g]	*Aeromonas salmonicida*	All finfish	+	+	Oxytetracycline, florfenicol	None
	Bacterial kidney disease/BKD	*Renibacterium salmoninarum*	Salmonids	+	+	Erythromycin	None
	Salmon rickettsiosis[a]	*Piscirickettsia salmonis*	Salmonids	-	+	Oxytetracycline, florfenicol	None
Virus	Infectious hematopoetic necrosis virus/IHNV	*Novirhabdovirus* sp.	Salmonids	+	+	Temperature management	None
	Infectious pancreatic necrosis virus/IPNV[b]	Birnavirus family	Salmonids	-	-		None

Disease/Pathogens Found in California			Host	Presence			Common Legal Veterinary Treatments for Internal and External Infections	
				+/- in Hatcheries	+/- in Wild Fish			
Common/Acronym Name	Scientific Name		Host	+/- in Hatcheries	+/- in Wild Fish		Hatcheries	Wild
Ceratomyxosis	*Ceratomyxa shasta*		Salmonids	+	+			None
Proliferative kidney disease/PKD	*Tetracapsuloides bryosalmonae*		Salmonids	+	+			None
Whirling disease/WD	*Myxobolus cerebralis*		Salmonids	+	+			Resistant fish species
Blood fluke	*Sanguinicola*		Salmonids	+	+		Snail control	None
Salmon poisoning disease	*Nanophyetus salmincola*[c]			+	+		Snail control	None
Gyrodactyliasis (skin and gill fluke)	*Gyrodactylus* sp.		All finfish	+	+		Perox-Aid, $CuSO_4$, $KMnO_4$, formalin	None
Copepods	*Salmincola californiesis*		Salmonids	+	+		Biological control with brook trout (*Salvelinus fontinalis*)	None
Trematodes	*Cryptocotyle lingua* and *Diplostomum spathaceum*		Salmonids	-	+			None
Cestodes	*Eubothrium* spp. and *Diphyllobothrium* spp.		Salmonids	-	+			None
Nematodes	*Anisakis* spp., *Cystidicola* spp., and *Eustrongylides* sp.		All finfish	-	+			None

(Left margin vertical labels: **Parasites**, **Metazoan**)

		Disease/Pathogens Found in California			Presence			Common Legal Veterinary Treatments for Internal and External Infections	
		Common/Acronym Name	Scientific Name	Host	+/- in Hatcheries	+/- in Wild Fish		Hatcheries	Wild
Parasites —Continued	Protozoan	Ich	*Ichthyophthirius multifilis*	All finfish	+	+		Perox-Aid, CuSO$_4$, KMnO$_4$, formalin	None
		Chilodonellosis	*Chilodonella* spp.	All finfish	+	+		Perox-Aid, CuSO$_4$, KMnO$_4$, formalin	None
		Trichodinosis	*Trichodina* spp.	All finfish	+	+		Perox-Aid, CuSO$_4$, KMnO$_4$, formalin	None
		Ciliates	*Epistylis* spp., *Apiosoma* spp., *Ambiphyra* spp., and *Capriniana piscium*	All finfish	+	+		Perox-Aid, CuSO$_4$, KMnO$_4$, formalin	None
		Costia	*Ichthyobodo necator*	All finfish	+	+		Perox-Aid, CuSO$_4$, KMnO$_4$, formalin, acetic acid	None
		Cryptobiosis	*Cryptobia* spp.	All finfish	+	+		Perox-Aid, CuSO$_4$, KMnO$_4$, formalin	None
		Tetrahymenosis	*Tetrahymena* sp.	All finfish	+	+		Perox-Aid, CuSO$_4$, KMnO$_4$, formalin	None
		Hexamitosis	Spironucleus salmonis[d]	All finfish	+	+		Epsom salts	None
	Microsporean	Nucleospora	*Nucleospora salmonis*	Salmonids	+	+			None

	Disease/Pathogens Found in California		Host	Presence		Common Legal Veterinary Treatments for Internal and External Infections	
	Common/Acronym Name	Scientific Name		+/- in Hatcheries	+/- in Wild Fish	Hatcheries	Wild
	Loma	*Loma* sp.	Salmonids	+	+		None
Anesthesia			All finfish			MS-222[f]	

Notes:

[a] In 1998 and 2005, epizootics in juvenile white sea bass from Hubbs–SeaWorld were attributed to the bacterium.

[b] Not detected in more than 40 years.

[c] The vector of *Neorickettsia helmintheca*, the agent of canine salmon poisoning disease.

[d] Formerly known as *Hexamita* sp.

[e] Perox-Aid is a brand name for hydrogen peroxide.

[f] The chemical name for MS-222 is tricane methane sulfonate.

[g] One case reported in 2009, not detected in the previous 25 years.

Source: California Department of Fish and Game 2009.

California has several hatcheries supplied with well water that is fish-free and therefore likely fish pathogen–free. Hatcheries with open water supplies can bring pathogens from native fish into the hatcheries, potentially infecting the hatchery fish. Control methods do not necessarily change the water quality, but they can either eliminate pathogens (e.g., ozone and UV) or separate them from their fish hosts (e.g., filtration). Hatchery design can aid in mitigating the spread of certain hatchery pathogens in effluent discharges. These efforts to reduce fish pathogens within hatchery waters contribute to reducing the occurrence of disease events within DFG hatcheries.

DFG maintains a comprehensive fish health monitoring program using a professional staff of pathologists and veterinarians. DFG Fish Health Lab pathologists conduct diagnostic examinations and health inspections of hatchery produced trout and salmon at DFG's fish hatcheries; at private registered aquaculture facilities; of imported fishes; and at any additional wild trout and salmon egg collecting stations. The DFG Fish Health Lab pathologists perform examinations for bacteria, viruses, fungi, protozoa, other parasites, and non-infectious diseases using a variety of laboratory techniques. Diagnostic procedures for pathogen detection follow American Fisheries Society professional standards (Thoesen 2007).

DFG Fish Health Lab pathologists advise hatchery personnel on methods for control of trout and salmon diseases and recommend appropriate preventative measures and treatments of fish diseases; and assist hatchery personnel during spawning of wild brood stock fish, including Eagle Lake rainbow trout and Cottonwood Lakes golden trout, by collecting ovarian fluids for virology and kidney cultures for bacteriology, and conducting workshops for training in trout and salmon disease recognition. Knowledge of pathogens and diseases allows for the accurate and rapid diagnosis and appropriate treatment of fish in hatcheries, with the goal of quickly addressing disease problems in order to maximize the health of released fish. Through this process, DFG minimize impacts on decision species.

The following summarizes the DFG hatchery fish health program.

- Annual hatchery-wide fish health certifications at all DFG hatcheries—Certifications are performed on an annual basis. This certification includes all species at each hatchery. These certifications include examinations and testing for bacteria, viruses, fungi, protozoa, other parasites, and non-infectious diseases using a variety of laboratory techniques. Diagnostic procedures for pathogen detection follow American Fisheries Society professional standards as described in *Bluebook: Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens* (Thoesen 2007).

- Brood stock evaluation at spawning—Samples are collected at spawning for virology and bacteriology testing. This includes spawning at all brood stock hatcheries and the spawning of wild brood stock fish, like Eagle Lake rainbow trout and Cottonwood Lakes golden trout. All brood stock are statistically sampled for viruses and other pathogens that could result in problems in later hatchery rearing or to wild fish residing in a hatchery discharge watershed. Only pathogen-free gametes are used for culture in the hatcheries.

- Pre-liberation health assessments of anadromous stocks—Anadromous stocks undergo a pre-liberation health assessment that evaluates and scores each particular stock. This score takes into consideration the length and weight of the fish; the condition of numerous organs, including the eyes, gills, pseudobranchs, thymus, liver, spleen, kidney, and gut; the hematocrit, leucocrit and total plasma protein; the fat content; and the smoltification index. This score helps determine whether the fish are healthy and fit for release.

- On-site diagnostic visits—Fish are routinely inspected by hatchery staff and fish pathologists throughout their growing cycle, which is generally 6 to 14 months. Reports are made of all pathology investigations. Treatments are administered as necessary to keep fish healthy. When hatchery staff notice a change in behavior of their fish, see increases in losses, or see visible signs of disease, they call the DFG Fish Health Lab and request a visit by a staff pathologist. The pathologist will diagnose the problem and recommend treatment if it is necessary. Additionally, representative lots of fish are statistically sampled for fish pathogens as they near catchable size. Diseased fish are not planted; they are either treated to eliminate the pathogen of concern or are destroyed. It is the policy of DFG not to plant diseased fish.

- Fish health training for hatchery staff—The DFG Fish Health Lab has developed a presentation to train hatchery staff members about fish diseases. The presentation covers general information about fish husbandry and fish health, disease prevention, pathogen identification, treatment, and safety. (Starr pers. comm.).

Although the literature reviewed noted examples of fish pathogens being discharged in hatchery effluents, there have been no reports of DFG hatcheries discharging pathogens capable of affecting downstream fish communities. DFG strives to minimize the impact of diseases on fish, amphibians, and aquatic invertebrates within California. When catastrophic diseases occur at state hatcheries or cooperative programs, the Fish Disease Review Committee may meet to advise the director on the recommended disposition of diseased fish. This committee is composed of the FB chief, Hatchery Operations Committee chairman, Fisheries Management Committee chairman, Fish Health Lab supervisor, Lands and Facilities Branch chief, and an appropriate regional manager. Fish diseases also occur in wild populations, and it is important to determine which diseases or parasites are present when significant mortalities occur or sick fish become apparent. Knowledge of the occurrence and distribution of diseases and parasites in wild and stocked fish populations throughout the state is of significant value to fishery managers, and DFG encourages reports of their occurrence. In addition, current hatchery management practices reduce both the frequencies and magnitudes of significant disease events within DFG hatcheries.

The effectiveness of DFG's approach to controlling the impact of pathogen transfer is attested by the fact that no diseases in wild fish populations have been documented as resulting from DFG hatchery discharges or other hatchery activities (Cox pers. comm.). Therefore, impacts associated with the dissemination of fish pathogens within hatchery effluent waters to native fish populations are less than significant.

Impact BIO-12: Pathogen Effects on Native Amphibian Populations (Less than Significant with Mitigation)

Experimental and genetic evidence has shown that the transfer of pathogens between fish and amphibians occurs and has been clearly demonstrated by the spread of *Ranavirus* sp. and *Saprolegnia ferax* from fish to amphibians (Mao et al. 1999; Kiesecker et al. 2001b). The potential for fish to carry *Batrachochytrium dendrobatidis*, a fungal disease that has devastated amphibian populations around the world, is an area of current investigation (Rachowicz et al. 2006). Although the presence of these pathogens has yet to be monitored within the hatchery setting within California, there is a risk that these pathogens can occur within the hatchery waters and fish and can be transferred via hatchery discharges. Kiesecker et al. (2001b) found that mortality induced by *Saprolegnia ferax*, a water-borne fungus that has been associated with embryonic mortality of amphibians, was greater in western toad (*Bufo boreas*) embryos exposed directly to hatchery-reared

rainbow trout (*Oncorhynchus mykiss*) experimentally infected with *S. ferax* than in control embryos exposed to hatchery-reared trout that were not experimentally infected with *S. ferax*. This result suggests that hatchery-reared fish may serve as vectors of *Saprolegnia ferax*.

Ranaviruses (genus *Ranavirus*, family Irodoviridae) comprise another important group of amphibian pathogens. These viruses are known to infect amphibians, reptiles, and fish, in which they are often highly virulent. Further evidence of the potential for transmission of pathogens between fish and amphibians was shown by Mao (1999), who isolated identical iridoviruses from wild sympatric fish and amphibians. However, no studies have appeared that investigate the potential for *Ranavirus* transmission to amphibians by any pathway involving fish hatcheries.

Currently, DFG has no management practices that address the potential impacts due to the dissemination of pathogens within hatchery effluent waters to native amphibian populations. Furthermore, DFG management practices do not outline how future policies will address emerging amphibian diseases that are associated with salmonid species. Therefore, this impact is considered significant.

To address this impact and reduce it to less than significant, DFG will implement Mitigation Measure BIO-12.

Mitigation Measure BIO-12: Develop and Implement Pathogen Monitoring and Control Management Practices

At any hatchery that discharges waters to a zone of influence within the range of an amphibian species identified in Table 4-1, DFG shall extend its current pathogen control program to include detection and control measures effective for detention and control of ranaviruses, *Saprolegnia ferax*, and *Batrachochytrium dendrobatidis*. This program shall be reviewed by the Aquaculture Disease Committee (ADC) (DFG Code 15506). The DFG Director shall instruct the ADC, in consultation with DFG and scientific experts of amphibian diseases if necessary, to meet no later than three months after certification of this project to develop standard procedures for amphibian pathogen detection and control. Additional pathogens may be added to this list as warranted. DFG shall conduct statistically based testing for amphibian pathogens of concern to demonstrate that hatchery production fish and hatchery discharge waters are not sources of key amphibian pathogens. The testing shall be performed annually at each hatchery in the program and annual reports of test results will be prepared and made available upon request. Implementation of such testing and evaluation measures will ensure that hatchery activities and fish are not sources of diseases that could adversely affect native amphibians.

Effects from Stream Flow Alteration or Groundwater Draw-Down

Impact BIO-13: Effects from Stream Flow Alteration or Groundwater Draw-Down Due to Hatchery Water Supply Intakes (Less than Significant)

Continuously suitable stream flows are important for the various life stages of many aquatic organisms that live downstream from the DFG hatcheries. Alterations to the natural flows of rivers and streams have the potential to affect biological resources through disruption of local ecological processes. For example, water needs to remain sufficiently deep, and flows need to be sufficiently continuous for many salmonid species to complete their migration from the ocean to upstream spawning grounds. In addition to disrupting migratory corridors, low summer flows could potentially reduce the effective juvenile rearing habitat. Increased temperatures associated with

reduced stream flows may result in increased susceptibility to viral and bacterial fish diseases and cause stress or mortality to riparian vegetation (McCullough 1999), as well as constituting a barrier to migration of coldwater fish such as salmonids. Groundwater pumping is a widely used source for hatchery waters. Groundwater pumping can cause groundwater depression that lowers the water table below the rooting depth of groundwater dependent vegetation.

It was concluded within Chapter 3, "Hydrology, Water Supply, and Water Quality," that surface water diversions associated with hatchery operations do not significantly reduce available water for downstream uses. No evidence of substantial consumptive use of water was identified at any of the DFG hatcheries. Furthermore, Impact HYD-9, "Effects of Hatchery Operations on Discharge Water Temperature," finds that hatchery operations have less-than-significant impacts on discharge water temperatures. Because hatchery operations have been found not to cause significant changes indownstream water availability or have significant impacts on surface water quality due to water temperature increases, less-than-significant impacts on downstream biological resources are expected.

The assessment of groundwater extractions in Chapter 3 determined that hatchery operations would not adversely reduce the availability of groundwater supplies for beneficial use of the water body. However, reports indicate that groundwater usage at both the Black Rock Rearing Ponds and Fish Springs Hatchery potentially cause local water table depressions that are affecting local vegetation. The Black Rock Rearing Ponds and Fish Springs Hatchery are located in the Owens Valley. Groundwater-dependent vegetation in the vicinity of these two facilities includes alkali meadows, a sensitive natural plant community identified as "Type C vegetation" in the *Agreement Between the County of Inyo and the City of Los Angeles and it's Department of Water and Power on a Long Term Groundwater Management Plan for Owens Valley and Inyo County* (Agreement). Alkali meadows are generally considered special status natural communities by DFG[1]. Special status natural communities are communities that are of limited distribution statewide or within a county or region and are often vulnerable to environmental effects of projects. These communities may or may not contain special status species or their habitat.

Additionally, alkali meadows in the vicinity of the Black Rock Rearing Ponds provide habitat for a species of Mariposa lily, *Calochortus excavatus*, a List 1B plant species. In order to assess potential impacts of this groundwater withdrawal on alkali meadow habitat and on *Calochortus excavatus*, a brief review of the regulatory environment governing groundwater in the Owens Valley is warranted. In historic times the Owens Valley was a relatively well-watered environment, containing a wide variety of aquatic and riparian habitats as well as extensive areas of groundwater-dependent vegetation. Exploitation of these water resources began in earnest in the early 20th Century, first with local use of the water for irrigation and then with construction of an aqueduct to transport water to the growing Los Angeles area. In 1970 a second aqueduct was constructed, fed by water supplied from an array of wells extracting groundwater. Following a lengthy legal dispute, in 1991 the Agreement was finalized along with an EIR (City of Los Angeles Department of Water and Power and County of Inyo, 1991) that identified water table lowering due to groundwater withdrawal as a significant impact to groundwater-dependent vegetation.

Several springs, including source springs previously supplying water to Fish Springs Hatchery and the Black Rock Rearing Ponds exhibited reduced flows or dried up completely prior to 1991. The 1991 EIR identified significant adverse impacts to vegetation associated with reduction or

[1] http://www.dfg.ca.gov/biogeodata/vegcamp/pdfs/natcomlist.pdf

elimination of flows at several springs (Impact 10-14). The 1991 EIR also required a number of mitigation measures for impacts associated with groundwater pumping, including limiting groundwater drawdown to depths consistent with maintaining vegetation cover according to baseline conditions measured during 1984-1987. In addition, the 1991 EIR determined that pumping for the Black Rock Rearing Ponds resulted in the following less than significant impacts: (1) a change in groundwater flow direction (Impact 9-11); and (2) lowered groundwater levels and spring flows (Impact 9-13). The 1991 EIR identifies the Black Rock Rearing Ponds and the Fish Springs Hatchery as mitigation (Mitigation Measure10-14) designed to compensate for significant adverse impacts to vegetation resulting from the loss of the spring flows.

Since 1991 (and in some cases earlier), the Los Angeles Department of Water and Power (LADWP) and the Inyo County Water Department (ICWD) have maintained an array of monitoring wells throughout the valley and performed monitoring of the condition of groundwater-dependent vegetation communities. Each year the two agencies review the monitoring data and set allowable pumping rates for the various wells based upon the data and the mitigation requirements established under the Agreement and the EIR. However, some of the wells are treated as "exempt" and are subject to consistent pumping rates regardless of monitoring findings. The Agreement states that "these exempt wells are specialized cases which are the sole source of supply water for towns, irrigation, and fish hatcheries" (Inyo County and City of Los Angeles 1990, AKA the "Green Book," page 6). They include the wells serving the Black Rock Rearing Ponds (wells W351 and W356) and the Fish Springs Hatchery (wells W330 and W332).

In both areas, monitoring wells indicate that groundwater levels have been more than 8 feet (2.4 meters) below the surface, and depth to water at monitoring well (BLK094) near the Black Rock Rearing Ponds has averaged below 4 meters since the late 1990's (ICWD 2007[2]). When withdrawal occurs below 2.4 meters, it may result in the death or a long-term decline of herbaceous vegetation in alkali meadow communities, including the herb *Calochortus excavatus*. This subject has been reviewed with reference to the two monitoring parcels near Black Rock Rearing Ponds, BLK094 and BLK099, by Manning (2005a, 2005b) and Pritchett and Manning (2009). Manning (2005b) finds that at BLK099, groundwater depths are generally maintained within 8 feet of the surface and that percent vegetation cover is positively correlated with depth to water. At BLK094, groundwater depth has exceeded 8 feet since 1988 and percent vegetation cover is positively correlated with annual precipitation. This observation is expected due to the fact that the plants are likely water-limited and thereby forced to rely on surface water, including precipitation, rather than groundwater.

Information received from CNPS (2009) contends that the low vegetation cover observed at parcel BLK094 is attributable to water table drawdown by the exempt wells serving the Black Rock Rearing Ponds. Rare alkali meadow habitat formerly existed in the area affected by groundwater draw-downs caused by pumping to supply the hatchery (CNPS 2008). However, monitoring data indicate that groundwater depths have been consistently deeper than -4 m since 1988 and have not been correlated with pumping rates at the wells serving the Black Rock Rearing Ponds. This result is expected because the pumping for the hatchery has remained somewhat constant since the 1970's (DWP 2009)[3], which may make it difficult to detect a correlation in the presence of a constant pumping regime. Additionally, these potential impacts are documented to have occurred prior to the 2004-2008 baseline period, and there is no evidence that continuation of the current pumping

[2] http://www.inyowater.org/Annual_Reports/2007_2008/vegetation_conditions.htm
[3] Coufal - DWP Comment Letter on hatchery EIR 2009

regime at Fish Springs Hatchery and Black Rock Rearing Ponds would cause incremental adverse impacts.

In order to better assure that the potential impacts from groundwater pumping at the Fish Springs Hatchery and Black Rock Rearing Ponds remains less than significant, DFG will operate Fish Springs Hatchery and Black Rock Rearing Ponds in a manner consistent with the 1991 EIR. DFG will strive to increase water efficiency and reduce water use at the hatchery and rearing ponds. DFG leases the property that the Black Rock Rearing Ponds and Fish Springs Hatchery is located on from the Los Angeles Department of Water and Power (LADWP). DFG will strive to operate the groundwater wells for the Black Rock rearing ponds in a manner that does not exceed the pumping at levels anticipated in the 1991 EIR.

Effects of Predator Control

Impact BIO-14: Effects of Predator Control at Hatchery Sites (Less than Significant)

Fish hatcheries contain dense populations of fish that can provide convenient foraging for fish-eating predators. Common predators at inland hatcheries include gulls, herons, osprey, egrets, cormorants, kingfishers, blackbirds, raccoons, and otters. To control these losses, fish hatcheries use predator exclusion and hazing measures, which include netting or wires installed over the surface of ponds, raceways, and tanks; perimeter fencing; removal of dead fish that attract scavengers; acoustic harassment devices; and visual frightening devices.

Potential impacts on predators due to DFG predator exclusion practices have been qualitatively evaluated through discussions with DFG staff and literature reviews. DFG does not use lethal predator control methods at any of its hatcheries. The primary method of predator control used at DFG hatcheries is passive control, including netting and fencing. These exclusion devices, while designed to prevent the passage of predatory animals through them, can sometimes entangle predators, primarily birds, which may attempt to pass through the exclusion device to obtain fish. These entanglements are not always fatal; however some mortality has been noted. Neither literature review nor personal communication with DFG personnel suggested that DFG predator control methods were leading to significant impacts on predator populations including sensitive species. DFG adaptively manages predator exclusion devices by removing netting and leaving only fences in place when take or mortality of predatory animals is evident. This impact is considered less than significant.

Effects on Food Webs

Impact BIO-15: Effects on Food Webs from Hatchery Discharges (Less than Significant)

Complex interactions exist between various trophic levels (e.g., plants, herbivores, and carnivores) within the aquatic environment. Water quality impacts, for example, can cause algal growth through biostimulation. This, in turn, can influence water quality by changing the DO and nutrient dynamics and invertebrate assemblage dynamics (Stevens 2002). Additional stream impacts, such as increased sedimentation or increased temperatures, may cause transitions in benthic communities, replacing sensitive aquatic insects with ones more suited to the affected conditions. Changes in the structure of benthic communities may have indirect effects on such other aquatic species as aquatic macroinvertebrates. Macroinvertebrates play an important role in the stream environment through their interactions with primary producers and by serving as prey for consumers higher in the food

chain. It has been observed that changes in invertebrate communities may lead to changes in fish and bird communities that feed on these organisms (Epanchin 2008). In one specific example, researchers have shown that the flux of aquatic insects emerging from streams is one of the most important factors affecting the distribution of riparian-foraging bats (Fukui et al. 2006). Furthermore, benthic communities colonizing streams have been shown to depend on the water quality and fish species present (Moyle 1999; Flecker 1994). Research on aquatic environments in California has demonstrated that adding top predator species can have impacts on primary producers within aquatic ecosystems (Power 1990).

A review of DFG records indicates that the discharges from three DFG-operated hatcheries have the potential to affect downstream food webs and therefore cause general changes in aquatic communities. These include the potential impacts on biological resources at the Hot Creek Hatchery due to nutrient and TSS discharges; the low levels of DO periodically discharged from the Mojave River Hatchery; and the elevated levels of copper contained in Darrah Springs Hatchery effluent. Hatchery operations that directly affect biological resources can further disrupt the local aquatic ecosystems through changes in local species densities or reduction in available habitat. These ecosystem shifts can have deleterious effects on food webs, leading to additional indirect impacts on the aquatic community via multiple pathways. As detailed earlier in this section, solutions have been and are being implemented at the Hot Creek, Mojave River, and Darrah Springs Hatcheries that reduce the likelihood of any future impacts on biological resources to less than significant. Hot Creek Hatchery is improving the facility's settling ponds, which will improve water clarification and effectiveness in reducing nutrient and TSS discharges. To increase the DO levels in discharge waters, Mojave River Hatchery is planning to install low head oxygenators (LHOs) in September, 2010. The Darrah Springs Hatchery, while developing alternative treatments, has determined the minimum concentrations of copper necessary to control the parasite and bacteria. The hatchery also has implemented changes in its treatment practices to minimize the concentration of copper in the discharge. The development and implementation of amphibian pathogen monitoring and control management practices at DFG hatcheries will extend current pathogen control BMPs to include detection and control measures demonstrated to be effective against ranaviruses, *Saprolegnia ferax*, and *Batrachochytrium dendrobatidis*. Therefore, DFG hatchery operations have a less-than-significant potential to affect aquatic communities via alteration of aquatic food webs.

Impacts of the Trout Stocking Program

Background

This section discusses the potential impacts of DFG trout stocking activities on biological resources, assuming the continuation of stocking activities that have taken place over the 2004–2008 baseline period. The analysis addresses both direct and indirect effects on special-status and other species and habitats present at locations stocked with hatchery fish. Alternative programs are discussed separately, in Chapter 7 of this EIR/EIS. Cumulative impacts on these resources are also discussed separately, in Chapter 8. The impacts of trout stocking have been organized into six categories:

- impacts related to predation, competition, and related changes in ecological relationships between stocked and native species;

- impacts related to non-target harvest, which is the catch of native fish by fisherman that are attracted to an area because the waters are stocked with trout;

- impacts related to invasive species and pathogens that are accidentally introduced during stocking operations;

- impacts that arise from interbreeding of hatchery and wild fish, altering the genetic composition of wild populations;

- impacts that arise from accidental or otherwise unauthorized releases of hatchery trout; and

- impacts that are caused by anglers during their pursuit of stocked trout.

This list of potential impacts was identified after considering types of impacts identified within the initial study for the Program, issues raised in the public scoping process, and additional data collected during preparation of this draft EIR/EIS. All impacts listed below have been analyzed using the best available science, including published and gray literature, personal communication with biologists from the state and federal resource agencies, and the best professional judgment of the authors. The analysis focuses on potential impacts on decision species, which were identified during the scoping process, and on various other species that are at high risk of being significantly affected by trout stocking.

The trout stocking program includes stocking of three types of non-anadromous salmon: Chinook, coho, and kokanee. Non-anadromous salmon are only stocked in a few locations, all of which are large artificial reservoirs. As explained in Chapter 2, potential impacts associated with stocking in large artificial reservoirs are generally very minor because these environments constitute artificial settings where introduced fish species have largely eliminated native species and a variety of factors (e.g., water level fluctuations and predatory fishes) tend to exclude populations of native amphibians and reptiles. However, some impact potential remains (e.g., with regard to bald eagles, osprey, and certain other special-status species). In the analysis presented in this document, reference to the "trout stocking program" includes stocking of non-anadromous salmon, and effects that are specifically associated with non-anadromous salmon stocking are discussed where appropriate within the analysis of impacts attributable to the trout stocking program.

As described in the historical review in Chapter 2, trout stocking has been practiced widely in California since the 19th century. For decades, this stocking was performed without apparent awareness of its potential effects on native species and ecosystems, contributing to extirpation and even extinction of some native species, with continued legacy effects in waters distributed throughout the state. The analysis presented here, however, only evaluates the impacts of the DFG trout stocking program as performed during the 2004–2008 baseline period. Impacts that accrued in earlier times, even if ongoing, are addressed in Chapter 8, "Cumulative Impacts."

Effects from Predation and Competition from Stocked Trout

Complex interactions exist between the various trophic levels within the aquatic environment. Most stocked salmonids function as top-level predators in the aquatic ecosystems where stocking occurs; certainly, this is true in settings where salmonids are stocked in waters that formerly contained amphibians or native non-salmonid fishes as the top-level aquatic predators. Therefore, the addition of hatchery-origin fish can alter food web structure and energetics. These changes can affect native fish and wildlife in many and diverse ways, but the most direct such effect is by altering predator-prey relationships and by altering competitive relationships between native species and between native and introduced species. Quantifying the impacts of trout stocking on ecosystem energetics and predator-prey relationships remains a challenge, and for most relationships, only a qualitative understanding yet exists. The analysis presented here, therefore, relies primarily on published

scientific literature detailing ecosystem-level studies involving hatchery trout, both in California and in other comparable ecosystems.

Interactions between Stocked Trout and Native Invertebrates

There are potentially a wide array of competition and predation effects of trout stocking on invertebrate communities. However, only two special-status invertebrate species are addressed in this analysis, and for both, extremely species-specific factors affect the potential for competition and predation effects vis-à-vis trout stocking. These potential impacts are detailed below.

Impact BIO-16: Predation and Competition Effects from Stocked Trout on Shasta Crayfish (Less than Significant)

The Shasta crayfish is a rare species in California (California Department of Fish and Game 2004). It is listed as endangered under both the ESA and the CESA. There are three trout stocking locations within the range of the Shasta crayfish (Figure 4-25). Shasta crayfish occur only in Shasta County, in the Pit River drainage and two tributary systems, the Fall River and Hat Creek drainages. They are the only remaining endemic California crayfish species, and they are principally threatened by the invasive signal crayfish; Shasta crayfish are only known to now survive in three disjunct populations. The largest remaining population is at the former rearing ponds of the Pit River Hatchery at Sucker Spring Creek, which was closed in 1997 to protect the crayfish and is now the site of various DFG-sponsored activities designed to protect and restore the Shasta crayfish (California Department of Fish and Game 2004). Shasta crayfish live in cool, clear, spring-fed lakes, rivers, and streams. The most important habitat requirement appears to be the presence of adequate volcanic rock rubble to provide escape cover from predators (U.S. Fish and Wildlife Service 2007c).

Trout stocking has not been identified as a factor in the decline of Shasta crayfish, which co-evolved with native trout. DFG stocks trout at Middle Hat Creek, Baum Lake, and two sites on upper Bear Creek. The potential for these stocking activities to affect Shasta crayfish was evaluated in the hatchery management plans for the Hat Creek and Pit 1 projects, and DFG determined that "planting of hatchery trout does not have a negative impact on Shasta crayfish in the project area" (California Department of Fish and Game 2003d, 2003e).

Shasta crayfish extirpations all have been attributed to competition and predation from the invasive signal crayfish, and trout stocking has not been cited as a factor in the decline of Shasta crayfish populations. As mentioned above, DFG has, in its hatchery management plans, previously investigated the potential for stocking impacts on Shasta crayfish and has found that no impact potential exists. Thus, the impact of trout stocking on Shasta crayfish is less than significant.

Impact BIO-17: Predation and Competition Effects from Stocked Trout on California Freshwater Shrimp (Less than Significant)

Trout are not stocked anywhere within the range of the California freshwater shrimp (Figure 4-25). Thus, there is no potential for trout stocking to affect the California freshwater shrimp, and the impact of trout stocking on California freshwater shrimp is less than significant.

Interactions Between Stocked Fish and Native Non-Salmonid Fishes

The relationship between stocked trout and native non-salmonid fishes is complex and is influenced by many factors including water body type, limnology, overall trophic relationships, stocked fish

size, overall fish assemblage (including both native and nonnative non-game fishes), and other factors.

Although widespread declines of native non-salmonid fishes have been documented in the Sierra Nevada (Moyle and Nichols 1973; Moyle and Nichols 1974), most have been attributed primarily to habitat alterations rather than to the introduction of hatchery trout (Moyle and Nichols 1974; Knapp 1996). Specialized habitat requirements of salmonids and non-salmonids generally do not overlap, and competition between salmonids and non-salmonids is rare (Blanchard 2002; Baltz and Moyle 1984). More generally, competition does not seem to be a major determinant of fish community makeup in California stream fishes. Baltz and Moyle (1993) studied microhabitat partitioning among native and nonnative fishes in Deer Creek, a relatively pristine tributary to the Sacramento River. They found that the high degree of spatial (microhabitat) segregation among the native fishes was not primarily due to competition, but to a combination of morphological specialization (reflecting evolutionary history), predation, and some competition. They concluded that native fish assemblages resist invasion through both environmental and biotic factors, with predation being an important biotic factor.

Predation is an important factor when considering introductions of brown trout, brook trout, and lake trout. Brown, brook, and lake trout are highly piscivorous (fish-eating), while rainbow trout are typically less so. Brown trout have been known to alter fish assemblages through competition and predation (Gatz et al. 1987; Strange et al. 1992; Baltz and Moyle 1993; Fausch 1988). However, Baltz and Moyle (1993) found that brown trout may co-occur with native fishes with minimal impacts under the following conditions.

- An unpredictable environment favors reproductive success of spring-spawning native species more than that of fall-spawning brown trout (this should also be true of the fall-spawning brook trout) or the late spring/early summer spawning habitats of other introduced species (Moyle 1976).

- There are few native predator species to prey selectively on "odd" invaders.

Thus, hydrological conditions during the spawning season and the abundance of native predators significantly alters the impact of introductions of exotic predators on the native fish community.

The nature of the water body receiving stocked trout, as well as the kinds of native fishes initially present, strongly affects the results of trout introductions. Most hatchery rainbow trout that are reared and released for "put-and-take" fisheries in streams would not be expected to live long after stocking (a few weeks) (Butler and Borgeson 1965; Moyle 2002), so there is low potential for impacts on native non-salmonid species through competition and predation associated with catchable-sized rainbow trout stocked in streams. In addition, as detailed in the discussion of competition between native and hatchery trout, the spatial extent for potential impacts from all trout species is generally limited to within a few miles of the stocking location.

Many lakes and streams affected by the trout stocking program are located in high-elevation areas (mostly above 6,000 feet) that, prior to stocking, contained no native fish. Thus, there is no potential for any type of interaction between stocked and wild native fish in these locations. Hatchery salmonids that are stocked into rivers, streams, lakes, or reservoirs where native fish communities exist or that are stocked into formerly fishless areas where outlets allow passage of stocked fish into downstream native fish communities may adversely affect native non-salmonid species through competition and predation.

Other factors, such as relative interspecific aggressiveness, water temperature, stream flow, habitat complexity, relative size, and the lack of competitive interactions among salmonids during overwintering, influence the impact of trout introductions on native fish populations. These complexities make it clear that the ecological implications of trout introductions on native non-salmonid fishes should be judged on a case-by-case basis.

The potential for predation and competition effects between stocked trout and various non-salmonid decision species is discussed in more detail below.

Impact BIO-18: Predation and Competition Effects from Stocked Trout on River Lamprey (Less than Significant)

River lampreys are a relatively common anadromous species that spawn in California coastal streams from San Francisco north and are most abundant in the lower Sacramento–San Joaquin River system (Moyle 2002). River lamprey have co-evolved with salmonids and threats to river lamprey are primarily anthropogenic, such as dams, habitat degradation and loss, and predator control programs.

Lamprey are known to prey on salmonids (Moyle 2002; Quinn 2005; Beamish and Neville 2001; Novomodnyy and Belyaev 2002), but salmonids are not prolific predators of lamprey. However, adult trout are known to prey on lamprey (both adult lamprey and ammocoetes [larval lamprey]) (Oregon Fish and Wildlife Commission 2005).

There is little information on predation on lamprey by fish. There are primarily three periods when lamprey might constitute prey of stocked trout, as eggs are deposited, during emergence from the nests and during high flow events that scour larvae from their burrows. Juvenile rainbow trout were identified by Close et al. (1995) as a predator of Pacific lamprey eggs and larvae in the Columbia basin.

Ammocoetes burrow in the substrate and filter feed on algae and detrital particles, until they transform to adults and are parasitic on fish. The adult stages migrate to the ocean, until they return to spawn in their natal streams. There is no overlap in diet between lamprey and stocked trout.

There are one trout stocking locations within the current range of river lamprey: the lower American River and five human-made reservoirs in the Central Valley. Because of the relatively extensive range of the river lamprey, their life history, and their co-evolution with salmonids, impacts from competition or predations from stocked trout are less than significant.

Impact BIO-19: Predation and Competition Effects from Stocked Trout on Kern Brook Lamprey (Less than Significant)

The Kern brook lamprey is not anadromous (does not migrate to the ocean), spending its entire life in fresh water. The Kern brook lamprey's range includes several eastern tributaries in the San Joaquin Valley: the Merced, San Joaquin, Kaweah, Kings Rivers, as well as the Friant-Kern Canal (Moyle 2002). Kern brook lamprey are non-predatory and feed only during the ammocoete stage; the adults are short-lived and do not feed. Ammocoetes remain buried, feeding on diatoms and other microorganisms until their metamorphosis to the adult stage (Moyle 2002). There is no competition for food with salmonids. Adults seek gravel riffles for spawning and rubble for cover. Thus, there is little overlap in habitat between this species and stocked trout, unless the trout spawn in gravels occupied by ammocoetes.

No literature could be found regarding fish predation on the Kern brook lamprey (U.S. Fish and Wildlife Service 2004b), and it was not cited as a factor of decline in USFWS review of the petition for listing the species (U.S. Fish and Wildlife Service 2004b).

There are six trout stocking locations within the current range of the Kern brook lamprey: Woollomes Lake, McSwain Reservoir, and the Merced River (Figure 4-26). As with other lamprey species, the Kern brook lamprey has co-evolved with salmonids, and there is little potential for predation or competition. Thus, the potential impact to the Kern brook lamprey from predation or competition with stocked trout is less than significant.

Impact BIO-20: Predation and Competition Effects from Stocked Trout on Klamath River Lamprey (Less than Significant)

There is very little information concerning the ecology or distribution of the Klamath river lamprey. It is a parasitic river lamprey known to occur in the Klamath River and Klamath Lake. Assuming its life history is similar to that of the river lamprey, described above, the potential for predation or competition effects from stocked trout is less than significant.

Impact BIO-21: Predation and Competition Effects from Stocked Trout on Green Sturgeon (Less than Significant)

There are no trout stocking locations within the green sturgeon's range (Figure 4-27). Thus, the potential for competition and predation effects on green sturgeon associated with trout stocking are less than significant.

Impact BIO-22: Predation and Competition Effects from Stocked Trout on Delta Smelt (Less than Significant)

There are no trout stocking locations within the Delta smelt's range (Figure 4-28). Thus, the potential for competition and predation effects on delta smelt associated with trout stocking are less than significant.

Impact BIO-23: Predation and Competition Effects from Stocked Trout on Longfin Smelt (Less than Significant)

The longfin smelt is a pelagic estuarine fish distributed from San Francisco Bay to Alaska (U.S. Fish and Wildlife Service 2009a). There are no trout stocking locations within the range of the longfin smelt (Figure 4-28); thus, impacts from predation and competition on longfin smelt associated with trout stocking are less than significant.

Impact BIO-24: Predation and Competition Effects from Stocked Trout on Eulachon (Less than Significant)

There are no trout stocking locations within the range of eulachon (Figure 4-27). Thus, the potential for predation or competition effects on eulachon associated with trout stocking are less than significant.

Impact BIO-25: Predation and Competition Effects from Stocked Trout on Tidewater Goby (Less than Significant)

There is one trout stocking location (Freshwater Lagoon) within the range of tidewater goby (Figure 4-41). Tidewater gobies are currently considered extirpated from Freshwater Lagoon, and this lagoon is not designated as critical habitat for the species (U.S. Fish and Wildlife Service 2009b). Tidewater goby predators include bass and crayfish (U.S. Fish and Wildlife Service 2009b). Although it is possible that the tidewater gobies could reoccupy Freshwater Lagoon if other causes of the extirpation were rectified, the current stocking of coastal cutthroat and rainbow trout in Freshwater Lagoon will not result in predation or competition effects on the tidewater goby.

Impact BIO-26: Predation and Competition Effects from Stocked Trout on Owens Tui Chub (Less than Significant)

Although extirpations of Owens tui chub populations throughout most of their range have been the result of interbreeding with Lahontan tui chubs (Chen et al. 2007), predation and competition by introduced fish has been implicated as the major threat facing remaining populations, with brown trout, formerly stocked in the basin, identified as one of the species of greatest concern (Chen et al. 2007; 50 FR 31594). Trout stocking occurs at five locations within the range of the Owens tui chub (Figure 4-44); however, all five locations support hybrid tui chub populations that are not important in efforts to conserve and recover the species. Thus, predation and competition effects on Owens tui chub due to trout stocking would be less than significant.

Impact BIO-27: Predation and Competition Effects from Stocked Trout on Goose Lake Tui Chub (Less than Significant)

There are no trout stocking locations within the range of the Goose Lake tui chub (Figure 4-44). Residual predation and competition impacts are possible due to the presence of previously stocked hatchery trout that have become established in the basin and that may compete or prey upon native fish to an unknown degree.

Impact BIO-28: Predation and Competition Effects from Stocked Trout on Arroyo Chub (Less than Significant)

There are 15 trout stocking locations within the range of arroyo chub (Figure 4-45). Richards and Soltz (1986) found minimal overlap in the feeding habits of arroyo chub and rainbow trout, and no arroyo chub were found in stomach contents of rainbow trout in the West Fork of the San Gabriel River, which contains a native rainbow trout population that is supplemented with hatchery rainbow trout. In view of this finding, and of the small overlap in microhabitat use between these species, predation and competition between hatchery rainbow trout and arroyo chub are considered minimal. Effects of predation and competition from stocked trout on arroyo chub are less than significant.

Impact BIO-29: Predation and Competition Effects from Stocked Trout on Hardhead (Less than Significant)

GIS analysis indicates that there are 67 trout stocking locations within the range of hardhead (Figure 4-45). Hardhead are regarded as widespread and abundant in central California although there are localized population declines attributed to habitat loss due to hydroelectric dam and other development, altered flow regimes, and predation by introduced non-native fish species specifically

black bass (Moyle 2002). While Moyle cites predation by smallmouth and other centrarchid basses as a cause of localized population declines, there is no evidence that these declines can be attributed to native and non-native trout stocking through increased predation or other behavioral mechanisms. While there is published information for native coastal rainbow and hardhead behavioral interactions, specific information on the behavioral interactions between non-native stocked trout species and hardhead is lacking. Coastal rainbow trout and hardhead co-evolved throughout their range and Reeves (1964, in Alley and Li 1977:27) speculated that rainbow trout and hardhead compete for food. However, a subsequent field study (Alley and Li 1977) showed differences in microhabitat use and found no behavioral interactions between the two species. Additionally, competition for spawning space with stocked hatchery species, including non-native stocked trout species, is unlikely, due to non-overlapping spawning periods and differing temperature requirements for trout and hardhead. Hardhead have been observed to co-occur in the Kern River where nonnative rainbow trout have been stocked in waters occupied by hardhead for 70 years with no perceived impacts upon hardhead (McGuire 2009). Because the hardhead and stocked trout use different microhabitats, and there is no evident predation on hardhead, effects of predation and competition from stocked trout are less than significant.

Impact BIO-30: Predation and Competition Effects from Stocked Trout on Owens Speckled Dace (Less than Significant)

The introduction of nonnative trout and water development have been identified as resulting in the reduction in the range of the Owens speckled dace. Sada (1989) indicates that decline of the Owens speckled dace is partly due to predation by introduced fishes such as brown trout. However, speckled dace do cohabitate with rainbow trout. Habitat use and benthic oriented feeding habits of the speckled dace overlap with those of trout. There are 18 trout stocking locations shown within the range of Owens speckled dace (Figure 4-46). However, conversations with DFG staff (Parmenter and Milliron, pers. comm.) and review of mapped dace distribution data (Sada 1989) indicate that this estimate is an artifact of a GIS database that presumes dace presence throughout the length of any stream segment in which they occur. In reality, the dace has highly specific habitat requirements that largely confine its distribution to isolated sections of slow-moving water, often associated with springs, that generally provide unsuitable habitat for trout and that, due to potential interactions with the dace, are actively avoided by DFG during trout stocking. Based on the existing DFG awareness of the importance of not stocking in Owens speckled dace habitat, and the absence of trout stocking within or in close proximity to dace habitat, potential impacts of the trout stocking program on Owens speckled dace are less than significant.

Impact BIO-31: Predation and Competition Effects from Stocked Trout on Santa Ana Speckled Dace (Less than Significant)

There are three trout stocking locations within the range of Santa Ana speckled dace (Figure 4-46); at each location, rainbow trout are the stocked species. Habitat use and benthic oriented feeding habits of the Santa Ana speckled dace overlap somewhat with those of juvenile trout. However, DFG surveys indicate a clear separation of habitats between stocked rainbow trout and Santa Ana speckled dace. Santa Ana speckled dace are a benthic species found primarily in shallow fast water habitats, whereas stocked trout reside in the middle and upper portions of deep slow water habitats (O'Brien pers. comm.). Because Santa Ana speckled dace rarely exceed 3 inches in length, whereas stocked trout are typically greater than 8 inches, competition for benthic macroinvertebrate food resources is not likely. DFG biological staff have performed underwater observations of Santa Ana

speckled dace and rainbow trout (both wild and stocked fish) behavior at locations throughout the Santa Ana speckled dace range in the San Gabriel River drainage. No predation, agonistic behavior, or competition between species was observed during these surveys (O'Brien pers. comm.). Santa Ana speckled dace and coastal rainbow trout/steelhead have coevolved and the highest densities of both species were found in the same streams during a recent study (O'Brien et al. 2009). This finding indicates that predation and competition are not significant factors in any ecological interactions between these species. Thus the potential for predation or competition effects from stocked rainbow trout is less than significant.

Impact BIO-32: Predation and Competition Effects from Stocked Trout on Owens Sucker (Less than Significant)

There are 8 trout stocking locations within the range of the Owens sucker (Figure 4-42). Owens sucker is endemic to the Owens River watershed in southeastern California and is most abundant in the Crowley Reservoir (Moyle 2002). Owens suckers have adapted to the damming of the Owens River and the creation of the Crowley Reservoir, so they still have large populations in a good portion of their native range. Successful introductions into June Lake and the Santa Clara River have also been made. Owens suckers have shown some capacity to adjust to the presence of nonnative fishes; they were once the only fish in Convict Lake, which they now share with introduced trout species. However, their total range is limited, and the bulk of their population seems to depend on reservoirs that are dominated by introduced game fishes, so their populations do need to be monitored (Moyle 2002). Several nonnative fish species have been introduced within the current range of the Owens sucker, including several piscivorous fish (e.g., smallmouth and largemouth bass and brown trout). That Owens sucker populations appear to be stable in spite of the presence of these introductions indicates that competition and predation with introduced trout have a less-than-significant impact on the Owens sucker.

Impact BIO-33: Predation and Competition Effects from Stocked Trout on Modoc Sucker (Less than Significant)

There is one trout stocking location (Ash Creek) within the range of Modoc sucker (Figure 4-43). Modoc suckers are commonly found in association with rainbow (redband) trout (Moyle 2002), and Baltz and Moyle (1984) have shown that the closely related Sacramento sucker and rainbow trout do not compete for food or microhabitat space. These observations indicate a low potential for competition and predation by rainbow trout under at least some conditions (e.g., normal fish densities). However, declines of Modoc suckers have been partially attributed to predation by introduced brown trout (Moyle 1976 in 50 FR 24523) and largemouth bass (Reid 2008), which indicates that highly predaceous non-native fish may affect Modoc sucker through competition and predation. Modoc sucker has coexisted with brown trout in the Ash Creek drainage for more than 70 years, suggesting that predation by brown trout is, on its own, unlikely to threaten the continued existence of the Modoc sucker. Brown trout presence in smaller streams, like Johnson and Rush Creeks, may substantially affect resident Modoc sucker populations.

In 1985, at the time of listing, there were an estimated 1,300 individual Modoc suckers within four streams in the Pit River system (Turner, Washington, and Hulbert Creeks within the Turner drainage and Rush Creek in the Ash Creek drainage). Since that time, the sucker's known range has been expanded by identification of other populations. The current known range of the Modoc sucker includes 10 stream populations of Modoc suckers in three subdrainages: Ash Creek drainage (Ash, Rush, Johnson, and Dutch Flat Creeks), Turner Creek drainage (Turner, Washington, Hulbert, Coffee,

and Mill Creeks, and Garden Gulch), and Goose Lake subbasin (Thomas Creek). While Ash Creek is recognized as an extant population, it exhibits a high degree of introgression, and the existence (past or present) of Modoc suckers in Willow Creek (Lassen County) is doubtful (Reid 2008). The distribution of Modoc suckers within the four stream populations recognized in 1985 either remained stable over the subsequent 22 years, or slightly expanded, and the 10 current populations occupy all available and suitable habitat within their streams (Reid 2008).

The one stocking location, Ash Creek, is in an area with little suitable habitat for Modoc suckers, mostly riffle and run habitat; therefore, the potential for predation and competition is low. Although Modoc suckers are probably suppressed by introduced predatory fishes, these populations remain extant after 35 years. The separation of the three known drainages containing Modoc suckers further reduces the probability that a new or existing introduced predator would affect all three drainages simultaneously. Therefore, introduced predators, while a major conservation concern for Modoc sucker populations and a factor in suppressing population size, do not appear to be a threat to the continued existence of the Modoc sucker throughout its range (Reid 2008).

USFWS designated critical habitat for the Modoc sucker includes 26 miles of streams within the Turner and Rush Creek drainages in Modoc County. The designated critical habitat does not include Ash Creek. Furthermore, the Ash Creek population is treated by Reid in his 2008 Modoc sucker conservation review for USFWS as "a distinct extant population [that] is not included in counting secure populations for the purpose of evaluating recovery" because of its "unique introgressed character and full sympatry with Sacramento suckers." Given the relatively large size of Ash Creek (17 stream miles), localized stocking and the small number of trout stocked, there is little potential that hatchery trout could adversely affect Modoc sucker. Although the Modoc sucker population size is relatively small, its expanded range makes it resistant to localized threats.

Because of the high level of hybridization of Sacramento and Modoc suckers within Ash Creek, the recognition of new populations expanding the known range of Modoc suckers, the absence of Modoc sucker habitat in stream segments stocked with trout, and the lack of overlapping micro-habitat use with resulting low potential for competition, the effects on Modoc sucker associated with trout stocking are less than significant.

Impact BIO-34: Predation and Competition Effects from Stocked Trout on Santa Ana Sucker (Less than Significant)

There are six stocking locations within the range of Santa Ana sucker (Figure 4-43). Baltz and Moyle (1984) stated that "most studies show that dietary overlap between suckers and trout is minimal (Ashley 1974; Li and Moyle 1976; Moyle 2002; Holey et al. 1979; Marrin and Erman 1982)" and found little evidence that trout competed with the closely related Sacramento suckers for space. Conversely, according to USFWS (65 FR 19694), "Moyle and Yoshiyama (1992) concluded that introduced brown trout (*Salmo trutta*) may have caused the extirpation of the Santa Ana sucker from the upper Santa Ana River in the San Bernardino Mountains." No data were provided in support of this assertion, and the original document (Moyle and Yoshiyama (1992)) could not be found, but this conclusion is based upon observed or suspected predation. However, within the 2004–2008 period, only rainbow trout have been stocked in the Santa Ana and San Gabriel River watersheds. Electrofishing surveys indicated a strong correlation between the abundance of Santa Ana suckers and the abundance of rainbow trout and Santa Ana speckled dace (Saiki et al. 2007), which indicates that rainbow trout likely have minimal predation or competition effects on Santa Ana suckers.

O'Brien (2009) reported on snorkel surveys of hatchery rainbow trout and Santa Ana suckers in the upper San Gabriel River and indicated that hatchery trout numbers diminished rapidly after a stocking event. The greatest distance away from a stocking location where hatchery trout were encountered was approximately 3.5 km (2.2 miles). Snorkel surveys in the San Gabriel River indicated that trout and Santa Ana suckers often occupied the same pool habitats but were clearly partitioned by microhabitats, with the suckers occupying benthic habitats and feeding on algae and detritus, and the trout occupying the heads of the pools and feeding on drift insects in the mid- to upper portions of the water column. This suggests that there is little potential for competition between trout and Santa Ana suckers.

Although trout stocking occurs at six locations in the range of Santa Ana sucker, six locations are lakes or ponds where the sucker would not be present. Because the Santa Ana sucker does not appear to compete with stocked trout, and there is no evidence of predation of suckers by stocked trout, the potential effects of predation and competition with stocked trout are less than significant.

Impact BIO-35: Predation and Competition Effects from Stocked Trout on Cui-Ui (Less than Significant)

Cui-ui are endemic to Pyramid Lake in northwest Nevada but use the Truckee River below Derby Dam to spawn. Derby Dam is in Nevada, downstream of the Reno-Sparks urban area, and there is negligible potential for trout stocked in California to migrate so far downstream. There is a fish ladder at Derby Dam, and in 2009 Reclamation, which operates the dam, and USFWS were considering opening the ladder to the cui-ui spawning migration. In this event, it would be possible for cui-ui to migrate upstream as far as the Pioneer Diversion in Reno, though it is not known whether they would do so (Werdon pers. comm.). Regardless, the Pioneer Diversion is still more than 15 miles downstream of the nearest trout stocking location on the Truckee River in California (Lahontan cutthroat trout are stocked in the lower Truckee River between the City of Truckee and Lake Tahoe). Thus, there is negligible potential for any form of interaction between stocked trout and cui-ui, and the impact on this species from predation and competition from stocked trout would be less than significant.

Impact BIO-36: Predation and Competition Effects from Stocked Trout on Unarmored Three-Spined Stickleback (Less than Significant)

Trout are not stocked within the range of the unarmored three-spined stickleback (Figure 4-41). Thus, the potential for predation and competition effects on unarmored three-spined stickleback associated with trout stocking is less than significant.

Impact BIO-37: Predation and Competition Effects from Stocked Trout on Sacramento Perch (Less than Significant)

Trout are not stocked within the Sacramento perch's native range (Figure 4-42). Thus, the potential for predation and competition effects on Sacramento perch associated with trout stocking is less than significant.

Interactions Between Stocked Trout and other Salmonids

Many lakes and streams where trout hatcheries stock nonnative trout are located in high-elevation lakes that contain no native fish, so there is no potential for adverse effects on native fish species associated with predation and competition in these locations. Hatchery salmonids that are stocked

into rivers, streams, lakes, or reservoirs where native salmonid communities exist or that are stocked into lakes that have no native fish but where outlets allow colonization into downstream native salmonid communities, may adversely affect native trout, salmon, and steelhead through competition and predation.

Competition for food, space, and other necessary resources can occur through two mechanisms: "individuals may pre-empt other fish from obtaining limited resources by depleting the resources first ('scramble' or 'exploitative' competition), or by actively preventing them from accessing resources ('contest' or 'interference' competition)" (Dunham et al. 2002:378). Competition may result in reduced growth, displacement into suboptimal habitats, increased susceptibility to predation, and mortality. In general, competition occurs when two animals require the same resources; thus, competition is most severe within a species and is only a factor between different species insofar as the species share life history attributes and habitat preferences. Competition between species that have not co-evolved can also be intense because the species have not developed behavioral and morphological mechanisms to reduce competition (Fausch 1988; Fresh 1997; Hearn 1987). Competition between salmonid species is minimized when the species have differing microhabitat preferences and environmental tolerances (Hearn 1987; Bisson, Sullivan et al. 1988).Interspecific competition modulated by differences in environmental preferences (stream size and gradient) and tolerances (especially thermal tolerances) likely underlie the longitudinal stratification of trout species within streams (Korsu et al. 2008). For instance, brook and cutthroat trout tend to occupy colder, swifter, headwater reaches, with rainbow trout occupying the midregion with intermediate habitat conditions and brown trout occupying the deeper, lower-velocity, warmer, and more fertile downstream reaches (Raleigh et al. 1986). In undisturbed watersheds and in areas where fish densities are within the carrying capacity of a stream, longitudinal stratification often allows multiple trout species to coexist. When, however, habitat degradation has occurred, or fish densities are excessive, interspecific competition is likely to be more intense and coexistence is less likely (Korsu et al. 2008). The degree of competition within and between species varies depending on size differences among competing individuals, environmental factors (e.g., temperature, stream flow, and physical habitat), and the details of interaction between species (Fausch and White 1986). For example, juvenile salmonid competition and aggressive behavior is influenced by the time of spawning and by the seasonal environment: Competition is reduced during the cooler winter months, when metabolic requirements are lower and higher flows produce a more spatially extensive habitat (Everest and Chapman 1972; Blanchard 2002). Therefore, competition for overwintering habitat is not a primary concern for most salmonids, except in areas where habitat is limiting and fish densities are high, such as on spawning grounds.

Aggressive interactions increase during the summer months when densities and energy requirements increase at the same time that temperatures increase, flow volumes decrease, and the size of the available habitat decreases (Glova 1986). Fish density has been found to be inversely related with survival and growth for mixed populations of coho salmon and steelhead (Fraser 1969 in Lau 1984), while growth of young-of-the-year coho salmon has been found to be negatively related to juvenile steelhead density and may be influenced by differences in resource availability (Harvey and Nakamato 1996).

Several hatchery species, including brown, brook, and lake trout, are exceptionally predatory or competitive with native salmonids. Brown trout are highly competitive and predatory with other fish species, particularly native trout, and "generally win, all things being equal (Sorenson et al. 1995)" (Moyle 2002:296). Brook trout released into streams typically displace native trout through competitive interactions (Moyle 2002) but are also predatory upon the native trout. Lake trout

greater than 50 centimeters (cm) primarily eat fish (Moyle 2002), including any available native species. Rainbow trout also may compete with native trout and be minimally to highly predatory, depending on conditions (Ward and Larkin 1964; Moyle 2002; Haddix and Budy 2005). Kokanee have been shown to be effective at regulating zooplankton biomass in nursery lakes (Moyle 2002) and therefore may affect other populations at juvenile life stages through scramble competition. Kokanee also have been shown to compete with bull trout for limited spawning habitat in Odell Lake, Oregon (Weeber 2006). As for the potential for behavioral interactions, Hutchison and Iwata (1997) studied subadults from several salmonid species and found that the most aggressive was brook trout, followed by rainbow trout, brown trout, and kokanee.

In the case of juvenile salmonids, competition is primarily for space rather than for food and other resources (Fresh 1997; Hearn 1987). Both juvenile and fresh water–resident adult salmonids are territorial and form distinct social hierarchies through aggressive interactions (i.e., interference competition) between individuals from the same species. Dominant individuals occupy preferred stream positions (i.e., locations where food can be acquired for the least amount of energy and where cover is nearby) and have the highest growth rates (Jenkins 1969; Griffith 1972 in Hearn 1987). Introduced rainbow trout have been shown to disrupt these social hierarchies, resulting in reduced growth rates in Atlantic salmon (Blanchet et al. 2007); comparable interactions may occur with native trout, such as various cutthroat races. Aggressive interactions between stocked and native salmonids may lead to a shift in the habitat niches used by native species and cause native fish to occupy suboptimal habitat or be displaced downstream, resulting in reduced growth or an increased susceptibility to predation. Once initial habitat shifts are made, differences in life stage timing, growth, and microhabitat preferences may reduce competition between species, given low fish densities (Blanchard 2002). At high fish densities, though, competition for space may lead to forced dispersal, downstream displacement, or mortality among less dominant fish (Chapman 1962; Mason and Chapman 1965; Slaney and Northcote 1974 in Fresh 1997).

In the case of fresh water–resident adult salmonids, similar preferences for spawning habitat may lead to competition among or between trout species when spawn timing overlaps. Native trout that may be affected in this manner include coastal cutthroat trout and Lahontan cutthroat trout.

Competition may be secondary to predation when different life history stages interact. McGrath and Lewis (2007) report that brook trout dominance over cutthroat trout is probably not related to adult competition for habitat or food, even though their microhabitat and food preferences strongly overlap; rather, it is attributable to a relatively brief interval when brook trout prey upon age-0 cutthroat trout. Except during this sensitive period, cutthroat trout appear to be unaffected by the presence of brook trout. It is unknown whether similar relationships exist between other stocked and native salmonid species.

As mentioned previously, brown, brook, and lake trout are highly piscivorous, while rainbow trout are typically less so. Stocked fish, however, are initially less likely to consume fish than their wild counterparts because they are habituated to artificial foods ("trout chow") (Marnell 1986; Cannamela 1992). According to Cannamela (1992:15), hatchery fish are not effective foragers, at least initially, and some period of "training" or exposure is necessary for recognizing novel prey items (Miller 1954; Hochachka 1961; Ware 1971; Suboski and Templeton 1989). Ware (1971) found that an average period of 4 days (range: 4–12 days) was required for "naïve" rainbow trout to begin feeding on novel prey items. Bachman (1984) found that some hatchery brown trout stocked in streams never learned to recognize and consume natural food.

Most hatchery rainbow trout that are stocked for put-and-take fisheries in streams are caught within 2 weeks of planting (Butler and Borgeson 1965; Moyle 2002), and the remainder likely die of starvation or stress within a few weeks (Moyle 2002). Therefore, the potential for impacts on native trout species through competition and predation associated with catchable-sized rainbow trout plantings in streams appears to be low. Even so, it is possible for introduced trout to temporarily displace native salmonids from preferred habitats, thereby increasing stress and the probability of native fish being consumed by predators. The spatial extent within which hatchery and wild trout interact is also relatively small, based on results of two experimental plants of catchable-sized rainbow trout (from the Hot Creek and Mount Whitney Hatcheries) in the Kern River. Most trout recoveries after 6 months (68% and 65%) occurred within 0.25 mile of the planting sites (Butler and Borgeson 1965). Additional fish were recovered at greater distances from the planting sites, including 23% between 0.25 mile and 2 miles downstream and 9% greater than 2 miles downstream for the Hot Creek Hatchery fish; and 23% between 0.25 mile and 2 miles upstream, 8% between 0.25 mile and 2 miles downstream, and 5% greater than 2 miles downstream for the Mount Whitney hatchery fish (Butler and Borgeson 1965). Information presented by Adams (1999) indicates that brook trout also may travel in-stream and have been found to travel up to 4 miles upstream in gradually sloping (2% gradient) streams (Flick and Webster 1975) and a little more than 0.5 mile both upstream and downstream in steep (8% to 18% gradient) streams (Moore et al. 1985).

Catchable-sized hatchery rainbow trout released into lakes survive for longer periods than stream-stocked fish because of lower energy costs associated with the absence of stream currents, and a relatively lower vulnerability to angling and predation (Moyle 2002). Therefore, the duration of competitive and predatory impacts on native lake populations following stocking of catchable-sized trout should be greater than the impacts following stream stocking. The same is true for hatchery stocked to lakes without native populations if such lakes are connected to water bodies that do support native populations. Survival rates of stocked catchable rainbow trout may be "high" only in comparison with the survival rates of stream-stocked fish. For example, the survival rates for two stockings of catchable-sized rainbow trout in a lightly fished lake 1 year after stocking were only 9.1% and 43%, and the outplants accounted for only 3.7% and 5.5% of the catch 3 to 5 years after stocking (Wales 1956; McCammon and Borgeson 1960 in Butler and Borgeson 1965). According to Knapp (1996), brook trout are more likely than other species of trout to establish self-sustaining populations after stocking because they can spawn in lake habitats. Stocked rainbow, golden, brown, and cutthroat trout are somewhat less likely to establish self-sustaining populations because of their need for spawning habitat in streams, though Armstrong and Knapp (2004) showed that the quantity of stream habitat needed is quite small. Armstrong and Knapp also found that more than half of the stocked, historically fishless HMLs they examined in the Sierra Nevada[4] supported self-sustaining populations of one or more of these species.

Put-and-grow trout management entails stocking fingerling trout into waters with environmental characteristics likely to support growth and survival to a catchable size. The usual targets of put-and-grow management are lakes and reservoirs. Since put-and-grow management presupposes an extended period in which stocked trout grow and feed, it is reasonable to suppose that put-and-grow management, when targeting lakes or reservoirs with high rearing quality, would entail higher risks of adverse interactions with wild fish than lake or stream stocking of catchable-sized fish. The potential for predation and competition effects on each native salmonid species is discussed below.

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[4] Portions of the John Muir Wilderness, Sequoia National Park and Kings Canyon National Park.

Impact BIO-38: Predation and Competition Effects from Stocked Trout on Coastal Cutthroat Trout (Less than Significant)

There are two trout stocking locations (Freshwater Lagoon and Dry Lake) within the range of coastal cutthroat trout (Figure 4-31). Coastal cutthroat trout are competitively subordinate to all other species of salmonid (Johnson et al. 1999; Moyle et al. 2008). Their subordinate nature may be due to a lack of morphological adaptation to either fast or slow water (Bisson, Sullivan and Nielsen 1988) and may cause them to be highly susceptible to potential predation and competition for rearing and spawning space from other trout stocked within their range. Blanchard (2002) states that "rainbow trout are able to out-compete cutthroat trout and can displace individuals to less desirable habitat locations and even cause extirpation of cutthroat when nonnative rainbow are introduced to streams (Griffith 1988)."

Neither of the trout stocking locations currently provides habitat for wild coastal cutthroat trout. Further, it is very unlikely that catchable-sized trout stocked in these locations could interact with other wild coastal cutthroat trout populations (Lentz pers. comm.). Thus, predation or competition between stocked trout and coastal cutthroat trout would result in less-than-significant impacts on coastal cutthroat trout.

Impact BIO-39: Predation and Competition Effects from Stocked Trout on Lahontan Cutthroat Trout (Less than Significant)

Lahontan cutthroat trout are stocked at 10 locations, within the historic range of Lahontan cutthroat trout (Figure 4-29). At the eight lake stocking sites, the stocking maintains Lahontan cutthroat trout fisheries. In the Truckee River, Lahontan cutthroat trout are stocked within the species' historic range, but in a section of the river that does not currently support a wild population of Lahontan cutthroat trout. Stocking of Lahontan cutthroat trout in Sagehen Creek is part of an experimental effort to restore this fish within the basin. Non-native trout are stocked within the historic range of Lahontan cutthroat trout in the Truckee, Carson and Walker River drainages (Figure 4-29), but not within habitats currently occupied by wild, self-sustaining populations of Lahontan cutthroat trout .

Non-native trout (rainbow, brown, brook, lake trout and kokanee salmon) are stocked in waters within the historic range of the Lahontan cutthroat trout in the Truckee, Carson, and Walker river drainages. However, none of these stocking locations supports wild, self-sustaining populations of Lahontan cutthroat trout. In waters where wild Lahontan cutthroat trout that are important, long-term conservation and recovery populations , there is no stocking of non-native hatchery trout. These populations are remnant or restored populations that are identified in the Lahontan cutthroat trout Recovery Plan.

DFG is signatory to a number of MOUs and Cooperative Agreements with the USFWS for the restoration of Lahontan cutthroat trout (LCT), which are listed as threatened under the Federal ESA. The USFWSs LCT Recovery Plan (1995) identifies the need for reintroduction plans to be developed for the Truckee, Carson, and Walker basins in California. Currently, recovery implementation teams (RIT) have been organized for the Truckee River, Lake Tahoe and Walker River. In 2003, the Truckee River RIT and the Walker River RIT each developed a Short-term Action Plan intended to facilitate restoration/recovery of naturally-reproducing lacustrine LCT with activities identified to be implemented over a 5-year period. The Lake Tahoe RIT is still developing its plan. Included in these actions are stocking of LCT in priority restoration reaches identified through the RIT planning process. Currently, certain priority restoration reaches are not stocked by DFG with non-native trout

when a LCT stocking program is in place within that reach. This cessation of non-native trout stocking in restoration reaches allows for evaluation of the stocking program by the RIT teams.

Because no stocking occurs within areas supporting wild Lahontan cutthroat trout populations, competition and predation would have a less-than-significant effect on wild populations of Lahontan cutthroat trout.

Impact BIO-40: Predation and Competition Effects from Stocked Trout on Paiute Cutthroat Trout (Less than Significant)

Within the currently managed range of Paiute cutthroat trout (Figure 4-30), stocking (which occurred in Silver King Creek below Llewellyn Falls) was discontinued in 1976 (CDFG files) Thus, the current trout stocking program does not have the potential to result in predation and competition impacts on this species.

Impact BIO-41: Predation and Competition Effects from Stocked Trout on California Golden Trout (Less than Significant)

Stocking of hatchery trout has been discontinued in the currently managed range of California golden trout. Stocking in the headwater lakes of Golden Trout Creek ended in 1993 and the stocked fish since have been eradicated (Lentz pers. comm.). Trout stocking has occurred at one location in the California golden trout range, in the South Fork Kern River at Kennedy Meadows (Figure 4-30). This area only supports highly hybridized populations of California golden trout, which are regarded by DFG as having no conservation significance. Additionally, three fish passage barriers prevent upstream migration of nonnative and hatchery fish to the upriver areas that support "pure strain" California golden trout (Lentz pers. comm.). Thus, current trout stocking does not have the potential to result in predation or competition impacts on California golden trout populations important to conservation of the species.

Impact BIO-42: Predation and Competition Effects from Stocked Trout on Eagle Lake Rainbow Trout (Less than Significant)

Eagle Lake rainbow trout occur only in Eagle Lake. There is no wild reproduction of Eagle Lake rainbow trout; the population formerly spawned only in Pine Creek, a tributary of Eagle Lake. But since the 1940s, flow in Pine Creek generally has been insufficient to support successful reproduction by the trout. Since 1959, the entire population has been supported by production of juvenile Eagle Lake trout to support the fishery in the lake. DFG has been stocking only hatchery origin Eagle Lake rainbow trout into Eagle Lake and Pine Creek. Given that Eagle Lake rainbow trout are all of hatchery origin, there is no potential for adverse competition and predation impacts from the stocking of hatchery trout, all of which are Eagle Lake rainbow trout.

Impact BIO-43: Predation and Competition Effects from Stocked Trout on Kern River Rainbow Trout (Less than Significant)

DFG believes that wild Kern River rainbow trout in stocked reaches of the Kern River (waters downstream of Johnsondale Bridge) represent hybrid fish due to the legacy of past interbreeding between stocked and wild fish. The remaining range of non-hybridized Kern River rainbow trout lies above impassable falls in the upper Kern River drainage, 30 to 60 miles upstream of the stocked reaches. Studies, in progress, of the genetic status of Kern River rainbow trout indicate that the trout least affected by genetic mixing with non-native rainbow trout, and therefore of greatest

conservation value, are those located in the Kern River and portions of select tributaries located in the Golden Trout Wilderness and Sequoia National Park more than 30 miles upstream of the stocking locations on the Kern River. These upper basin Kern River rainbow trout are no longer affected by stocking hatchery rainbow trout. As a result, the current trout stocking program does not have the potential to result in predation and competition impacts on Kern River rainbow trout, and such impacts are less than significant.

Impact BIO-44: Predation and Competition Effects from Stocked Trout on Goose Lake Redband Trout (Less than Significant)

Stocking of hatchery trout within the range of Goose Lake redband trout (Figure 4-31) was discontinued in 1980 (Benthin pers. comm.). Thus, the current trout stocking program does not have the potential to result in predation and competition impacts on Goose Lake redband trout. This impact is less than significant.

Impact BIO-45: Predation and Competition Effects from Stocked Trout on McCloud River Redband Trout (Less than Significant)

There are no trout stocking locations within the range of McCloud River redband trout (Figure 4-32). Two locations are within the vicinity but outside the currently managed areas for this species (i.e., the section of the main stem McCloud River and its tributaries above the confluence with Bundoora Spring Creek) (Lentz pers. comm.), so there is little potential for predation and competition impacts associated with current trout stocking. Any residual predation and competition impacts would be due to the presence of previously stocked, nonnative trout that have become established in the basin. This impact is less than significant.

Impact BIO-46: Predation and Competition Effects from Stocked Trout on Warner Valley Redband Trout (Less than Significant)

There is no stocking of hatchery trout within the three streams that suppport Warner Valley redband trout (Figure 4-32) (Lentz pers. comm.), so the current trout stocking program does not have the potential to result in predation and competition impacts on Warner Valley redband trout. This impact is less than significant.

Impact BIO-47: Predation and Competition Effects from Stocked Trout on Little Kern Golden Trout (Less than Significant)

Stocking of hatchery trout within the currently managed range of Little Kern golden trout (Figure 4-29) was discontinued in the 1950s, so current trout stocking does not result in predation and competition impacts. Nonnative trout cannot migrate upriver into the range of Little Kern golden trout because of downstream barrier falls (Lentz pers. comm.). Thus, there is no potential for the trout stocking program to affect the Little Kern golden trout. This impact is less than significant.

Impact BIO-48: Predation and Competition Effects from Stocked Trout on Northern California Steelhead and Klamath Mountains Province Steelhead DPSs and Coho Salmon ESUs (Less than Significant)

No hatchery trout are stocked within the currently managed range of Northern California steelhead, central California coast coho salmon, or southern Oregon/northern California coho salmon (Figures 4-36 and 4-34 respectively), and one location for the Klamath Mountains Province (KMP) steelhead,

so there is no potential for predation and competition impacts associated with trout stocking. This impact is less than significant.

Impact BIO-49: Predation and Competition Effects from Stocked Trout on Steelhead DPSs (Except Northern California DPS and Klamath Mountains Province DPS) and Chinook Salmon ESUs (Less than Significant with Mitigation)

Limited information exists regarding stocked hatchery trout predation and competitive interactions with steelhead and salmon populations, but some studies regarding wild populations provide an indication of potential impacts. Only rainbow trout are stocked into watersheds supporting wild anadromous salmonids, so impacts are considered in terms of this species.

Rainbow trout have been observed preying upon juvenile steelhead; additionally, their diets and habitat preferences overlap (Finlay et al. 2002; McMichael et al. 1997; Bratovich et al. 2004). Therefore, hatchery rainbow trout may prey upon native steelhead or compete with them for rearing and spawning habitat. According to Kostow and Zhou (2006:837), the "implications of competitive interactions between hatchery and wild fish may be particularly serious for steelhead because the freshwater environment probably limits production (Slaney et al. 1985)."

As for potential impacts on Chinook salmon, Blanchard (2002) states that "Everest and Chapman (1972) found no evidence that either steelhead or Chinook changed their habitat preferences in the presence of the other species." In addition, no significant growth rate differences between Chinook, steelhead, and rainbow trout were found, whether they were raised together or apart (Pearsons et al. 1996 in Blanchard 2002; McMichael and Pearsons 1998). Nonetheless, juvenile Chinook salmon are of a size that would constitute suitable prey for rainbow trout and thus are likely subject to the same type of predation described above for steelhead.

There is also a potential for hatchery trout to compete for spawning sites with native steelhead, due to overlapping spawn times and spawning habitat preferences. This potential is low for Chinook salmon because of their propensity for spawning over very coarse substrates in large rivers, but the potential is greater for steelhead, which use substrates comparable to those selected by rainbow trout for spawning.

There are between one and 16 trout stocking locations within the ranges of the various steelhead and Chinook salmon ESUs (Figures 4-35, 4-37, 4-38, and 4-39). Many of these stocking locations are in lakes and reservoirs upstream of salmon and steelhead habitat. Depending on the condition and amount of available habitat, food availability, densities of hatchery trout released, and timing of releases, there is a reasonably foreseeable potential for some measure of predation and competition to affect native salmon and steelhead, but the level of impacts is unknown. Nonetheless, the possibility of impacts at the identified planting locations cannot be ruled out within the context of available data. Because of this uncertainty, competition and predation with stocked trout may have a significant adverse effect on wild native Chinook salmon and steelhead populations.

To minimize these effects and reduce the impact to less than significant, DFG shall implement Mitigation Measure BIO-49.

> **Mitigation Measure BIO-49: Implement Pre-Stocking Evaluation Protocol for Steelhead and Chinook Salmon**
>
> As detailed for Impact BIO-49, trout stocking may have a significant impact on steelhead DPSs noted above and on Chinook salmon. To mitigate for this impact, DFG shall implement a PSEP

(see Appendix K) at each location where stocking occurs within the range of these species. Under the protocol, each stocking location shall be evaluated in a stepwise fashion to determine whether interactions between stocked trout and the potentially affected sensitive species may occur and to evaluate the potential for trout stocking to result in an substantial effect on the sensitive species. If such an impact is determined likely, then DFG shall either cease stocking at that location or develop and implement, prior to stocking at that location, an ABMP (as described in Chapter 2).

Implementation of the PSEP at each site where trout stocking occurs within the range of steelhead DPSs noted above and of Chinook salmon would reduce potential impacts to less than significant.

Interactions Between Stocked Fish and Native Amphibians and Reptiles

The factors attributed to the observed decline of native amphibians and reptiles in California parallel those cited in the observed decline of amphibian species worldwide. These factors are numerous, complex, inter-related and include but are not limited to; climate change (Kiesieker 2002), increased exposure to ultraviolet radiation (Kiesieker 2002), pathogen outbreaks (Daszak 1999), habitat modification (including hydroelectric dams and associated alterations to stream flow regimes) (Moyle 1973, Kupferberg et al. 2009), as well as competition, predation, and displacement associated with non-native species introductions including bullfrogs and various salmonid and non-salmonid species (Moyle 1973, Hayes and Jennings 1986, Bradford 1989, Bradford et al. 1993, Bradford et al. 1998 in Knapp 2005, Knapp and Matthews 2000, Vredenburg 2004). While no single factor can be cited as the foremost factor causing amphibian declines in California, the primary purpose of this section is to discuss the impacts fish stocking associated with the Program and its elements as described in Chapter 2. Nonetheless, determination of significance of Program impacts on native amphibians and reptile species must be considered in context with the aforementioned causes of amphibian and reptile declines.

Many lakes and streams stocked from trout hatcheries are located in high-elevation, formerly fishless areas. Estimates indicate that as a result of fish stocking that occurred prior to 1996, the proportion of trout-containing lakes in the Sierra Nevada increased from "less than 1% of all lakes larger than 1 ha (2.5 acres) to approximately 63% of all such lakes" (Knapp 1996). Since 1996, there has been increasing awareness of the potential biological impacts of trout stocking in HMLs. Although the proportion of lakes containing trout has decreased in response to concerns regarding amphibian declines, the practice of stocking in formerly fishless areas is still widespread. Knapp (1996) observed that "the relatively simple food webs of [high mountain, oligotrophic] lakes are believed to make them especially sensitive to impacts from introduced species (Li and Moyle 1981; McQueen et al. 1986)" and predatory trout introduced by stocking programs are an excellent example of this phenomenon, because amphibians and reptiles found in formerly fishless areas lack adaptations for defense from predatory fish. Due to stocking in these areas, amphibians and aquatic reptiles may be substantially adversely affected through competition and predation with hatchery fish. Lesser, but still potentially significant, adverse impacts may occur in settings where hatchery salmonids are stocked into waters where amphibians and reptiles have long coexisted with native fish communities. In this case, the hatchery fish may increase the frequency of competition and predation events (e.g., by competing with native fish for amphibian prey or by competing with native amphibians and reptiles for various prey species). A similar impact occurs when hatchery fish are stocked into formerly fishless areas where the hatchery fish are able to colonize downstream areas hosting native fishes and amphibians or reptiles.

Declines of one of the most studied amphibians in the Sierra Nevada, the northern DPS of the mountain yellow-legged frog, were first noticed in association with trout introductions in the 1920s (Grinnell and Storer 1924). Introduced trout were implicated later as a primary factor in this species' decline (Bradford 1989; Bradford et al. 1993; Bradford et al. 1998 in Knapp 2005; Knapp and Matthews 2000; Vredenburg 2004). Although the mountain yellow-legged frog has been the focus of many studies and is highly susceptible to trout predation because of its highly aquatic nature, introduced trout also have been found detrimental to populations of other amphibians and reptiles (see individual species discussions below).

Most native amphibians are adapted to breeding and rearing primarily in lake or pond habitats, though some use streams and rivers for this purpose. Fishless lakes provide exceptional growth and survival opportunities for amphibians and reptiles. Amphibians that evolved in fish-bearing waters often display adaptations that function to reduce the risk of predation, such as producing unpalatable larvae or larvae that sense and avoid chemical cues produced by fish (Kats et al. 1988; Grasso 2005). Such adaptations may help them avoid predation by hatchery trout. Such physiological and behavioral adaptations may not provide protection from sublethal effects, such as reduced growth rate and development (Skelly 1992; Skelly and Werner 1990; Rundio and Olson 2003).

Besides directly preying upon native amphibians and reptiles, introduced fish also may cause ecological changes that affect the competition for resources between fish and amphibians. Examples include changes in native zooplankton populations (Carpenter et al. 1985, 1987; Stoddard 1987; Richards et al. 1975; Morgan et al. 1978; Goldman et al. 1979; Melack et al.1989; Bradford et al. 1994 in Knapp 1996) and benthic macroinvertebrate communities within lakes (Reimers 1958; Melack et al. 1989; Bradford et al. 1994; Walters and Vincent 1973; Bahls 1990 in Knapp 1996; Bradford et al. 1998 in Dunham et al. 2004; Luecke 1990; Knapp et al. 2001). Introduced trout have been found to compete with adult amphibians for food resources and to suppress the availability of emerging large aquatic insects that make up a major portion of the diets of adult frogs (Finlay and Vredenburg 2007). More subtle but equally important changes may occur also. For example, hatchery stocking has adversely affected the mountain garter snake (*Thamnophis elegans elegans*), a primary native predator of amphibians, which loses its food source to predation by introduced trout (Matthews et al. 2002; Dunham et al. 2004).

The degree of competition and predation varies with habitat, the life stage of the predator, the life stage of the amphibian or reptilian prey, the species of introduced salmonid, and the size of fish at release. There is a higher potential for impacts to occur in formerly fishless areas (generally HMLs but also some high-mountain streams) and in locations where there is little habitat complexity, limiting cover for prey species. Larval amphibians are most susceptible to predation because they live wholly in an aquatic environment and are small enough to constitute prey for fish of many sizes. The risk of predation to adults is lower because they are larger and more mobile, can often exit the water, and may grow too large to be eaten by most introduced fish. Even in the absence of predation, though, both adults and larvae may be affected through competition for limited resources, especially resources that affect the amount and type of forage (mostly invertebrates).

Fish are not, however, the only predator of adult amphibians. Other wildlife also prey upon different life history stages of amphibians, but their effect is unknown. In the Sierra Nevada, the mountain garter snake (*Thamnophis elegans elegans*) preys predominately on amphibians (Matthews et al. 2002). Mathews et al. present data indicating that mountain garter snakes appear to be declining in response to the decline in amphibian abundance. Matthews et al. surveyed 2,103 high-elevation

lakes in the Sierra Nevada, quantifying the distributional relationship between garter snakes and anurans (frogs and toads). They observed a strong association between amphibian presence and garter snake presence: The probability of finding snakes in lakes with amphibians was 30 times greater than in lakes without amphibians. Moreover, lakes with snakes had over six times as many (4,019 vs. 642) amphibians living in or within 1 km of the lake. In Kings Canyon National Park (where 40% of larger lakes contain nonnative trout) amphibians were found in 52% of lakes, and garter snakes were found in 33 of the 1,059 lakes surveyed. In contrast, in the John Muir Wilderness, where 80% of larger lakes contain nonnative trout, amphibians were found in 19% of lakes, and no snakes were found in any of the 1,044 lakes surveyed.

The impact on amphibians from trout stocked into streams depends in part on the species stocked (Dunham et al. 2004) and may be less severe than the impact of trout stocked into lakes, because of the higher survival rates observed for fish stocked into lakes and reservoirs (Moyle 2002; Wales 1956; McCammon and Borgeson 1960 in Butler and Borgeson 1965). According to Dunham et al. (2004), different species of introduced trout may have different effects on amphibians. For example, Bull and Marx (2002) found that brook trout, but not rainbow trout, negatively affected the abundance of long-toed salamanders and Pacific treefrogs. Most hatchery rainbow trout that are reared and released for put-and-take fisheries in streams do not survive very long and do not travel far from the point of release (Butler and Borgeson 1965; Moyle 2002), suggesting a low potential for predation of and competition with native amphibian species. However, large numbers of hatchery trout may be released when larval amphibians are very abundant. If the amphibian population is small, even a relatively brief encounter between larval amphibians and thousands of hatchery trout could result in heavy predation of the amphibians.

Catchable-sized hatchery rainbow trout released into lakes and reservoirs may survive for several years, and put-and-grow fingerlings and subcatchables released into lakes and reservoirs typically do survive at good rates until reaching catchable size (Moyle 2002; Wales 1956; McCammon and Borgeson 1960 in Butler and Borgeson 1965; Lee pers. comm.). Moreover, recent data indicate that many introductions of trout to lakes and reservoirs result in self-sustaining populations and therefore an ongoing risk of predation and competition. Armstrong and Knapp (2004) found that 70% of HMLs in the John Muir Wilderness maintained naturally reproducing populations 4–8 years after stocking ceased and that 68% of HMLs in the Sequoia-Kings Canyon National Park retained natural populations 20 or more years after stocking was halted. Moreover, they concluded that any historically fishless lake below 3,520 m elevation with at least some spawning habitat should be *a priori* be considered capable of supporting self-sustaining populations of trout of the genus *Oncorhynchus*. Introduced brook trout and sometimes kokanee are also able to establish self-sustaining populations in lakes and reservoirs because they can spawn in lake habitats and do not require suitable gravel substrate in streams. In lakes that contain native amphibian populations or have a connection to accessible upstream or downstream reaches with native amphibian populations, the potential for impacts on native amphibian species through competition and predation associated with catchable-sized trout plantings and put-and-grow releases into lakes is higher than for stream plantings due to the greater survivability of hatchery fish from lake plantings. The threat to native amphibians from trout escaping from stocked lakes may also be substantial, as there are now numerous wild populations of introduced trout.

A distinction must be drawn between lakes and reservoirs with regard to the threat posed by stocked trout to native amphibians. Most reservoirs do not support populations of native amphibians.

Manipulative experiments involving fish removals have been, or are currently being, conducted in habitats containing mountain yellow-legged frogs (Vredenburg 2004; Knapp et al. 2007) and the Cascades frog (Pope et al. 2009).Results of these experiments, combined with other available literature (Knapp et al. 2001; Knapp 2005), indicate that recovery of amphibian populations can occur following removal of introduced trout populations. However, introduced trout are not the only stressor currently affecting amphibians and reptiles (see cumulative effects section) and populations that recover following removal of introduced trout may subsequently decline due to other stressors. For instance, following the initial increase in mountain yellow-legged frog populations observed in Vredenburg (2004), the populations declined as a result of a *Batrachochytrium dendrobatidis* outbreak (Knapp et al. 2007). Nonetheless, in 1998 DFG began developing aquatic biodiversity management plans (ABMPs) that identify mountain yellow-legged frog restoration opportunities and has also begun implementing recovery efforts in nine river basins. Approximately 24 plans have been written to date, and several others are under development.

In addition to predation and competition, introduced trout may indirectly affect amphibians by disrupting connectivity among habitats (Bradford et al. 1993; Pilliod and Peterson 2001). Local extirpations caused by introduced trout can isolate remaining frog populations from each other, which decreases their effective population size and increases the risk of any individual population being extirpated (Bradford et al. 1993; Knapp and Matthews 2000).

Finlay and Vredenburg (2007) describe competitive interactions between introduced trout and the mountain yellow-legged frog in some detail. They note that frogs and introduced trout feed in different portions of alpine lakes but that stable-isotope analyses clearly show that the same resource base of benthic invertebrates sustains both populations. They cite an observation of a 20-fold higher rate of insect emergence from a fishless lake adjacent to lakes with trout and contend that this observation, in combination with their stable isotope analysis, shows that fish reduce the availability of aquatic prey to amphibious and terrestrial consumers. In support of this conclusion, they show that foraging post-metamorphic frogs are 10 times more abundant in the absence of trout. They conclude that the disruption of trophic connections between aquatic and terrestrial food webs is an important but poorly understood consequence of fish introduction to montane lakes and streams worldwide and may contribute to declines of native consumers in riparian habitats.

The potential level of predation and competition effects for each amphibian and reptile species is discussed below.

Impact BIO-50: Predation and Competition Effects from Stocked Trout on California Tiger Salamander (Less than Significant)

There are 72 trout stocking locations within the range of the California tiger salamander (Figure 4-47). California tiger salamanders spend much of their time in subterranean refugia and, as adults, primarily use terrestrial habitats, such as annual grasslands and grassy understories of hardwood habitats. California tiger salamanders breed primarily in vernal pools and other ephemeral ponds that fill during winter and often dry out by summer (Loredo et al. 1996), although they sometimes use permanent human-made ponds (e.g., stock ponds), reservoirs, and small lakes that do not support predatory fish or bullfrogs (Stebbins 1972; Zeiner et al. 1988-1990). A literature review did not indicate that predation by stocked trout is a factor in California tiger salamander biology and the habitat separation between use of ephemeral or fishless waters by salamanders and use of perennial streams and lakes by trout likely explains this circumstance.

California tiger salamander is a rare and declining species within its range. It is listed as threatened under the ESA; DFG lists them as a species of special concern, and it has recently been designated a candidate for endangered listing under the CESA. Trout stocking has not been cited as a factor in declines of California tiger salamander populations. Thus, the impact of trout stocking on California tiger salamanders is less than significant.

Impact BIO-51: Predation and Competition Effects from Stocked Trout on Northwestern Salamander (Less than Significant)

There are 15 trout stocking locations within the range of the northwestern salamander (Figure 4-48). Northwestern salamanders are a common pond-dwelling salamander that often co-occurs with trout and with other native fishes and thus is co-evolved with trout. The literature records a range of interactions between northwestern salamanders and trout. Adams et al. (2001) found no effect associated with the presence of trout, but Larson and Hoffman (2002) found that northwestern salamanders are potentially extirpated by introduction of trout to their habitat. Currens et al (2007) found that trout presence alone was enough to reduce growth in larval northwestern salamanders due to chemical cues produced by the trout. Removal of brook trout from a mountain lake in Washington was followed by a substantial increase in the northwestern salamander population of the lake (Hoffman et al. 2004). Based on this evidence, it appears clear that although northwestern salamanders and trout can coexist, there are likely many cases in which the presence of stocked trout has contributed directly to the decline or extirpation of northwestern salamanders from the stocked lake (northwestern salamanders rarely inhabit streams).

Northwestern salamanders are a very common species within their range and are not classified as a protected species under either federal or state law. Northwestern salamander extirpations are not reported to be widespread in California, and trout stocking has not been cited as a factor in decline of northwestern salamander populations. Thus, the impact of trout stocking on northwestern salamanders is less than significant.

Impact BIO-52: Predation and Competition Effects from Stocked Trout on Long-toed Salamander (Less than Significant)

There are 228 trout stocking locations within the range of the long-toed salamander (Figure 4-60). Long-toed salamanders are an extremely common salamander that primarily breeds in and inhabits, in all life history stages, quiet waters such as ephemeral and perennial ponds and in lakes; the adults also occur in terrestrial environments, chiefly wetlands and riparian habitats. In many such settings, long-toed salamanders coexist with native fish, including trout. However, long-toed salamander extirpations appear to have resulted from introduction of trout into formerly fishless lakes in both the Klamath and the Sierra Nevada mountains. Welsh et al. (2006), studying mountain lakes in the Klamath-Siskiyou region, found that long-toed salamanders were 44 times more likely to be found in lakes without fish (primarily trout) than in lakes with fish. Leyse (2005), studying mountain lakes in the Sierra Nevada (Desolation Wilderness), found that long-toed salamanders were present in 92% of the study sites, but were found at only 38% of the sites where trout had been introduced. Comparable results have been obtained elsewhere. In a study of mountain lakes in northeast Oregon, Bull and Marx (2002) found long-toed salamanders in 20 of 23 fishless lakes, but in only 7 of 20 lakes supporting trout. Studying lower-elevation waters in the Willamette Valley of Oregon, Pearl et al. (2005) found that the best predictor of long-toed salamander presence was the absence of non-native fish. Based on the results of these and comparable studies, it is now well-established that long-toed salamanders are substantially more abundant in fishless waters than in waters supporting

trout; and specifically, that this finding extends to include mountain lakes that were formerly fishless but that are and for many years have been stocked with trout, but which would no longer support trout if stocking were to cease. Moreover, Funk and Dunlap (1999) demonstrated that long-toed salamander populations have colonized mountain lakes in Montana following the extirpation of introduced trout. It therefore appears likely that historical stocking of trout into high mountain lakes in California resulted in extirpation of long-toed salamanders in many of those lakes, and that in lakes where trout cannot establish self-sustaining populations, the ongoing trout stocking program serves to prevent long-toes salamanders from re-colonizing those lakes.

Long-toed salamanders are a very common species within their range and are not classified as a protected species under either federal or state law. Although historic trout stocking likely resulted in a geographically widespread extirpation of long-toed salamander populations from high mountain lakes in the Sierra Nevada, Cascade and Klamath mountain ranges, the continuing conduct of the trout-stocking program during the 2004-2008 baseline period has likely no resulted in any further population changes that would constitute a significant impact on the long-toed salamander. Thus, the impact of the trout stocking program on long-toed salamanders is less than significant.

Impact BIO-53: Predation and Competition Effects from Stocked Trout on Santa Cruz Long-Toed Salamander (Less than Significant)

Trout are not stocked within the range of the Santa Cruz long-toed salamander (Figure 4-47). Thus, there is no potential for trout stocking to affect the Santa Cruz long-toed salamander, and the impact of trout stocking on Santa Cruz long-toed salamanders is less than significant.

Impact BIO-54: Predation and Competition Effects from Stocked Trout on California Giant Salamander (Less than Significant)

There are 11 trout stocking locations within the range of the California giant salamander (Figure 4-53). California giant salamander biology is essentially the same as that of the Pacific giant salamander, described below; until recently, they were treated as being the same species. Consequently there is no published literature that specifically treats the interactions between trout and California giant salamanders, and the impact determination for this species is based upon the rationale and literature presented below for the Pacific giant salamander.

California giant salamander is a common species within its range and is not classified as a protected species under either federal or state law. California giant salamander extirpations are not reported to be widespread in California, and trout stocking has not been cited as a factor in decline of California giant salamander populations. Thus, the impact of trout stocking on California giant salamanders is less than significant.

Impact BIO-55: Predation and Competition Effects from Stocked Trout on Pacific Giant Salamander (Less than Significant)

There are 182 trout stocking locations within the range of the Pacific giant salamander (Figure 4-54). Pacific giant salamander is a common stream-dwelling salamander that occurs either in the headwaters of streams, above the limit of trout, or in mountain streams that are also occupied by trout and other salmonids (Bury et al. 1991). At adult size, it is a large salamander (up to 1 foot long) and has been observed to both eat and be eaten by salmonids (Jones and Welsh 2009). Rundio and Olson (2003) found that larval Pacific giant salamanders are preyed upon by native cutthroat trout, but that the larval salamanders respond to chemical cues produced by the trout and seek refuge. A

similar defense mechanism has been described for northwestern salamanders and in that species has been found to result in reduced growth rate of the larval salamanders (Currens et al. 2007).

Pacific giant salamanders are also in direct competition with trout. Mechanisms of competition have been studied in the case of Pacific giant salamander competition with native cutthroat trout by Rundio (2002), who found no significant differences in the survival, growth, or activity level of salamanders in pools with or without cutthroat trout. Rundio (2002) acknowledged but did not investigate the consequences for stream food webs of having two top-level predators, the trout and the salamander. There is thus no basis for a determination of whether trout stocking in the range of Pacific giant salamander alters competition between these species in an ecologically meaningful way.

Pacific giant salamander is a very common species within its range and is not classified as a protected species under either federal or state law. Pacific giant salamander extirpations are not reported to be widespread in California, and trout stocking has not been cited as a factor in decline of Pacific giant salamander populations. Thus, the impact of trout stocking on Pacific giant salamanders is less than significant.

Impact BIO-56: Predation and Competition Effects from Stocked Trout on Southern Torrent Salamander (Less than Significant)

There are 14 trout stocking locations within the range of the southern torrent salamander (Figure 4-49). Southern torrent salamanders are a stream-dwelling salamander that occurs in the headwaters of streams, where it is subject to predation by Pacific giant salamanders and perhaps by salmonids (Welsh and Karraker 2009). In response to this predation, it primarily occurs upstream of the limit of perennial flow or, in perennial streams, in very shallow water microhabitats that are not used by these predators (Rundio and Olson 2001). Thus, there is a strong niche separation between most southern torrent salamanders and their potential predator, stocked trout. Additionally, Rundio and Olson (2001) found that larval southern torrent salamanders are unpalatable to Pacific giant salamanders; they are also unpalatable to shrews (Nussbaum et al. 1983), and it is thus quite possible, although not demonstrated, that they are unpalatable to trout. No information was found documenting trout predation on southern torrent salamanders, but in view of the information provided above, it seems likely that trout are only occasionally stocked in habitats occupied by southern torrent salamanders, that trout and salamanders use different microhabitats, and that the salamanders are likely unpalatable to trout. Thus, predation of southern torrent salamanders by trout is likely infrequent.

Southern torrent salamander is a common species within its range and is not classified as a protected species under either federal or state law. Southern torrent salamander extirpations are not reported to be widespread in California, and trout stocking has not been cited as a factor in decline of southern torrent salamander populations. Thus, the impact of trout stocking on southern torrent salamanders is less than significant.

Impact BIO-57: Predation and Competition Effects from Stocked Trout on Rough-Skinned Newt (Less than Significant)

There are 213 trout stocking locations within the range of the rough-skinned newt (Figure 4-50). The rough-skinned newt occupies ponds and slow-moving streams, where it often co-occurs with trout, but is seldom preyed upon due to its high content of the toxic compound tetrodotoxin; its principal predators are other rough-skinned newts and the common garter snake, which are

resistant to the effects of tetrodotoxin (Marks and Doyle 2009a). Thus, there is evidently little risk of newt predation by stocked trout (Welsh et al. 2006). Newts are omnivorous and thus may compete with stocked trout for foods such as aquatic invertebrates; no information was found addressing this potential competition, but it may occur and, if so, would be detrimental to the newt, particularly if stocking levels were to exceed the carrying capacity of the stream, as might sometimes occur in an active put-and-take fishery.

Rough-skinned newts are a very common species within their range and are not classified as a protected species under either federal or state law. Rough-skinned newt extirpations are not reported to be widespread in California, and trout stocking has not been cited as a factor in decline of rough-skinned newt populations. Thus, the impact of trout stocking on rough-skinned newts is less than significant.

Impact BIO-58: Predation and Competition Effects from Stocked Trout on Red-Bellied Newt (Less than Significant)

There are four trout stocking locations within the range of the red-bellied newt (Figure 4-50). The biology of the red-bellied newt is generally similar to that of the rough-skinned newt, described above, but differs in two important respects: (1) it has very strong site fidelity coupled with a narrow range, so local extirpations result in a much stronger effect on the species as a whole compared with the rough-skinned newt; and (2) it occupies faster waters and more headward stream habitat compared with the rough-skinned newt (Marks and Doyle 2009b). However, it shares the high tetrodotoxin-derived toxicity of the rough-skinned newt, and its only reported predator is the common garter snake (Twitty 1966, cited by Marks and Doyle 2009b). Thus, there is evidently little risk of newt predation by stocked trout. Newts are omnivorous and thus may compete with stocked trout for foods such as aquatic invertebrates; no information was found addressing this potential competition, but it may occur and if so would be detrimental to the newt, particularly if stocking levels were to exceed the carrying capacity of the stream, as might sometimes occur in an active put-and-take fishery.

Red-bellied newt is a common species within its range and is not classified as a protected species under either federal or state law. Red-bellied newt extirpations are not reported to be widespread in California, and trout stocking has not been cited as a factor in decline of red-bellied newt populations. Thus, the impact of trout stocking on red-bellied newts is less than significant.

Impact BIO-59: Predation and Competition Effects from Stocked Trout on Sierra Newt (Less than Significant)

There are 147 trout stocking locations within the range of the Sierra newt (Figure 4-51). The Sierra newt occupies streams during the breeding season, which is approximately January through May but can vary depending upon rainfall and elevation. Males arrive first and leave last, and females leave immediately after oviposition (Vance 2000). In extremely dry years breeding may not occur at all and only a few males will arrive at the stream and will stay only briefly (Vance, pers comm.). The timing of male newts leaving the stream coincides with hatching of newt larvae from egg clusters (Vance 2000). The remainder of the year, adjacent terrestrial habitats are used by adults, metamorphs and juveniles; adults of the related rough-skinned newt do not reach sexual maturity until about 4-5 years of age, but Twitty (1961) estimates that the period before sexual maturity is even longer in Sierra newt, because these species are terrestrial during most of the year, and feeding

and growth opportunities are more limited than for rough-skinned newt which is aquatic during most of the year.

Sierra newt often co-occurs with trout but is seldom preyed upon due to its high content of the toxic compound tetrodotoxin (Chen 2008). Accordingly, there is evidently little risk of newt predation by stocked trout. Newts would likely only co-occur with trout at montane and higher elevations where there are perennial streams with sufficient water to support trout; many lower elevational streams are intermittent and are completely dry by late summer (Vance, pers comm). Garter snakes appear to be little affected by tetrodotoxin (Nussbaum et al. 1983) and are the principal predators of other newts in this genus and thus are likely the principal predators of the Sierra newt.

Newts are omnivorous and may compete with stocked trout for foods such as aquatic invertebrates; no information was found addressing this potential competition, but it may occur and, if so, would be detrimental to the newt, particularly if stocking levels were to exceed the carrying capacity of the stream, as might sometimes occur in an active put-and-take fishery. Adults of the closely related Coast Range newt eat a wide variety of terrestrial and aquatic invertebrates such as earthworms; insects, snails, beetles, butterflies, stoneflies, carrion (Hanson et al. 1994), and conspecific eggs and larvae (Kats et al. 1992). Coast Range newt adults appear to be opportunistic feeders as well; after fire-induced sedimentation caused an increase in stream earthworm density, earthworms comprised a larger part of the adult newts' diet than in comparable unburned stream sites (Kerby and Kats, 1998). Based on the time of year that adult newts are active in the stream vis-à-vis the period of trout stocking within the newt's range (April to October), predation and competition interactions between stocked trout and adult newts would only occur for about a month at higher elevations, and would not occur at all at lower elevations where newt breeding is completed by April (Vance, 2000 or pers comm).

Sierra newts are locally abundant throughout much of their range and are not classified as a protected species under either federal or state law. Sierra newt extirpations are not reported to be widespread in California, and trout stocking has not been cited as a factor in decline of Sierra newt populations. Thus, the impact of trout stocking on Sierra newts is less than significant.

Impact BIO-60: Predation and Competition Effects from Stocked Trout on Coast Range Newt (Less than Significant)

The Sierra newt and the Coast Range newt are the Sierra and Coast Range subspecies of the California newt. They share a very similar biology. There are 40 trout stocking locations within the range of the Coast Range newt (Figure 4-51). The Coast Range newt occupies lakes, slow-moving streams and, in post-metamorphic life history stages, adjacent terrestrial habitats (Jennings and Hayes 1994). Like other newts of the genus *Taricha*, it has a potent defense against predators due to its high content of the toxic compound tetrodotoxin; nonetheless, predation by mosquitofish and crayfish has been documented (Garcia et al. 2008; Gamradt and Kats 1996 in Garcia et al. 2008). Garter snakes appear to be little affected by tetrodotoxin (Nussbaum et al. 1983) and are the principal predators of other newts in this genus and thus are likely predators of the Coast Range newt. Thus, there is evidently little risk of newt predation by stocked trout. Newts are omnivorous and may compete with stocked trout for foods such as aquatic invertebrates; no information was found addressing this potential competition, but it may occur and if so would be detrimental to the newt, particularly if stocking levels were to exceed the carrying capacity of the stream, as might sometimes occur in an active put-and-take fishery.

Coast Range newt is a common species within portions of its range and is not classified as a protected species under federal law, but newts occurring southward from the Salinas River in Monterey County are a species of special concern in California. Of the 40 trout stocking locations within the range of the Coast Range newt, 11 locations are south of the Salinas River (Figure 4-52). Coast Range newt extirpations have been widespread in southern California, due to habitat loss and degradation associated with development (Jennings and Hayes 1994), but trout stocking has not been cited as a factor in decline of Coast Range newt populations. Thus, the impact of trout stocking on Coast Range newts is less than significant.

Impact BIO-61: Predation and Competition Effects from Stocked Trout on Western Tailed Frog (Less than Significant)

There are 167 trout stocking locations within the range of the western tailed frog (Figure 4-60). The western tailed frog occupies fast-flowing mountain streams in all life stages, and it often co-occurs with trout. Although tailed frogs co-evolved with trout and display avoidance strategies to minimize their predation risk, trout do prey upon tailed frogs (Adams and Pearl 2009). Accordingly, trout population establishment or enhancement caused by stocking may result in increased predation on tailed frogs. Field experiments by Feminella and Hawkins (1994) have shown that the presence of cutthroat trout reduces tailed frog tadpole activity threefold compared with predator-free conditions, and for experiments using brook trout, a sixfold reduction in tadpole activity occurred. Such activity reductions may be expected to result in slower growth and a longer time to metamorphosis. Subsequent laboratory experiments showed that these predators could pursue and consume tailed frog tadpoles even in structurally complex environments (Feminella and Hawkins 1994). Because the tailed frog is a species with low fecundity that often takes several years to metamorphose (Jennings and Hayes 1994; Adams and Pearl 2009), such predation upon the tadpoles can be expected to have detrimental effects on population status.

Tailed frog is a common species within its range and is not classified as a protected species under federal law, though it is a species of special concern under California law. It has not exhibited evidence of a rangewide decline, and the principal described threat to the species is timber harvest, which typically results in water temperatures that exceed the species' tolerance (Jennings and Hayes 1994); trout introductions have not been cited as a factor in decline of tailed frog populations. Thus, the impact of trout stocking on western tailed frogs is less than significant.

Impact BIO-62: Predation and Competition Effects from Stocked Trout on Western Spadefoot (Less than Significant)

There are109 trout stocking locations within the range of the western spadefoot (Figure 4-49). The western spadefoot breeds in isolated, ephemeral waters, while post-metamorphic toads are primarily terrestrial (Morey 2005). Thus, there is essentially no potential for western spadefoot eggs, tadpoles, or adults to suffer trout predation. Trout predation is not discussed in the literature on the species; its principal predators are probably California tiger salamanders, garter snakes, great blue herons, and raccoons (Jennings and Hayes 1994).

Western spadefoots are a common species within their range and are not classified as a protected species under federal law, although they are listed as a species of special concern by the state of California. In view of the absence of western spadefoot in habitats used by stocked trout, the impact of trout stocking on western spadefoots is less than significant.

Impact BIO-63: Predation and Competition Effects from Stocked Trout on Western Toad (Less than Significant)

There are 929 trout stocking locations within the range of the western toad (Figure 4-48). The western toad is largely terrestrial as an adult and breeds in shallow ponds and slow-moving streams that generally are not suitable habitat for trout (Muths and Nanjappa 2009); thus, there is low potential for western toads to suffer trout predation. Nonetheless, some populations occur in lakes or along rivers that are inhabited by trout, and the species has co-evolved with native trout. The tadpoles are unpalatable to trout; moreover, they do not even show a response to the presence of trout and evidently do not regard trout as potential predators (Kiesecker et al. 1996; Welsh et al. 2006). Thus, there is low potential for stocked trout to materially affect western toad population status via predation. Although widespread declines of the western toad have been noted, most reports have been from populations outside of California, with the exception of a reported decline in the Yosemite region (Drost and Fellers 1996). Trout stocking has not been implicated as a cause of these declines.

The Welsh et al. (2006) study warrants additional comment because of the ecological insights it affords. Welsh et al. examined the influence of introduced trout in the Klamath-Siskiyou Bioregion of northern California on the distributions and abundances of a subalpine amphibian assemblage with a wide array of life-history and defense strategies. Specifically, Welsh et al. examined the relationship between trout distribution and the distribution of five amphibian species:

- the Pacific treefrog, which breeds both in permanent and ephemeral waters and is palatable to fish;

- the western toad, which is unpalatable to fish;

- the rough-skinned newt, which in the adult form is also unpalatable to fish;

- the Cascades frog, which breeds in permanent waters and is palatable to fish; and

- the long-toed salamander, which also breeds only in permanent waters and is palatable to fish.

A survey of 728 ponds, lakes, and wet meadow sites during the summers of 1999–2002 showed that the distributions of Pacific treefrogs, Cascades frogs, and long-toed salamanders were strongly negatively correlated with trout presence. The long-toed salamander was 44 times more likely to be found in lakes without fish than in lakes with fish, and Cascade frogs and Pacific treefrogs were 3.7 and 3.0 times more likely, respectively, to be found in fishless than fish-bearing waters. In contrast, the two unpalatable species were either uncorrelated (rough-skinned newt) or positively correlated (western toad) with fish presence. Welsh et al. also found that the relative density of fish (catch per unit effort) was negatively correlated with the combined abundances of the three palatable amphibians and also with both the length and the condition of the fish themselves. Welsh et al. concluded that the findings were consistent with other evidence that introduced fishes greatly alter the aquatic community structure of mountain lakes, ponds, and wet meadows.

Western toads are a common species within their range and are not classified as a protected species under either federal or state law. Western toad extirpations are not reported to be widespread in California, and trout stocking has not been cited as a factor in decline of western toad populations. Thus, the impact of trout stocking on western toads is less than significant.

Impact BIO-64: Predation and Competition Effects from Stocked Trout on Yosemite Toad (Less than Significant)

There are224 trout stocking locations within the range of the Yosemite toad (Figure 4-52). There is likely little or no interaction between trout and Yosemite toads because the toads are largely terrestrial and generally breed in shallow ponds that do not support trout (Knapp 1996). Knapp (2005) found that, of 74 surveyed Yosemite toad populations, only 11% were in water bodies that were presumed to support trout (i.e., water more than 4 m deep).

Many species of the genus *Bufo* are unpalatable to a host of fish predators during their egg (Licht 1968, 1969) and tadpole stages (Voris and Bacon 1966; Kruse and Stone 1984; Kats et al. 1988; Kiesecker et al. 1996; Lawler and Hero 1997). Grasso (2005) found in laboratory studies that brook trout found Yosemite toad tadpoles unpalatable and that the tadpoles survived the trouts' attempts to eat them. The post-metamorphic stage was not evaluated during this study but this stage could be vulnerable to predation by trout. Toadlets of the closely related western toad (*Bufo boreas*) have been found in trout stomachs (Grasso 2005; Knapp 2005). However, the likelihood of predation on adult toads appears low based on findings from Knapp (2005), Welsh et al. (2006), and recent HML surveys conducted by DFG.

Although Knapp (2005) found no correlation between the presence of Yosemite toad tadpoles and the presence of introduced trout, he also speculated that some Yosemite toad mortality might occur because individual trout must consume tadpoles to discover they are unpalatable and/or because toadlets may be palatable enough to fuel enough predation to reduce population densities but not result in extirpation[5]. However, Grasso (2005) found that tadpoles did not suffer from mortality during brook trout attempts to eat them, and Welsh et al. (2006) and DFG found a positive correlation of Yosemite toads with trout, indicating a low likelihood of trout-induced abundance declines associated with trout preying on subadult toads. Observed positive correlations may be the result of trout eating macroinvertebrates (such as dragonfly larvae) that prey upon Yosemite toad tadpoles, thus increasing the survival of early toad life stages (Welsh et al. 2006).

Because of the unpalatability of Yosemite toad larval and egg stages, apparent neutral or positive associations of Yosemite toad with introduced trout, and low likelihood of occurrence in larger water bodies that support trout, the potential competition and predation effects on Yosemite toad associated with trout stocking are less than significant.

Impact BIO-65: Predation and Competition Effects from Stocked Trout on Arroyo Toad (Less than Significant)

There are 23 trout stocking locations within the range of the arroyo toad (Figure 4-52). As noted above, many species of the genus *Bufo* are unpalatable to a host of fish predators during their egg (Licht 1968, 1969) and tadpole stages (Voris and Bacon 1966; Kruse and Stone 1984; Kats et al.

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[5] In his discussion, Knapp (2005) states the following*:* "While the regression results suggest that trout have no effect on the distribution of *B. canorus* and *T. sierrae*, other more subtle impacts of trout are possible and should be explored further before a negative effect of trout on these species is totally discounted. First, it is possible that trout do prey on some life stages of these two species at a high enough level to influence population densities but not presence/absence. For example, trout readily prey on subadults of the closely related California toad (*Bufo boreas halophilus*) in the southern Sierra Nevada [Knapp 2005], and it is possible that at least the subadults of *B. canorus* are also palatable. Second, assuming that predators must learn to reject unpalatable toad and newt life stages (Peterson and Blaustein, 1991), some mortality of *B. canorus* and *T. sierrae* may be incurred as a result of handling by trout during this learning process. The extent to which such mortality might influence population densities of these two species remains unknown."

1988; Kiesecker et al. 1996; Lawler and Hero 1997; Grasso 2005). However, arroyo toad eggs and larvae likely lack this protective mechanism:

> [V]irtually all rivers that contain or once contained arroyo toads support populations of introduced predatory fish, such as green sunfish (*Lepomis cyanellus*), largemouth bass (*Micropterous salmoides*), mosquitofish (*Gambusia affinis*), black bullhead (*Ictalurus nebulosus*), arroyo chub (*Gila orcutti*), prickly sculpin (*Cottus asper*), rainbow trout (*Oncorhynchus mykiss*), oriental gobies (*Tridentiger* sp.), and red shiners (*Notropis lutrensis*) (Sweet 1992). All of these introduced fish prey on tadpoles and have been observed inducing high arroyo toad larval mortality in breeding pools on the Piru, Sespe, and Santa Ynez drainages. It is probable that predation by introduced fish species occurs elsewhere. [59 FR 64866]

It is thus possible that arroyo toads are vulnerable to trout predation, and that such predation occasionally occurs in association with trout stocking. However, the USFWS has determined that "native rainbow trout do not pose a serious threat to arroyo toads," and that the final rule listing arroyo toads as a threatened species inadvertently mentioned trout as a potential competitor with arroyo toads (USFWS 1995b). Thus, although competition and predation with stocked trout may occur on rare occasions, trout stocking overall has a less-than-significant effect on arroyo toads.

Impact BIO-66: Predation and Competition Effects from Stocked Trout on Woodhouse's Toad (Less than Significant)

There are 2 trout stocking locations within the range of the Woodhouse's toad (Figure 4-53). Woodhouse's toad is largely terrestrial as an adult, and breeds in shallow, warm lakes, ditches and ponds that generally are not suitable habitat for trout (Sullivan 2009); thus there is low potential for Woodhouse's toads to suffer trout predation. The tadpoles are presumably unpalatable to trout; although the question seems not to have been investigated for this species, unpalatability has been shown for *Bufo fowleri*, which was formerly included in this species (Lawler 1989). Thus, there is low potential for stocked trout to materially affect Woodhouse's toad population status via predation.

Woodhouses's toads are a common species within their range and are not classified as a protected species under either federal or state law. Woodhouse's toad extirpations are not reported to be widespread in California and trout stocking has not been cited as a factor in decline of Woodhouse's toad populations. Thus, the impact of trout stocking on Woodhouse's toads is less than significant.

Impact BIO-67: Predation and Competition Effects from Stocked Trout on Pacific Treefrog (Less than Significant)

There are 983 trout stocking locations within the range of the Pacific treefrog (Figure 4-55). The Pacific treefrog breeds and metamorphoses in aquatic habitats, chiefly ponds and lake margins but occasionally in streams, and is largely terrestrial as an adult (Rorabaugh and Lannoo 2009). It occupies habitats that are used by native trout and is coevolved with native trout. Welsh et al. (2006) found a strong negative correlation between Pacific treefrog and trout abundance in three wilderness areas within the Klamath Mountains, and infer that this is due to predation of the palatable treefrog by trout. Drost and Fellers (1996), examining native amphibian declines in the Yosemite area, found little evidence for decline of Pacific treefrogs or for any effects on the species related to historical stocking of HMLs with trout. Matthews et al. (2001), however, found evidence of strong suppression of Pacific treefrog populations in high elevation (more than 10,000 feet [3,000 m]) Sierra Nevada lakes stocked with trout. Their analytical model indicated that the probability of finding treefrogs was 2.4 times higher in lakes without trout than in lakes with trout, and that for

water bodies containing treefrogs, the number of frogs was 3.7 times higher in lakes without trout than in lakes with trout. These data suggest that historical introductions of trout to Sierra Nevada HMLs likely contributed to treefrog declines in those lakes, but do not speak to the question of whether trout stocking affects treefrog abundance in lower elevation waters where treefrogs have historically coexisted with native trout. Treefrog declines have not been noted at lower elevations in California, and numerous authors (cited by Rorabaugh and Lannoo 2009) have noted their historical and current abundance, with little evidence of population decline, throughout their historical range.

Pacific treefrog are a very common species within their range and are not classified as a protected species under either federal or state law. Pacific treefrog extirpations are not reported to be widespread in California and trout stocking has not been cited as a factor in decline of Pacific treefrog populations. Thus, the impact of trout stocking on Pacific treefrogs is less than significant.

Impact BIO-68: Predation and Competition Effects from Stocked Trout on California Treefrog (Less than Significant)

There are 51 trout stocking locations within the range of the California treefrog (Figure 4-55). The California treefrog occupy habitat very similar to that used by Pacific treefrogs within the relatively warm, low-elevation Southern California range of the California treefrog. They breed and metamorphose in aquatic habitats, chiefly ponds and slow-moving streams, and are largely terrestrial as adults (Ervin 2009). Tadpoles have been noted as most abundant in fishless pools and the introduced green sunfish (*Lepomis cyanellus*) has been implicated in the decline of this species (Ervin 2009). Nonetheless, Ervin (2009) reports that California treefrogs share the same stream reaches and macrohabitats with several native fish species including rainbow trout, southern steelhead, threespine stickleback (*Gasterosteus aculeatus*), Santa Ana sucker, arroyo chub, and speckled dace (*Rhinichthys osculus*). Thus, like the Pacific treefrog, this species appears to be capable of coexisting with populations of trout, notwithstanding that local population declines or extirpations could occur in response to the elevated concentrations of trout associated with stocking for put-and-take fisheries.

California treefrogs are a common species within their range and are not classified as a protected species under either federal or state law. California treefrog extirpations are not reported to be widespread in California and trout stocking has not been cited as a factor in decline of California treefrog populations. Thus, the impact of trout stocking on California treefrog is less than significant.

Impact BIO-69: Predation and Competition Effects from Stocked Trout on Oregon Spotted Frog (Less than Significant with Mitigation)

Trout are not stocked within the range of the Oregon spotted frog. No one has reported a living Oregon spotted frog in California since at least 1989 (Jennings and Hayes 1994); nonetheless populations may persist in Oregon, downstream of stocking locations, so it remains possible that trout stocking results in interactions between trout and Oregon spotted frogs. Cushman and Pearl (2007) state that "Reaser (2000) concluded that introduced trout are one of the main limitations on Columbia spotted frog [a closely related species] distribution in Nevada. Bull and Marx (2002) did not detect any effect of trout presence in eastern Oregon ponds and lakes, but Columbia spotted frogs were associated with littoral vegetation along north shores. Such a pattern is consistent with an ability of spotted frogs to coexist with fish in sites with cover for breeding and rearing." Based on this limited evidence, it is plausible that trout stocking within the range of the Oregon spotted frog (Figure 4-59) could impair the status of affected populations.

Oregon spotted frogs are at best rare and possibly extirpated in California; if present, they are likely represented by a very small number of populations. Rangewide, the species has suffered severe and ongoing declines (Cushman and Pearl 2007). The species is a federal candidate for protection under the ESA and is classified as a species of special concern in California. Impairment or loss of even a single California population would represent a substantial change in species status in California. Thus, the impact of trout stocking on Oregon spotted frogs is potentially significant.

Mitigation Measure BIO-69: Implement Pre-Stocking Evaluation Protocol for Oregon Spotted Frog

Currently the Oregon spotted frog appears to be extirpated in California, with no occurrences reported since 1989. If any occurrence of Oregon spotted frog are identified in California in the future, trout stocking within their range could result in significant adverse impacts on the population, as detailed in Impact BIO-69. To mitigate for this impact, DFG shall implement a PSEP (see Appendix K) at any location where stocking is proposed within the range of this species. Under the protocol, each stocking location shall be evaluated in a stepwise fashion to determine whether interactions between stocked trout and Oregon spotted frogs may occur and to evaluate the potential for trout stocking to result in an substantial effect on Oregon spotted frogs. If such an impact is determined likely, then DFG shall either cease stocking at that location or develop and implement, prior to stocking at that location, an ABMP (as described in Chapter 2).

Implementation of the PSEP at each site where trout stocking occurs within the range of Oregon spotted frog would reduce potential impacts to less than significant.

Impact BIO-70: Predation and Competition Effects from Stocked Trout on Northern Red-Legged Frog (Less than Significant)

There are two trout stocking locations within the range of the northern red-legged frog (Figure 4-56). No studies have expressly analyzed the effect of hatchery trout on northern red-legged frogs. In general, northern red-legged frogs have shown a "negative association with nonnative fish, although the relationship was not as strong as it was for Pacific treefrogs and long-toed salamanders" (Pearl et al. 2005). Absent further information, it is currently reasonable to assume that, like related red-legged frog species of California and the Cascades, stocked trout may prey upon northern red-legged frogs.

Northern red-legged frogs are not classified as a protected species under federal law, although they are listed by DFG as a species of special concern. Although trout stocking may be a locally important factor in decline of northern red-legged frog populations, the limitation of stocking to only two locations within this species' range is unlikely to result in any substantial change in the number or distribution of populations of this species. Thus, the impact of trout stocking on northern red-legged frogs is less than significant.

Impact BIO-71: Predation and Competition Effects from Stocked Trout on California Red-Legged Frog (Less than Significant with Mitigation)

There are 153 trout stocking locations within the range of the California red-legged frog (Figure 4-56). Trout have been cited as common predators of California red-legged frog tadpoles (Schmieder and Nauman 1994 in U.S. Fish and Wildlife Service 2002). The larvae are particularly vulnerable right after hatching when they are in their non-feeding, yolk-reabsorbing period and are relatively

immobile (Schmieder and Nauman 1994 in U.S. Fish and Wildlife Service 2002). California red-legged frogs are absent or less abundant in lakes where introduced fish (not necessarily trout) are present (Hayes and Jennings 1986), which implies that there may be negative effects associated with stocking. However, the potential level of effects and the importance of stocking as a factor leading to the decline of the California red-legged frog are difficult to discern due to other contributing factors such as habitat loss and predation by introduced bullfrogs (Knapp 1996). For instance, a laboratory study by Kiesecker and Blaustein 1998 found that exposure to bullfrogs resulted in substantial competitive effects on red-legged frog tadpoles, including increased time to metamorphosis and reduced weight at metamorphosis. Other demonstrated adverse impacts of bullfrogs on red-legged frogs include predation by larval bullfrogs, predation by adult bullfrogs, decreased survival, and altered microhabitat use (Blaustein and Kiesecker 2002).

California red-legged frogs are classified as threatened under federal law and are listed by DFG as a species of special concern. Trout stocking may be a locally important factor in decline of California red-legged frog populations and stocking is a widespread activity within this species' range, so there is a potential for trout stocking to produce a substantial change in the number or distribution of populations of this species. Thus, the impact of trout stocking on California red-legged frogs is potentially significant.

To minimize these effects and reduce the impact to less than significant, DFG shall implement Mitigation Measure BIO-71.

Mitigation Measure BIO-71: Implement Pre-Stocking Evaluation Protocol for California Red-Legged Frog

As detailed in Impact BIO-71, trout stocking may have a significant impact on California red-legged frog. To mitigate for this impact, DFG shall implement a Pre-Stocking Evaluation Protocol (PSEP; Appendix K) at each location where stocking occurs within the range of this species. Under the protocol, each stocking location shall be evaluated in a stepwise fashion to determine whether interactions between stocked trout and the potentially affected sensitive species may occur and to evaluate the potential for trout stocking to result in an substantial effect on the sensitive species. If such an impact is determined likely, then DFG shall either cease stocking at that location or develop and implement, prior to stocking at that location, an ABMP (as described in Chapter 2).

Implementation of the PSEP at each site where trout stocking occurs within the range of the California red-legged frog would reduce potential impacts to less than significant.

Impact BIO-72: Predation and Competition Effects from Stocked Trout on Foothill Yellow-Legged Frog (Less than Significant with Mitigation)

The foothill yellow-legged frog resides exclusively in rivers and streams. Modification of habitat and the presence of the non-native bullfrog have been cited as the primary factors in the species decline. (Knapp 1996, Moyle 1973, Jennings and Hayes 1994, Kupferberg 1995). In particular, Kupferberg (2009) attributed declines to altered flow regimes and habitat fragmentation associated with water storage and hydropower dams that are widespread throughout the species' range. Moyle (1973) defined the habitat of foothill yellow-legged frogs as small permanent foothill streams not occupied by introduced bullfrogs and stated that continuing reduction of the range is attributed to habitat alteration coupled with predation and competition from bullfrogs.

Foothill yellow-legged frogs are a DFG species of special concern. Numerous populations have been extirpated in the Sierra Nevada and southern California portions of its range (Jennings and Hayes 1994). Populations in the southern Sierra Nevada may be in the most severe decline, however the populations in the northern Sierra are more robust, but declines may not be as evident (Fellers 2005).

There are 280 trout stocking locations within the range of the foothill yellow-legged frog (Figure 4-57). Many of these locations are lakes and reservoirs that do not support this species. Foothill yellow-legged frogs have co-evolved with fishes and co-occur with rainbow trout (Bourque 2008). There are no reports of native salmonids predation on foothill yellow-legged frogs (Fellers 2005), but foothill yellow frogs are generally absent from habitats containing introduced fishes (not necessarily trout) (Hayes and Jennings 1986). Since they have likely evolved behavioral responses to fish predation, the potential for adverse effects from predation and competition may be minimal where fishes, including rainbow trout, are native species. It is unclear, however, whether stocked trout introduced into their native range are a contributing factor in the decline of the foothill yellow-legged frog. Where trout stocking constitutes a species introduction, stocking may be a locally important factor in the decline of foothill yellow-legged frog populations. Thus, the impact of predation and competition by stocked trout on foothill yellow-legged frogs is potentially significant.

To minimize these effects and reduce the impact to less than significant, DFG shall implement Mitigation Measure BIO-72.

Mitigation Measure BIO-72: Implement Pre-Stocking Evaluation Protocol for Foothill Yellow-Legged Frog

As detailed in Impact BIO-72, trout stocking may have a significant impact on foothill yellow-legged frog. To mitigate for this impact, DFG shall implement a PSEP (see Appendix K) at each location where stocking occurs within the range of this species. Under the protocol, each stocking location shall be evaluated in a stepwise fashion to determine whether interactions between stocked trout and the potentially affected sensitive species may occur and to evaluate the potential for trout stocking to result in an substantial effect on the sensitive species. If such an impact is determined likely, then DFG shall either cease stocking at that location or develop and implement, prior to stocking at that location, an ABMP (as described in Chapter 2).

Implementation of the PSEP at each site where trout stocking occurs within the range of the foothill yellow-legged frog would reduce potential impacts to less than significant.

Impact BIO-73: Predation and Competition Effects from Stocked Trout on Cascades Frog (Less than Significant with Mitigation)

There are 175 trout stocking locations within the range of the Cascades frog (Figure 4-57). Studies in the Trinity Alps of California have shown that Cascades frog densities increased within lakes after trout removal treatments (Pope 2008). This indicates that Cascades frog populations were being suppressed by the presence of trout. Trout may suppress Cascades frog populations through predation and/or competition or through hyperpredation[6]. The latter has been observed in the Klamath Mountains where the Pacific coast aquatic garter snake (*Thamnophis atratus*) was able to expand its distribution by preying upon introduced trout, which facilitated its ability to

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[6] Hyperpredation occurs when nonnative prey facilitates predators, which then suppress native prey.

opportunistically prey upon the Cascades frog and resulted in greater declines of these frogs, in excess of the impacts caused directly by introduced trout (Pope et al. 2008).

Although Cascades frog population declines have been attributed to introduced trout in the Klamath region (Pope 2008; Welsh et al. 2006), Fellers et al. (2008) presents two lines of evidence that suggest that trout are not the primary cause of Cascades frog declines in the Lassen region: (1) "timing of trout introductions at Lassen Volcanic National Park does not correlate with the decline of the Cascades frog in that area" and (2) "trout are less widely distributed in the Lassen region than in other mountainous regions where ranid [frog] populations are still viable (Knapp and Matthews 2000; Welsh et al. 2006)." Even so, it is possible that introduced trout in combination with other factors have interacted to cause the declines observed in the Lassen region (Fellers et al. 2008).

Cascades frogs are not classified as a protected species under federal law, although they are listed by DFG as a species of special concern. Trout stocking may be a locally important factor in decline of Cascades frog populations and stocking is a widespread activity within this species' range, so there is a potential for trout stocking to produce a substantial change in the number or distribution of populations of this species. Thus, the impact of trout stocking on Cascades frogs is potentially significant.

To minimize these effects and reduce the impact to less than significant, DFG shall implement Mitigation Measure BIO-73.

> **Mitigation Measure BIO-73: Implement Pre-Stocking Evaluation Protocol for Cascades Frog**
>
> As detailed in Impact BIO-73, trout stocking may have a significant impact on Cascades frog. To mitigate for this impact, DFG shall implement a PSEP (see Appendix K) at each location where stocking occurs within the range of this species. Under the protocol, each stocking location shall be evaluated in a stepwise fashion to determine whether interactions between stocked trout and the potentially affected sensitive species may occur and to evaluate the potential for trout stocking to result in an substantial effect on the sensitive species. If such an impact is determined likely, then DFG shall either cease stocking at that location or develop and implement, prior to stocking at that location, an ABMP (as described in Chapter 2).
>
> Implementation of the PSEP at each site where trout stocking occurs within the range of the Cascades frog would reduce potential impacts to less than significant.

Impact BIO-74: Predation and Competition Effects from Stocked Trout on Mountain Yellow-Legged Frog (Less than Significant with Mitigation)

There are 402 trout stocking locations within the range of the northern DPS, and 49 within the range of the southern DPS, of the mountain yellow-legged frog (Figure 4-58). Both the northern and southern DPSs of mountain yellow-legged frogs have experienced serious population declines in the last century (Bradford 1989; Bradford et al. 1993; Bradford et al. 1994; Jennings and Hayes 1994; Drost and Fellers 1996; Jennings 1996; Knapp 1996; Knapp and Matthews 2000) and introduced trout are considered a primary factor in those declines (Knapp 1996; Knapp and Matthews 2000). Unlike most frogs, whose tadpoles spend less than a year in water, mountain yellow-legged frog tadpoles spend at least two years in water prior to metamorphosis (Bradford 1989; Knapp and Matthews 2000). The adults are also highly aquatic and are usually found near water. As such, they require deep-water habitats that don't dry up or freeze (usually deeper than 6 feet [2 m]) in order to

overwinter. Trout are known to prey on mountain yellow-legged frogs; predation is especially intense on tadpoles, but also affects adults (Bradford 1989; Bradford et al. 1993; Vredenburg 2004; Needham and Vestal 1938 in Knapp 1996; Pope and Matthews 2001). Besides preying upon the frogs, introduced trout have also fragmented and isolated frog populations, reducing their ability to recolonize areas where local extirpations have occurred (Bradford et al. 1993 in Knapp and Matthews 2000).

Although mountain yellow-legged frogs and introduced trout do co-occur at some sites, these co-occurrences likely represent frog populations that would have negative growth rates in the absence of immigration (73 FR 75175). Recent assessments indicated that 63% (n=63) of surveyed populations were "at risk" and only 7% (n=7) were "healthy"[7] (California Department of Fish and Game unpublished data). This suggests that only a small percentage of mountain yellow-legged frog sites represent healthy populations and a number of populations may not persist in absence of management efforts to protect them. In 1999 the DFG began restoration efforts by removing introduced trout from selected lakes (Milliron pers. comm.), with similar activities since 2001 within the Sequoia and Kings Canyon National Parks (73 FR 75175). These efforts resulted in substantial increases in the affected mountain yellow-legged frog populations (73 FR 75175). DFG has removed or is in the process of removing nonnative trout from more than 20 water bodies in the Inyo, Humboldt-Toiyabe, Sierra, and El Dorado National Forests. Field experiments have shown that when nonnative trout are removed, mountain yellow-legged frog populations may recover quickly (Vredenburg 2004; Knapp et al. 2007).

The southern DPS of the mountain yellow-legged frog is listed as endangered under the ESA, and the southern DPS is a candidate for listing. Both DPSs are listed by DFG as species of special concern. Trout stocking is likely a locally important factor in decline of mountain yellow-legged frog populations, and stocking is a widespread activity within this species' range, so there is a potential for trout stocking to produce a substantial change in the number or distribution of populations of this species. DFG has two active restoration projects that remove non-native trout from streams in the range of the southern DPS. Mountain yellow-legged frogs appear to be recovering quickly at the one project near completion. Based on the foregoing analysis, impacts of trout stocking on both northern and southern DPS of mountain yellow-legged frogs are potentially significant.

To minimize these effects and reduce the impact to less than significant, DFG shall implement Mitigation Measure BIO-74.

Mitigation Measure BIO-74: Implement Pre-Stocking Evaluation Protocol for Mountain Yellow-Legged Frog

As detailed in Impact BIO-74, trout stocking may have a significant impact on mountain yellow-legged frog. To mitigate for this impact, DFG shall implement a PSEP (see Appendix K) at each location where stocking occurs within the range of this species. Under the protocol, each stocking location shall be evaluated in a stepwise fashion to determine whether interactions between stocked trout and the potentially affected sensitive species may occur and to evaluate the potential for trout stocking to result in an substantial effect on the sensitive species. If such an impact is determined likely, then DFG shall either cease stocking at that location or develop and implement, prior to stocking at that location, an ABMP (as described in Chapter 2).

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[7] Healthy defined as having at least 500 larvae and over 100 adults/subadults

Implementation of the PSEP at each site where trout stocking occurs within the range of the mountain yellow-legged frog would reduce potential impacts to less than significant.

Impact BIO-75: Predation and Competition Effects from Stocked Trout on Northern Leopard Frog (Less than Significant with Mitigation)

There are 32 trout stocking locations within the Northern leopard frog's range (Figure 4-58). Only 10 of these locations are north of Lake Tahoe and east of the Sierra-Cascade crest, and thus are likely to be native populations. The remaining Northern leopard frog occurrences likely represent introduced populations, and many may represent races of the leopard frog derived from the eastern United States; such frogs have long been used in educational programs and have been widely introduced in the U.S. Northern leopard frog populations native in California primarily occur in the northeast part of the state, at elevations of 4000 to 5000 feet (Jennings and Hayes 1994). Northern leopard frogs breed in ponds and overwinter in aquatic habitats as well, and thus may use habitats that are also used by trout; there is presumably a potential for trout to prey upon eggs, tadpoles, or adults. However, no literature was found addressing this possibility, and Jennings (1996) did not find introduced trout to be a substantial factor contributing to the decline of this species in California, although he did identify "introduced predators" as a "minor contributor" to the species' decline. Given the use of perennial aquatic habitats by northern leopard frogs and the reliance of all life history stages on aquatic habitats, it appears likely that stocked trout would have opportunities to prey upon northern leopard frogs.

Northern leopard frogs are not classified as a protected species under federal law, although native populations of the species are listed by DFG as a species of special concern. Northern leopard frogs have a very limited range in California, and although few data are available, it appears likely that they are represented in the state by only a few populations. Trout stocking may be a locally important factor in decline of northern leopard frog populations, and stocking is a widespread activity within this species' range, so there is a potential for trout stocking to produce a substantial change in the number or distribution of populations of this species. Thus, the impact of trout stocking on both the northern leopard frogs is potentially significant.

To minimize these effects and reduce the impact to less than significant, DFG shall implement Mitigation Measure BIO-75 prior to stocking anywhere within the native range of northern leopard frog in California. It is not necessary to implement this mitigation measure prior to stocking on northern leopard frog populations that have been identified by DFG biologists as comprised of frogs not native to California.

Mitigation Measure BIO-75: Implement Pre-Stocking Evaluation Protocol for Northern Leopard Frog

As detailed in Impact BIO-75, trout stocking may have a significant impact on native California northern leopard frogs. To mitigate for this impact, DFG shall implement a PSEP (see Appendix K) at each location where stocking occurs within the range of this species. Under the protocol, each stocking location shall be evaluated in a stepwise fashion to determine whether interactions between stocked trout and the potentially affected sensitive species may occur and to evaluate the potential for trout stocking to result in an substantial effect on the sensitive species. If such an impact is determined likely, then DFG shall either cease stocking at that location or develop and implement, prior to stocking at that location, an ABMP (as described in Chapter 2).

Implementation of the PSEP at each site where trout stocking occurs within the range of the native California northern leopard frog would reduce potential impacts to less than significant.

Impact BIO-76: Predation and Competition Effects from Stocked Trout on Lowland Leopard Frog (Less than Significant)

Trout are not stocked anywhere within the range of the lowland leopard frog. Thus, there is no potential for trout stocking to impact the lowland leopard frog, and the impact of trout stocking on lowland leopard frogs is less than significant.

Impact BIO-77: Predation and Competition Effects from Stocked Trout on Western Pond Turtle (Less than Significant)

The western pond turtle is a dietary generalist, while stocked trout primarily feed upon invertebrate prey and small vertebrates. Thus, the species may compete with stocked trout for food under some circumstances. No information was found detailing the circumstances or potential effects of such competition. The potential for competition for space is also unknown; western pond turtles often occupy areas that have little habitat value for trout, such as terrestrial basking and nesting sites, but also use areas such as deep pools and areas with heavy cover that have high value for trout. Largemouth bass predation on hatchlings and small turtles has been documented, but predation by rainbow trout is only suspected (Holland 1994) and is unlikely to be effected by stocked catchable-sized trout due to mouth gape limitations of trout. There is accordingly an uncertain potential for predation and competition effects; such effects may be expected to occur in some habitats and under some circumstances. However, it is noteworthy that pond turtles and trout often co-occur and have co-evolved, so competitive interactions between the two species are evidently not particularly deleterious to either, likely due to their differing forage and habitat preferences.

There are 316 trout stocking locations within the range of western pond turtle (Figure 4-61). Stocked trout are not known to prey upon the Western pond turtle, and substantial competitive effects have not been described. Due to Western pond turtle's differing habitat selection and forage requirements compared to stocked trout, competition with and predation by with stocked trout are inferred to have a less than significant effect on western pond turtles.

Impact BIO-78: Predation and Competition Effects from Stocked Trout on Common Garter Snake (Less than Significant)

There are 669 trout stocking locations within the range of the common garter snake (Figure 4-63). The common garter snake uses both terrestrial and aquatic habitats, foraging in still waters such as ponds. Their principal prey species include amphibians, small mammals (e.g. mice), small birds, lizards, and various invertebrates (e.g. slugs, leeches, earthworms). Their principal predators are mammals, birds, and other snakes (Ziener et al. 1988–1990). Thus, the common garter snake is unlikely to be preyed upon by stocked trout, but while foraging in aquatic habitats may compete with stocked trout for food resources.

Matthews et al. (2002), studying formerly fishless HMLs in the Sierra Nevada, found that trout introductions has resulted in dramatic declines in amphibian populations, which in turn resulted in a steep decline in populations of the mountain garter snake, which preys predominately on amphibians. Knapp (2005) records a similar effect, again for HMLs in the Sierra Nevada. The same effect, expressed on common garter snakes, was found by researchers studying garter snakes and introduced trout in the Trinity Alps wilderness. In that study, lakes with introduced trout had

severely depressed amphibian populations which led to an adverse effect on common garter snake populations, as the common garter snakes in that area were observed to feed almost exclusively on amphibians. A closely related snake, the aquatic garter snake, primarily feeds upon stocked trout, and was observed to be thriving (Garwood n.d.; Lawler and Pope 2006). These researchers subsequently suggested that the aquatic garter snake, which commonly occurs along streams inhabited by native trout, had expanded its range to include waters inhabited only be introduced trout; this phenomenon whereby the presence of one predator (trout) facilitates that of another (the aquatic garter snake) is called hyperpredation and provides an example of how trout stocking can alter aquatic food webs (Pope et al. 2008). In this case, the effect is a competitive interaction that adversely impacts common garter snake populations.

Hyperpredation effects on common garter snakes have only been reported in settings where trout were introduced to formerly fishless waters. Within the greater portion of the common garter snake's range in California, trout stocking only affects waters that also support native (and often unstocked nonnative) fish populations. In these settings, hyperpredation is not a mechanism of effect. Also, a large fraction of HMLs now contain self-sustaining trout populations and thus the hyperpredation effects discussed above are not an effect of current trout stocking, but are a legacy of historic stocking activities. Nonetheless it is likely that there are some waters within the range of the common garter snake where trout stocking has contributed to decline or extirpation of local common garter snake populations.

Common garter snakes are a common species within their range in California and are not classified as a protected species under either federal or state law. Common garter snake extirpations are not reported to be widespread in California and, except in the specialized instances of hyperpredation discussed above, trout stocking has not been cited as a factor in decline of any common garter snake populations. Thus, the impact of trout stocking on common garter snakes is less than significant.

Impact BIO-79: Predation and Competition Effects from Stocked Trout on Mountain Garter Snake (Less than Significant)

There are 878 trout stocking locations within the range of the mountain garter snake (Figure 4-62). The mountain garter snake uses primarily terrestrial and secondarily aquatic habitats, foraging in still waters such as ponds. Their principal prey species include amphibians, fish, mice, small birds, lizards, and various invertebrates (Ziener et al. 1988–1990). Like the common garter snake, the mountain garter snake is unlikely to be preyed upon by stocked trout, but may compete with stocked trout for food resources.

Potential effects of trout stocking on mountain garter snakes are discussed above in the context of impacts on the common garter snake. As discussed there, trout introductions to formerly fishless HMLs have led to competitive interactions that have resulted in the steep decline or local extirpation of mountain garter snake populations. However, within a large portion of the mountain garter snake's range in California, trout stocking only affects waters that also support native (and often unstocked nonnative) fish populations. In these settings, hyperpredation is not a mechanism of effect. Also, a large fraction of HMLs now contain self-sustaining trout populations and thus hyperpredation effects are not an effect of the current trout stocking, but are a legacy of historic stocking activities. Nonetheless there are many lakes within the range of the mountain garter snake where trout stocking has likely contributed to decline or extirpation of local mountain garter snake populations.

Mountain garter snakes are a common species within their range in California and are not classified as a protected species under either federal or state law. Mountain garter snake extirpations are not reported to be widespread in California and, except in the HML settings discussed above, trout stocking has not been cited as a factor in decline of mountain garter snake populations. Thus, the impact of trout stocking on mountain garter snakes is less than significant.

Impact BIO-80: Predation and Competition Effects from Stocked Trout on Sierra (Western Aquatic) Garter Snake (Less than Significant)

There are 291 trout stocking locations within the range of the Sierra garter snake (Figure 4-61). The Sierra garter snake uses primarily permanent or semi-permanent bodies of water, especially rocky creeks, from slow-moving, low-elevation seasonal creeks to high-elevation mountain streams, ponds, and lakes in a variety of habitats (Rossman et al. 1996 in Ziener et al. 1988–1990). Their principal prey species include amphibians and fish, and their principal predators are birds, mammals and other snakes (Ziener et al. 1988–1990). Thus, the Sierra garter snake is unlikely to be preyed upon by stocked trout, but may compete with stocked trout for food resources.

Potential effects of trout stocking on Sierra garter snakes are discussed above in the context of impacts on the common garter snake. Knapp (2005) studied the effects of introduced trout populations on both mountain and Sierra garter snakes and found the effects described above for mountain garter snakes; for Sierra garter snakes, the effects were "similar except that the direct effect of nonnative trout was considerably weaker."

Sierra garter snakes are a common species within their range in California and are not classified as a protected species under either federal or state law. Sierra garter snake extirpations are not reported to be widespread in California and, except in the HML settings discussed by Knapp (2005), trout stocking has not been cited as a factor in decline of Sierra garter snake populations. Thus, the impact of trout stocking on Sierra garter snakes is less than significant.

Impact BIO-81: Predation and Competition Effects from Stocked Trout on Two-Striped Garter Snake (Less than Significant)

There are 84 trout stocking locations within the range of the two-striped garter snake (Figure 4-63), which primarily includes coastal watersheds from Salinas to the Mexican border. The two-striped garter snake is a highly aquatic species that primarily lives in streams, where it forages upon fish (primarily trout, sculpins and their eggs), adult and larval amphibians, and various invertebrates, and may be preyed upon by various birds, mammals, and introduced fish (chiefly largemouth bass and channel catfish). They often co-occur with common garter snakes (Jennings and Hayes 1994; Ziener et al. 1988–1990). Like the common garter snake, the two-striped garter snake is unlikely to be preyed upon by stocked trout, but may compete with stocked trout for food resources.

No literature was found describing either competition or predation between stocked trout and two-striped garter snakes. Two-striped garter snakes feed upon either fish or amphibians and do not occur in the HML settings described above for some other garter snake species, so it appears unlikely that hyperpredation is a potential mechanism of effect. Although widespread declines have been noted in two-striped garter snake populations, they are attributed primarily to alteration and loss of aquatic habitat, with lesser effects attributable to introduced warmwater fish such as bass and channel catfish (Jennings and Hayes 1994).

Two-striped garter snakes are a declining species within their range in California and are not classified as a protected species under federal law, but are classified by DFG as a species of special concern. Trout stocking has not been cited as a factor in decline of two-striped garter snake populations. Thus, the impact of trout stocking on two-striped garter snakes is less than significant.

Impact BIO-82: Predation and Competition Effects from Stocked Trout on Giant Garter Snake (Less than Significant)

There are 19 trout stocking locations within the range of the giant garter snake (Figure 4-62), which includes areas in the Central Valley at elevations of less than 400 feet. The giant garter snake is a highly aquatic species that primarily inhabits wetlands, slow moving portions of rivers, sloughs, and other still waters (mostly in rice-growing areas), where it forages primarily upon fish and amphibians, and may be preyed upon by various birds and mammals (Miller et al. 1999). Like the common garter snake, the giant garter snake is unlikely to be preyed upon by stocked trout, but may compete with stocked trout for food resources.

No literature was found describing either competition or predation between stocked trout and giant garter snakes. The giant garter snake inhabits low-elevation waters where trout are unlikely to remain viable through the summer months when the snake is most active; in winter, when low water temperatures allow trout stocking in potential giant garter snake habitat, the snake is inactive within terrestrial burrows (Miller et al. 1999). The most likely form of interaction between stocked catchable-size trout and giant garter snakes would be predation of the trout by the snakes.

Giant garter snakes are a severely declining species within their range in California and are classified as threatened under both the ESA and the CESA. Trout stocking has not been cited as a factor in decline of giant garter snake populations. Thus, the impact of trout stocking on giant garter snakes is less than significant.

Impact BIO-83: Predation and Competition Effects from Stocked Trout on San Francisco Garter Snake (Less Than Significant With Mitigation)

There are 3 trout stocking locations within the range of the San Francisco garter snake (Figure 4-64), which includes a very limited area south-west of San Francisco Bay (U.S. Fish and Wildlife Service 2006). The San Francisco garter snake primarily occurs in habitats that provide densely vegetated aquatic habitat near an open hillside where they can sun themselves, feed, and find cover in rodent burrows. Their principal prey is the California red-legged frog, and the principal prey of juveniles is Pacific treefrogs. The decline of the garter snake has paralleled the frogs' decline as habitats within the snake's range have been increasingly developed and degraded (U.S. Fish and Wildlife Service 2007d). Like the common garter snake, the San Francisco garter snake is unlikely to be preyed upon by stocked trout, but may compete with stocked trout for food resources.

No literature was found describing either competition or predation between stocked trout and San Francisco garter snakes. Nonetheless, it is plausible that stocked trout prey upon the larval and adult amphibians that constitute the principal prey base for the San Francisco garter snakes. If so, this competition would have an adverse impact on San Francisco garter snake foraging. San Francisco garter snakes are a rare species within their range in California, are classified as endangered under both the ESA and the CESA, and are a fully protected species in California. There is thus potential for trout stocking to contribute to the decline of San Francisco garter snake populations. Thus, the impact of trout stocking on San Francisco garter snakes is potentially significant.

Mitigation Measure BIO-83: Implement Pre-Stocking Evaluation Protocol for San Francisco Garter Snake

As detailed in Impact BIO-83, trout stocking may have a significant impact on San Francisco garter snakes. To mitigate for this impact, DFG shall implement a PSEP (see Appendix K) at each location where stocking occurs within the range of this species. Under the protocol, each stocking location shall be evaluated in a stepwise fashion to determine whether interactions between stocked trout and San Francisco garter snakes may occur and to evaluate the potential for trout stocking to result in an substantial effect on San Francisco garter snakes. If such an impact is determined likely, then DFG shall either cease stocking at that location or develop and implement, prior to stocking at that location, an ABMP (as described in Chapter 2).

Implementation of the PSEP at each site where trout stocking occurs within the range of the San Francisco garter snake would reduce potential impacts to less than significant.

Impact BIO-84: Predation and Competition Effects from Stocked Trout on South Coast Garter Snake (Less than Significant)

Trout are not stocked anywhere within the range of the South Coast garter snake (Figure 4-64). Thus, there is no potential for the trout stocking program to impact the South Coast garter snake, and the impact of trout stocking on South Coast garter snakes is less than significant.

Impact BIO-85: Predation and Competition Effects from Stocked Trout on Bald Eagle (Less than Significant)

There are 883 trout stocking locations within the range of the bald eagle (Figure 4-66). The bald eagle is a raptor that usually roosts and nests within sight of large water bodies such as rivers and lakes, where it forages primarily upon fish (Johnsgard 1990).

No literature was found describing either competition or predation between stocked trout and bald eagles. It is likely, since the bald eagle is a large bird that typically consumes relatively large fish, that plantings of catchable-sized trout provide a forage base for the eagle. There is no evident potential for adverse competition or predation effects between bald eagles and stocked trout.

Bald eagles in California have been delisted under the ESA but remain listed as endangered under the CESA and are a fully protected species. Trout stocking has not been cited as a factor in decline of bald eagle populations, and may help to support them. Thus, the impact of trout stocking on bald eagles is less than significant.

Impact BIO-86: Predation and Competition Effects from Stocked Trout on Osprey (Less than Significant)

There are 941 trout stocking locations within the range of the osprey (Figure 4-66). The osprey is a raptor that usually roosts and nests within sight of large water bodies such as rivers and lakes, where it forages primarily upon fish (Johnsgard 1990).

No literature was found describing either competition or predation between stocked trout and osprey. It is likely, since the osprey is a large bird that typically consumes relatively large fish, that plantings of catchable-sized trout provide a forage base for the osprey. There is no evident potential for adverse competition or predation effects between ospreys and stocked trout.

Ospreys are a common species within their range in California and are not classified as a protected species under either federal or state law, although DFG has placed them on a "watch list" of potentially sensitive species. Osprey extirpations are not reported to be widespread in California and trout stocking has not been cited as a factor in decline of osprey populations. Thus, the impact of trout stocking on ospreys is less than significant.

Impact BIO-87: Predation and Competition Effects from Stocked Trout on Willow Flycatcher (Less Than Significant With Mitigation)

There are 288 trout stocking locations within the range of the willow flycatcher (Figure 4-65). The willow flycatcher is a passerine (songbird) that is a summer resident in wet meadow and montane riparian habitat from 2,000 to 8,000 feet elevation in the Sierra Nevada and Cascades, and in riparian habitats in portions of coastal California (Ziener et al. 1988–1990).

No literature was found describing either competition or predation between stocked trout and willow flycatchers. However, Epanchin (2009), studying the gray-crowned rosy finch near HMLs in the Sierra Nevada, found that mayflies (a common aquatic insect) were 50 times as abundant at fishless lakes compared to lakes containing trout. Rosy finches, which forage on the mayfly, were six times as abundant near fishless lakes compared to lakes with fish. The finch, which is normally a seed-eater, consumed large amounts of mayflies (38% of the finch's diet) when they were available. No comparable studies have been done on other songbirds. However, the willow flycatcher also nests and forages around HMLs in the Sierra Nevada (and elsewhere), and unlike the rosy finch, its diet primarily consists of flying insects (Ziener et al. 1988–1990), so its abundance and breeding success are strongly influenced by the availability of adequate insect prey. It is therefore likely that at some locations, fish stocking of mountain lakes is either increasing the availability of trout beyond natural carrying capacity, or is perpetuating the existence of trout in waters where they would naturally disappear in the absence of stocking, and is thereby contributing to a reduction in availability of food resources (flying insects) that would otherwise be available for use by songbirds such as the willow flycatcher. Data are not currently available to determine the proportion of the 288 trout stocking locations within willow flycatcher range at which this situation exists. This impact mechanism would not be expected to operate, or would operate at a very low level of intensity, in waters where a healthy native or introduced fish community would persist even in the absence of trout stocking, particularly when the stocking involves catchable-sized trout. In such waters the potential for competition between willow flycatchers and stocked trout is very low.

The willow flycatcher is an uncommon species in California and, although not a protected species under federal law, is classified as endangered under CESA. Willow flycatcher extirpations are locally common, for example in montane meadow habitats, in California. Trout stocking has not been shown to be a factor in decline of willow flycatcher populations, but there has been little investigation on this point. The impact mechanism discussed above, which only applies to willow flycatcher populations near mountain lakes where the trout populations are partially or wholly reliant on supplementation by stocking, constitutes a potentially significant impact on willow flycatcher. Accordingly Mitigation Measure BIO-86 is required.

Mitigation Measure BIO-87: Implement Pre-Stocking Evaluation Protocol for Willow Flycatcher

As detailed in Impact BIO-87, trout stocking may have a significant impact on willow flycatchers. To mitigate for this impact, DFG shall implement a PSEP (see Appendix K) at each location

where stocking occurs at mountain lakes (here defined to be lakes with a surface elevation of 2,000 feet or more) within the range willow flycatcher. Under the protocol, each stocking location shall be evaluated in a stepwise fashion to determine whether interactions between stocked trout and willow flycatchers may occur and to evaluate the potential for trout stocking to result in an substantial effect on willow flycatchers. If such an impact is determined likely, then DFG shall either cease stocking at that location or develop and implement, prior to stocking at that location, an ABMP (as described in Chapter 2).

Implementation of the PSEP at each site where trout stocking occurs within the range of the willow flycatchers would reduce potential impacts to less than significant.

Impact BIO-88: Predation and Competition Effects from Stocked Trout on Southwestern Willow Flycatcher (Less than Significant)

There are 10 trout stocking locations within the range of the southwestern willow flycatcher (Figure 4-65). The southwestern willow flycatcher, although a subspecies of the willow flycatcher discussed above, uses substantially different habitat: in California, it occupies riparian areas along streams, lakes, wetlands, and other water bodies, in areas of dense vegetation (primarily willow or tamarisk) at elevations from sea level to 3300 feet [1000 m] (Sogge et al. 1997; Durst et al. 2007).

No literature was found describing either competition or predation between stocked trout and southwestern willow flycatchers. Southwestern willow flycatchers occur along streams at sufficiently low elevation that the associated water bodies already contain populations of fish that consume quantities of flying insects regardless of whether stocked trout are present; thus the type of competition for flying insect prey described by Epanchin (2009) and detailed above probably does not occur between stocked trout and southwestern willow flycatchers. Thus, the potential for competition between southwestern willow flycatchers and stocked trout is very low.

The southwestern willow flycatcher is a rare species in California, only known to breed at 96 sites in the state (Durst et al. 2007). It is listed as endangered under both the ESA and the CESA. Southwestern willow flycatcher extirpations are not reported to be widespread in California and trout stocking has not been cited as a factor in decline of willow flycatcher populations. Thus, the impact of trout stocking on southwestern willow flycatchers is less than significant.

Effects from Non-Target Harvest

Non-targeted fish species may incidentally be caught[8] during legal and illegal angling for stocked trout. Only 10 fish species in California are fully protected and may not be taken or possessed at any time (California Fish and Game Code 5515). Of those, the only species that occupies waters stocked for trout is the Modoc sucker (see Impact BIO-33, above). Other species of fish may be taken by anglers in numbers and at times of the year as specified in the annual Sport Fishing Regulations. The Sport Fishing Regulations outlines specific angling restrictions (e.g., limit seasonal time, areas fished, method of catch, and daily bag limits). Incidentally hooked fish that are either fully protected or that are under a zero bag limit restriction must be immediately released unharmed to the waters where they are hooked.

Catch-and-release angling is now being practiced and regulated in many recreational fisheries to help reduce direct impacts on species and aquatic ecosystems by allowing released individuals a chance to survive long enough to contribute their genes to subsequent generations (Wydoski 1977; Cooke et al. 2002 in Donaldson et al. 2008). Although catch-and-release obviously results in lower mortality than direct removal of fish from a system, it can also result in "immediate, short-term or delayed mortality (Muoneke and Childress 1994; Bartholomew and Bohnsack 2005) and sublethal consequences associated with stress, including post-release behavioral impairments and physiological responses (Cooke et al. 2002; Cooke and Sneddon 2007; Arlinghaus et al. 2007)" (Donaldson et al. 2008). Stress and associated mortality can be minimized by anglers being properly educated and following appropriate catch-and-release guidelines (Casselman 2005) such as those presented in DFG regulations (California Department of Fish and Game 2008h).

The remainder of this section discusses the potential for Program-related trout stocking to result in incidental harvest of fish belonging to species listed in Table 4-1.

Impact BIO-89: Effects from Trout Stocking Program Non-Target Harvest on Green Sturgeon, Longfin Smelt, Eulachon, Goose Lake Tui Chub, Unarmored Three-Spined Stickleback, and Sacramento Perch (Less than Significant)

DFG does not stock trout anywhere within the range of the green sturgeon, longfin smelt, eulachon. unarmored three-spined stickleback, Sacramento perch or Goose Lake tui chub. Thus, there is no potential for stocked trout to impact these species, and for these species, trout stocking results in a less than significant level of non-target harvest.

Impact BIO-90: Effects from Trout Stocking Program Non-Target Harvest on River Lamprey, Kern Brook Lamprey, and Klamath River Lamprey (Less than Significant)

There are three trout stocking locations within the range of each of these lamprey species (Figures 4-26 and 4-67) and they may be captured incidentally by anglers targeting trout. The frequency of incidental capture is not known, but the California Freshwater Sport Fishing Regulations (California Department of Fish and Game 2008e) provide no harvest limits on these species, except as noted in special regulations (water specific regulations), thus these species may be targeted. It is unlikely that a lamprey would be incidentally caught on lures or bait (other than by snagging or by being attached to fish that are targeted) because the juveniles (ammocoetes) are filter feeders, and the adults are either parasitic or do not feed. Thus, there is little potential for stocked trout to affect

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[8] Incidental catch (a.k.a., "bycatch") refers to fish that are caught incidentally while fishing for a different species or populations of the same species in a directed fishery.

populations of river lamprey, Kern brook lamprey, or Klamath River lamprey, and for these species, trout stocking results in a less than significant level of non-target harvest.

Impact BIO-91: Effects from Trout Stocking Program Non-Target Harvest on Delta Smelt (Less than Significant)

There are no trout stocking locations that occur within the range of the Delta smelt. Delta smelt and trout occupy different habitats due to their differing salinity requirements. They also use different prey (Delta smelt feed predominantly on zooplankton). Thus, there is no potential for stocked trout to impact the Deltas smelt, and for this species, trout stocking results in a less than significant level of non-target harvest.

Impact BIO-92: Effects from Trout Stocking Program Non-Target Harvest on Tidewater Goby (Less than Significant)

Trout stocking only occurs at one location within the tidewater goby's range (Freshwater Lagoon). Because the tidewater goby is a benthic inhabitant feeding on benthic invertebrates, it occupies a different habitat and pursues different prey compared to trout. Thus, there is negligible potential for stocked trout to impact the tidewater goby, and for this species, trout stocking results in a less than significant level of non-target harvest.

Impact BIO-93: Effects from Trout Stocking Program Non-Target Harvest on Arroyo Chub, Owens Tui Chub, Hardhead, Owens Speckled Dace, and Santa Ana Speckled Dace (Less than Significant)

There are several trout stocking locations within the range of arroyo chub, Owens tui chub, hardhead and Owens speckled dace (Figures 4-44, 4-45 and 4-46). Each of these species occupies a different habitat and pursues different prey, compared to trout. Arroyo chub are omnivorous, feeding primarily (60% to 80%) on algae, and supplementing that diet with opportunistic predation on insects and small crustaceans (Moyle 2002). The Owens tui chub feeds on benthos and detritus (Moyle 2002). Hardhead are benthic omnivores, foraging for benthic invertebrates, aquatic plants, drifting insects and algae. The Owens and Santa Ana speckled dace are also bottom feeders, foraging for small invertebrates, especially those taxa found in riffles, such as hydropsychid caddisflies, baetid mayflies, and chironomid and simuliid midges. In lakes, speckled dace feed opportunistically on large flying insects at the water's surface and on zooplankton (Moyle 2002).

Recreational fishing for salmonids targets fish that feed either at the surface or within the water column and fishing gear is designed for these feeding behaviors. The arroyo chub, Owens tui chub, hardhead, Owens speckled dace, and Santa Ana speckled dace have a relatively low potential for incidental capture by anglers targeting salmonids due to their benthic feeding behavior and to the size and type of angling gear used to catch trout. For these species, the risk of incidental harvest by anglers targeting stocked trout is less than significant.

Impact BIO-94: Effects from Trout Stocking Program Non-Target Harvest on Owens Sucker, Modoc Sucker, and Santa Ana Sucker (Less than Significant)

There are several trout stocking locations within the range of the Owens, Modoc and Santa Ana suckers (Figures 4-42 and 4-43). The suckers primarily feet on benthic deposits of detritus and algae, and to a lesser degree, aquatic insect larvae and crustaceans that live in or on muddy substrates or among filamentous algae. Additionally, the jaw structure of these suckers indicates

they may be better adapted to scraping algae from rocks than most other sucker species (Moyle 2002). Larger fish tend to feed more on insects than do smaller fish (Moyle 2002).

Recreational fishing for salmonids targets fish that feed either at the surface or within the water column and fishing gear is designed for these feeding behaviors. Owens, Modoc and Santa Ana suckers have a relatively low potential for incidental capture by anglers targeting salmonids due to their benthic feeding behavior and to the size and type of angling gear used to catch trout. For these species, the risk of incidental harvest by anglers targeting salmonids is less than significant.

Impact BIO-95: Effects from Trout Stocking Program Non-Target Harvest on Cui-Ui (Less than Significant)

DFG stocks Lahontan cutthroat trout in the lower Truckee River at sites more than 12 miles upstream of areas of the Truckee River accessible to spawning cui-ui. Thus, there is little potential for stocked trout to affect populations of cui-ui, and for this species, trout stocking results in a less than significant level of non-target harvest.

Impact BIO-96: Effects from Trout Stocking Program Non-Target Harvest on Paiute Cutthroat Trout, Kern River Rainbow Trout, Goose Lake Redband Trout, Warner Valley Redband Trout, and Little Kern Golden Trout (Less than Significant)

DFG does not stock trout within the range of the Paiute cutthroat trout, Little Kern golden trout, or Warner Valley redband trout, thus, there is no potential for stocked trout to impact these species, resulting in less than significant level of non-target harvest. For Kern River rainbow and Goose Lake redband trout, stocking occurs in parts of the historic ranges that now support only hybridized trout that are of low conservation value. Waters harboring less hybridized Kern River rainbow and Goose lake redband trout populations having high conservation value are not stocked. These populations are protected by special angling regulations with limited or no harvest, resulting in negligible potential for impacts from stocked trout and less than significant level of non-target harvest.

Impact BIO-97: Effects from Trout Stocking Program Non-Target Harvest on Coastal Cutthroat Trout (Less than Significant)

There are two trout stocking locations within the range of coastal cutthroat trout, Freshwater Lagoon in Humboldt County and Dry Lake in Del Norte County (Figure 4-29). At these sites, incidental capture of cutthroat trout may occur. However, these two locations contain populations of hatchery origin coastal cutthroat trout, and no wild coastal cutthroat trout would be subject to non-target harvest from trout stocking. Thus, there is negligible potential for stocked trout to impact coastal cutthroat trout, and for this species, trout stocking results in a less than significant level of non-target harvest.

Impact BIO-98: Effects from Trout Stocking Program Non-Target Harvest on Lahontan Cutthroat Trout (Less than Significant)

Lahontan cutthroat trout are stocked at 10 stocking locations within the range of Lahontan cutthroat trout (Figure 4-29). At the eight lake stocking sites, the stocking maintains existing stocked Lahontan cutthroat trout populations. In the Truckee River, Lahontan cutthroat trout are stocked within the species' range, but in a section of the river that does not currently support a wild population of Lahontan cutthroat trout. At one site, Sagehen Creek, stocking of Lahontan cutthroat

trout is not performed to support a fishery, but is part of an experimental effort to restore these fish within the basin.

DFG is signatory to a number of MOUs and Cooperative Agreements with USFWS for the restoration of Lahontan cutthroat trout, which are listed as threatened under the Federal ESA. USFWS's Lahontan Cutthroat Trout Recovery Plan (USFWS 1995a) identifies the need for reintroduction plans to be developed for the Truckee, Carson, and Walker basins in California. Currently, recovery implementation teams (RIT) have been organized for the Truckee River, Lake Tahoe and Walker River. In 2003, the Truckee River RIT and the Walker River RIT each developed a Short-term Action Plan intended to facilitate restoration/recovery of naturally-reproducing lacustrine Lahontan cutthroat trout with activities identified to be implemented over a 5-year period. The Lake Tahoe RIT is still developing its plan. Included in these actions are stocking of Lahontan cutthroat trout in priority restoration reaches identified through the RIT planning process. Currently, certain priority restoration reaches are not stocked by DFG with non-native trout when a Lahontan cutthroat trout stocking program is in place within that reach. This cessation of non-native trout stocking in restoration reaches allows for evaluation of the stocking program by the RIT.

Non-native trout (rainbow, brown, brook, lake trout and kokanee salmon) are stocked in waters within the historic range of the Lahontan cutthroat trout in the Truckee, Carson, and Walker river drainages. However, none of these stocking locations supports wild, self-sustaining populations of Lahontan cutthroat trout. In waters where wild Lahontan cutthroat trout that are important, long-term conservation and recovery populations , there is no stocking of non-native hatchery trout. These populations are remnant or restored populations that are identified in the Lahontan cutthroat trout Recovery Plan.

Because no stocking occurs within areas supporting wild Lahontan cutthroat trout populations, there is no potential for non-target harvest, and non-target harvest would have a less-than-significant effect on wild populations of Lahontan cutthroat trout.

Impact BIO-99: Effects from Trout Stocking Program Non-Target Harvest on California Golden Trout (Less than Significant)

Trout stocking occurs at one location within the range of the California golden trout. Stocking in the headwater lakes of Golden Trout Creek ended in 1993 and the stocked fish have since been eradicated (Lentz pers. comm). Trout stocking has occurred at one location in the California golden trout range, in the South Fork Kern River at Kennedy Meadows (Figure 4-30). This area only supports highly hybridized populations of California golden trout, which are regarded by DFG as having no conservation significance. Additionally, there are three fish passage barriers which prevent upstream migration of nonnative and hatchery fish to the upriver areas which support "pure strain" California golden trout (Lentz pers. comm.). Thus, current trout stocking does not have the potential to result in non-target harvest impacts on California golden trout populations important to conservation of the species.

Impact BIO-100: Effects from Trout Stocking Program Non-Target Harvest on Eagle Lake Rainbow Trout (Less than Significant)

The Eagle Lake rainbow trout only occurs in Eagle Lake. The Eagle Lake rainbow trout population is sustained through a hatchery stocking program, which supports a fishery for the Eagle Lake rainbow. The Eagle Lake rainbow trout is the only trout in Eagle Lake and is the target species for the fishery. The brook trout in Pine Creek provide a very minor fishery, which does not result in a

significant not-target take of Eagle Lake trout. Thus, there is no non-target harvest of Eagle Lake rainbow trout. This impact would be less than significant.

Impact BIO-101: Effects from Trout Stocking Program Non-Target Harvest on McCloud River Redband Trout (Less than Significant)

There are no trout stocking locations within the range of McCloud River redband trout (Figure 4-32). There are two sites immediately outside of the currently managed refugium (i.e., habitats that support sustainable populations of organisms that are limited to fragments of their previous historic and geographic range, such as the section of the main stem McCloud and its tributaries above the confluence with Bundoora Spring Creek), so there is little potential for incidental harvest impacts associated with trout stocking. This impact would be less than significant.

Impact BIO-102: Effects from Trout Stocking Program Non-Target Harvest on Klamath Mountains Province and Northern California DPS Steelhead (Less than Significant)

No trout stocking occurs within the range of the KMP or Northern California Steelhead DPSs. Thus, non-target harvest associated with trout stocking does not affect these DPSs. This impact would be less than significant.

Impact BIO-103: Effects from Trout Stocking Program Non-Target Harvest on Central Valley DPS Steelhead, Central California Coast DPS Steelhead, South-Central Coast DPS Steelhead, and Southern California DPS Steelhead (Less than Significant with Mitigation)

There are 5 trout stocking locations in the range of Central Valley steelhead, 2 locations in the range of central California coast steelhead, 3 locations in the range of south-central California coast steelhead and 6 locations within the southern California steelhead (Figure 4-34 and Figure 4-37). Sport fishing regulations have reduced the impact of recreational angling in anadromous coastal rivers and streams within significant portions of steelhead range. Regulations such as seasonal and annual closures, gear restrictions (e.g., artificial lures, barbless hooks and no bait), and zero bag limits reduce potential effects in portions of other species ranges. Nonetheless , incidental capture of these steelhead may occur. Due to the uncertainty regarding the potential for incidental harvest and the stocking of hatchery trout in portions of these species ranges, incidental harvest may result in a significant impact on these steelhead DPSs.

To minimize effects and reduce this impact to less than significant, DFG shall implement Mitigation Measure BIO-103.

Mitigation Measure BIO-103: Implement Pre-Stocking Evaluation Protocol for Central Valley DPS Steelhead, Central California Coast DPS Steelhead, South-Central Coast DPS, and Southern California DPS Steelhead

As detailed in Impact BIO-103, trout stocking may have a significant impact through increased angling pressures and catch rates of non-target species, such as steelhead of the Central Valley, Central California Coast, South-Central and Southern California DPSs. To mitigate for this impact, DFG shall implement a PSEP (see Appendix K) at each location where stocking occurs within the range of these steelhead DPSs. Under the protocol, each stocking location shall be evaluated in a stepwise fashion to determine whether interactions between stocked trout and these DPSs of steelhead may occur and to evaluate the potential for trout stocking to result in an substantial effect on to these DPSs. If such an impact is determined likely, then DFG shall either cease trout

stocking at that location or develop and implement, prior to stocking at that location, an ABMP (described in Chapter 2).

Implementation of the PSEP at each site where trout stocking occurs within the range of these steelhead DPSs would reduce potential impacts to less than significant.

Impact BIO-104: Effects from Trout Stocking Program Non-Target Harvest on Central California and Southern Oregon/Northern California Coast Coho Salmon (Less than Significant)

One trout stocking location occurs within the range of the central California or southern Oregon/northern California coast coho salmon ESUs. Thus, non-target harvest associated with trout stocking does not affect these ESUs. This impact would be less than significant.

Impact BIO-105: Effects from Trout Stocking Program Non-Target Harvest on Klamath-Trinity River Spring-Run, Sacramento River Winter-Run, Central Valley Spring-Run, and California Coast Chinook Salmon ESUs (Less than Significant with Mitigation)

There are 11 trout stocking locations within the range of the five California Chinook salmon ESUs (Figures 4-33, 4-37, 4-38, and 4-39). Sport fishing regulations have reduced the impact of recreational angling in anadromous coastal rivers and streams within significant portions of the Chinook salmon's range. Regulations such as seasonal and annual closures, gear restrictions (e.g., artificial lures, barbless hooks and no bait), and zero bag limits reduce potential effects in portions of other species ranges. Nonetheless , incidental capture of these Chinook may occur. Due to the uncertainty regarding the potential for incidental harvest and the stocking of hatchery trout in portions of these species ranges, incidental harvest may result in a significant impact on these Chinook salmon ESUs.

To minimize effects and reduce this impact to less than significant, DFG shall implement Mitigation Measure BIO-105.

Mitigation Measure BIO-105: Implement Pre-Stocking Evaluation Protocol for Klamath-Trinity River Spring-Run, Sacramento River Winter-Run, Central Valley Spring-Run, and California Coast Chinook Salmon ESUs

As detailed in Impact BIO-105, trout stocking may have a significant impact through increased angling pressures and catch rates of non-target species, such as Klamath-Trinity River Spring-run, Sacramento River Winter-run, Central Valley Spring-run and California Coast Chinook Salmon ESUs. To mitigate for this impact, DFG shall implement a PSEP (see Appendix K) at each location where stocking occurs within the range of these Chinook salmon ESUs. Under the protocol, each stocking location shall be evaluated in a stepwise fashion to determine whether interactions between stocked trout and these ESUs of Chinook salmon may occur and to evaluate the potential for trout stocking to result in an substantial effect on to these DPSs. If such an impact is determined likely, then DFG shall either cease trout stocking at that location or develop and implement, prior to stocking at that location, an ABMP (described in Chapter 2).

Implementation of the PSEP at each site where trout stocking occurs within the range of these Chinook salmon ESUs would reduce potential impacts to less than significant.

Effects from Introduction of Invasive Species and Pathogens

During trout stocking, aquatic invasive species (AIS) and/or aquatic pathogens may inadvertently be introduced into native ecosystems. These impacts are of greatest concern when the transfers occur between watersheds and entail the introduction of AIS or pathogens to which native fish and amphibian populations are highly susceptible (Pacific Northwest Fish Health Protection Committee 1989).

The greatest risk of pathogen transfer between watersheds occurs either when hatchery-raised salmonids are transported to distant release waters or through the transportation of eggs between hatcheries (Chen 1984; Pacific Northwest Fish Health Protection Committee 1989; Hulbert 1996). Transfer of pathogens, however, is most likely with the transfer of fish (rather than eggs) since fish cannot be disinfected, whereas eggs can be water hardened in an iodophore disinfectant at fertilization and surface disinfected prior to transfer (USFWS 2004c).

DFG stocking programs also have the potential to spread AIS. Once established within waters of the state, AIS threaten the diversity, abundance, and stability of native ecosystems and sensitive native species.

The dissemination of aquatic pathogens and AIS during DFG stocking activities may result the following impacts on native fish or wildlife:

- Impacts of spreading pathogens in native fish populations.
- Impacts of introducing pathogens to native amphibian populations.
- Impacts of introducing AIS into native ecosystems.

Impact BIO-106: Impacts of Introducing Pathogens to Native Fish Populations as a Result of the Trout Stocking Program (Less than Significant)

Many pathogens that occur in cultured fish are also present in the free-ranging fishes in the region. Accordingly, it is often difficult to determine whether hatchery fish are a source of pathogens . Where native fish populations have co-evolved with certain pathogens, there is a relatively low risk of transmission of disease from hatchery to wild fish populations (Amos and Thomas 2002). In a California-Nevada Fish Health Center study, a sample of wild Chinook salmon that were taken from the upper Sacramento River were exposed to the Nimbus strain of infectious hematopoietic necrosis (IHN) found at Coleman National Fish Hatchery in the upper Sacramento River basin. Results in this study found no evidence of viral transmission between fish.

It is hypothesized that fish have a certain level of resistance to diseases with which they have coevolved. Therefore, stock transfer between watersheds carries a high risk of introducing disease to especially susceptible native populations (Pacific Northwest Fish Health Protection Committee 1989). Chen (1984), for example, suggested that there are several strains of the IHN virus, and that salmonid juveniles often lack resistance to the non-endemic strains. Additionally, it is hypothesized that the brown trout's resistance to whirling disease is the result of co-evolution with the disease parasite over many generations in Northern Europe, far longer than whirling disease has been present in North American rainbow and cutthroat fisheries. This observation is strengthened by the recent discovery that a rainbow trout strain in Germany (the "Hofer" strain), transferred from Colorado in 1903, has equal or better resistance to whirling disease than brown trout (Hedrick et al. 2003, Schisler et al. 2006).

Although fish can develop resistance to endemic pathogens, there is also a clear relationship between stocking and the presence of fish disease in natural populations. For example, several years of stocking disease-free fish in waters that previously had been planted with Infectious Pancreatic Necrosis Virus (IPNV)-carrier fish, resulted in a decline in the IPNV incidence in the fish population (Yamamoto and Kistoff 1979; Rosenlund 1977). According to Sonstegard and McDermott (1972), "planting IPNV-infested fish in natural waters creates a potential source of infection and that if egg collections continue to be made from wild stock, it is important to maintain fish in the natural environment as free of disease as possible."

Some fish pathogens are able to exist on the fish host without causing symptoms of disease. For example, fish infected with viral haemorrhagic septicaemia (VHS) may not show clinical signs of infection, creating the risk of unintentionally stocking infected fish into the wild. It is unlikely, however, that within a hatchery setting only one non-clinically infected fish would exist; the disease most likely would be present in various stages within the hatchery fish population, and would be detected via methods discussed below.

In the United States, there are varied examples of inadvertently stocking diseased fish into the wild, with subsequent spread of disease within wild fish populations. One well known example of this is the spread of whirling disease throughout the western United States, which has been largely attributed to fish stocking practices. For instance, in California, whirling disease was detected in fish obtained from a hatchery in Idaho under a private stocking program and stocked in a southern California lake. Although such incidents are rare, as DFG requires all shipments of fish entering the state be certified as disease free by a certified laboratory, the impact of a single disease introduction could be substantial. In response to the Idaho hatchery incident, DFG no longer uses fish from this hatchery or the testing facility that certified the fish as disease free. Within the past five years, there are no other known examples of pathogen transfer to wild fish as a result of DFG stocking programs.

DFG uses a variety of precautions to minimize the spread of fish pathogens by stocking. DFG, in consultation with the California Aquaculture Disease Committee (CADC), compiles a list of diseases and parasites and the aquatic plants and animals they are known to infect or parasitize. The CADC may recommend such regulations as monitoring and diagnostic procedures, criteria for ordering quarantine, methods for the destruction of quarantined animals, and compensation. CFGC Section 15500-15516 details regulatory requirements pertaining to monitoring and diagnostic procedures, criteria for ordering quarantine, methods for the destruction of quarantined animals, and compensation. Hatchery and stocking BMPs are followed to pre-empt disease transfer from hatchery to wild fish. Hatchery staffs observe fish condition daily. The hatchery manager also can request that DFG pathology staff be called in to do health assessments. Fish pathologists prescribe appropriate treatment methods for disease outbreaks, and hatchery staff administers the treatment protocols. Treatment methods are dictated by the identified cause of the disease outbreak. Prior to release, all hatchery reared fish are monitored by DFG pathologists and determined to be acceptable for release.

DFG maintains a comprehensive fish health monitoring program utilizing a professional staff of pathologists and veterinarians. DFG Fish Health Lab pathologists conduct diagnostic examinations and health inspections of hatchery produced trout and salmon at the Department's fish hatcheries, at private registered aquaculture facilities, of imported fishes, and at any additional wild trout and salmon egg collecting stations. DFG Fish Health Lab pathologists perform examinations for bacteria, viruses, fungi, protozoa, other parasites and non-infectious diseases using a variety of laboratory techniques. Diagnostic procedures for pathogen detection follow American Fisheries Society professional standards as described by Thoesen (2007).

DFG Fish Health Lab pathologists advise hatchery personnel on methods for control of trout and salmon diseases and recommend appropriate preventative measures and treatments of fish diseases; and assist hatchery personnel during spawning of wild brood stock fish by collecting ovarian fluids for virology and kidney cultures for bacteriology, and conducting workshops for training in trout and salmon disease recognition. Knowledge of pathogens and diseases allows for the accurate and rapid diagnosis and appropriate treatment of fish in hatcheries, with the goal of quickly addressing disease problems in order to maximize the health of released fish. Through the hatchery fish health program DFG attempts to minimize potential negative health impacts on decision species.

The DFG hatchery fish health program is summarized in the analysis of Impact BIO-11. Table 4-3 lists fish diseases observed in DFG hatcheries and which potentially could spread to wild fish populations during stocking activities. Based on the rarity of disease introduction events, and the current implementation of numerous precautions to minimize the risk of such events, there is a less-than-significant risk that accidental pathogen introduction via DFG trout stocking will have a substantial adverse effect on native fish populations. No mitigation is necessary.

Impact BIO-107: Impacts of Introducing Pathogens to Native Amphibian Populations as a Result of the Trout Stocking Program (Less than Significant with Mitigation)

Experimental and genetic evidence has shown that the transfer of the amphibian pathogens *Ranavirus* sp. and *Saprolegnia ferax* between fish and amphibians occurs and that these amphibian pathogens are transferred during stocking practices (Mao et al. 1999; Kiesecker et al. 2001b). In addition, the potential for fish to carry *Batrachochytrium dendrobatidis,* a fungal disease that has devastated amphibian populations around the world, is an area of current investigation (Rachowicz et al. 2006).

Work conducted by Kiesecker (2001b) clearly showed that hatchery reared fish served as vectors for *Saprolegnia ferax,* a water-borne fungus that can cause embryonic mortality of amphibians. In these studies mortality induced by *Saprolegnia ferax* was greater in western toad (*Bufo boreas*) embryos exposed directly to hatchery-reared rainbow trout (*Oncorhynchus mykiss*) experimentally infected with *S. ferax* and hatchery-reared trout not experimentally infected, than in control embryos.

Ranaviruses (genus *Ranavirus*, family Irodoviridae) comprise another important group of amphibian pathogens. These viruses are known to infect amphibians, reptiles and fish, in which they are often highly virulent. Transmission studies have shown that some ranaviruses can cross animal orders, or even classes, while others appear to be more species-specific (Daszak et al. 2003). Further evidence of the potential for transmission of pathogens between fish and amphibians was shown by Mao et al. (1999) who isolated identical iridoviruses from wild sympatric fish and amphibians.

Currently DFG has no BMP practices that address the potential impacts due to the dissemination of pathogens within hatchery effluent waters to native amphibian populations. Furthermore DFG does not outline how future policies will address emerging amphibian diseases that are associated with salmonid species. Therefore, there is a potential for fish stocked under the trout stocking program to convey potentially epizootic pathogens to a wide variety of sensitive amphibian species, causing a substantial adverse impact on amphibian populations.

This impact is significant. In response and to reduce the impact to less than significant, DFG shall implement Mitigation Measure BIO-107. Residual impacts are less than significant.

Mitigation Measure BIO-107: Implement Monitoring and Best Management Practices Program to Minimize Risk of Disease Transmission to Native Amphibian Populations

At any hatchery that stocks trout at locations within the range of amphibian species listed in Table 4-1 of the EIR/EIS, DFG shall extend its current pathogen control BMPs to include detection and control measures effective for detention and control of ranaviruses, *Saprolegnia ferax*, and *Batrachochytrium dendrobatidis.* This program shall be reviewed by the Aquaculture Disease Committee (ADC) (DFG Code 15506). The DFG Director shall instruct the ADC, in consultation with DFG and scientific experts of amphibian diseases if necessary, to meet no later than three months after certification of this project to develop standard procedures for amphibian pathogen detection and control. Additional pathogens may be added to this list as warranted. DFG shall conduct statistically based testing for amphibian pathogens of concern to demonstrate that hatchery production fish and hatchery discharge waters are not sources of key amphibian pathogens. The testing shall be performed annually at each hatchery in the program and annual reports of test results will be prepared and made available upon request. Implementation of such testing and evaluation measures will ensure that hatchery activities and fish are not sources of diseases that could adversely affect native amphibians. Prior to stocking, all hatchery-reared fish shall be certified to be acceptable for release in waters supporting native California amphibians listed in Table 4.1 of the EIR/EIS. **Impact BIO-108: Impacts of Introducing Aquatic Invasive Species into Native Ecosystems as a Result of the Trout Stocking Program (Less than Significant with Mitigation)**

The DFG aquatic invasive species management plan (California Department of Fish and Game 2008d) identifies the accidental transport of invasive species through stock enhancement as a primary vector for invasive species introduction. Early detection of invasive species in hatchery waters is critical, therefore, to prevent their unintended distribution. Potential invasive species threats and DFG hatchery practices to address invasive species threats are detailed above, in the analysis of Impact BIO-10.

Based on the absence of invasive species introductions during the baseline evaluation period, active DFG monitoring of invasive species, and other precautionary measures currently implemented at hatcheries as described in the analysis of Impact BIO-10, the risk of invasive species introduction during trout stocking operations is low. However, the potential consequences of inadvertent introduction of AIS are severe. Adoption of HACCPs at some California hatcheries has proven useful in addressing this risk. Accordingly the risk of invasive species introduction during trout stocking is potentially significant, and mitigation measure BIO-10 is required. Adoption of this measure would reduce potential impacts to less than significant.

Genetic Changes from Interbreeding with Stocked Trout

Trout, whether native or hatchery origin, cannot interbreed with non-salmonids, salmon, or trout from different genera. Thus, potential genetic impacts of the trout stocking program are limited to native trout and steelhead, all of which are forms of cutthroat or rainbow trout in the genus *Oncorhynchus.* For these species, the concern is that hatchery and wild trout or rainbow trout and steelhead may interbreed, producing hybrids that are either infertile (as is usually the case with crosses between different species), are poorly adapted to the wild fish's habitat, or are reproductively viable but contribute to a loss of the genetic diversity that renders the wild fish unique. In all cases, reproduction of wild fish is impaired and their unique genetic makeup is compromised. These outcomes can have adverse effects, up to and including the threat of extinction,

in species that have already been imperiled by other types of impact. Hybridization with introduced species is already recognized as a factor contributing to the decline of many California native fish (salmonids as well as other species).

As noted at the beginning of this chapter, the trout stocking program also includes stocking of coho, Chinook and kokanee salmon in selected inland waters. In no case are these salmon stocked in waters accessible to wild salmon, and there is negligible risk that these species may interbreed with native trout.

Many lakes and streams stocked with trout are located in high elevation, formerly fishless areas where there are no trout other than introduced types, and where there is no passage to downstream areas inhabited by native trout or steelhead. In these settings, there is no potential for adverse genetic effects to native salmonid species. Hatchery trout that are stocked into rivers, streams, lakes, or reservoirs where native fish communities currently exist, or that are stocked into areas where outlets allow colonization into downstream native fish communities, may adversely affect genetic fitness and diversity of some trout species.

Genetic diversity allows a species to adapt and survive under changing environmental conditions. Species with low genetic diversity are at risk of not being able to respond to these changes, resulting in reduced survival. Genetic fitness refers to the extent that an individual is adapted to, or is able to produce offspring in its local environment. Results of studies over the last two decades indicate that hatchery programs may reduce both genetic diversity and fitness of both hatchery and naturally spawned salmonid populations through various mechanisms (Hindar et al. 1991; Waples 1991; Vogel and Marine 1991; Lynch 1991; Hedrick and Miller 1992; Busack and Currens 1995; Campton 1995; Waples 1995; Allendorf and Waples 1996; Reisenbichler 1997; Reisenbichler and McIntyre 1977; Reisenbichler and Rubin 1999; Waples 1999; Lynch and O'Hely 2001; Ford 2002; Wang et al. 2002; Reisenbichler et al. 2004; Myers et al. 2004; Araki et al. 2008) including:

● Straying of hatchery-origin fish and consequent hybridization with natural populations, resulting in reduced genetic variation among wild populations and the transfer of non-adaptive genes from the hatchery population.

● Domestication, whereby wild fish acquire trait that are suitable for the hatchery environment but are not suitable for the natural environment.

● Accumulation of deleterious mutations, since mutations that are neutral in hatchery populations may be deleterious to wild fish.

● Outbreeding depression, whereby brood stock from divergent populations may result in hybrid progeny that possess traits not suited to the local environment, or may result in reduced fitness due to disruption of co-adapted gene complexes, which are groups of genetic traits that have high fitness when they occur together, but have lower fitness otherwise.

● Inbreeding depression, whereby use of a small brood stock population exposes individuals to the effects of deleterious recessive genes that are expressed by matings between close relatives.

● Hybridization and introgression, whereby interbreeding effectively produces a new species.

Some populations may be relatively more vulnerable to these effects due to a variety of factors such as genetic drift, spatial and temporal isolation, and susceptibility to hybridization with hatchery fish.

Hatcheries are artificial rearing environments that subject fish to substantially different conditions than those where they would have adapted over time and, as a result, apply different selection

pressures on fish than would be encountered in natural environments. These different selective pressures may cause hatchery fish to change genetically[9] with associated declines in fitness occurring as quickly as within one or two generations of captive rearing (Araki et al. 2008).

Biological significance is the biological uniqueness of a population relative to other populations within its range. Hatcheries can change a fish population's biological significance through two mechanisms, domestication and stock transfers.

Domestication occurs because, over time, hatchery populations become genetically adapted to their artificial environment, resulting in increased fitness under artificial conditions (domestication) but decreased fitness under natural conditions (Price 1984; Kohane and Parsons 1988; Hemmer 1990 in Hatchery Scientific Review Group 2004). Three principal factors can lead to domestication: "(1) relaxation of natural selection that would otherwise occur in the wild (e.g., spawning behavior); (2) artificial or inadvertent selection imposed by the hatchery environment; and (3) direct selective breeding of adult spawners by hatchery personnel" (Hatchery Scientific Review Group 2004:A-22). Domestication results in morphological, physiological, and behavioral changes in hatchery fish that can affect both the fitness of the hatchery fish themselves and of the natural populations into which they are released. According to the Hatchery Scientific Review Group (HSRG) (2004:A-22), some differences in hatchery fish that have been demonstrated include:

- "reduced expressions of morphological characters important during breeding, such as secondary sexual characters (Fleming and Gross 1989, 1994; Petersson and Järvi 1993; Hard et al. 2000 [Please provide reference info for Hard.]),"

- "greater swimming activity, greater surface orientation, and increased agonistic feeding behavior relative to natural fish (Ruzzante 1994; Campton 1995; Berejikian et al. 1996; Reinhardt 2001),"

- "increased vulnerability to predators under natural conditions (Berejikian 1995),"

- "behavioral dominance and aggression" of juveniles that may result in competitive displacement of native fish from preferred habitats (Nickelson et al. 1986; Berejikian et al. 1996);"

- "earlier age at maturation, reduced egg size and numbers, and spawning hatchery adults that are generally less aggressive and more submissive to natural origin adults (Fleming and Petersson 2001);"

- "hatchery females show increased delays in the onset of breeding (Fleming and Gross 1993), fewer nests and greater retention of unspawned eggs (Fleming and Gross 1993; Fleming et al. 1996), and more likely for their eggs to be fertilized by several secondary males (most likely parr) than wild females (Thompson et al. 1999);" and

- "hatchery males tend to be less aggressive and accomplish fewer spawnings than wild males (Fleming 1994)."

Stock transfers occur when fish are moved between basins (or from out-of-state sources), resulting in differences in adult and juvenile size, resistance to disease, and other traits than those that the receiving stock developed over time in response to its environment. A change in these traits may result in lower survival, productivity, diversity and abundance.

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[9] Genetic change refers to the "change in gene frequencies between generations, or between a parental population and a progeny population (offspring) when measured at the same life history stage" (Hatchery Scientific Review Group 2004).

Genetic viability (i.e., successfully avoiding the problems of inbreeding) requires that a population has a certain amount of genetic diversity. This is conventionally measured by the effective population size, which is the number of individuals in a population that contribute genes to succeeding generations by breeding. The genetic viability of a population depends on its genetic fitness and the environmental conditions it experiences. Hatcheries can alter the genetic fitness of a population in several ways (Hatchery Scientific Review Group 2004):

● Founder effect: Loss of genetic variation occurs when a population is established by a brood stock containing either a very small number of individuals or a very selective type of individual (e.g., large size, coloration). The founder effect is an extreme example of genetic drift.

● Genetic drift: Random changes in gene frequencies occur between generations if the effective population size is small. This occurs because there are only a small number of copies of each gene, so a gene can be lost by a random event. If that happens, it reduces the amount of genetic variation in the population, reducing the population's flexibility to respond to long-term changes in environmental conditions. Effective population sizes should be greater than 500 to minimize genetic drift and the potential loss of alleles.

● Sperm competition: The mixing of sperm (milt) from multiple males to fertilize eggs may result in a reduction in the effective size of the breeding population from sperm competition. Sperm from some males may be more effective at fertilizing eggs than others resulting in a high number of offspring from multiple females being propagated by one or a few males. A reduced number of males contributing to reproduction may result in a decrease in genetic diversity and overall fitness of the population.

Genetic changes that occur in hatchery populations may be transferred to natural populations if non-harvested hatchery fish are able to spawn naturally, causing reduced fitness and productivity of the natural population. The potential magnitude of genetic effects depends on the species, number, size, and location of the hatchery fish released, as well as the potential overlap in spawn timing and habitat preferences between hatchery and native salmonid populations. The reproductive success of hatchery fish can affect the genetic composition and biological significance of natural populations through hybridization.

Hybridization is more common in fish than in other vertebrates because interspecific hybrids may be fertile, giving rise to introgression[10]. Individuals produced by hybridization (e.g., between rainbow trout and cutthroat trout) may display traits and characteristics from both parents, but may also display traits not observed in either parent (hybrid vigor). Hybridization occurs between populations, and they may represent different species (e.g. rainbow and cutthroat trout), between subspecies (e.g., rainbow trout and golden trout), or simply between populations (e.g., hatchery golden trout and wild golden trout). Intraspecific hybridization sometimes causes outbreeding depression, which is the loss of important local adaptations that are crucial for the viability of natural populations (Utter 2000; Reisenbichler and Rubin 1999; Einum and Fleming 1997 in Allendorf et al. 2004). Loss of adaptations may be difficult to detect because the adaptation may only be necessary during times of extreme environmental conditions (e.g., drought or fire) (Thompson 1965 in Allendorf et al. 2004). Hybrid vigor, or heterosis, may occur whenever the hybrid has greater fitness than the parents (Rhymer and Simberloff 1996; Allendorf et al. 2004), but hybrids can also have reduced vigor in populations with introgression (Epifanio and Philipp 2001 in

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[10] Introgression is the backcrossing of an interspecific hybrid. In nature it usually occurs in the zone of overlap between two species that are capable of producing fertile hybrids.

Allendorf et al. 2004). According to Allendorf et al. (2004:1207), "this occurs because the production of hybrids is unidirectional (all of the progeny of a hybrid will be hybrids); thus, the frequency of hybrids within a local population may increase even when up to 90% of the hybrid progeny do not survive."

Although hybridization and introgression commonly occur in nature, human-influenced hybridization (e.g., through stocking) is "causing extinction of many taxa (species, subspecies and locally adapted populations) by both replacement and genetic mixing" (Allendorf et al. 2001:621). Types of human-influenced hybridization that potentially occur as a result of nonnative trout stocking include (Allendorf et al. 2004):

- Hybridization without introgression: hybridization occurs between hatchery and native fish but the first generation progeny do not reproduce either as a result of infertility or some other mechanism. Although no genetic mixing occurs, there may be detrimental effects to native fish because they bred with other species in a wasted reproductive effort.

- Introgression: hybridization occurs over multiple generations allowing gene flow to occur between hatchery fish and natural fish. Some genetically pure populations remain but other populations consist of hybrids.

- Complete admixture: introgression continued to the point where no genetically pure populations remain.

Attempts have been made to establish acceptable threshold levels of hybridization (Utah Division of Wildlife Resources 2000 in Stephens et al. 2004), but adaptive management strategies may be more appropriate than thresholds (Allendorf et al. 2001) and the best approach to introgressed species management may be monitoring populations to determine whether or not management activities are facilitating the reduction of hybrid populations over time (Stephens et al. 2004). For situations where small pure populations exist (e.g., California golden trout), Stephens et al. (2004) recommend that two types of refuge populations be established to reduce the potential for losing the genotypes of the different remaining populations: non-hybridized refuge populations and refuge populations containing relatively low levels of hybridization and introgression.

The potential impact is summed up by the HSRG (Hatchery Scientific Review Group 2004:A-47):

genetic changes in natural populations, particularly those related to fitness, are difficult to measure. Genetic effects on natural populations depend on factors including the frequency and consequence of the interaction. Hatchery fish contribute to gene flow only when they reproduce successfully. The magnitude of genetic effects is also influenced by genotypic and phenotypic dissimilarity between hatchery and wild populations. The greater the genetic distance, and the more dissimilar the hatchery and wild fish, the greater the potential deleterious effects (Withler 1997). Further, the duration and magnitude of interbreeding, as well as the size of the natural population, also influence the potential for genetic effects. The proportion of genes incorporated into the local population (rather than the absolute size of the local population) determines the rate of gene flow and the potential genetic effects. Although the factors influencing genetic effects are well characterized (Grant 1997), predicting the magnitude of genetic effects is difficult due to their inherent complexity and our inability to accurately measure natural processes on salmonid populations (Busack and Currens 1995; Campton 1995). ... A reduction in among-population diversity can result from propagation of a single hatchery stock over a wide area, if these fish successfully interbreed with wild fish (Hindar et al. 1991; McGinnity et al. 1997). Loss of variation is influenced both by the level of straying (stray or stocking rate) and the success of hatchery fish in reproducing in the wild (rate of gene flow). As these rates increase, allele frequency differences among populations decrease. ... Some studies suggest that hatcheries have substantial genetic effects in reducing diversity, while others

support the hypothesis that wild patterns of diversity have been maintained despite repeated stock transfers (Bugert et al. 1995; Wishard et al. 1984; Currens et al. 1990).

The potential level of genetic effects from trout stocking for each native trout species and for each steelhead DPS is discussed below.

Impact BIO-109: Genetic Effects on Paiute Cutthroat Trout, Kern River Rainbow Trout, and Goose Lake Redband Trout from Interbreeding with Stocked Trout (Less than Significant)

Hatchery trout are not stocked anywhere within the range of Paiute cutthroat trout, so interbreeding with stocked trout would have a less-than-significant effect on this species.

For both Kern River rainbow trout and Goose Lake redband trout, historic stocking activities have produced a situation where, within the range of the species, some populations have hybridized extensively with introduced rainbow trout, while other populations show much less hybridization. DFG regards the latter group (slightly hybridized populations) as having high conservation value and manages these populations for conservation goals. One aspect of this management is to avoid any trout stocking within the range of populations having high conservation value.

In the case of Kern River rainbow trout, DFG believes that wild Kern River rainbow trout in stocked reaches of the Kern River (waters downstream of Johnsondale Bridge) represent highly hybridized fish with low conservation value. The remaining range of minimally-hybridized Kern River rainbow trout lies above impassable falls in the upper Kern River drainage, 30 to 60 miles upstream of the stocked reaches. Studies, in progress, of the genetic status of Kern River rainbow trout indicate that the trout least affected by genetic mixing with non-native rainbow trout, and therefore of greatest conservation value, are those located in the Kern River and portions of select tributaries located in the Golden Trout Wilderness and Sequoia National Park more than 30 miles upstream of the stocking locations on the Kern River. These upper basin Kern River rainbow trout are no longer affected by stocking hatchery rainbow trout. As a result, the current trout stocking program has a less than significant potential to result in genetic impacts on Kern River rainbow trout.

In the case of Goose Lake redband trout, stocking in some reservoirs/lakes within the South Fork Pit River drainage has occurred for decades; the Goose Lake redband trout in those waters are extensively hybridized and have little conservation value. Relatively little-hybridized populations occupy Goose lake and its tributaries. These populations are regarded as having high conservation value, and no stocking is performed in any waters having hydrologic continuity with Goose Lake and its tributaries. As a result, the current trout stocking program has a less than significant potential to result in genetic impacts on Goose Lake redband trout.

Impact BIO-110: Genetic Effects on Coastal Cutthroat Trout from Interbreeding with Stocked Trout (Less than Significant)

Hybridization between coastal cutthroat trout and rainbow trout (or steelhead) is widespread along the West Coast with about 30% of samples analyzed containing hybrid individuals (Johnson et al. 1999). According to Moyle et al. (2008) hybrids can occur naturally "with no obvious impacts on cutthroat trout populations (Neillands 2001)," but with a caveat that "habitat disturbance and other factors may increase rates of hybridization, with unknown consequences." However, the potential for hybridization is reduced by the variety of habitat-partitioning techniques and life history strategies that coastal cutthroat trout employ (Johnston 1982; Campton and Utter 1987; Griffith 1988). Natural hybridization makes it difficult to ascertain the potential for, and degree of,

hybridization with hatchery stocks. There are 2 trout stocking locations within the coastal cutthroat trout's range, Freshwater Lagoon Humboldt County and Dry Lake in Del Norte County (Figure 4-29). Neither of these locations currently provides habitat for wild coastal cutthroat trout (Lentz pers. comm.). Further, it is very unlikely that catchable-sized trout stocked in these locations could interact with other wild coastal cutthroat trout populations (Lentz pers. comm.). Thus, genetic effects from interbreeding between stocked trout and coastal cutthroat trout would result in less-than-significant impacts on coastal cutthroat trout.

Impact BIO-111: Genetic Effects on Lahontan Cutthroat Trout from Interbreeding with Stocked Trout (Less than Significant)

Lahontan cutthroat trout are stocked at 10 trout stocking locations within the historic range of Lahontan cutthroat trout (Figure 4-29) At the eight lake stocking sites the stocking maintains Lahontan cutthroat trout fisheries. In the Truckee River, Lahontan cutthroat trout are stocked within the species' historic range, but in a section of the river that does not currently support a wild population of Lahontan cutthroat trout. Stocking of Lahontan cutthroat trout in Sagehen Creek is part of an experimental effort to restore these fish within the basin. Non-native trout are stocked within the historic range of Lahontan cutthroat trout in the Truckee, Carson and Walker River drainages (Figure 4-29), but not within habitats currently occupied by wild, self-sustaining populations of Lahontan cutthroat trout Because no stocking occurs within areas supporting wild Lahontan cutthroat trout populations, interbreeding with stocked trout would have a less-than-significant effect on wild populations of Lahontan cutthroat trout.

DFG is signatory to a number of MOUs and Cooperative Agreements with USFWS for the restoration of Lahontan cutthroat trout, which are listed as threatened under the Federal ESA. USFWS's Lahontan Cutthroat Trout Recovery Plan (USFWS 1995a) identifies the need for reintroduction plans to be developed for the Truckee, Carson, and Walker basins in California. Currently, recovery implementation teams (RIT) have been organized for the Truckee River, Lake Tahoe and Walker River. In 2003, the Truckee River RIT and the Walker River RIT each developed a Short-term Action Plan intended to facilitate restoration/recovery of naturally-reproducing lacustrine Lahontan cutthroat trout with activities identified to be implemented over a 5-year period. The Lake Tahoe RIT is still developing its plan. Included in these actions are stocking of Lahontan cutthroat trout in priority restoration reaches identified through the RIT planning process. Currently, certain priority restoration reaches are not stocked by DFG with non-native trout when a Lahontan cutthroat trout stocking program is in place within that reach. This cessation of non-native trout stocking in restoration reaches allows for evaluation of the stocking program by the RIT.

Impact BIO-112: Genetic Effects on California Golden Trout from Interbreeding with Stocked Trout (Less than Significant)

Stocking of hatchery trout has been discontinued in the currently managed range of California golden trout. Stocking in the headwater lakes of Golden Trout Creek ended in 1993 and those stocked trout have since been eradicated (Lentz pers. comm.) Trout stocking has occurred at one location in the historic range of California golden trout, in the South Fork Kern River at Kennedy Meadows (Figure 4-30). This area supports non-native wild brown trout and the golden trout present there are heavily hybridized. Trout stocking at this location in the previous five years was with triploid (sterile) rainbow trout and no stocking occurred in 2009. The hybridized golden trout at Kennedy Meadows have no conservation significance as less hybridized or genetically "pure" golden trout are present farther upstream, above three fish passage barriers on the South Fork Kern

River that prevent upstream migration of non-native trout and/or hatchery trout (Lentz pers. comm.). The two concrete barriers farthest downstream have been recently reconstructed and have been designed and engineered to provide long-term protection for the golden trout in the headwaters. Thus, golden trout with conservation significance are isolated from the highly hybridized golden trout and stocked sterile trout and interbreeding with stocked trout would be a less-than-significant effect for California golden trout.

Impact BIO-113: Genetic Effects on Eagle Lake Rainbow Trout from Interbreeding with Stocked Trout (Less than Significant)

Eagle Lake rainbow trout occur only in Eagle Lake. There is no wild reproduction of Eagle Lake rainbow trout; the population formerly spawned only in Pine Creek, a tributary of Eagle Lake, but since the 1940s flow in Pine Creek has generally been insufficient to support successful reproduction by the trout. Since 1959, the entire population has been supported by production from the Eagle Lake egg taking facility, and Eagle Lake rainbow trout are the only trout stocked in Eagle Lake (Dean and Chappell 2005). Given that Eagle Lake rainbow trout are all of hatchery origin, there is no potential for adverse impacts to result from the stocking of hatchery trout, all of which are Eagle Lake rainbow trout. Interbreeding with stocked trout would have a less-than-significant effect on the Eagle Lake rainbow trout.

Impact BIO-114: Genetic Effects on McCloud River Redband Trout from Interbreeding with Stocked Trout (Less than Significant)

There are two trout stocking locations in the vicinity of McCloud River redband trout range (Figure 4-32). Both locations are downstream of the currently managed areas for this species (i.e., the section of the main stem McCloud and its tributaries above the confluence with Bundoora Spring Creek) and only brook trout are stocked, so there is no potential for current trout stocking to result in interbreeding with wild redband trout. Thus trout stocking has a less-than-significant potential to result in genetic effects on McCloud River redband trout.

Impact BIO-115: Genetic Effects on Warner Valley Redband Trout from Interbreeding with Stocked Trout (Less than Significant)

Stocking of hatchery trout within the currently managed range of Warner Valley redband trout (Figure 4-32) was discontinued in 1989, so trout stocking does not have the potential to result in any interbreeding with wild fish. Interbreeding with stocked trout would have a less-than-significant effect on the Warner Valley redband trout.

Impact BIO-116: Genetic Effects on Little Kern Golden Trout from Interbreeding with Stocked Trout (Less than Significant)

Stocking of non-native hatchery trout within the currently managed range of the Little Kern golden trout (Figure 4-29) was discontinued in the 1950's. Recovery efforts for the federally Threatened Little Kern golden trout included stocking of hatchery-produced Little Kern golden trout and transplanting of wild Little Kern golden trout during the 1990's. These efforts were not fully successful and the stocking of hatchery-produced Little Kern golden trout was discontinued. Further recovery efforts will be guided by a genetics management plan to be developed. Nonnative trout cannot migrate upriver into the range of the Little Kern golden trout due to barrier falls located downstream in the Little Kern drainage (Lentz pers. comm.). Thus, interbreeding with stocked trout would have a less than significant effect on the Little Kern golden trout.

Impact BIO-117: Genetic Effects on Northern California DPS Steelhead and Klamath Mountains Province DPS Steelhead from Interbreeding with Stocked Trout (Less than Significant)

Stocking of hatchery trout only occurs in one location in the currently managed range of KMP or Northern California steelhead (Figures 4-35 and 4-36). Other stocking may occur in the non-anadromous, upstream portions of watersheds where steelhead are found and hatchery trout may consequently travel downstream into areas where steelhead are present. This is likely an infrequent event, which reduces the potential for genetic effects from hatchery trout. This likelihood of low occurrence is corroborated by the finding, discussed below (Impact BIO-117), that hatchery influence is minimal in most coastal steelhead populations. Also, according to Girman and Garza (2006), "there is no evidence of widespread admixture or introgression of hatchery trout into breeding populations of naturally spawning trout either above or below the dams" from trout raised at Fillmore Hatchery and planted in dam reservoirs in their study area (Monterey Bay south to Ventura County). Accordingly, interbreeding with stocked trout would have a less-than-significant effect on the KMP DPS steelhead and the Northern California DPS steelhead.

Impact BIO-118: Genetic Effects on Central Valley DPS Steelhead, Central California Coast DPS Steelhead, South-Central Coast DPS Steelhead, and Southern California DPS Steelhead from Interbreeding with Stocked Trout (Less than Significant with Mitigation)

Several genetic studies have been conducted in coastal steelhead populations throughout California (KMP, Northern California, Central California Coast, South-Central California, and Southern California DPS) and results suggest that hatchery influence is minimal in most populations (Garza et al. 2004; Papa et al. 2004; Deiner et al. 2007; Girman and Garza 2006; Nielsen, Pavey et al. 2003). However, a few southern California steelhead populations display some hatchery influence (Girman and Garza 2006; Nielsen, Zimmerman et al. 2003).

Recent genetic analyses suggest that below-barrier *O. mykiss* populations in the Central Valley region "have been widely introgressed by hatchery fish from out of basin brood stock sources" (i.e., Eel River); while above-barrier populations "are likely to most accurately represent the ancestral population genetic structure of steelhead in the Central Valley" (Garza and Pearse 2008). Also, 10 of 31 sampled adult *O. mykiss* entering the Nimbus Hatchery in one year were identified as hatchery rainbow trout from the nearby American River Hatchery; in the following year, no such trout were found among 39 sampled adults, and sampling occurred only in these two years (Garza and Pearse 2008). It is not known how these trout arrived at the Nimbus Hatchery. Regardless of how they got there, some of these hatchery rainbow trout likely did not enter the hatchery and could hybridize with wild steelhead, leading to detrimental effects associated with their "reduced genetic variation, genetic predisposition against anadromy, and past hatchery selection pressures" (Garza and Pearse 2008).

There are one or more trout stocking locations within the range of Central Valley steelhead, Central California coast steelhead, South-central coast steelhead, and Southern California steelhead (Figure 4-34 and 4-36). Although the current level of hybridization between hatchery stocks and native steelhead appears low in most Coastal steelhead populations, there is still a potential for hybridization and introgression to occur in coastal populations as evidenced by a few existing introgressed populations. Based on the clustering together of Central Valley below-barrier populations with northern coastal populations, it is most likely that the introgression observed in Central Valley steelhead populations is associated with fish released from anadromous steelhead

hatcheries. However, some hatchery rainbow trout released from trout hatcheries could potentially hybridize with wild steelhead, particularly in light of the American River Hatchery rainbow trout observed at Nimbus Hatchery. The degree of susceptibility to hybridization with hatchery rainbow trout for individual coastal and Central Valley steelhead populations is currently unknown. Due to the unknown susceptibility of wild steelhead populations to hybridization with hatchery stocks and the stocking of hatchery trout in portions of these three steelhead DPS ranges, trout stocking may have a significant adverse impact on these steelhead DPSs.

To minimize effects and reduce this impact to less than significant, DFG shall implement Mitigation Measure BIO-118.

> **Mitigation Measure BIO-118: Evaluate Trout Stocking Locations and Stock Triploid Trout as Needed to Reduce the Potential for Interbreeding with Steelhead**
>
> DFG will reduce potential genetic effects by implementing the following measure:
>
> - Where there is the potential for stocked trout to interbreed with anadromous steelhead then DFG will only stock those locations with sterile triploid trout.

Effects of Unintentional Releases of Hatchery-Reared Trout

Impact BIO-119: Effects of Unintentional Releases of Hatchery-Reared Trout (Less than Significant with Mitigation)

Unintentional releases are releases of juvenile, subadult, and adult trout in places, times and numbers not specified in the hatchery stocking management plan. Unintentional release occurring at a hatchery is discussed above (Impact BIO-9). Unintentional release may also occur when trout are accidentally stocked into the wrong water body. Such accidents have been recorded in aerial drops (Knapp 1996) and, although not documented, could in theory occur as a result of errors during stocking from trucks.

Unintentional releases primarily impact fish and wildlife through predation, competition and genetics, via the same types of impact mechanism described earlier in this chapter. The most direct such effect is by altering predator-prey relationships and by altering competitive relationships between hatchery trout and other organisms resident in the affected waters. Genetic impacts may occur when hatchery trout are unintentionally released in locations where hatchery and wild fish may interbreed, producing hybrids that are either infertile (as is usually the case with crosses between different species), are poorly adapted to the wild fish's habitat, or that are reproductively viable but contribute to a loss of the genetic diversity that renders the wild fish unique. In all cases, reproduction of wild trout may be impaired and their unique genetic makeup compromised. These outcomes can have substantial adverse effects on species that have already been imperiled by other types of impact. Hybridization with introduced species is already recognized as a factor contributing to the decline of many California native fish (salmonids as well as other species).

In order to minimize the risk that unintentional releases occur in the future, and to provide verification that releases occur in accordance with release plans, Mitigation Measure BIO-119 is required. Implementation of this mitigation measure would reduce impacts to less than significant.

Mitigation Measure BIO-119: Minimize Unintentional Releases

No releases of fish shall be allowed by DFG hatchery staff except with prior approval of the Regional manager. In emergency situations, DFG hatchery staff shall seek regional fishery management approval prior to any release that has not been previously authorized (usually, via a stocking plan). Hatchery managers shall inform staff of the potential impacts of unauthorized releases and require that approval be obtained prior to the release of any fish, even in emergency situations. Hatchery personnel (hatchery staff, hatchery truck drivers, etc) shall be instructed on this policy. They shall be informed that it would be better to let fish die than to liberate them without formal authorization. The policy shall clearly identify the procedures for hatchery staff to develop and implement "emergency contingency plans" in the case of equipment failure.

To prevent the risk of accidentally stocking at unauthorized sites, stocking sites shall be identified by maps and GPS coordinates, airplanes performing stocking shall carry GPS receivers, hatchery managers shall check to confirm that stocking did in fact occur at the designated GPS coordinates. Hatchery managers shall maintain a written record of such checks.

Effects of Anglers at Fishing Sites

Anglers are an implicit impact of trout stocking because the stocking program exists primarily in response to recreational fishing demands. It is likely that without the stocking programs, recreational fishing activity would decline, as would the impacts caused by recreational anglers. The magnitude of such a decline is not known. Although angling is a common activity at or near stocking locations, most of these waters are also used for a variety of other recreational purposes, and most impacts (discussed below) caused by anglers, are also caused by other recreational users of the same waters. The degree to which this occurs likely varies with the water type; for instance, relatively few non-anglers will wade through the cold waters of a trout stream or will navigate dense riparian brush in trailless areas, whereas waters subject to boating are used by a wide array of recreationists, and in popular or urban areas may be subject to development of social trails by many types of users. In a study of HMLs conducted by Hendee et al. (1977), the researchers concluded that "manipulating the fishery to modify visitation at high lakes is, at best, a partial solution" because other visitors would continue to affect the resources. Many anglers observed and interviewed during the course of the 1977 study cited reasons other than fishing as their primary motivation for visiting the lakes, which suggests that their use patterns may not change as a result of fish removal.

Recreational fishing activity may deliver a variety of potential impacts on native fish or wildlife or to sensitive ecosystems. Specific potential impacts include:

- Disturbance of riparian systems that occurs when anglers access fishing locations.

- Disturbance of benthic aquatic areas due to anglers moving through aquatic areas.

- Disturbance of sensitive species due to anglers moving through aquatic areas.

- Distribution of invasive species or pathogens by anglers.

- Impacts caused by motorized fishing boats.

- Incidental harvest of non-target fish (this is separately addressed under "Impacts of the Trout Stocking Program," in the subsection "Effects from Non-Target Harvest").

Impact BIO-120: Disturbance of Riparian Systems Due to Use of Vehicles and Foot Travel to Access Fishing Locations as a Result of the Trout Stocking Program (Less than Significant with Mitigation)

Shoreline vegetation along stocked lakes and streams may be trampled by anglers, by their pack stock, or by their vehicles (primarily automobiles, ORV's, or beached watercraft). The potential severity of such effects depend on the type of vegetation, the type of shoreline, and the intensity of angler use relative to use by other visitors.

Type of vegetation includes the structural form of the vegetation, as well as the presence or absence of special-status plant species. Cole and Trull (1992) found that tree seedlings and low woody species with brittle stems are resistant to low levels of trampling but recover slowly following damage at high levels of trampling. Both plant stature and location of perennating tissues at or below the ground influence the ability of vegetation types to resist and recover from trampling. Tall, tough, woody shrubs and grasses that occur in bunches or as turf (e.g., sedges) are relatively resistant to damage by trampling, while broad-leaved herbaceous species are highly sensitive to the effects of trampling. Fast-growing herbs and tufted or turf-producing grasses recover relatively quickly following damage, while woody species and some herbs recover relatively slowly following damage (Cole and Trull 1992).

Special-status plant species have a disproportionate likelihood of occurring in aquatic and riparian habitats, which in turn occupy a small fraction of the landscape. Such sensitive species are especially likely to occur in riparian areas that include marshes, wet meadows, bogs, seeps, stream edges, and swamps. The distribution of such special-status species relative to stocking locations is not known, especially since many rare plant populations are small, highly localized, and are not yet discovered. It may be unlikely that, in any given area, such a population would be affected by angler activities; yet at the larger scale of the state or a given DFG management region, it becomes much more likely that at some stocking location, such an impact would occur, with potential to severely alter the population status of a rare plant. Even very light visitor or angler use at a given lake or stream could result in significant impacts on a particular special-status species. Actions that can be taken to reduce impacts include surveys and subsequent monitoring of indicator or rare plants at and near stocking locations, erecting signs and fencing, relocating (or even closing) trail access, and establishing other important mitigation measures that may vary depending on the site, the biology of the sensitive species, and the land management authority.

The type of shoreline also determines ecosystem vulnerability to angler impacts. Developed areas such as bridges and docks are likely least vulnerable, as are shorelines around reservoirs with fluctuating water levels. Conversely, the loss of plant cover due to trampling may cause indirect effects such as erosion and sedimentation associated with loss of roots and the plants' ability to hold soils. These changes may alter plant communities and alter food and nutrient inputs to surrounding lakes and creeks. In moist soil areas, trampling may lead to changes in site hydrology, which may exclude sensitive wetland species from impacted sites. Terrestrial insects and other organisms that get into the lake and become prey to aquatic organisms may also be affected indirectly through loss of shoreline vegetation that serves as habitat. These impacts are ecologically plausible, but there are no data on the levels of indirect impacts anglers may have on lakeshore environments (Washington Department of Fish and Wildlife 2001). One impact that has been studied is habitat fragmentation due to angler activity in the riparian zone. Müller et al. (2003) found that dragonfly diversity declined with increasing habitat fragmentation caused by trampling, down to a scale of patch fragments less than 10 meters in size.

Angler use of riparian areas is often intense. Research conducted in the late 1980s by Hospodarsky and Brown (1992) suggests that anglers spent three times longer in riparian zones than other user groups. The researchers hypothesized that if time spent in the riparian zone were proportionate to impacts, then anglers would have up to three times as great an impact as hikers (Hospodarsky and Brown 1992). Conversely, many anglers fish from boats or other watercraft, or from docks and bridges, and thereby have minimal potential to directly impact riparian ecosystems. Bahls (1992) reported that the recreational impact of anglers at HMLs has been severe in the Sierra Nevada, with most regions reporting a level of use greater than that which the fragile lakeshore environments can withstand, although it is unclear how much the observed impacts were due to anglers rather than to other users.

In view of the potential impacts on special-status plant species and the potential to degrade and fragment riparian habitat areas that provide essential ecosystem support services to special-status fish and wildlife species, recreational fishing activity could cause a substantial adverse effect on riparian habitats essential to special-status fish and wildlife species.

Implementation of Mitigation Measure BIO-120 would reduce impacts to less than significant.

Mitigation Measure BIO-120: Minimize Disturbance in Riparian Areas

A significant adverse impact on riparian ecosystems may be caused by angler activities. This impact derives from potential trampling of special-status plant species, and the potential to degrade and fragment riparian habitat areas that provide essential ecosystem support services to special-status fish and wildlife species.

In order to minimize impacts on special-status plant species, DFG shall evaluate the potential for impacts on a state or federally listed threatened or endangered plant when the species is known to occur within 200 feet of a water body where trout are proposed to be planted. Knowledge of species occurrence shall be based upon records in the CNDDB database. Observations reported by DFG biologists or other recognized botanical experts shall also be regarded as credible evidence of the presence of a listed plant species.

Evaluation of stocking locations vis-à-vis known plant occurrences shall occur prior to use of any proposed stocking location, and will be repeated at intervals of no less than 5 years for established stocking locations.

The DFG will provide signage at and near entry points to fishing areas and trail heads stating the importance of preserving and protecting both the riparian and sensitive plant species. In addition, the DFG will post information on our Internet pages and in the DFG fishing regulations stating the importance of preserving and protecting both the riparian and sensitive plant species.

Impact BIO-121: Disturbance of Benthic Aquatic Areas Due to Anglers Moving through Aquatic Areas as a Result of the Trout Stocking Program (Less than Significant)

Anglers in trout streams, especially, commonly wade in the stream. There is a risk that this activity could disturb redds of native trout species. Roberts and White (1992) report a Montana study of experimental trampling of eggs in the manner of an angler wading through redds. In a laboratory setting, they found that a single wading killed up to 43% of trout eggs and pre-emergent fry. However, stocking does not occur in areas where the redds of trout decision species may occur, and public education programs exist to warn anglers of the risks of trampling redds of any trout species.

Thus, this impact is likely infrequent, and unlikely to affect any of the special-status trout species addressed in this analysis. This impact would be less than significant.

Impact BIO-122: Disturbance of Special-Status Species Due to Anglers Moving through Aquatic Areas (Less than Significant)

A wide variety of special-status fish, amphibian, and reptile species could be disturbed by anglers moving through aquatic areas where trout stocking locations are present within the range of these species. Such disturbance could take many forms, e.g. flushing animals from feeding and holding areas, animals relocating within the water column, animals seeking cover, animals injured by powerboat activity. In general, though, anglers attempt to cause little disturbance to the aquatic habitat, as they are targeting trout and do not want to disturb the target species. Anglers would be informed of potential impacts on special-status species at water body access points (Mitigation Measure BIO-120 above). Impacts associated with disturbance of non-target species would be less than significant.

Some types of angler activity, especially use of powerboats, also have the potential to disturb each of the special-status bird species in Table 4-1 (bald eagle, osprey, willow flycatcher, and southwestern willow flycatcher). Disturbance of these birds would be a particular concern during the nesting season. Bald eagles and osprey often nest near popular recreational boating areas and are well habituated to such disturbance; thus disturbance effects on these species would be less than significant. The flycatchers typically nest and forage in very densely vegetated riparian areas that are not easily accessible to anglers, and the angler behavior noted above (stealthy pursuit of trout) would indicate that noise and disturbance by anglers would be unusual in areas near flycatcher nesting and foraging habitats. Anglers would be informed of potential impacts on special-status species at water body access points (Mitigation Measure BIO-120 above). Thus, noise and disturbance impacts on the flycatchers would also be less than significant.

Impact BIO-123: Distribution of Invasive Species by Anglers as a Result of the Trout Stocking Program (Significant and Unavoidable)

California's Aquatic Invasive Species Management Plan (California Department of Fish and Game 2008d) identifies recreational fishing as a primary vector for introduction of aquatic invasive species (AIS), noting that "Initial introductions can occur when bait buckets and live tank contents are dumped. Gear used for fishing (boats, nets, floats, anchors, wading boots, tackle, etc.) can spread AIS. For example, fly fishing gear used in waters infested with New Zealand mud snails, may be the primary vector associated with the spread of this AIS into California's rivers." Examples of AIS introduction issues within the trout stocking program area include the distribution of aquatic weeds such as hydrilla on boats, boat trailers and other gear; and the distribution of invasive crayfish used as bait. Johnson et al. (2001), investigating zebra mussel spread by recreational boaters in Michigan, found that (a) several mechanisms functioned to transport mussels, including water (primarily bilges and live wells), entangled aquatic macrophytes, and anchors; and (b) although any individual vessel had a very low probability of carrying mussels (0.12%), the overall level of boating traffic was sufficient to result in a predicted 170 dispersal events per year from one busy boat launch studied. These findings suggest that recreational boaters have a very high probability of dispersing organisms that can be dispersed in bilge water or live wells, or by attachment to vessels, trailers or anchors; and that even strict enforcement of precautionary measures is unlikely to be fully effective due to the intensity of boating activity in popular waters.

Anglers may also disperse invasive species via gear other than boats, for instance, on rafts, float tubes, or waders. It is widely thought that some diseases of fish and amphibians may be transmitted on waders or wading shoes. Diseases implicated by this mechanism include whirling disease (Gates et al. 2008), didymo (*Didymosphenia geminata*) (Pennsylvania Fish and Boat Commission 2009), and amphibian chytridiomycosis (Padgett-Flohr 2007), which are currently present and causing harm to trout and amphibian populations in California. Amphibian chytridiomycosis has been detected in California populations of California red-legged frogs, foothill yellow-legged frogs, mountain yellow-legged frogs, Yosemite toads, California tiger salamanders, and several other species not of conservation concern (Padgett-Flohr 2007); a few localized didymo infestations have been reported (e.g. on the South Fork of the American River [Elwell 2009]); and whirling disease is now widespread in California's trout streams (Modin 1998). The introduction of any of these diseases is potentially a highly significant event that can result in substantial declines or even extirpation of local populations of special-status species. Other AIS that are commonly introduced on fishing gear include aquatic weeds such as Eurasian watermilfoil (California Department of Fish and Game 2008d) and invasive animals such is the zebra mussel, quagga mussel, and New Zealand mud snail (California Department of Fish and Game 2009a, 2009b).

Currently, DFG has an active program to educate boaters, anglers and other recreationists concerning the risks of AIS and the methods available to address those risks. The DFG web site prominently features information on mussel control and invasive species in general.

Although recreational boating is very likely to result in the distribution of invasive species, potentially resulting in a significant adverse impact on native aquatic ecosystems and sensitive species therein, it is likely that in many waters such introductions would occur regardless of angler activities because anglers constitute only a fraction of the recreational water users. In some waters, though, anglers may be the predominant recreational users and one of the principal vectors for human introduction of invasive species. These include waters such as cold mountain lakes and streams that are inaccessible to boaters but may be visited by anglers equipped with gear such as waders and float tubes; as well as waters used by drift boaters, where anglers may comprise the majority of the boating traffic. In such settings, anglers may cause a significant adverse impact on local ecosystems and special-status species by introduction of aquatic invasive species and/or pathogens. This impact would be mitigated by implementation of Mitigation Measure BIO-123.

Picco and Collins (2008) have documented the spread of amphibian pathogens via tiger salamanders sold as bait. They found that tiger salamanders sold as bait are collected in the wild, usually in eastern states where they are abundant, and are then transported in interstate commerce. Use of any salamander for bait in California is illegal (CCR Title 14 Section 4), as is possession or transport of any member of the genus *Ambystoma* without a permit from CDFG (CCR Title 14 Section 671). There is, however, at least a limited illegal trade in *A. tigrinum* (formerly used for bait in California and now established in the wild) as evidenced by a Santa Barbara area Craigslist ad selling them in 2008 (Bolster pers. comm.).

In angler surveys conducted in Arizona, Colorado and New Mexico, Picco and Collins (2008) found that an average 50% of anglers use tiger salamanders as bait, 45% of anglers release bait salamanders into the wild, and 4% of bait shops release unsold bait salamanders into the wild. Since such use is illegal in California, corresponding percentages in this state would likely be much lower. The bait salamanders analyzed by Picco and Collins (2008) were found to carry both diseases that were screened for: ranavirus strains, and the chytrid fungus *Batrachochytrium dendrobatidis* (Bd). Both pathogens have been implicated in large-scale amphibian die-offs within California. Picco et al.

(2007) have documented California tiger salamander susceptibility to tiger salamander ranavirus, while most native California amphibian species are known be susceptible to Bd, including the California red-legged frog, the foothill yellow-legged frog (U.S. National Park Service 2009), the arroyo toad (Nichols 2003), the Yosemite toad (Green and Kagarise-Sherman 2001), and the mountain yellow-legged frog (Fellers et al. 2001). The disease has now been reported in all major types of amphibians and is presumably capable of harming all California amphibian species.

In view of the documented sale of diseased tiger salamanders at bait shops in Arizona, Colorado and New Mexico, the broad interstate commerce in tiger salamanders, and the advertising of this illegal bait in California, it is likely that diseased tiger salamanders are sometimes used as bait by California anglers, and may cause a significant adverse impact to native amphibians by transmission of diseases including, at a minimum, Bd and ranaviruses. Another threat to the California tiger salamander from the spread of invasive tiger salamanders is hybridization (Riley et al. 2003); the resultant hybrid vigor has resulted in larger hybrid body sizes and increased predation rates of other members of the ecological community by hybrids (Ryan et al. 2009).

The distribution of invasive species by anglers would be mitigated by implementation of Mitigation Measure BIO-123 but would remain significant and unavoidable.

Mitigation Measure BIO-123: Educate Anglers to Control Invasive Species

A significant adverse impact to riparian and aquatic ecosystems may be caused by angler introduction of aquatic invasive species and diseases. This impact derives from the high potential of such invasive species to be transported on recreational fishing equipment such as felt-soled boots, waders, nets, boat trailers, and in the bilges and wet wells of boats, coupled with the difficulty of effectively controlling invasive organisms that may be microscopically small and tolerant of severe thermal and chemical stresses. Although in many waters these invasive organisms may be transported by any water-oriented recreationists, there are some waters, such as cold water trout streams, where recreational anglers constitute the most likely vectors of contamination.

Currently, DFG has an active program to educate boaters, anglers and other recreationists concerning the risks of aquatic invasive species and the methods available to address those risks. The DFG web site prominently features information on mussel control and invasive species in general. However, in order to further minimize impacts from spread of aquatic invasive species and diseases, DFG shall make available to anglers information describing aquatic invasive species and diseases that have a high risk of being introduced to stocked waters, emphasizing the important both to aquatic ecosystems and to a healthy fishery from controlling these risks, and detailing methods to achieve control. In some waters it may be appropriate to require avoidance of live baits and to require specific decontamination procedures. DFG shall provide educational information on the DFG website, in the annually published fishing regulations, and at water body access points where DFG regularly posts information for anglers.

Residual Impacts

Accidental introduction of aquatic invasive species and diseases by anglers has been a persistent problem throughout the United States despite decades of efforts to educate anglers and control their behavior so as to minimize the risk of such introductions. This may be largely due to the cumulatively very large number of anglers and angler visits to water bodies, which renders invasive

species introductions likely even if there is a high rate of angler compliance with guidelines and requirements designed to halt the spread of invasive species (Johnson et al. 2001). Thus, this mitigation measure is not likely to end the problem, or to reduce it to insignificance. Invasive species will likely remain one of the principal factors of decline for most special-status fish and amphibian species in California.

Impact BIO-124: Impacts Caused by Motorized Fishing Boats as a Result of the Trout Stocking Program (Less than Significant)

Motorized recreational boating has been implicated in a variety of harmful effects on biological organisms. Impacts include water quality impairment due to petrochemicals and human waste; and physical effects from water movement (wakes and propeller wash) such as shoreline erosion and suspension of bottom sediments.

Petrochemical pollution comes from use of two-stroke motors, flow-through cooling systems, underwater motor exhausts, pumping or bailing of bilge water contaminated with fuel and oil residues, atmospheric deposition of combustion engine exhaust products, and accidental spills of fuel and oil. Although modern watercraft have largely corrected or minimized the problems caused by two-stroke motors, flow-through cooling systems and exhaust products, these impacts still persist due to legacy equipment, poor maintenance, and noncompliance with regulations intended to protect water quality. However, petrochemical pollution from recreational boats is not regarded as a major issue in most recreational waters.

Human waste comes primarily from discharges from boats equipped with heads. Such discharge is prohibited in California waters and public education programs exist to ensure widespread understanding and compliance with the regulations. Thus, this is a relatively minor issue in most waters.

Physical effects include shoreline erosion and suspension of bottom sediments. These activities can increase turbidity. Increased turbidity inhibits sunlight penetration through water, negatively impacting photosynthetic activity and health of algae and shallow water or submerged aquatic vegetation (SAV). Increased wave energy can also result in bottom conditions that are too unstable for SAV (N.C. Division of Water Quality 2006). Effects of this severity, however, have primarily been observed in and near marinas and other areas subject to a very high intensity of boater activity.

The impacts described above are caused by motorized recreational boats; they are not caused exclusively by anglers. Although data are not available to quantify the relative proportion of motorized craft used by trout anglers and those used by other recreationists, it seems likely that trout anglers constitute a large fraction of the total only in certain relatively specialized waters, such as cold-water reservoirs and in relatively large streams used by drift boaters. In such waters, recreational fishing may constitute a substantial fraction of the total impact caused by recreational motor boat use. However, in view of the existing regulation and enforcement intended to minimize the impacts of recreational motor boat use, the impacts of this activity are less than significant.

Impacts of the Salmon and Steelhead Stocking Program

Background

This section of Chapter 4 contains an analysis of the potential impacts of DFG salmon and steelhead stocking activities on biological resources, assuming the continuation of stocking activities that have taken place over the 2004-2008 baseline period. The analysis addresses both direct and indirect effects on decision species (Table 4-1) and wildlife habitats present at locations stocked with hatchery salmon and steelhead. Alternative projects are discussed separately, in another chapter of the document. Cumulative impacts on these resources are also discussed in a separate chapter. The impacts of salmon and steelhead stocking have been organized into six categories:

- Impacts related to predation, competition, and related changes in ecological relationships between stocked and wild populations of native species.

- Impacts related to non-target harvest, which is the catch of wild native fish by fisherman that are attracted to an area because the waters are stocked.

- Impacts related to invasive species and pathogens that may be accidentally introduced during stocking operations.

- Impacts that arise from interbreeding of hatchery and wild fish, altering the genetic composition of wild populations.

- Impacts that arise from accidental or otherwise unauthorized releases of hatchery fish.

- Impacts that are caused by anglers during their pursuit of stocked fish.

This list of potential impacts was identified after considering types of impacts identified within the Initial Study, issues raised in the public scoping process, and additional data collected during preparation of the draft EIR/EIS. All impacts listed below have been analyzed using the best available science, including published and grey literature, personal communication with biologists from the state and federal resource agencies, and the best professional judgment of the authors. The analysis focuses on potential impacts on sensitive, native or legally protected species, which were identified during the scoping process, and on various other species that are at high risk of being significantly affected by salmon and steelhead stocking (decision species; see Table 4-1).

Effects from Predation and Competition from Stocked Salmon and Steelhead

Effects on Invertebrates

Impact BIO-125: Predation and Competition Effects from Stocked Salmon and Steelhead on Shasta Crayfish (Less than Significant)

Salmon and steelhead are not stocked anywhere within the range of the Shasta crayfish (Figure 4-25). Thus, there is no potential for predation or competition impacts from salmon or steelhead stocking to the Shasta crayfish, and therefore the impact is less than significant.

Impact BIO-126: Predation and Competition Effects from Stocked Salmon and Steelhead on California Freshwater Shrimp (Less than Significant)

There are 5 salmon and steelhead stocking locations shown within the range of the California freshwater shrimp (Figure 4-25). However, interviews with DFG personnel indicate that only one location is potentially within the current range of the freshwater shrimp. California freshwater shrimp are restricted to shallow, low-elevation, low-gradient streams in Marin, Napa, and Sonoma counties. They are the only freshwater California shrimp, and have declined in response to numerous factors, among them introduced fishes (California Department of Fish and Game 2004). California freshwater shrimp are only known to now survive in 23 or 24 stream segments (U.S. Fish and Wildlife Service 2007e).

Salmon and steelhead stocking has not been identified as a factor in the decline of California freshwater shrimp. The recent 5-year review of the recovery plan for the California freshwater shrimp (U.S. Fish and Wildlife Service 2007e) affirms that "predation by nonnative fish is still a significant threat" and details that threat: "introduced fish, such as green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), smallmouth bass (*Micropterus dolomieui*), largemouth bass (*Micropterus salmoides*), mosquitofish (*Gambusia affinis*), and various introduced minnows may contribute to the shrimp's current limited distribution (Eng 1981; Serpa 1991) as a result of predation. Additionally, several native fish species may also prey on the shrimp. Results from stomach content analysis from a study on habitat requirements of the shrimp in Lagunitas and Olema creeks found that prickly sculpin (*Cottus asper*) and riffle sculpin (*Cottus gulosus*) prey on the shrimp (Saiki 2006)." Salmonids are conspicuously absent from this detailed catalog of predators, and no information was found indicating that salmonids pose any threat to California freshwater shrimp.

The California freshwater shrimp is a rare species in California. It is listed as endangered under both the ESA and the CESA. Although predation by fish is identified as a factor of decline for California freshwater shrimp, salmonids have not been identified as a potential predator of the shrimp. Thus, the impact of predation and competition from stocking salmon or steelhead on California freshwater shrimp is less than significant.

Effects on Native Non-Salmonid Fish

Salmon and steelhead hatcheries stock native steelhead, coho salmon, and Chinook salmon within Central Valley and coastal rivers and streams that empty to the ocean. DFG hatcheries stocking non-anadromous kokanee and coho salmon are addressed in the trout stocking program analysis. Native fishes in coastal streams and rivers have generally co-evolved with native salmon and steelhead, which are also used for hatchery stocks. Although under natural conditions native fishes may subsist with minimal, if any, negative interactions with salmon and steelhead in rivers and streams, the addition of large numbers of hatchery fish at one time and location such as occurs under the salmon and steelhead stocking program may potentially result in locally elevated rates of predation and competition. As described in the analysis for "Impacts of the Trout Stocking Program," under the subheading "Effects from Predation and Competition from Stocked Trout", competition between native non-salmonids and salmonids is infrequent (Blanchard 2002; Baltz and Moyle 1984) and the degree of interspecific competition varies with size differences among competing individuals, environmental factors (e.g., temperature, stream flow, and habitat structure), and with species-specific types of interactions (Fausch and White 1986).

Impact BIO-127: Predation and Competition Effects from Stocked Salmon and Steelhead on Kern Brook Lamprey, Owens Tui Chub, Goose Lake Tui Chub, Arroyo Chub, Owens Speckled Dace, Santa Ana Speckled Dace, Owens Sucker, Modoc Sucker, Santa Ana Sucker, Cui-Ui, and Unarmored Three-Spined Stickleback(Less than Significant)

Salmon and steelhead are not stocked within the range of the Owens tui chub, Goose lake tui chub, Arroyo chub, Owens speckled dace, Santa Ana speckled dace, Owens sucker, Modoc sucker, Santa Ana sucker, cui-ui, or unarmored three-spined stickleback (Figures 4-26, 4-41, 4-42, 4-43, 4-44, 4-45 and 4-46). Chinook salmon are stocked in the Merced River where Kern Brook Lamprey have been observed, but there is no evidence that stocked salmon are a factor in the lamprey's distribution Thus, there is little or no potential for predation or competition from stocking of salmon or steelhead to impact these species; the impact on these species is less than significant.

Impact BIO-128: Predation and Competition Effects from Stocked Salmon and Steelhead on River Lamprey (Less than Significant)

There is a total of 23 salmon and steelhead stocking locations within the current range of river lamprey (Figure 4-26). River lampreys are a relatively common anadromous species that spawn in California coastal streams from San Francisco north, and are most abundant in the lower Sacramento – San Joaquin River system (Moyle 2002) . River lamprey have co-evolved with salmonids and threats to river lamprey are primarily anthropogenic, such as dams, habitat degradation and loss, and predator control programs.

Lamprey are known to prey on salmonids (Moyle 2002; Quinn 2005; Beamish and Neville 2001; Novomodnyy and Belyaev 2002), but salmonids are not prolific predators of lamprey. There is little information on predation on lamprey by fish. There are primarily three periods when lamprey might constitute prey of stocked juvenile salmon or steelhead, as eggs are deposited, during emergence from the nests and during high flow events that scour larvae from their burrows.

Larval lamprey (ammocoetes) burrow in the substrate and filter feed on algae and detrital particles, until they transform to adults and are parasitic on fish. The adult stages migrate to the ocean, until they return to spawn in their natal streams. There is no overlap in diet between lamprey and stocked salmon or steelhead.

Due to the relatively extensive range of the river lamprey, their life history, and their co-evolution with salmonids, impacts from competition or predation from stocked salmon or steelhead are less than significant.

Impact BIO-129: Predation and Competition Effects from Stocked Salmon and Steelhead on Klamath River Lamprey (Less than Significant)

There is very little information concerning the ecology or distribution of the Klamath River lamprey. It is a parasitic river lamprey known to occur in the Klamath, Trinity, Mad and Eel River systems and Klamath Lake. Assuming its life history is similar to that of the river lamprey, described above, the potential for predation or competition impacts from stocked salmon would be less than significant.

Impact BIO-130: Predation and Competition Effects from Stocked Salmon and Steelhead on Green Sturgeon (Less than Significant)

There are 19 anadromous salmon and steelhead stocking locations within the range of the green sturgeon (Figure 4-27). Due to differences in diet and habitat usage between salmonids and green

sturgeon and the low likelihood of juvenile salmonid predation on green sturgeon, the potential competition and predation impacts on green sturgeon associated with salmon and steelhead stocking would be less than significant.

Impact BIO-131: Predation and Competition Effects from Stocked Salmon and Steelhead on Delta Smelt (Less than Significant)

Salmon and steelhead are stocked at 14 locations within the range of delta smelt (Figure 4-28). Further, all stocked Central Valley salmon and steelhead would move through the delta as they migrate to the ocean, which would be the primary period when salmon or steelhead could predate or compete with delta smelt. As Chinook salmon smolts (juvenile salmon which are transforming from freshwater to saltwater existence) migrate through the delta and San Francisco Bay to the ocean, their diets progressively change from invertebrates to fish larvae (MacFarlane and Norton 2002). When Chinook first emerge from the rivers, they feed primarily on gammaridean amphipods crustacean larvae, and insects. Once through Suisun Bay, diets include hemipterans, calanoid copepods, mysids, fish larvae and insects. In the central bay, fish larvae dominate juvenile Chinook salmon diets (MacFarlane and Norton 2002).

In their study of delta smelt life history, Moyle et al. (1992) found that post-larval delta smelt fed exclusively on copepods, and adults fed on copepods throughout the year, and seasonally on cladocerans, in addition to opossum shrimp.

Based on the foregoing, it is possible that competition with and predation of delta smelt from salmon and steelhead does occur as the salmonids are migrating through the delta. However, USFWS (1995) found no evidence that competition or predation has caused a decline in delta smelt populations, and it was not identified as a limiting factor to the population. This issue of potential predation from hatchery stocking was reviewed in 2008 (U.S. Bureau of Reclamation 2008) and the conclusion was the greater risk from predatory species was striped bass and largemouth bass. Therefore, the potential for competition and predation impacts on delta smelt from stocked salmon or steelhead would be less than significant.

Impact BIO-132: Predation and Competition Effects from Stocked Salmon and Steelhead on Longfin Smelt (Less than Significant)

The longfin smelt's distribution is more extensive than that of the delta smelt, and includes several northern California estuaries in addition to the Sacramento-San Joaquin estuary. Salmon and steelhead are stocked at 14 locations within the longfin smelt's range (Figure 4-28). The potential for predation and competition impacts on longfin smelt from stocked salmon and steelhead is similar to that described for delta smelt. Longfin smelt and salmon and steelhead cohabitate the estuarine areas as smolts move through the estuaries to the ocean. The primary prey of longfin smelt is the opossum shrimp, with copepods and other crustaceans periodically important in their diet (U.S. Fish and Wildlife Service 1995). Because salmon and steelhead feed on similar pelagic zooplankton, and fish (likely including longfin smelt) during their transit of the estuaries, there is potential for predation and competition between longfin smelt and stocked salmonids. However, although little literature exists, stocked salmon and steelhead likely have only a minor or negligible predatory and competitive effect on longfin smelt due to their transitory presence in the estuaries during ocean migration. Therefore, the potential for competition and predation impacts on delta smelt from stocked salmon or steelhead would be less than significant.

Impact BIO-133: Predation and Competition Effects from Stocked Salmon and Steelhead on Eulachon (Less than Significant)

The eulachon's distribution includes estuaries in northern California (Humboldt Bay and northward). Salmon and/or steelhead are stocked at two locations within the range of the eulachon, in the Mad and Klamath Rivers (Figure 4-27). The potential for predation and competition impacts on eulachon from stocked salmon and steelhead occurs as salmon and steelhead move through the lower river and estuaries as smolts to the ocean. The diet of eulachons consist of crustaceans such as copeopods and euphausiids, which overlaps somewhat with the diets of salmon and steelhead smolts when in estuarine habitats. Salmon and steelhead were not identified as predators to eulachon in the proposed listing of the southern DPS eulachon by NMFS (74 FR 10847).

Stocked salmon and steelhead likely have only a minor or negligible predatory and competitive effect on eulachon due to their transitory presence in the estuaries during ocean migration. Therefore, the potential for competition and predation impacts on eulachon from stocked salmon or steelhead would be less than significant.

Impact BIO-134: Predation and Competition Effects from Stocked Salmon and Steelhead on Tidewater Goby (Less than Significant)

Salmon and steelhead are not stocked within the currently managed range of the tidewater goby (Figure 4-41), so there is no potential for predation and competition impacts associated with salmon and steelhead stocking. Potential impacts are therefore less than significant. Tidewater goby could be preyed upon by outmigrating juvenile salmon and steelhead; however, predation does not appear to be an important regulator of population size in lagoons in southern California. Instead, populations are controlled by environmental conditions (Moyle 2002). Therefore, the potential for competition and predation impacts on tidewater goby from stocked salmon or steelhead would be less than significant.

Impact BIO-135: Predation and Competition Effects from Stocked Salmon and Steelhead on Hardhead (Less than Significant)

There are 22 salmon and steelhead hatchery stocking locations within the hardhead's range (Figure 4-45).However, stocked salmon and steelhead would have minimal predation and competition impacts on hardhead. The species utilize different microhabitats, with hardheads being benthic feeders and salmon and steelhead feeding on drift organisms (Moyle 2002). The potential for stocked salmon and steelhead to prey on hardheads is minimal due to their small size at stocking and relatively short residence before migrating to the ocean. Therefore, the potential for competition and predation impacts on hardheads from stocked salmon or steelhead would be less than significant.

Impact BIO-136: Predation and Competition Effects from Stocked Salmon and Steelhead on Sacramento Perch (Less than Significant)

Salmon and steelhead are stocked at 3 locations within the Sacramento perch's range (Figure 4-42) in the Sacramento and San Joaquin River drainages. Sacramento perch are opportunistic feeders, and the diets change as they grow, from small crustaceans to insect larvae to fish (Moyle 2002). Although there is some overlap in diet, stocked salmon and steelhead feed in faster flowing water than Sacramento perch. The potential for predation on Sacramento perch by stocked salmon and steelhead would also likely be minimal due to their small size at stocking and relatively short

residence before migrating to the ocean. Therefore, the potential for competition and predation impacts on Sacramento perch from stocked salmon or steelhead would be less than significant.

Effects on Wild Populations of Native Trout

Salmon and steelhead hatcheries stock native steelhead, coho salmon, and Chinook salmon within Central Valley and coastal rivers and streams that empty to the ocean. DFG hatcheries stocking non-anadromous kokanee and coho, and Chinook salmon in inland waters are addressed in the trout stocking program analysis. Native trout in coastal streams and rivers have generally co-evolved with native salmon and steelhead, which are also used for hatchery stocks, so predation and competition effects in undisturbed settings are minimized through niche partitioning. However, the addition of large numbers of hatchery fish at one time and location, such as occurs with salmon and steelhead stocking, may potentially result in adverse predation and competition effects on wild native trout.

As described more fully in the analysis for "Impacts of the Trout Stocking Program," under the subheading "Effects from Predation and Competition from Stocked Trout," intraspecific (within species) competition is more a concern than interspecific (between different species) due to shared life stage timing and microhabitat preferences. Competition between salmonid species is minimized by the species having slightly different microhabitat preferences and environmental tolerances (Hearn 1987; Bisson, Sullivan, and Nielsen 1988). The degree of intraspecific and interspecific competition varies depending on size differences among competing individuals, environmental factors (e.g., temperature, stream flow, and habitat structure), and, for interspecific competition, with species-specific interactions (Fausch and White 1986).

Several studies have indicated that starvation, resulting from an inability to forage effectively, is a primary cause of poor post-release survival of stocked fish (Miller 1952; Reimers 1963; O'Grady 1983; Myers 1980; Hochachka 1961 in Flagg et al. 2000). Sosiak et al. (1979) found that foraging effectiveness could be reduced for at least two months after release for hatchery Atlantic salmon parr. Myers (1980) found that hatchery Chinook salmon were less effective foragers than wild fish until they spent an extended residence in an estuary, indicating either that "hatchery fish eventually learn to forage more efficiently, or that only the efficient foragers remain to be sampled after inept foragers starved" (Flagg et al. 2000:5). It can be inferred from these observations that both competition and predation from individual hatchery fish is generally low; however, incremental effects from large releases of hatchery fish could result in relatively high levels of competition and predation. This effect would be expected to be particularly severe for releases of relatively large hatchery fish, such as yearling steelhead, which are of a size comparable to most native non-anadromous trout. Naman (2008) found that hatchery steelhead released in the Trinity River consumed 9.0 % of Chinook salmon and coho salmon fry that were naturally produced. Other studies reviewed by Naman (2008) reported far lower predation rates. According to Naman (2008:3), the high rates reported for the Trinity River may be due to a number of factors including spatial and temporal overlap of predator and prey (Mobrand et al. 2005), size differential of predator and prey (Pearsons and Fritts 1999), high concentrations of predators (Mather 1998), as well as abiotic factors including low, regulated flow (8.5 ms-1) and high water clarity (< 2 NTU) (Gregory and Levings 1998; Robertis et al. 2003), and prey density (Beauchamp et al. 1999).

High predation rates from hatchery yearling Chinook on naturally produced fry in the Feather River have also been found with an estimated 7.5 million fry (Sholes and Hallock 1979; Williams 2006) consumed. As a result, yearling Chinook are no longer released. Hatchery steelhead present a greater risk to natural populations because they are generally larger at release and a relatively high

portion of them can become residualized (i.e., remain in the river instead of migrating to ocean) which provides more opportunities for them to compete for resources and prey upon naturally spawned salmon and steelhead throughout the year. For example, Bumgarner et al.(2002) estimated that the number of residualized steelhead present in the Touchet River in Washington was 14.7% of the 125,000 released. Naman (2008) estimated (assuming a minimum 10% residualization rate) that roughly 80,000 hatchery steelhead could be present year-round in the Trinity River.

Secondary predation on naturally produced juveniles may also occur by other predators (e.g., Sacramento pikeminnow, striped bass) that are attracted by the large numbers of hatchery trout released into an area. Predators attracted by hatchery fish may incidentally consume more wild smolts than would have occurred naturally (Nickelson 2003; Williams 2006).

Competition and predation may also be influenced by a phenomenon known as the "pied piper effect" which refers to the downstream sweeping of wild fish by large numbers of downstream migrant hatchery fish (Einum and Fleming 2001; Flagg et al. 2000). As wild fish interact with this large group of hatchery fish during their downstream migration, they may compete for resources and be subjected to predation by either hatchery fish or secondary predators. Both the potential for predation and competition to occur associated with this phenomenon and the potential for other effects caused by wild fish migrating earlier than they would have in absence of hatchery fish is unknown. According to Flagg et al. (2000), there is little or no documentation of the frequency of the phenomenon [i.e., "pied piper effect"], or the conditions under which it occurs. There are no quantitative studies of the impacts of such behavior on subsequent survival of Pacific salmon species, or data documenting the effects on differential survival between hatchery and wild fish.

The potential level of predation and competition for wild native trout is discussed below.

Impact BIO-137: Predation and Competition Effects from Stocked Salmon and Steelhead on Lahontan Cutthroat Trout, Paiute Cutthroat Trout, California Golden Trout, Eagle Lake Rainbow Trout, Kern River Rainbow Trout, Goose Lake Redband Trout, McCloud River Redband Trout, Warner Valley Redband Trout, and Little Kern Golden Trout (Less than Significant)

Salmon and steelhead are not stocked within the range of the Lahontan cutthroat trout, Paiute cutthroat trout, California golden trout, Eagle Lake rainbow trout, Kern River rainbow trout, Goose Lake redband trout, McCloud River redband trout, Warner Valley redband trout, or Little Kern golden trout (Figures 4-29, 4-30, 4-31, 4-32 and 4-33). Thus, there is no potential for the stocking of salmon or steelhead to impact these species, and the impact would be less than significant.

Impact BIO-138: Predation and Competition Effects from Stocked Salmon and Steelhead on Coastal Cutthroat Trout (Less than Significant)

Salmon or steelhead are stocked within the range of coastal cutthroat trout in the Eel, Mad and Klamath Rivers (Figure 4-31). In the juvenile stages, the diets of salmon, steelhead and cutthroat overlap considerably, consisting primarily of drift organisms. Juvenile salmon and steelhead could therefore compete with cutthroat trout for these resources. Such competition would primarily affect cutthroat trout of a size comparable to that of the released salmon and steelhead. Conversely, larger cutthroat trout would be expected to prey upon released salmon and steelhead, and thereby to derive a measure of benefit from salmon and steelhead stocking. Data are not available, however, to quantify the frequency, extent or magnitude of either of these effects.

Coastal cutthroat trout are currently a managed game fish within their range in California, with harvest times and allocations (prescribed in the fishing regulations, [California Department of Fish and Game 2008h]) managed by DFG to produce a sustainable fishery. Thus, the coastal cutthroat trout is managed consistent with ongoing DFG harvest goals, and population-level impacts attributable to competition and predation with stocked salmon and steelhead are not of sufficient magnitude to preclude those management objectives. The impacts of salmon and steelhead stocking therefore have a less than significant effect on the status of coastal cutthroat trout populations.

Effects on Wild Populations of Native Anadromous Salmonid Fish

The potential for predation and competition between hatchery-reared and naturally produced salmonids depends on the degree of spatial and temporal overlap, differences in size and feeding habitats, migration rate and duration of freshwater residence, and the distribution, habitat use, and densities of hatchery and natural juveniles (Mobrand et al. 2005). Recently, concern has been expressed about the potential for hatchery-reared salmon and steelhead to prey on or compete with wild juvenile Pacific salmonids (*Oncorhynchus* spp.) and the impact this may have on threatened or endangered salmonid populations (Williams 2006).

Hatchery-reared ocean-going Chinook salmon typically migrate as fingerlings ranging in size from 30-100 mm and are unlikely to prey on wild salmonids because of their relatively small size and non-piscivorous feeding habits (Hatchery Scientific Review Group 2004). In California, yearling Chinook salmon, steelhead, and coho salmon have the greatest potential for preying on wild salmonid fry because of their relatively large size and piscivorous feeding habits. For example, Sholes and Hallock (1979) estimated that 500,000 yearling Chinook salmon released in the Feather River consumed 7.5 million Chinook salmon and steelhead fry. As a result, yearling Chinook salmon are no longer released in the Feather River. Hallock (1989) estimated that steelhead yearlings released into Battle Creek in February and March 1975 had consumed approximately 1.4 Chinook salmon fry. Hatchery steelhead present a greater risk to natural populations because they are relatively large at release and a relatively high portion of them can residualize (i.e., remain in the river instead of migrating to ocean), providing more opportunities for them to compete for resources and prey on naturally produced salmon and steelhead throughout the year (see Kostow 2009 for a review of this subject). For example, Naman (2008) reported relatively high predation rates on wild salmonid fry by residualized (331 mm average length) and juvenile (167 mm average fork length) hatchery steelhead released in areas of high fry densities in the Trinity River.

Hatchery juvenile salmon and steelhead share common areas with naturally produced juveniles during their seaward migration. The spatial and temporal overlap is a time when intraspecific (within species) and interspecific (between species) predation and competition may occur. Along their path to the ocean the number and species composition of the hatchery and natural co-migrants varies and so does the potential for ecological interactions. The lower portion of these rivers and their estuaries are not simply a migration corridor as rearing and growth also occurs in these areas. Interactions may occur through competition for resources (food and space), predation, and disease. These factors may directly affect behavior and survival of co-migrants. Further exacerbating these potential impacts are the loss of habitat in the lower rivers and estuaries.

There is little evidence that wild salmonids are preyed on by other salmonids in estuarine and marine environments. Numerous studies suggest that salmonids (hatchery or wild) are not significant predators on juvenile salmonids in these environments but no studies have been designed to specifically investigate predation by hatchery-reared salmonids (Hatchery Scientific

Review Group 2004). Offshore predation on wild salmonids by hatchery-reared smolts may be rare because of low encounter rates between fish of different sizes in the marine environment (Hatchery Scientific Review Group 2004).

Competition and predation impacts on wild populations of anadromous trout may also be influenced by the same "pied piper effect" as was described for impacts on wild populations of native trout. This impact may be more significant with considering intraspecies interactions. Nickelson (2003) demonstrated that the productivity of wild coho salmon in 14 Oregon coastal basins was negatively correlated to the average number of hatchery smolts released into these basins, suggesting strong ecological interactions between hatchery and wild fish. Nickelson reviews evidence for the role of behavior and concludes that large numbers of hatchery fish likely increase mortality of wild fish by attracting predators and/or increasing their exposure to predators.

At present, the effect of the hatchery stocking program on wild populations of coho salmon, steelhead, and Chinook salmon is difficult to assess because of little available information on natural production and hatchery performance. However, broad inferences can be made by comparing annual records of hatchery releases with the general distribution, rearing and migration periods, and sizes of fish stocked relative to wild origin fish. The potential magnitude of predation and competition impacts of the salmon and steelhead stocking program on each ESU was assessed by considering all hatchery releases within the ESU boundaries. The potential for significant impacts was evaluated based on the amount of spatial and temporal overlap between hatchery and naturally produced fish, the numbers of hatchery fish stocked each year, the probability of predation or competitive interactions based on the relative body sizes of hatchery and naturally produced fish, and seasonal variation in habitat conditions that could affect the intensity of such interactions.

The primary data sources for this analysis were annual hatchery records of species, numbers, sizes (number/lb), release dates and release locations for the period 2004-2008 (California Department of Fish and Game 2008a). These records are summarized in Table 4-4. Additional information was obtained from draft hatchery and genetic management plans for individual hatcheries where available .

Table 4-4. Summary of Annual Hatchery Release Records for the Period 2004–2008

Hatchery	Species/ Run	Life Stage	Size No./lb	Number (millions)	Release Dates	Release Locations
Feather River Hatchery	Spring-Run	Fry[1]	200-500	2.5	Jan–Feb	Feather River
	Chinook	Yearling	40-60	1.0	Apr–May	Feather River
				1.0	Apr–May	San Pablo Bay
	Fall-Run	Fry	200-500	0.3	Feb–Mar	Sacramento River-Delta[2]
	Chinook			0.1	Feb–Mar	Mokelumne River-Delta[2]
		Fingerling	30-60	<0.1	Apr	San Joaquin River-Delta[2]
				0.2	Apr–May	Sacramento River
				9.0	Apr–Jun	Suisun Bay, San Pablo Bay, San Francisco Bay
	Steelhead	Yearling	2-6	0.4	Feb–Jun	Feather River, Thermalito Afterbay[2]
Nimbus Hatchery	Fall-Run	Fingerling	50-70	4.4	May–Jun	San Pablo Bay, San Francisco Bay
	Chinook					
	Steelhead	Yearling	4-6	0.5	Jan–Feb	Sacramento River-Delta
Mokelumne River Hatchery	Fall-Run	Fingerling	30-60	3.2	Apr–Jun	Mokelumne River-Delta
	Chinook[3]			3.0	May–Jun	San Pablo Bay, San Francisco Bay
	Steelhead[4]	Yearling	3-6	0.3	Feb–Jun	Mokelumne River-Delta
				0.1	Jan	San Joaquin River-Delta[2]
				0.3	Jan–Feb	San Pablo Bay[2]
Merced River Hatchery	Fall-Run	Fingerling	30-100	0.5	Apr–Jun	Merced River
	Chinook			<0.1	Apr–May	Stanislaus River[2]
				<0.1	Apr–May	Tuolumne River[2]
				0.2	Apr–May	San Joaquin River[2]
Warms Springs Hatchery	Coho	Fingerling	110-180	<0.1	May–Jun	Russian River tributaries
		Advanced Fingerling	30-90	<0.1	Oct	Russian River tributaries
	Steelhead	Yearling	3-5	0.5	Jan–Apr	Russian River
Mad River Hatchery	Steelhead	Yearling	2-13	0.2	Mar	Mad River

Hatchery	Species/ Run	Life Stage	Size No./lb	Number (millions)	Release Dates	Release Locations
Iron Gate Hatchery	Fall-Run	Fingerling	90-120	5.5	Apr–Jun	Klamath River
	Chinook	Yearling	9-11	0.9	Sep–Nov	Klamath River
	Coho	Yearling	10-15	<0.1	Apr–May	Klamath River
	Steelhead	Yearling	8-15	<0.1	Apr–May	Klamath River
Trinity River Hatchery	Fall-Run	Fingerling	80-120	1.6	Jun	Trinity River
	Chinook	Advanced Fingerling	15-20	1	Oct	Trinity River
	Spring-Run	Fingerling	40-100	1	Jun	Trinity River
	Chinook	Advanced Fingerline	10-13	1	Oct	Trinity River
	Coho	Yearling	9-11	0.5	Mar–Apr	Trinity River
	Steelhead	Yearling	3-9	0.8	Mar	Trinity River

Source: California Department of Fish and Game (2008a).

[1] This was a one-time release of fry at the Feather River Hatchery from the 2004 brood year resulting from a shift to separate early and late timed spring-run Chinook.

[2] These are experimental releases for survival studies.

[3] Releases originating from both Mokelumne River and American River hatchery stocks.

[4] Releases originating from Mokelumne River and Feather River hatchery stocks.

Impact BIO-139: Predation and Competition Effects from Stocked Salmon and Steelhead on Steelhead, Klamath Mountains Province DPS (Significant and Unavoidable)

Salmon and steelhead are stocked at 5 locations within the Steelhead Klamath Mountains Province DPS in the Klamath and Trinity River basins (Figure 4-36). Naturally produced steelhead juveniles may be preyed on by hatchery steelhead that may be residualizing in the Klamath and Trinity Rivers below Iron Gate and Trinity River Hatcheries. Residualization of hatchery steelhead and predation on naturally produced salmon and steelhead fry has been demonstrated in the Trinity River (Naman 2008), representing a potential threat to natural salmon and steelhead populations. Based on the time and size at release, hatchery coho salmon yearlings may also prey on naturally produced steelhead fry. The hatchery programs have the potential to cause significant impact to the survival of wild juvenile salmon and steelhead. Mitigation Measure BIO-139 is required. Impacts with mitigation would be significant and unavoidable.

Mitigation Measure BIO-139: Complete Hatchery Genetic Management Plans

Release strategies and other hatchery practices that potentially affect ESA listed salmon and steelhead populations in California are currently being addressed by DFG through HGMP processes. Through these processes DFG will continue to work with NMFS toward implementation of a comprehensive action plan that addresses the goals of these hatcheries, ESA obligations to protect listed species, and public trust responsibilities to protect other natural populations of salmon and steelhead. In addition, DFG will recommend the formation of an independent hatchery scientific review panel (HSRP) to provide ecological and hatchery operations recommendations that can later be incorporated into the HGMPs, as appropriate. Because significant uncertainties remain, actions will be implemented using an adaptive approach in which monitoring and evaluation of these actions will be used to guide

implementation of the plans to maximize their effectiveness in meeting the harvest and conservation objectives established for each hatchery.

For hatchery programs propagating non-ESA listed species of salmon and steelhead, DFG will develop expanded Hatchery Goals and Constraints documents based on the NMFS HGMP template. These documents will clearly state the purpose of the hatchery program and measures to avoid and/or minimize program impacts on ESA-listed salmonids, affected non-ESA listed salmonid species in the watershed and surrounding areas, and the natural-origin component of the propagated stock.

The potential impacts described above are considered significant and unavoidable pending successful development and implementation of HGMPs or expanded Hatchery Goals and Constraints documents for the hatchery programs. Refer to Appendix K for a more detailed discussion of this mitigation process.

Impact BIO-140: Predation and Competition Effects from Stocked Salmon and Steelhead on Steelhead, Northern California DPS (Less than Significant)

The potential for intraspecific competition between Mad River Hatchery steelhead yearlings and naturally produced steelhead juveniles appears to be low based on evidence of rapid seaward migration and minor temporal overlap between hatchery yearlings and naturally produced age 1+ and 2+ steelhead (Sparkman 2002, 2003 as cited by California Department of Fish and Game 2006a). This impact would be less than significant.

Impact BIO-141: Predation and Competition Effects from Stocked Salmon and Steelhead on Steelhead, California Central Valley DPS (Less than Significant)

The potential for competitive interactions between hatchery steelhead produced by Feather River, Nimbus (American River) and Mokelumne River Hatcheries and naturally produced steelhead is considered low because all hatchery releases are made below the primary steelhead rearing areas in these tributaries. This impact would be less than significant.

Impact BIO-142: Predation and Competition Effects from Stocked Salmon and Steelhead on Steelhead, Central California Coast DPS (Less than Significant)

In 2004-2008, Warm Springs Hatchery and the Coyote Valley Fish Facility released an average of approximately 500,000 yearling steelhead smolts (<4/lb) per year in Dry Creek and East Fork Russian River in January-April. The potential for competition or predation between hatchery and naturally produced steelhead juveniles is considered low because the releases of juveniles from the Warm Springs Hatchery and the Coyote Valley Fish Facility are conducted at times, locations, and fish sizes believed to minimize the opportunity for ecological interaction between hatchery and natural-origin fish (FishPro, Inc. and Entrix, Inc. 2004; National Marine Fisheries Service 2008). For example, time of release and size of juveniles released is generally consistent with time periods that promote rapid out-migration, minimizing opportunity for freshwater interaction with naturally-produced juveniles. Also, all steelhead from the Warm Springs Hatchery and the Coyote Valley Fish Facility are released on-site or immediately downstream of the hatchery facility to reduce likelihood of straying upon their return as adults. Tagged fish studies conducted by the Sonoma County Water Agency indicate rapid migration (transport time) of released steelhead from the release locations to lower portions of the watershed (Manning et al. 2005). Additionally, out-migrant wild run steelhead trapping by the Sonoma County Water Agency over a nine year period indicates that the peak of the

wild run occurs after the majority of the hatchery facility releases, further reducing the concern that the hatchery stock have a competitive or predation impact on wild stock (Chase et al. 2005). This impact would be less than significant.

Impact BIO-143: Predation and Competition Effects from Stocked Salmon and Steelhead on Steelhead, South-Central California Coast DPS (Less than Significant)

No hatchery stocking is currently conducted or permitted in waters known to support or potentially support South-Central California Coast steelhead. However, the straying of hatchery origin Chinook salmon into systems that have not historically supported Chinook salmon has been documented (Garcia-Rossi and Hedgecock 2002 and Salsbery 2009) and could result in additional competition and potential predation upon other native salmonids, such as steelhead. The extent to which additional competition and potential predation pressures may be applied in systems that have not historically supported Chinook salmon has not been quantified. Historically, salmonids have successfully co-existed within the same systems, and continue to do so. The extent to which hatchery Chinook salmon straying into watersheds that did not historically support them may affect native steelhead populations that occur in those watersheds, is not known. This impact would be less than significant.

Impact BIO-144: Predation and Competition Effects from Stocked Salmon and Steelhead on Steelhead, Southern California DPS (Less than Significant)

No hatchery stocking is currently conducted or permitted in waters known to support or potentially support Southern California Coast steelhead. This impact would be less than significant.

Impact BIO-145: Predation and Competition Effects from Stocked Salmon and Steelhead on Coho Salmon, Southern Oregon/Northern California Coast ESU (Significant and Unavoidable)

In 2004–2008, Iron Gate and Trinity River Hatcheries volitionally released an average of 570,000 yearling coho salmon (<20/lb) in March–May. These fish are slightly larger than their natural counterparts and are presumed to migrate rapidly to the ocean. However, some hatchery yearlings reside in the Klamath River for approximately 1.5 to 2 months before outmigrating (California Department of Fish and Game 2003b as cited in California Department of Fish and Game 2006b). Therefore, the potential exists for intraspecific competition or predation by hatchery yearlings on naturally produced juveniles.

Iron Gate Hatchery's and Trinity River Hatchery's release strategy for Chinook salmon may result in competition between hatchery fish and naturally produced coho salmon for limited habitat during the late spring. The potential for adverse effects on natural coho salmon populations is highest in late spring when lower flows and higher water temperatures may increase competition for suitable rearing habitat (Joint Hatchery Review Committee 2001a).

Naturally produced coho salmon juveniles may be preyed on by hatchery steelhead that may be residualizing in the Klamath and Trinity Rivers below Iron Gate and Trinity River hatcheries. Trinity River Hatchery released an average of approximately 800,000 steelhead yearlings, and Iron Gate Hatchery released an average of 90,000 steelhead yearlings in 2004–2008. Residualization of hatchery steelhead and predation on naturally produced salmon and steelhead fry has been demonstrated in the Trinity River (Naman 2008), representing a potential threat to natural salmon and steelhead populations.

In 2004–2008, Mad River Hatchery released an average of 200,000 steelhead yearlings into the Mad River (<13/lb) in March of each year. The potential for interspecific competition or predation between hatchery steelhead yearlings and naturally produced coho salmon juveniles is considered low because steelhead are released downstream of the primary coho spawning and rearing tributaries. In addition, trapping of hatchery and naturally produced steelhead in the Mad River in 2001 and 2002 indicated rapid migration and no indications of residualism of hatchery steelhead (Sparkman 2002, 2003 in California Department of Fish and Game 2006a).

The release strategies described above for the Klamath and Trinity Rivers have the potential to cause competition and predation impacts on natural coho salmon populations in these rivers. This potential impact is considered significant and unavoidable. Mitigation Measure BIO-139 is required. Impacts with mitigation would be significant and unavoidable.

Impact BIO-146: Predation and Competition Effects from Stocked Salmon and Steelhead on Coho Salmon, Central California Coast ESU (Less than Significant)

From 2004-2008, Warm Springs Hatchery released an average of approximately 30,000 coho salmon fingerlings annually in a number of Russian River tributaries (Dutch Bill, Gilliam, Green Valley, Mill, Palmer, Sheephouse, Ward Creeks) as part of the Russian River Coho Salmon Recovery (Captive Broodstock) Program initiated by DFG, NMFS, and USACE in 2001. The goals of this program are to prevent extirpation of Russian River coho salmon; preserve genetic, ecological, and behavioral attributes of Russian River coho salmon while minimizing potential effects to other stocks and species; and build a naturally sustaining coho salmon population. The USACE, Sonoma County Water Agency, and Mendocino County Russian River Flood Control and Water Conservation Improvement District are required to continue this program pursuant to the Biological Opinion recently issued by NMFS for operations of Warm Springs Dam and Coyote Valley Dam and associated activities (FishPro, Inc and Entric, Inc 2004; National Marine Fisheries Service 2008). The program includes a monitoring and evaluation plan to evaluate the effectiveness and performance of the program and an adaptive management component to guide implementation of the program as information is gathered. Almost all current production of coho salmon in the affected tributaries is sustained by this recovery program production and associated planting. The captive brood stock programs is considered essential in maintaining the abundance, spatial distribution, and genetic diversity of coho salmon in these tributaries until sufficient good quality habitats are restored or established (FishPro, Inc and Entrix, Inc 2004; National Marine Fisheries Service 2008). Therefore, no adverse ecological effects are expected.

In 2004-2008, Warm Springs Hatchery released an average of approximately 500,000 yearling steelhead smolts (<4/lb) per year in Dry Creek and East Fork Russian River in January-April. The potential for predation or competition of hatchery steelhead smolts on naturally produced coho salmon fry or recovery program produced coho planted into the tributaries of the Russian River is low because steelhead are released into the main body of the Russian River and outside of the any remaining wild coho spawning habitat or the tributaries where they occur or are released. Additionally, hatchery steelhead are released at a size and time associated with rapid migration to the estuary (FishPro, Inc and Entrix, Inc 2004; National Marine Fisheries Service 2008). Coho planted in the lower Russian River tributaries occurs seasonally, well after the release of hatchery produced steelhead and are placed in locations where the intent is to have them over-summer in the tributaries where they are planted. This impact would be less than significant.

Impact BIO-147: Predation and Competition Effects from Stocked Salmon and Steelhead on Chinook Salmon, Upper Klamath-Trinity Rivers ESU (Significant and Unavoidable)

In 2004-2008, Iron Gate and Trinity River Hatcheries released an average of approximately 7 million fall-run Chinook salmon smolts and 3 million fingerling and yearlings each year to the Klamath and Trinity Rivers. The smolts were released in the spring and the fingerlings and yearlings were released in the fall. The potential for competitive interactions with naturally produced Chinook salmon juveniles is high in the river and estuary, especially during the late spring when lower flows and higher water temperatures may increase competition for suitable rearing habitat (Joint Hatchery Review Committee 2001a). Fall releases of fingerling and yearling Chinook salmon would not be expected to result in competitive interactions with naturally produced Chinook salmon because of improved habitat conditions and low numbers of naturally produced juveniles at this time of year. Current information on the status and distribution of spring-run Chinook salmon in the Klamath and Trinity River Basins (National Academy of Sciences 2004) indicates that the potential for significant interactions between hatchery Chinook (fall- and spring-run Chinook salmon) and natural spring-run Chinook salmon juveniles is low because natural populations of spring-run occur only in the Salmon River and Wooley Creek, and because natural spring-run juveniles occur in the main stem Klamath River and estuary primarily as yearling smolts in the spring.

Naturally produced Chinook salmon juveniles may be preyed on by hatchery steelhead that may be residualizing in the Klamath and Trinity Rivers below Iron Gate and Trinity River Hatcheries. Trinity River Hatchery released an average of 800,000 yearling steelhead and Iron Gate Hatchery released an average of 90,000 yearling steelhead in 2004–2008. Residualization of hatchery steelhead and predation on naturally produced salmon and steelhead fry has been demonstrated in the Trinity River (Naman 2008), representing a potential threat to natural salmon and steelhead populations.

The current release strategies described above have the potential to cause competition and predation impacts on natural fall-run Chinook salmon populations in the upper Klamath and Trinity Rivers. Therefore, these impacts are considered significant and unavoidable. Mitigation Measure BIO-139 is required. Impacts with mitigation would be significant and unavoidable.

Impact BIO-148: Predation and Competition Effects from Stocked Salmon and Steelhead on Chinook Salmon, California Coast ESU (Less than Significant)

In 2004–2008, Mad River Hatchery released an average of 200,000 steelhead yearlings per year into the Mad River (<13/lb) in March of each year. The potential for interspecific competition or predation between hatchery yearlings and naturally produced Chinook salmon juveniles is considered low because of the apparent rapid downstream migration of hatchery steelhead (Sparkman 2002, 2003 in California Department of Fish and Game 2006a) and minimal spatial and temporal overlap with Chinook salmon juveniles.

In 2004-2008, Warm Springs Hatchery and the Coyote Valley Fish Facility released an average of approximately 500,000 steelhead yearlings (<4/lb) per year in Dry Creek and East Fork Russian River during the natural out-migration period (January-April). The majority of the hatchery (approximately 300,000 annually) produced steelhead from the Warm Springs hatchery facility are released into Dry Creek, below the available Chinook spawning habitat in the Russian River. The potential for predation of hatchery steelhead smolts on naturally produced Chinook salmon fry is considered low because steelhead are released at a size, time, and location associated with rapid migration to the estuary (FishPro, Inc and Entrix, Inc 2004; National Marine Fisheries Service 2008). Tagged fish studies conducted by the Sonoma County Water Agency indicate rapid migration

(transport time) of released steelhead from the release locations to lower portions of the watershed (Manning et al. 2005). This impact would be less than significant.

Impact BIO-149: Predation and Competition Effects from Stocked Salmon and Steelhead on Chinook Salmon, Sacramento River Winter-Run ESU (Less than Significant)

Similar to the assessment of late fall-run Chinook salmon, the potential for adverse interactions between hatchery salmonids and naturally produced winter-run Chinook salmon is considered low based on the large body size and migratory behavior of winter-run Chinook salmon in the areas of temporal overlap. Most natural-origin winter-run Chinook salmon are >70 mm in length and actively migrating through the Delta and estuary during the primary planting season for hatchery Chinook salmon and steelhead (February-June).This impact would be less than significant.

Impact BIO-150: Predation and Competition Effects from Stocked Salmon and Steelhead on Chinook Salmon, Central Valley Spring-Run ESU (Significant and Unavoidable)

Because of broad spatial and temporal overlap in freshwater, naturally produced spring-run Chinook salmon juveniles may interact with both hatchery spring- and fall-run Chinook salmon juveniles. In 2004–2008, Feather River Hatchery released an average of 1 million spring-run smolts (≤60/lb) per year at various locations in the Carquinez Straits and San Pablo Bay during the spring emigration period (April-May). These releases coincided with the release of millions of fall-run Chinook salmon smolts in Suisun Bay, San Pablo Bay, and San Francisco Bay (see Chinook Salmon, Central Valley Fall-/Late Fall-Run ESU). The current practice of releasing most Central Valley spring- and fall-run Chinook salmon hatchery production as smolts in the estuary avoids potential competition or predation between hatchery and naturally produced juveniles in upstream rearing areas. The tradeoff with this strategy is the potential for greater adverse interactions in the estuary. Field observations in the Sacramento River indicate that hatchery Chinook salmon released as smolts do not compete with naturally produced juveniles for freshwater rearing habitat because of their strong migratory behavior (Weber and Fausch 2003). Although these hatchery releases substantially increase the densities of smolts (hatchery and non-hatchery) migrating through the estuary, the potential for competition (for estuarine food resources) may be low because of relatively rapid migration rates and limited dependence on the estuary for rearing (MacFarlane and Norton 2002). However, concerns remain regarding the potential density-dependent effects of hatchery releases on the survival and growth of naturally produced juveniles during their first year at sea, especially in years of low marine productivity (Williams 2006). Furthermore, releasing large numbers of hatchery spring- and fall-run Chinook salmon in the estuary is likely to result in potentially significant genetic impacts on natural spring-run Chinook salmon populations by promoting high levels of straying of Feather River hatchery fish . In addition to estuary releases, Feather River Hatchery released approximately 2.5 million spring-run Chinook salmon fry (>200/lb) into the Feather River in January–February 2005. This was an atypical release; fry releases are not included in the current hatchery goals. Releases of fry may result in competition for space and/or food with naturally produced spring-run Chinook salmon fry, especially in years when the availability of rearing habitat may be limited by low winter and spring flows in the lower Feather and Sacramento Rivers. This potential impact is avoided by the current practice of releasing only smolt-size fish. However, the current strategy of releasing approximately half of the hatchery spring-run Chinook salmon in the estuary may also result in adverse ecological interactions with natural spring-run Chinook salmon in the estuary and/or ocean.

Naturally produced spring-run Chinook salmon may be preyed on by hatchery steelhead yearlings released in the lower Feather and Sacramento Rivers. For example, Feather River Hatchery released an average of 400,000 yearling steelhead (5–6/lb) annually in the lower Feather River in 2004–2008. These releases were made primarily in February which generally coincides with the period of peak emergence and downstream dispersal (January–March) of naturally produced Chinook salmon fry from upstream spawning areas (Seeholtz et al. 2004). Because of the relatively large size of yearling steelhead (≥200 mm) and substantial spatial and temporal overlap between annual releases of yearlings and naturally produced spring-run Chinook salmon fry, the potential for predation by hatchery steelhead yearlings on spring-run Chinook salmon fry is high.

The current release strategies described above have the potential to cause significant adverse competition and predation impacts on natural spring-run Chinook salmon populations in the Central Valley and is unavoidable. Mitigation Measure BIO-139is required. Impacts with mitigation would be significant and unavoidable.

Impact BIO-151: Predation and Competition Effects from Stocked Salmon and Steelhead on Chinook Salmon, Central Valley Fall-/Late Fall–Run ESU (Significant and Unavoidable)

As discussed above, most Central Valley fall-run and spring-run Chinook salmon hatchery production is released as smolts in the estuary (Suisun Bay, San Pablo Bay, and San Francisco Bay) during the spring emigration period. Annual releases of fall-run Chinook salmon to the estuary from Feather River, Nimbus, and Mokelumne River Hatcheries averaged 9.0, 4.4, and 3.0 million smolts, respectively, in 2004–2008. Relatively large numbers of hatchery smolts (3.2 million per year) were also released in the lower Mokelumne River (upper portion of the Delta) in these years.

The potential for adverse ecological interactions between salmonids produced by Feather River, Nimbus, Mokelumne, and Merced River Hatcheries and naturally produced late fall-run Chinook salmon is considered low based on the large body size and migratory behavior of late fall-run Chinook salmon in the areas of temporal overlap. Most wild late fall-run Chinook salmon are >100 mm in length and actively migrating through the Delta and estuary during the primary stocking period for hatchery Chinook salmon and steelhead (February–June).

Like spring-run Chinook salmon, naturally produced fall-run Chinook salmon juveniles may be adversely affected by competition with hatchery spring- and fall-run Chinook salmon juveniles in the estuary and ocean (see Impact BIO-150). The potential for predation by hatchery steelhead yearlings also exists. Because of similarities in body size and spatial and temporal distribution of rearing and emigrating spring-run and fall-run Chinook salmon, the potential for adverse ecological impacts of hatchery Chinook salmon and steelhead on natural stocks of fall-run Chinook salmon is considered significant and unavoidable. Mitigation Measure BIO-139 is required. Impacts with mitigation would be significant and unavoidable.

Effects on Native Amphibians, Reptiles, and Birds

Salmon and steelhead hatcheries stock native steelhead, coho salmon, and Chinook salmon within Central Valley and coastal rivers and streams that empty to the ocean. DFG hatcheries stocking non-anadromous kokanee, Chinook and coho salmon inland waters are addressed in the trout stocking program analysis. Native amphibians, reptiles and birds in coastal streams and rivers have co-evolved with native fish communities including native salmon and steelhead that are used as hatchery stocks. Although under natural conditions amphibians, reptiles and birds may subsist with salmon and steelhead in rivers and streams, the stocking of large numbers of hatchery fish at one

time and location may potentially result in predation and competition effects similar to those described in the discussion of "Impacts of the Trout Stocking Program," under the subheading "Effects from Predation and Competition from Stocked Trout." The potential level of predation and competition effects for each amphibian, reptile and bird species in Table 4-1 is discussed below.

Impact BIO-152: Predation and Competition Effects from Stocked Salmon and Steelhead on Santa Cruz Long-Toed Salamander, Long-Toed Salamander, Arroyo Toad, Yosemite Toad, Woodhouse's Toad, California Treefrog, Northern Leopard Frog, Lowland Leopard Frog, Mountain Yellow-Legged Frog (Northern and Southern DPS), Cascades Frog, Oregon Spotted Frog, Two-Striped Garter Snake, and South Coast Garter Snake (Less than Significant)

Salmon and steelhead are not stocked within the range of the Santa Cruz long-toed salamander, Long-toed salamander, arroyo toad, Yosemite toad, Woodhouse's toad, California treefrog, northern leopard frog, lowland leopard frog, Cascades frog, mountain yellow-legged frog (northern and southern DPS), Oregon spotted frog, two-striped garter snake, or South Coast garter snake. Thus, there is no potential for the stocking of salmon or steelhead to impact these species, and the impact would be less than significant.

Impact BIO-153: Predation and Competition Effects from Stocked Salmon and Steelhead on California Tiger Salamander (Less than Significant)

There are 18 salmon and steelhead stocking locations within the range of the California tiger salamander (Figure 4-47). California tiger salamanders spend much of their time in subterranean refugia, and as adults, primarily utilize terrestrial habitats such annual grasslands and grassy understories of hardwood habitats. California tiger salamanders breed primarily in vernal pools and other ephemeral ponds that fill during winter and often dry out by summer (Loredo et al. 1996), although they sometimes use permanent human-made ponds (e.g., stock ponds), reservoirs, and small lakes that do not support predatory fish or bullfrogs (Stebbins 1972; Zeiner et al. 1988-1990). A literature review did not indicate that predation by stocked salmonids is a factor in California tiger salamander biology and the habitat separation between use of ephemeral or fishless waters by salamanders and use of perennial streams and lakes by salmonids likely explains this circumstance.

California tiger salamanders are a rare and declining species within their range. They are listed as threatened under the ESA, DFG lists them as a species of special concern, and they have recently been designated a candidate for endangered listing under the CESA. Salmon and steelhead stocking has not been cited as a factor in decline of California tiger salamander populations. Thus, the impact would be less than significant.

Impact BIO-154: Predation and Competition Effects from Stocked Salmon and Steelhead on Northwestern Salamander (Less than Significant)

There are 7 salmon and steelhead stocking locations within the range of the northwestern salamander (Figure 4-48). Northwestern salamanders are a common pond-dwelling salamander that often co-occurs with salmonids and with other native fishes, and thus is co-evolved with salmonids. The literature records a range of interactions between northwestern salamanders and salmonids. Adams et al. (2001) found no effect associated with presence of trout, but Larson and Hoffman et al. (2004) found that northwestern salamanders are potentially extirpated by introduction of trout to their habitat. Currens et al. (2007) found that trout presence alone was enough to reduce growth in larval northwestern salamanders due to chemical cues produced by the

trout. Removal of brook trout from a mountain lake in Washington was followed by a substantial increase in the northwestern salamander population of the lake (Hoffman et al. 2004). Based on this evidence, it appears clear that although northwestern salamanders and salmonids can subsist, there are likely some cases in which the presence of stocked salmon or steelhead has contributed to the decline or extirpation of northwestern salamanders.

Northwestern salamanders are a very common species within their range and are not classified as a protected species under either federal or state law. Northwestern salamander extirpations are not reported to be widespread in California and salmon and steelhead stocking has not been cited as a factor in decline of northwestern salamander populations. Thus, the impact would be less than significant.

Impact BIO-155: Predation and Competition Effects from Stocked Salmon and Steelhead on Coast Range Newt (Less than Significant)

There are 5 salmon and steelhead stocking locations within the range of the Coast Range newt (Figure 4-52). The Coast Range newt occupies ponds and slow-moving streams during the breeding portion of their life cycle. Eggs are deposited in these water environments and the larvae remain in the water until metamorphosis is complete. During these life stages, the species can co-occur with salmonids, but is seldom preyed upon, except during the larval stage, due to its high content of the toxic compound tetrodotoxin. Its principal predators are exotic species such as green sunfish, mosquito fish, and crayfish. Habitat degradation is a significant factor in its current status. Newts are omnivorous and thus may compete with stocked fish for foods such as aquatic invertebrates; no information was found addressing this potential competition, but it may occur and if so would be detrimental to the newt, particularly if stocking levels were to exceed the carrying capacity of the stream, as might sometimes occur soon after a large stocking.

Coast Range newts are common species within their range and are not classified as a protected species under either federal or state law. Populations of this newt south of the Monterey area are DFG species of special concern. Coast Range newt extirpations are not reported to be widespread in California and salmon and steelhead stocking has not been cited as a factor in decline of Coast Range newt populations. Thus, the impact would be less than significant

Impact BIO-156: Predation and Competition Effects from Stocked Salmon and Steelhead on California Giant Salamander (Less than Significant)

There are 15 salmon and steelhead stocking locations within the range of the California giant salamander (Figure 4-53). California giant salamander biology is essentially the same as that of the Pacific giant salamander, described below; until recently, they were treated as being the same species. Consequently there is no published literature that specifically treats the interactions between salmonids and California giant salamanders, and the impact determination for this species is based upon the rationale and literature presented below for the Pacific giant salamander.

California giant salamanders are a common species within their range and are not classified as a protected species under either federal or state law. California giant salamander extirpations are not reported to be widespread in California and salmon and steelhead stocking has not been cited as a factor in decline of California giant salamander populations. Thus, the impact would be less than significant.

Impact BIO-157: Predation and Competition Effects from Stocked Salmon and Steelhead on Pacific Giant Salamander (Less than Significant)

There are 14 salmon and steelhead stocking locations within the range of the Pacific giant salamander (Figure 4-54). Pacific giant salamanders are a common stream-dwelling salamander that occurs either in the headwaters of streams, above the limit of salmonid use, or in mountain streams that are also occupied by salmonids (Bury et al. 1991). At adult size they are a large salamander (up to one foot long), and have been observed to both eat and to be eaten by salmonids (Jones and Welsh 2009). Rundio and Olson (2003) found that larval Pacific giant salamanders are predated upon by native cutthroat trout, but that the larval salamanders respond to chemical cues produced by the trout and seek refuge. A similar defense mechanism has been described for northwestern salamanders and in that species has been found to result in reduced growth rate of the larval salamanders (Currens et al. 2007).

Pacific giant salamanders are also in direct competition with salmonids. Mechanisms of competition have been studied in the case of Pacific giant salamander competition with native cutthroat trout by Rundio (2002), who found no significant differences in the survival, growth, or activity in level of salamanders in pools with or without cutthroat trout. Rundio (2002) acknowledged but did not investigate the consequences for stream food webs of having two top-level predators, salmonids and salamanders. There is thus no basis for a determination whether salmon and steelhead stocking in the range of Pacific giant salamander alters competition between these species in an ecologically meaningful way.

Pacific giant salamanders are a very common species within their range and are not classified as a protected species under either federal or state law. Pacific giant salamander extirpations are not reported to be widespread in California and salmon and steelhead stocking has not been cited as a factor in decline of Pacific giant salamander populations. Thus, the impact would be less than significant.

Impact BIO-158: Predation and Competition Effects from Stocked Salmon and Steelhead on Southern Torrent Salamander (Less than Significant)

There are 7 salmon and steelhead stocking locations within the range of the southern torrent salamander (Figure 4-49). Southern torrent salamanders are a stream-dwelling salamander that occurs in the headwaters of streams, where it is subject to predation by Pacific giant salamanders and perhaps by salmonids (Welsh and Karraker 2009). In response to this predation it primarily occurs upstream of the limit of perennial flow or, in perennial streams, in very shallow water microhabitats that are not used by these predators (Rundio and Olson 2001). Thus, there is a strong niche separation between most southern torrent salamanders and their potential predator, salmonids. Additionally, Rundio and Olson (2001) found that larval southern torrent salamanders are unpalatable to Pacific giant salamanders; they are also unpalatable to shrews (Nussbaum et al. 1983), and it is thus quite possible, although not demonstrated, that they are unpalatable to salmonids. No information was found documenting salmonid predation on southern torrent salamanders, but in view of the information provided above, it seems likely that salmon and steelhead are only occasionally stocked in habitats occupied by southern torrent salamanders; that salmonids and salamanders use different microhabitats; and that the salamanders are likely unpalatable to salmonids. Thus, predation of southern torrent salamanders by salmonids is likely infrequent.

Southern torrent salamanders are a common species within their range and are not classified as a protected species under either federal or state law. Southern torrent salamander extirpations are not reported to be widespread in California and salmon and steelhead stocking has not been cited as a factor in decline of southern torrent salamander populations. Thus, the impact would be less than significant.

Impact BIO-159: Predation and Competition Effects from Stocked Salmon and Steelhead on Rough-Skinned Newt (Less than Significant)

There are 32 salmon and steelhead stocking locations within the range of the rough-skinned newt (Figure 4-50). The rough-skinned newt occupies ponds and slow-moving streams, where it often co-occurs with salmonids, but is seldom preyed upon due to its high content of the toxic compound tetrodotoxin; its principal predators are other rough-skinned newts and the common garter snake, which are resistant to the effects of tetrodotoxin (Marks and Doyle 2009a). Thus, there is evidently little risk of newt predation by stocked salmon or steelhead. Newts are omnivorous and thus may compete with stocked fish for foods such as aquatic invertebrates; no information was found addressing this potential competition, but it may occur and if so would be detrimental to the newt, particularly if stocking levels were to exceed the carrying capacity of the stream, as might sometimes occur soon after a large stocking.

Rough-skinned newts are a very common species within their range and are not classified as a protected species under either federal or state law. Rough-skinned newt extirpations are not reported to be widespread in California and salmon and steelhead stocking has not been cited as a factor in decline of rough-skinned newt populations. Thus, the impact would be less than significant.

Impact BIO-160: Predation and Competition Effects from Stocked Salmon and Steelhead on Red-Bellied Newt (Less than Significant)

There are 16 salmon and steelhead stocking locations within the range of the red-bellied newt (Figure 4-50). The biology of the red-bellied newt is generally similar to that of the rough-skinned newt, described above, but differs in two important respects: (1) it has very strong site fidelity coupled with a narrow range, so local extirpations result in a much stronger effect on the species as a whole compared to the rough-skinned newt; and (2) it occupies faster waters and more headward stream habitat compared to the rough-skinned newt (Marks and Doyle 2009a). However, it shares the high tetrodotoxin-derived toxicity of the rough-skinned newt, and its only reported predator is the common garter snake (Twitty 1966 in Marks and Doyle 2009a). Thus, there is evidently little risk of newt predation by stocked salmon and steelhead. Newts are omnivorous and thus may compete with stocked salmon and steelhead for foods such as aquatic invertebrates; no information was found addressing this potential competition, but it may occur and if so would be detrimental to the newt, particularly if stocking levels were to exceed the carrying capacity of the stream, as might sometimes occur soon after a large stocking.

Red-bellied newts are a common species within their range and are not classified as a protected species under either federal or state law. Red-bellied newt extirpations are not reported to be widespread in California and salmon and steelhead stocking has not been cited as a factor in decline of red-bellied newt populations. Thus, the impact would be less than significant.

Impact BIO-161: Predation and Competition Effects from Stocked Salmon and Steelhead on Sierra Newt (Less than Significant)

There are 4 salmon and steelhead stocking locations within the range of the Sierra newt (Figure 4-51). The Sierra newt occupies streams and, in the post-metamorphic stage, adjacent terrestrial habitats. It often co-occurs with salmonids, but is seldom preyed upon due to its high content of the toxic compound tetrodotoxin (Chen 2008). Garter snakes appear to be little affected by tetrodotoxin (Nussbaum et al. 1983) and are the principal predators of other newts in this genus, and thus are likely the principal predators of the Sierra newt. There is evidently little risk of newt predation by stocked salmon and steelhead. Newts are omnivorous and may compete with stocked salmon and steelhead for foods such as aquatic invertebrates; no information was found addressing this potential competition, but it may occur and if so would be detrimental to the newt, particularly if stocking levels were to exceed the carrying capacity of the stream, as might sometimes occur soon after a large stocking.

Sierra newts are a common species within their range and are not classified as a protected species under either federal or state law. Sierra newt extirpations are not reported to be widespread in California and salmon and steelhead stocking has not been cited as a factor in decline of Sierra newt populations. Thus, the impact would be less than significant.

Impact BIO-162: Predation and Competition Effects from Stocked Salmon and Steelhead on Western Tailed Frog (Less than Significant)

There are 11 salmon and steelhead stocking locations within the range of the western tailed frog (Figure 4-60). The western tailed frog occupies fast-flowing mountain streams in all life stages, and it often co-occurs with salmonids. Although tailed frogs co-evolved with salmonids and display avoidance strategies to minimize their predation risk, salmonids do prey upon tailed frogs (Adams and Pearl 2009). Accordingly, salmonid population establishment or enhancement caused by stocking could result in increased predation on tailed frogs. Field experiments by Feminella and Hawkins (1994) have shown that the presence of cutthroat trout reduces tailed frog tadpole activity threefold compared to predator-free conditions, and for experiments using brook trout, a sixfold reduction in tadpole activity occurred. Such activity reductions may be expected to result in slower growth and a longer time to metamorphosis. Subsequent laboratory experiments showed that these predators could pursue and consume tailed frog tadpoles even in structurally complex environments (Feminella and Hawkins 1994). Since the tailed frog is a species with low fecundity that often takes several years to metamorphose (Jennings and Hayes 1994; Adams and Pearl 2009), such predation upon the tadpoles can be expected to have detrimental effects on population status.

Tailed frogs are a common species within their range and are not classified as a protected species under federal law, although they are a species of special concern under California law. They have not exhibited evidence of a rangewide decline and the principal described threat to the species is timber harvest, which typically results in water temperatures that exceed the species' tolerance (Jennings and Hayes 1994); salmon and steelhead stocking has not been cited as a factor in decline of tailed frog populations. Thus, the impact would be less than significant.

Impact BIO-163: Predation and Competition Effects from Stocked Salmon and Steelhead on Western Spadefoot (Less than Significant)

There are 17 salmon and steelhead stocking locations within the range of the western spadefoot (Figure 4-49). The western spadefoot breeds in isolated, ephemeral waters, while the adult stage is

primarily terrestrial (AmphibiaWeb); thus there is essentially no potential for western spadefoot eggs, tadpoles, or adults to suffer salmonid predation. Salmonid predation is not discussed in the literature on the species; its principal predators are probably California tiger salamanders, garter snakes, great blue herons, and raccoons (Jennings and Hayes 1994).

Western spadefoots are a common species within their range and are not classified as a protected species under federal law, although they are listed as a species of special concern by the state of California. In view of the absence of western spadefoot in habitats used by stocked salmon and steelhead, the impact would be less than significant.

Impact BIO-164: Predation and Competition Effects from Stocked Salmon and Steelhead on Western Toad (Less than Significant)

There are 45 salmon and steelhead stocking locations within the range of the western toad (Figure 4-48). The western toad is largely terrestrial as an adult, and breeds in shallow ponds that generally are not suitable habitat for salmonids (Muths and Nanjappa 2009); thus there is low potential for western toads to suffer salmonid predation. Nonetheless, some populations occur in lakes or along rivers that are inhabited by salmonids, and the species has co-evolved with native salmonids. The tadpoles are unpalatable to salmonids; they moreover do not even show a response to the presence of salmonids and evidently do not regard salmonids as potential predators (Kiesecker et al. 1996). Thus, there is low potential for stocked salmon and steelhead to materially affect western toad population status via predation. Although widespread declines of the western toad have been noted, most reports have been from populations outside of California, with the exception of a reported decline in the Yosemite region (Drost and Fellers 1996). Salmon and steelhead stocking has not been implicated as a cause of these declines.

Western toads are a common species within their range and are not classified as a protected species under either federal or state law. Western toad extirpations are not reported to be widespread in California and salmon and steelhead stocking has not been cited as a factor in decline of western toad populations. Thus, the impact would be less than significant.

Impact BIO-165: Predation and Competition Effects from Stocked Salmon and Steelhead on Pacific Treefrog (Less than Significant)

There are 45 salmon and steelhead stocking locations within the range of the Pacific treefrog (Figure 4-55). The Pacific treefrog breeds and metamorphoses in aquatic habitats, chiefly ponds and lake margins, and is largely terrestrial as an adult (Rorabaugh and Lannoo 2009). It occupies habitats that are used by native salmonids and is coevolved with native salmonids. Treefrog declines have not been noted at lower elevations in California (i.e. outside of the HMLs areas where trout have been introduced to formerly fishless lakes), and numerous authors (cited by Rorabaugh and Lannoo 2009) have noted their historical and current abundance, with little evidence of population decline, throughout their historical range.

Pacific treefrogs are a very common species within their range and are not classified as a protected species under either federal or state law. Pacific treefrog extirpations are not reported to be widespread in California and salmon and steelhead stocking has not been cited as a factor in decline of Pacific treefrog populations. Thus, the impact would be less than significant.

Impact BIO-166: Predation and Competition Effects from Stocked Salmon and Steelhead on Northern Red-Legged Frog (Less than Significant)

There are 6 salmon and steelhead stocking locations within the range of the northern red-legged frog (Figure 4-56). No studies have expressly studied the effect of stocked salmonids on northern red-legged frogs. In general, northern red-legged frogs have shown a "negative association with nonnative fish, although the relationship was not as strong as it was for Pacific treefrogs and long-toed salamanders" (Pearl et al. 2005). Absent further information, it is currently reasonable to assume that, since they share potential habitat and the frogs are not known to be unpalatable, stocked salmon and steelhead may prey upon northern red-legged frogs.

Northern red-legged frogs are not classified as a protected species under federal law, although they are listed by DFG as a species of special concern. Although salmon and steelhead stocking may be a locally important factor in decline of northern red-legged frog populations, the limitation of stocking to only six locations within this species' range is unlikely to result in any substantial change in the number or distribution of populations of this species. Thus, the impact would be less than significant.

Impact BIO-167: Predation and Competition Effects from Stocked Salmon and Steelhead on California Red-Legged Frog (Less than Significant)

There are 23 salmon and steelhead stocking locations within the range of the California red-legged frog (Figure 4-56). In some circumstances, fish are known to prey upon these frogs. The larvae are particularly vulnerable right after hatching when they are in their non-feeding, yolk-reabsorbing period and are relatively immobile (Schmieder and Nauman 1994 in U.S. Fish and Wildlife Service 2002). California red-legged frogs are absent or less abundant in lakes where introduced fish (primarily centrarchids and not necessarily salmonids) are present (Hayes and Jennings 1986), which implies that there may be negative effects associated with stocking. However, salmonids prefer aquatic habitat that is cold, deep, and swiftly moving while California red-legged frogs prefer shallow pools that are warm. Salmonids also exhibit migratory behaviors that limit their co-occurrence with California red-legged frogs to certain anadromous life stages when they are either too small to predate on susceptible amphibian life stages or have limited or no feeding for breeding purposes. Due to these factors salmonid co-occurrence and predation on susceptible California red-legged frog life stages is likely limited (Hayes and Jennings 1986). The importance of stocking as a factor leading to the decline of the California red-legged frog is difficult to discern due to other contributing factors such as habitat loss and predation by introduced bullfrogs (Knapp 1996).

California red-legged frogs are classified as threatened under federal law and are listed by DFG as a species of special concern. Salmon and steelhead stocking is not likely an important factor in the decline of California red-legged frog populations due to habitat partitioning and co-occurrence timing of the species. Thus the impact of salmon and steelhead stocking is less than significant.

Impact BIO-168: Predation and Competition Effects from Stocked Salmon and Steelhead on Foothill Yellow-Legged Frog (Less than Significant)

There are 27 salmon and steelhead stocking locations within the range of the foothill yellow-legged frog (Figure 4-57). Unlike other frogs, the foothill yellow-legged frog resides exclusively in rivers and streams where they have typically co-evolved with fish species and have been found to co-occur with salmonids (Bourque 2008). Since they have likely developed behavioral responses to fish over time in these areas, the potential for adverse effects from predation and competition is reduced.

Foothill yellow frogs are generally absent from habitats containing introduced fish (not necessarily trout) (Hayes and Jennings 1986), implying that harmful effects might be associated with stocking. However, importance of stocking as a factor leading to the decline of the foothill yellow-legged frog is difficult to discern due to other contributing factors associated with modification of their habitats (Knapp 1996). Substantial predation of foothill yellow-legged frog by stocked salmon and steelhead is unlikely due to the small size of these fish, which primarily prey upon zooplankton and aquatic invertebrates. Some stocked steelhead residualize and grow to a size where they may prey upon tadpoles or frogs, by such fish are not abundant in comparison with native salmonids and other potential predators on the frogs, so they have low potential to cause substantial incremental impacts.

Foothill yellow-legged frogs are not classified as a protected species under federal law, although they are listed by DFG as a species of special concern. Salmon and steelhead stocking has a very low potential to affect foothill yellow-legged frog populations. Thus, the potential impact is considered less than significant.

Impact BIO-169: Predation and Competition Effects from Stocked Salmon and Steelhead on Western Pond Turtle (Less than Significant)

There are 45 salmon and steelhead stocking locations within the western pond turtle's distribution (Figure 4-61). The western pond turtle is a dietary generalist, so it likely does not compete for food with stocked salmonids. The potential for competition for space is unknown; western pond turtles often occupy areas that have little habitat value for salmonids, such as terrestrial basking and nesting sites, but also use areas such as deep pools and areas with heavy cover that have high value for salmonids. Largemouth bass predation on hatchlings and small turtles has been documented, but predation by salmonids is only suspected (Ashton et al. 1997) and is likely limited to the hatchling stage due to mouth gape limitations of salmonids. There is accordingly a fairly low potential for predation and competition effects. However, the western pond turtle is a long-lived species with low fecundity, so even a low level of predation could affect a western pond turtle population.

Western pond turtles are not classified as a protected species under federal law, although they are listed by DFG as a species of special concern. Salmon and steelhead stocking may be a minor factor in decline of western pond turtle populations, but stocking is not widespread within this species' range, and competition with stocked salmon and steelhead has not been cited as a factor in western pond turtle declines. Thus, the impact would be less than significant.

Impact BIO-170: Predation and Competition Effects from Stocked Salmon and Steelhead on Common Garter Snake (Less than Significant)

There are 45 salmon and steelhead stocking locations within the range of the common garter snake (Figure 4-63). The common garter snake uses both terrestrial and aquatic habitats, foraging in still waters such as ponds. Their principal prey species include amphibians, small mammals (e.g. mice), small birds, lizards, and various invertebrates (e.g., slugs, leeches, earthworms). Their principal predators are mammals, birds, and other snakes (Ziener et al. 1988–1990). Thus, the common garter snake is unlikely to be preyed upon by stocked salmonids, and utilizes food resources substantially different from the small aquatic insects and crustaceans that constitute the principal prey of stocked salmon and steelhead. Moreover, salmon and steelhead stocking only affects waters that also support native (and often unstocked nonnative) fish populations. Therefore, there is a low potential for salmon and steelhead stocking to result in direct competition or predation with common garter

snakes, or to alter aquatic ecosystems sufficiently to result in indirect competition or predation mechanisms.

Common garter snakes are a common species within their range in California and are not classified as a protected species under either federal or state law. Common garter snake extirpations are not reported to be widespread in California and salmon and steelhead stocking has not been cited as a factor in decline of any common garter snake populations. Thus, the impact would be less than significant.

Impact BIO-171: Predation and Competition Effects from Stocked Salmon and Steelhead on Mountain Garter Snake (Less than Significant)

There are 37 salmon and steelhead stocking locations within the range of the mountain garter snake (Figure 4-62). The mountain garter snake uses primarily terrestrial and secondarily aquatic habitats, foraging in still waters such as ponds. Their principal prey species include amphibians, fish, mice, small birds, lizards, and various invertebrates (Ziener et al. 1988–1990). Like the common garter snake, the mountain garter snake is unlikely to be preyed upon by stocked salmon and steelhead, and utilizes food resources substantially different from the small aquatic insects and crustaceans that constitute the principal prey of stocked salmon and steelhead. Moreover, salmon and steelhead stocking only affects waters that also support native (and often unstocked nonnative) fish populations. Therefore, there is a low potential for salmon and steelhead stocking to result in direct competition or predation with mountain garter snakes, or to alter aquatic ecosystems sufficiently to result in indirect competition or predation mechanisms.

Mountain garter snakes are a common species within their range in California and are not classified as a protected species under either federal or state law. Mountain garter snake extirpations are not reported to be widespread in California and salmon and steelhead stocking has not been cited as a factor in decline of mountain garter snake populations. Thus, the impact would be less than significant.

Impact BIO-172: Predation and Competition Effects from Stocked Salmon and Steelhead on Sierra (Western Aquatic) Garter Snake (Less than Significant)

There are 10 salmon and steelhead stocking locations within the range of the Sierra garter snake (Figure 4-61). The Sierra garter snake uses primarily permanent or semi-permanent bodies of water, especially rocky creeks, from slow-moving, low-elevation seasonal creeks to high-elevation mountain streams, ponds, and lakes in a variety of habitats (Rossman et al. 1996 in Ziener et al. 1988–1990). Their principal prey species include amphibians and fish, and their principal predators are birds, mammals and other snakes (Ziener et al. 1988–1990). Thus, the Sierra garter snake is unlikely to be preyed upon by stocked salmon and steelhead, and utilizes food resources substantially different from the small aquatic insects and crustaceans that constitute the principal prey of stocked salmon and steelhead. Moreover, salmon and steelhead stocking only affects waters that also support native (and often unstocked nonnative) fish populations. Therefore, there is a low potential for salmon and steelhead stocking to result in direct competition or predation with Sierra garter snakes, or to alter aquatic ecosystems sufficiently to result in indirect competition or predation mechanisms

Sierra garter snakes are a common species within their range in California and are not classified as a protected species under either federal or state law. Sierra garter snake extirpations are not reported

to be widespread in California and salmon and steelhead stocking has not been cited as a factor in decline of Sierra garter snake populations. Thus, the impact of the would be less than significant.

Impact BIO-173: Predation and Competition Effects from Stocked Salmon and Steelhead on Giant Garter Snake (Less than Significant)

There are 17 salmon and steelhead stocking locations within the range of the giant garter snake (Figure 4-62), which includes areas in the Central Valley at elevations of less than 400 feet. The giant garter snake is a highly aquatic species that primarily wetlands and other still waters (primarily in rice-growing areas), where it forages primarily upon fish and amphibians, and may be preyed upon by various birds and mammals (Miller et al. 1999). Like the common garter snake, the giant garter snake is unlikely to be preyed upon by stocked salmon or steelhead, and utilizes food resources substantially different from the small aquatic insects and crustaceans that constitute the principal prey of stocked salmon and steelhead.

No literature was found describing either competition or predation between stocked salmon and steelhead and giant garter snakes. The giant garter snake inhabits low-elevation waters where salmon and steelhead are unlikely to remain viable through the summer months when the snake is most active; in winter, when low water temperatures allow salmon and steelhead stocking in potential giant garter snake habitat, the snake is inactive within terrestrial burrows (Miller et al. 1999). The most likely form of interaction between stocked salmon and steelhead and giant garter snakes would be predation of juvenile salmon and steelhead by the snakes.

Giant garter snakes are a severely declining species within their range in California and are classified as threatened under both the ESA and the CESA. Salmon and steelhead stocking has not been cited as a factor in decline of giant garter snake populations. Thus, the impact would be less than significant.

Impact BIO-174: Predation and Competition Effects from Stocked Salmon and Steelhead on San Francisco Garter Snake (Less then Significant)

There is one salmon and steelhead stocking location within the range of the San Francisco garter snake (Figure 4-64), which includes a very limited area south-west of San Francisco Bay (U.S. Fish and Wildlife Service 2006). The San Francisco garter snake primarily occurs in habitats that provide densely vegetated aquatic habitat near an open hillside where they can sun themselves, feed, and find cover in rodent burrows. Their principal prey is the California red-legged frog, and the principal prey of juveniles is Pacific treefrogs. The decline of the garter snake has paralleled the frogs' decline as habitats within the snake's range have been increasingly developed and degraded (U.S. Fish and Wildlife Service 2007d). Like the common garter snake, the San Francisco garter snake is unlikely to be preyed upon by stocked salmon and steelhead, and utilizes food resources substantially different from the small aquatic insects and crustaceans that constitute the principal prey of stocked salmon and steelhead. No literature was found describing either competition or predation between salmonids and San Francisco garter snakes.

San Francisco garter snakes are a rare species within their range in California, are classified as endangered under both the ESA and the CESA, and are a fully protected species in California. Salmon and steelhead stocking has not been cited as a factor in decline of giant garter snake populations. Thus, the impact would be less than significant.

Impact BIO-175: Predation and Competition Effects from Stocked Salmon and Steelhead on Bald Eagle and Osprey (Less than Significant)

There are 45 salmon and steelhead stocking locations within the range of the bald eagle (Figure 4-66), and 45 salmon and steelhead stocking locations within the range of the osprey (Figure 4-66). Both the bald eagle and the osprey are raptors that usually roost and nest within sight of large water bodies such as rivers and lakes, where they forage primarily upon fish, the bald eagle especially preferring the carcasses of spawned-out salmon (Johnsgard 1990).

No literature was found describing either competition or predation between stocked salmonids and bald eagles or ospreys. It is likely, since the bald eagle and osprey are large birds that typically consume relatively large fish, that stocking which generates returning wild spawners provides an important prey base for the birds. There is no evident potential for adverse competition or predation effects between stocked salmon and steelhead, and eagles and ospreys.

Bald eagles in California have been delisted under the ESA but remain listed as endangered under the CESA and are a fully protected species. Ospreys are a common species within their range in California and are not classified as a protected species under either federal or state law, although DFG has placed them on a "watch list" of potentially sensitive species. Salmon and steelhead stocking has not been cited as a factor in decline of bald eagle or osprey populations, and may help to support them. Thus, the impact would be less than significant.

Impact BIO-176: Predation and Competition Effects from Stocked Salmon and Steelhead on Willow Flycatcher and Southwestern Willow Flycatcher (Less than Significant)

There are no anadromous salmon and steelhead stocking locations within the range of the willow flycatcher (Figure 4-65) or the southwestern willow flycatcher (Figure 4-65). Thus, there is no potential for the stocking of salmon or steelhead to impact these species, and the impact would be less than significant.

Nontarget Harvest Effects on Native Inland Salmonid and Non-Salmonid Fish from Angling for Stocked Salmon and Steelhead

Non-targeted fish species may incidentally be caught during legal and non-legal angling attempts to catch hatchery salmonid game fish species that are stocked by salmon and steelhead hatcheries. See the discussion "Impacts of the Trout Stocking Program," under the subheading "Effects from Non-Target Harvest," for general remarks regarding the potential for incidental harvest effects from recreational fishing. The potential for incidental harvest effects on non-salmonids, wild native trout, and wild native anadromous salmonids as a result of the salmon and steelhead stocking program is discussed below.

Impact BIO-177: Effects from Salmon and Steelhead Stocking Program Non-Target Harvest on Santa Ana Speckled Dace, Owens Sucker, Kern Brook Lamprey, Tidewater Goby, or Unarmored Three-Spined Stickleback (Less than Significant)

Salmon and steelhead are not stocked anywhere within the range of the Santa Ana speckled dace, Owens sucker, tidewater goby, or unarmored three-spined stickleback. Chinook salmon are stocked in the Merced River where Kern Brook Lamprey are observed. Thus, there is no potential for the salmon and steelhead stocking to impact the these species, and the impact of the Program on these species would be less than significant.

Impact BIO-178: Effects from Trout Stocking Program Non-Target Harvest on River Lamprey and Klamath River Lamprey (Less than Significant)

There are 23 salmon and steelhead stocking locations within the range of the river lamprey and five stocking locations within range of the Klamath river lamprey (Figures 4-26 and 4-67) and they may be captured incidentally by anglers targeting salmon and steelhead. Five salmon and steelhead stocking locations occur within the range of the Kern Brook lamprey. The frequency of incidental capture is not known, however the California Freshwater Sport Fishing Regulations (California Department of Fish and Game 2008a) provide no harvest limits on these species, except as noted in special regulations (water specific regulations), thus these species may be targeted. It is unlikely that a lamprey would be incidentally caught on lures or bait (other than snagging or attached to fish that are targeted) because they are either parasitic or do not feed once they morph to the adult stage and are filter feeders as ammocoetes (larvae). Also because these species can be legally targeted, the potential impact from non-target harvest of these lamprey species would be less than significant.

Impact BIO-179: Effects from Salmon and Steelhead Stocking Program Non-Target Harvest on Delta Smelt and Longfin Smelt (Less than Significant)

There are 14 salmon and steelhead stocking locations that occur within the distribution of the delta smelt and 14 stocking locations that occur within the distribution of the longfin smelt. Because these smelt, and salmon and steelhead occupy different habitats when fisheries occur, and smelt feed predominantly on zooplankton, the potential for incidental harvest of these smelt is negligible. This impact would be less than significant.

Impact BIO-180: Effects from Salmon and Steelhead Stocking Program Non-Target Harvest on Eulachon (Less than Significant)

Salmon and steelhead stocking occurs at two locations within the eulachon's range. Eulachon are anadromous and do not feed upon entry into freshwater, thus the potential for them to be incidentally caught by anglers is negligible. This impact would be less than significant.

Impact BIO-181: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on Hardhead (Less than Significant)

There are 22 salmon and steelhead stocking locations within the range of hardhead. Hardhead are omnivorous, foraging for benthic invertebrates and aquatic plant material on the bottom, but also forage on drifting insects and algae (Moyle 2002). Recreational fishing for salmonids targets fish that feed either at the surface or within the water column and fishing gear is designed for these feeding behaviors. Hardhead have a relatively low potential for incidental capture by anglers targeting salmonids due to the gear used (e.g. size, imitation of specific prey resources) and the bottom feeding behaviors of hardhead. For this species, the risk of incidental harvest by anglers targeting salmonids is very low. This impact would be less than significant.

Impact BIO-182: Effects from Salmon and Steelhead Stocking Program Non-Target Harvest on Sacramento Perch (Less than Significant)

There are three salmon and steelhead stocking locations within the range of the Sacramento perch (Figure 4-42). Sacramento perch formerly inhabited sloughs, slow-moving rivers, and lakes, but are now mostly found in reservoirs and farm ponds and are often associated with beds of rooted, submerged, and emergent vegetation and submerged objects. Most populations of Sacramento perch

today are established in warm (summer water temps of 18°C–28°C), turbid, moderately alkaline reservoirs or farm ponds. Anglers targeting salmon and steelhead are not likely to fish waters occupied by Sacramento perch or in the areas within those waters where Sacramento perch would occupy and thus the potential for Sacramento perch to be caught incidentally by anglers targeting salmon and steelhead is negligible. Additionally, because this species can be legally targeted, the potential impact from non-target harvest of Sacramento perch would be less than significant.

Impact BIO-183: Effects from Salmon and Steelhead Stocking Program Non-Target Harvest on Cui-Ui (Less than Significant)

There is no salmon or steelhead stocking in waters used by cui-ui, thus there is no potential for incidental harvest by anglers. This impact would be less than significant.

Impact BIO-184: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on Green Sturgeon (Less than Significant)

The green sturgeon southern DPS inhabits waters stocked with anadromous salmonids from the Russian River southwards to the Central Valley (Figure 4-27). Directed fishing with hook and line is the main mode of capture (Moyle 2002). In the Sacramento-San Joaquin drainage, most incidental capture occurs during the white sturgeon sport fishery (Moyle 2002). During the 2007 white sturgeon season, 311 green sturgeon were reported caught and released (Gleason et al. 2008). As noted by Adams et al. (2002:13), harvest of green sturgeon "is all bycatch in two fisheries." These fisheries are Tribal gillnet fisheries which contribute a smaller portion of the bycatch (including from the Klamath River, where catches of sturgeon are from the green sturgeon northern DPS), and commercial and recreational fisheries for white sturgeon, which provide the larger portion of the bycatch. It is therefore concluded that the impact of salmon and steelhead stocking on the green sturgeon by non-target harvest from anglers targeting hatchery-origin salmonids within the geographic range of the green sturgeon DPS would be less than significant.

Impact BIO-185: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on Goose Lake Tui Chub, Owens Tui Chub, Owens Speckled Dace, Arroyo Chub, Modoc Sucker, and Santa Ana Sucker (Less than Significant)

Stocking of hatchery salmon and steelhead does not occur in the currently managed range of the Owens tui chub, Goose Lake tui chub, Arroyo chub, Modoc sucker, Santa Ana sucker, or Owens speckled dace (Figures 4-44, 4-46, 4-45, and 4-43), which eliminates the potential for incidental harvest of these species by anglers pursuing stocked anadromous salmon or steelhead. Thus, potential impacts on these species would be less than significant.

Impact BIO-186: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on Coastal Cutthroat Trout (Less than Significant)

There are three anadromous salmon and steelhead stocking locations (Klamath, Mad, and Eel Rivers) within the coastal cutthroat trout's distribution (Figure 4-31). Coastal cutthroat trout are not targeted in commercial fisheries, however targeted recreational fisheries and incidental capture of cutthroat trout by anglers targeting salmon and steelhead in the Eel, Mad and Klamath Rivers may occur . The status of coastal cutthroat trout was evaluated by in 1999 (Johnson et al. 1999). Historically, targeted and incidental recreational fisheries likely resulted in significant mortality of coastal cutthroat trout. However, DFG has implemented fishing regulations (i.e. size and bag limits) that has resulted in a decrease to targeted and incidental harvest. Because of harvest restrictions on

naturally produced coastal cutthroat trout in many areas and the lack of targeted fisheries, direct mortality due to fishing pressure is thought to be relatively low (Johnson et al. 1999). Specific to coastal cutthroat trout in these basins, Johnson et al. (1999) were "encouraged by recent changes in harvest regulations aimed at reducing risks to natural trout from direct and indirect harvest mortality". Because harvest regulations have been established to reduce risks to coastal cutthroat trout populations in basins are stocked, impacts from non-target harvest would be less than significant.

Impact BIO-187: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on Lahontan Cutthroat Trout, Paiute Cutthroat Trout, Goose Lake Redband Trout, Warner Valley Redband Trout, McCloud River Redband Trout, California Golden Trout, and Little Kern Golden Trout (Less than Significant)

Anadromous salmon and steelhead are not stocked in the currently managed range of Lahontan cutthroat trout, Paiute cutthroat trout, Goose Lake redband trout, Warner Valley redband trout, California golden trout, McCloud River redband trout, and Little Kern golden trout (Figures 4-29, 4-30, 4-31, and 4-32), which eliminates the potential for incidental harvest of these species by anglers pursuing stocked anadromous salmon or steelhead. Thus, potential impacts on these species would be less than significant.

Nontarget Harvest Effects on Wild Populations of Native Anadromous Salmon and Steelhead

DFG operations stock anadromous Chinook salmon, coho salmon, and steelhead that support ocean and inland fisheries. The incidental capture and harvest of wild anadromous fish occurs during these fisheries. Ocean fisheries are managed by a the Pacific Fishery Management Council (PFMC) and the states of California, Oregon and Washington. PFMC is responsible for salmon fisheries in federal waters in the Exclusive Economic Zone three to 200 miles off the coasts of Washington, Oregon, and California. The California Fish and Game Commission is responsible for setting salmon regulations in all California waters, including all coastal waters extending three miles offshore. Once the PFMC process is completed for federal waters, the California Fish and Game Commission normally adopts a similar set of regulations for state waters (within 3 miles). Freshwater fishery regulations in California are set by the California Fish and Game Commission. DFG recommends regulations to the Commission. These regulations follow conservation goals and harvest guidelines established by the PFMC and any restrictions under the Endangered Species Act.

Fisheries conducted off the California coast are non-selective (i.e., marked hatchery and unmarked wild fish are kept). This analysis generally assumed harvest rates on co-mingled hatchery and wild fish are the same in these types of fisheries. Selective commercial and recreational ocean fisheries (such as those that currently take place off of the coast of Oregon and Washington for coho) and freshwater catch-and-release recreational fisheries potentially affect unmarked wild fish through delayed mortality. Mortality from selective fisheries is affected by a variety of factors: proportion of fish marked in fishery, fishing gear, and handling of unmarked fish prior to release. Estimates of mortality for both hatchery and non-hatchery stocks ranging from 0 to almost 50% of released fish (Table 4-5).

Recreational steelhead fisheries are selective for marked hatchery fish in most watersheds in California.

This section evaluates incidental harvest risk related to DFG anadromous salmonid and steelhead stocking, for each anadromous salmonid ESU or steelhead DPS in California., This assessment includes 2008 when all ocean fisheries in California were closed to salmon fishing. The analysis does not consider 2008 to be the norm when evaluating ocean harvest impacts on wild populations of coho and Chinook.

Table 4-5. Recent Estimates of Salmonid Mortality Following Release from Commercial or Recreational Fisheries

Species	Location	Capture Method	Mortality	Reference	Comment
Chinook salmon	Coastal California	Mooching	31% (circle hook); 46% (J hook)	Grover et al. (2002)[a]	
Chinook salmon	Unknown	Mooching/trolling	0% (circle hook); 15% (J hook)	McNair (1997)[a]	
Coho salmon	Unknown	Trolling	14% (circle hook); 14% (J hook)	Grover (unpublished data)[a]	
Coho salmon	Unknown	Mooching/trolling	3% (circle hook); 24% (J hook)	McNair (1997)[a]	
Coho salmon	Coastal British Columbia	Seine/troll/gillnet	2.40%	Farrell et al. (2000)	Used recovery boxes
Coho salmon	Coastal British Columbia	Seine/troll/gillnet	3.40%	Hargreaves (unpublished data)[b]	
Rainbow trout	Unknown	Casting	10.4% (circle hooks); 19.0% (J hooks)	Parmenter (2001)[a]	
Rainbow trout	Unknown	Casting/bobber	10.1% (circle hooks); 15.9% (J hooks)	Pecora (unpublished data)[a]	
Rainbow trout	Eastern Sierra Nevada (California)	Casting/bobber	0.7-9%	Jenkins (2003)	Various gear and handling configurations

Species	Location	Capture Method	Mortality	Reference	Comment
Steelhead	Mad River, California	Casting	9.5% (J/treble hooks)	Taylor and Barnhart (1999)	Northern California Coastal Summer Steelhead DPS
Steelhead	Chilliwack River, British Columbia	Casting	3.6% (J hooks)	Nelson et al. (2005)	

aCited by Cooke and Suski (2004).
bCited by Farrell et al. (2000)

Impact BIO-188: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on Sacramento River Winter-Run Chinook Salmon ESU (Less than Significant)

Fish in the Sacramento River winter-run Chinook salmon ESU are incidentally harvested by ocean fishers targeting the Central Valley fall-run Chinook salmon ESU, a major portion of which is hatchery-reared fish (Barnett-Johnson et al. 2007). Harvest in inland fisheries was assumed to take 16.7% of fish escaping ocean fisheries from 1967 to 1991, after which inland harvest was assumed to be negligible (Figure 4-68). Ocean harvest averaged over 56% of total natural production from 1967 to 1995, declining to about 25% on 1998 to 2000 brood year returns (Grover et al. 2004) following adoption of revised fishing regulations; harvest was zero in 2008 due to fishery prohibition caused by the very low abundance of the fall-run Chinook salmon returning to the Central Valley. Grover et al. (2004) estimated impact rates on 3- and 4-year-olds of the Sacramento River winter-run Chinook salmon ESU from 20 to 23% and 57 to 74% on 3 and 4 yr Chinook, respectively. Resumption of harvest at the rates prior to 2008 are not expected to have a substantial adverse impact on the Sacramento River winter-run Chinook salmon ESU. The Pacific Coast Salmon Plan (FMP) was developed by PFMC to manage west coast ocean salmon fisheries. The current FMP conservation objective for Sacramento winter-run Chinook is the consultation standard set out in the NMFS 2004 Winter Chinook Salmon Biological Opinion. This document reviewed the current status of Sacramento River winter Chinook, the environmental baseline for the action area, the effects of the proposed implementation of the Pacific Coast Salmon Plan and the protective measures proposed, and concluded that the proposed ocean harvest is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon. Resumption of ocean harvest under similar regulations is therefore likely to have a less than significant impact on winter-run Chinook.

Impact BIO-189: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on Central Valley Spring-Run Chinook Salmon ESU (Less than Significant)

As with the Sacramento River winter-run Chinook salmon ESU, fish in the Central Valley spring-run Chinook salmon ESU are harvested by ocean fishers primarily targeting the Central Valley fall-run Chinook salmon ESU, much of which is hatchery production (Barnett-Johnson et al. 2007). Harvest rates reported in the Anadromous Fishery Restoration Program (AFRP) indicate that the ocean harvest of spring-run Chinook salmon averaged approximately 55% of total production from 1967 to 1995 and then declined to about 40% of production from 1996 to 2007 (Figure 4-69); ocean harvest was zero in 2008. Inland fishing harvested an estimated 14% of fish escaping the ocean fishery between 1967 and 1994 and about 9.5% of fish thereafter (with the exception of zero fish in

2008). Grover et al. (2004) estimated impact rates on 3- and 4-year-olds of the Central Valley spring-run Chinook salmon ESU of 5 to 12% and 55 to 62% on 3 and 4 yr old spring Chinook, respectively. Total harvest impacts reported by Grover et al. (2004) were 36% and 42% for the 1998 to 2000 brood years. Harvest impacts were based on coded-wire tag analysis of Butte Creek wild spring-run Chinook. The NMFS 2004 Winter Chinook Salmon Biological Opinion reviewed population trends for spring-run Chinook originating in Butte, Deer, and Mill Creeks (Grover et al. 2004) and the impact of recreational and commercial ocean fisheries and recreational fisheries in the San Francisco area, and concluded that authorization of fishery management measures, consistent with the requirements of the Fishery Management Plan and the requirements of other biological opinions on the effects of the ocean salmon fishery, was not likely to jeopardize the continued existence of Central Valley spring-run Chinook. Resumption of ocean harvest under similar regulations is therefore likely to have a less than significant impact on spring-run Chinook.

Impact BIO-190: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on Central Valley Fall- and Late Fall–Run Chinook Salmon ESU (Significant and Unavoidable)
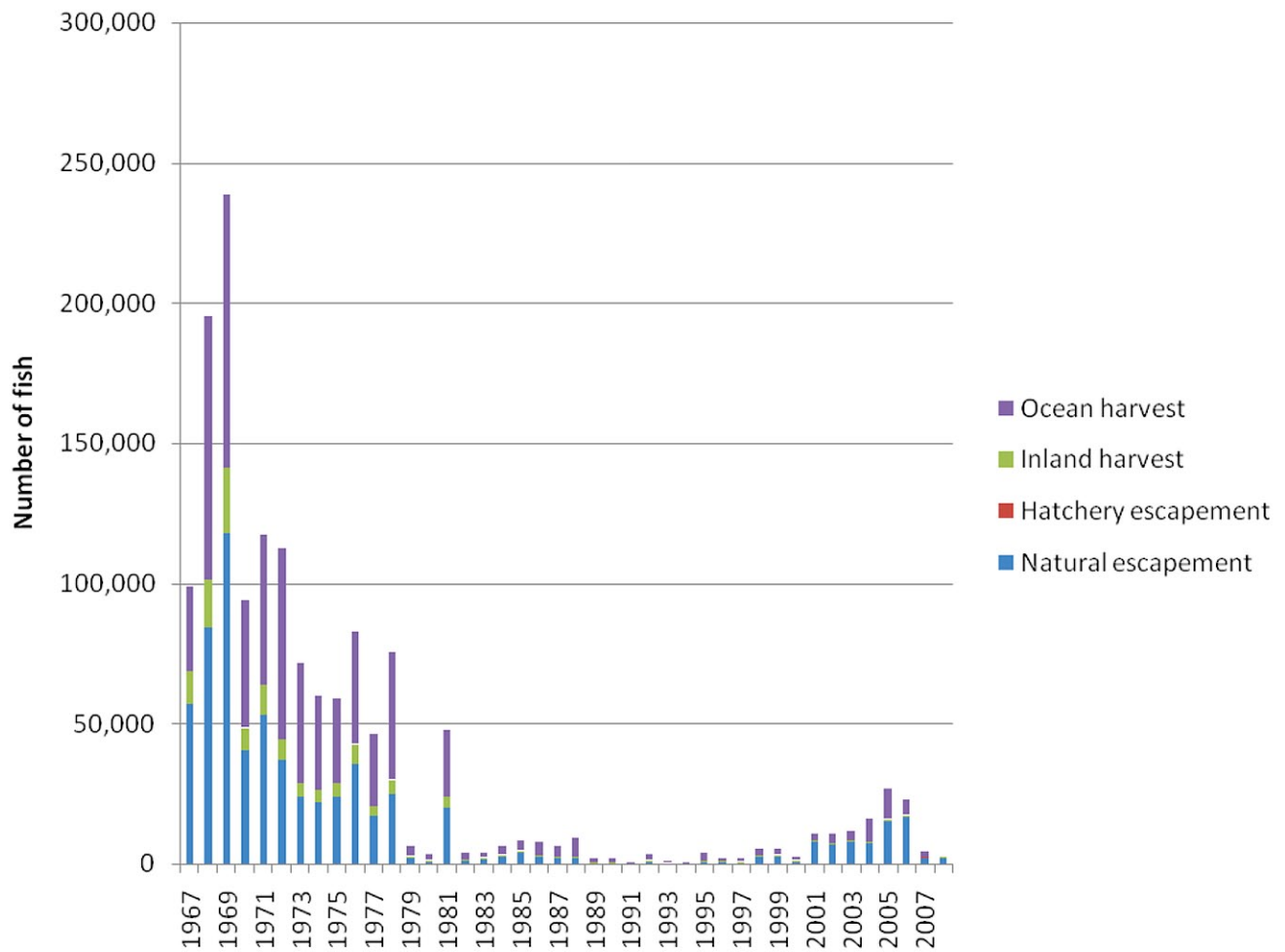
The Central Valley fall and late-fall-run Chinook salmon ESU is the largest ESU within the Central Valley and supports the bulk of Chinook salmon fisheries in California. Barnett-Johnson et al. (2007) estimated that fall-run Chinook salmon from Central Valley hatcheries contribute approximately 90% (plus or minus 6%) to the commercial fishery off Central California. However, the study by Barnett-Johnson et al. (2007)was based on a small sample size in a single year of harvest, so results may not be representative of hatchery composition in all years. Data from the Anadromous Fish Restoration Program (2009) suggest that the ocean fisheries exploitation rates averaged about 56% from 1967 to 1995 and 40% from 1996 to 2007 (no fish were caught in 2008) (Figure 4-70). Inland harvest averaged almost 16% of fish escaping the ocean fisheries from 1967 to 2007 leading to a combined total exploitation rate of 50% on both hatchery and wild stocks. Without a complete, population specific evaluation, the implications of a 50% exploitation rate on wild stocks is not completely clear, but the high potential for capture of wild fish from the Central Valley fall and late-fall-run Chinook salmon ESU during a fishery largely composed of hatchery-raised fish suggests that the DFG fall-run Chinook stocking program has a significant adverse impact on wild fish. Mitigation measure BIO-190 is required. Impacts with mitigation would be significant and unavoidable.

Mitigation Measure BIO-190: Reduce the Potential for Non-Target Harvest on Fall- and Late Fall–Run Chinook ESU

Harvest strategies that would likely affect the fall and late-fall run Chinook salmon ESU are currently being addressed by DFG through a review of harvest. DFG is currently evaluating mass marking and mark-selective fisheries as part of a broader proposed fishery management system designed to maximize fishing opportunity while meeting the annual conservation objectives and ESA consultation requirements for all west coast salmon and steelhead stocks. The potential impacts described above are significant and unavoidable pending successful development and implementation of a harvest plan. Refer to Appendix K for a more detailed discussion of this mitigation process.

Impact BIO-191: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on California Coast Chinook Salmon ESU (Less than Significant)
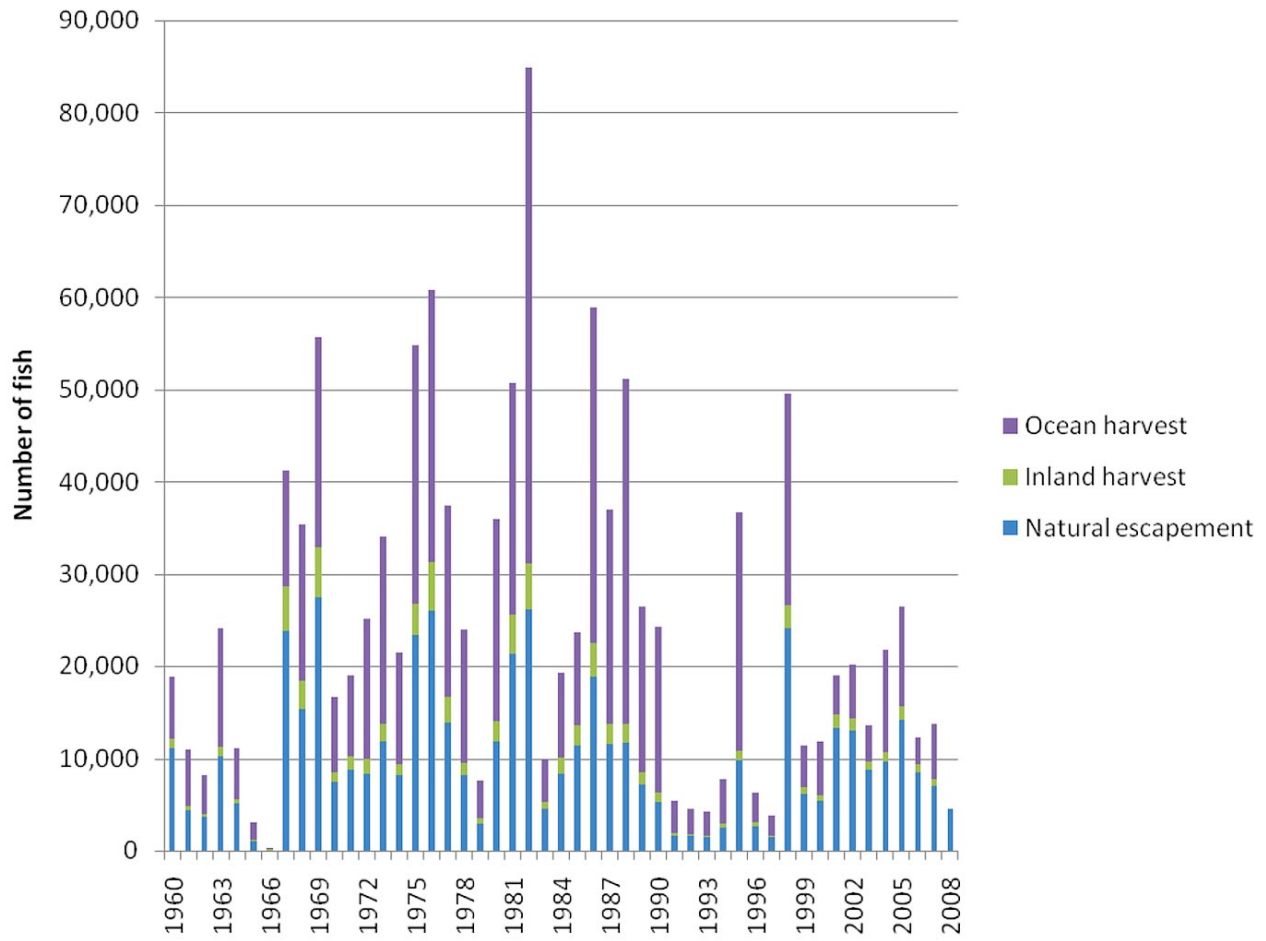
There are no DFG anadromous fish hatcheries stocking Chinook salmon in the geographic region occupied by the California Coast Chinook salmon ESU. It is unclear to what extent Chinook salmon

Number of fish

300,000

250,000

200,000

150,000

100,000

50,000

0

1967 1969 1971 1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007

■ Ocean harvest
■ Inland harvest
■ Hatchery escapement
■ Natural escapement

Source: AFRP 2009.

Figure 4-68
Trends in Abundance of the Sacramento River
Winter-Run Chinook Salmon ESU

Source: AFRP 2009.

Figure 4-69
Trends in Abundance of the Central Valley
Spring-Run Chinook Salmon ESU
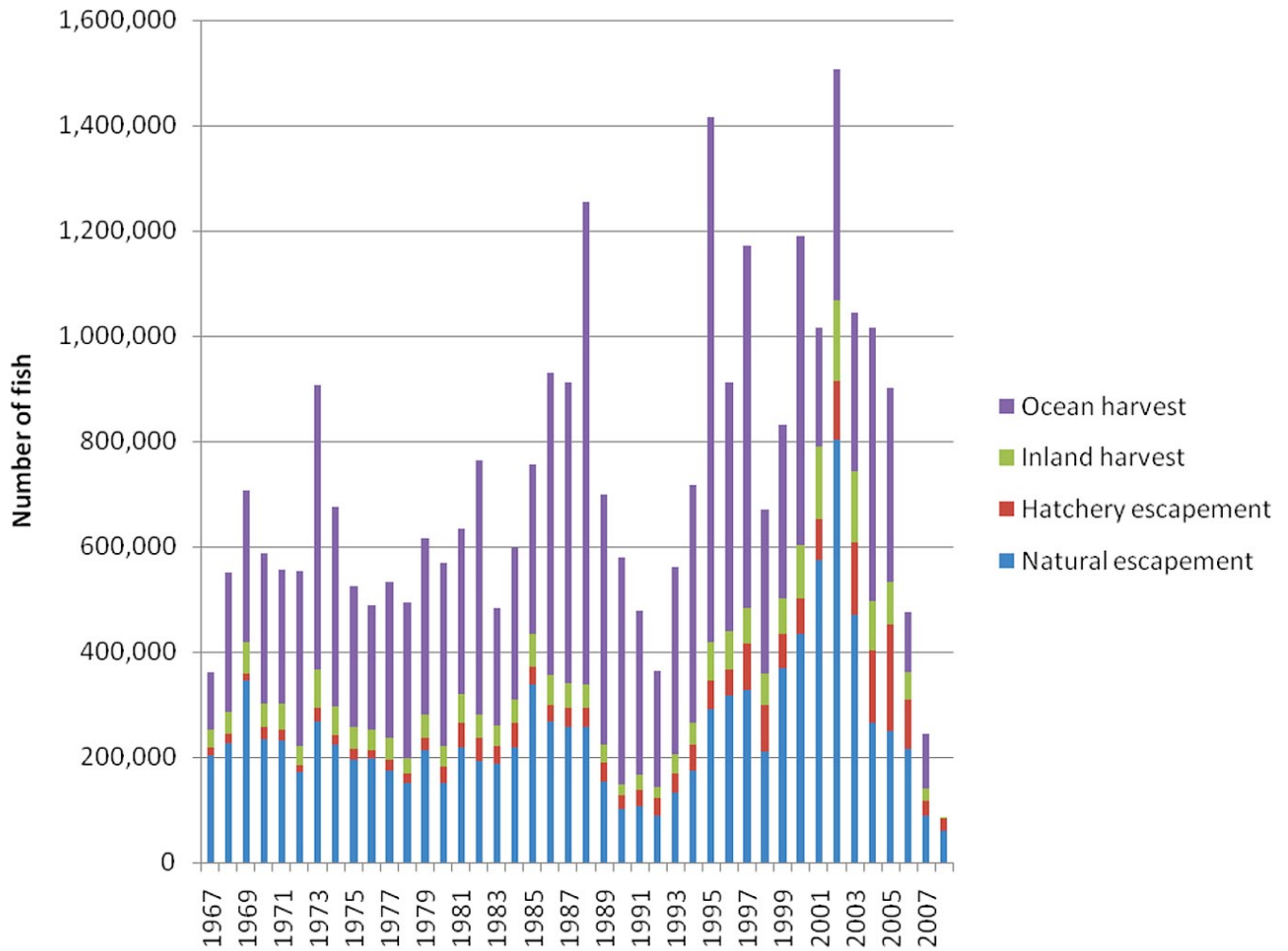
Source: AFRP 2009.

Figure 4-70
Trends in abundance of the Central Valley
Fall and Late-Fall-Run Chinook Salmon ESU

originating in this ESU could be affected by fishers targeting hatchery or wild fish from neighboring ESUs to the north and south. Bjorkstedt (2005) noted that exploitation rates are not estimated for this ESU, but that restrictions on fisheries for Klamath basin fall-run Chinook salmon (i.e., a maximum 16% exploitation rate of 4-year-old fish) (Pacific Fishery Management Council 2008) may maintain low ocean harvest for the California Coast Chinook salmon ESU. There is therefore no significant impact of incidental harvest of the California Coast Chinook salmon ESU by fishers targeting anadromous fish reared by the DFG Hatchery Program. Thus, potential impacts on this ESU would be less than significant.

Impact BIO-192: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on Upper Klamath-Trinity Rivers Chinook Salmon ESU (Significant and Unavoidable)

Chinook salmon from the Iron Gate Hatchery (fall-run) and the Trinity River Hatchery (fall- and spring-run) are released within the range of the Upper Klamath-Trinity Rivers Chinook salmon ESU. From a harvest-management perspective, spring-run Chinook salmon are not considered distinct from fall-run Chinook, which allows legal commercial and recreational harvest of both races (Moyle et al. 2008). Given the depressed status of the spring-run populations, even a relatively small exploitation rate "presumably has an effect, if not known" (Moyle et al. 2008). Kinziger et al. (2008) showed that hybridization of fall-run and spring-run Chinook salmon returning to Trinity River Hatchery had occurred but could not ascribe this to hatchery operations or construction of Lewiston Dam in the upper Trinity River. The only available data on harvest of spring-run Chinook salmon within this ESU is from tribal harvest within the Klamath River watershed (Table 4-6), which show an average of around 10,000 spring-run Chinook harvested per year from 2000 to 2007. The bulk of these fish are presumably of hatchery origin. Moyle et al. (2008) suggested that the total number of wild spring-run Chinook in the Klamath and Trinity Rivers rarely exceeds 1,000 fish and may drop to <300 in many years. The number of fish returning to the Trinity River Hatchery averaged almost 7,000 fish per year from 2002 to 2008 (California Department of Fish and Game 2008a). It is therefore likely that incidental and directed fisheries are significantly adversely affecting the spring-run populations within the Upper Klamath-Trinity Rivers Chinook Salmon ESU and that this impact can be attributed to fisheries targeting the hatchery-reared component of the ESU. Mitigation Measure BIO-192 is required. Impacts with mitigation would be significant and unavoidable.

Mitigation Measure BIO-192: Reduce the Potential for Non-Target Harvest on Upper Klamath-Trinity Rivers Chinook Salmon ESU

Harvest strategies that would likely affect the upper Klamath-Trinity Rivers Chinook salmon ESU are currently being addressed by DFG through a review of harvest. DFG is currently evaluating mass marking and mark-selective fisheries as part of a broader proposed fishery management system designed to maximize fishing opportunity while meeting the annual conservation objectives and ESA consultation requirements for all west coast salmon and steelhead stocks. The potential impacts described above are significant and unavoidable pending successful development and implementation of a harvest plan. Refer to Appendix K for a more detailed discussion of this mitigation process.

Table 4-6. Estimates of Yurok and Hoopa Valley Reservation Indian Gillnet Chinook Harvest in Numbers of Fish, 2000-2007

Year	Area	Spring Run				Fall Run		
		Jack	Adult	Total		Jack	Adult	Total
2000	Commercial: Estuary	-	33	33		-	4,104	4,104
	Middle Klamath	-	2	2		-	186	186
	Upper Klamath	-	1	1		-	813	813
	Subsistence: Estuary	5	1,739	1,744		35	13,174	13,209
	Middle Klamath	0	509	509		29	1,049	1,078
	Upper Klamath	8	909	917		111	4,127	4,238
	Trinity River	29	1,325	1,354		128	5,962	6,090
	Total	42	4,518	4,560		303	29,415	29,718
2001	Commercial: Estuary	79	4,637	4,716		63	7,011	7,074
	Upper Klamath	1	58	59		1	51	52
	Subsistence: Estuary	152	8,846	8,998		198	21,956	22,154
	Middle Klamath	0	134	134		28	1,697	1,725
	Upper Klamath	19	1,504	1,523		49	2,976	3,025
	Trinity River	46	4,164	4,210		60	4,954	5,014
	Total	297	19,343	19,640		399	38,645	39,044
2002	Commercial: Estuary	7	1,852	1,859		7	8,952	8,959
	Upper Klamath	-	-	-		-	-	-
	Subsistence: Estuary	25	6,551	6,576		10	11,197	11,207
	Middle Klamath	70	1,310	1,380		10	729	739
	Upper Klamath	24	2,205	2,229		31	2,528	2,559
	Trinity River	40	3,052	3,062		68	1,168	1,236
	Total	166	14,970	15,136		126	24,574	24,700
2003	Commercial: Estuary	4	779	783		11	17,084	17,095
	Upper Klamath	0	0	0		0	0	0

Year	Area	Spring Run				Fall Run		
		Jack	Adult	Total		Jack	Adult	Total
	Subsistence: Estuary	10	1,800	1,810		4	5,604	5,608
	Middle Klamath	0	2,355	2,355		5	1,376	1,381
	Upper Klamath	0	1,730	1,730		12	3,199	3,211
	Trinity River	7	2,380	2,387		12	2,771	2,783
	Total	21	9,044	9,065		44	30,034	30,078
2004	Commercial: Estuary	2	408	410		13	14,251	14,264
	Upper Klamath	0	0	0		13	540	554
	Subsistence: Estuary	10	2,178	2,188		62	6,787	6,848
	Middle Klamath	6	2,346	2,352		14	577	591
	Upper Klamath	11	1,715	1,726		46	1,959	2,005
	Trinity River	62	1,944	2,006		20	1,689	1,709
	Total	91	8,591	8,682		168	25,083	25,971
2005	Commercial: Estuary	0	0	0		0	0	0
	Upper Klamath	0	0	0		0	0	0
	Subsistence: Estuary	0	477	477		21	2,293	2,314
	Middle Klamath	0	518	518		5	464	469
	Upper Klamath	0	1,320	1,320		33	2,851	2,884
	Trinity River	17	1,858	1,858		11	2,409	2,420
	Total	33	7,286	7,302		70	8,017	8,087
2006	Commercial: Estuary	0	0	0		0	0	0
	Upper Klamath	0	0	0		0	0	0
	Subsistence: Estuary	8	302	310		30	2,726	2,756
	Middle Klamath	3	1,113	1,116		93	1,310	1,403
	Upper Klamath	36	1,257	1,293		147	2,086	2,233
	Trinity River	58	1,632	1,690		145	4,161	4,306
	Total	105	4,304	4,409		415	10,283	10,698

Year	Area	Spring Run				Fall Run		
		Jack	Adult	Total		Jack	Adult	Total
2007	Commercial: Estuary	0	2,300	2,300		15	21,087	21,102
	Upper Klamath			0				0
	Subsistence: Estuary	0	1,332	1,332		1	2,235	2,236
	Middle Klamath	0	200	200		0	411	411
	Upper Klamath	0	631	631		5	1,350	1,355
	Trinity River	6	1,349	1,355		0	2,298	2,298
	Total	6	5,812	5,818		21	27,381	27,402

Source: Pacific Fishery Management Council 2008.

Impact BIO-193: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on Central California Coast Coho Salmon ESU (Less than Significant)

The Central California coast coho salmon ESU includes 14 areas stocked with coho salmon raised in a conservation program at the DFG Warm Springs Hatchery on the Russian River. Commercial and recreational harvest of all coho salmon in California has been prohibited since 1995 (Moyle et al. 2008). The total estimated illegal or incidental ocean harvest has been less than 1,000 coho salmon per year since 1993 (Spence and Bjorkstedt 2005). DFG (2003c in Spence and Bjorkstedt 2005) considered that incidental catch-and-release mortality of the central California coast coho salmon ESU was likely to be low because of the minimal overlap of the coho migration period with the steelhead fishery season.

There is therefore a less-than-significant impact due to low incidental harvest of the central California coast coho salmon ESU by anglers targeting anadromous salmon and steelhead stocked by DFG.

Impact BIO-194: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on Southern Oregon/Northern California Coast Coho Salmon ESU (Less than Significant)

The southern Oregon/northern California coast coho salmon ESU occupies waters stocked with coho salmon from the Iron Gate Hatchery (Klamath River) and the Trinity River Hatchery. The only remaining coho salmon harvest within California (following implementation of the restrictions noted above in the central California coast coho salmon ESU account) is minor and occurs in tribal fisheries of the Klamath River (Moyle et al. 2008). There is potential for mortality in catch and release fisheries, but this is also probably minor (Moyle et al. 2008). Harvest does occur in ocean fisheries off Oregon, most of which target Chinook salmon, but fishery management from 1999–2002 kept exploitation rates below 8% (Spence et al. 2005).

There is therefore a less-than-significant impact due to incidental harvest of southern Oregon/northern California coast coho salmon by anglers targeting anadromous salmon and steelhead stocked by DFG.

Impact BIO-195: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on Southern California Coast Steelhead DPS (Less than Significant)

DFG does not stock steelhead within the range of the southern California coast steelhead DPS and an annual average of only two fishing trips for steelhead were reported from 2003 to 2005 (see Table 4-7). An average of one wild-origin fish steelhead was caught annually (and released). There are no effects of incidental harvest on this DPS as a result of DFG hatchery operations.

This impact would be less than significant.

Table 4-7. Average Annual Recreational Fishing Effort, Harvest, and Release of Steelhead in Regions including the Southern California Coast Steelhead DPS, as Summarized from 2003–2005 Steelhead Report Card Returns

Region	Trips	Wild Kept	Wild Released	Hatchery Kept	Hatchery Released
Pt Conception to Ventura	0	0	0	0	0
Ventura River	0	0	0	0	0
Santa Clara River	1	0	1	0	0
South of Santa Clara	1	0	0	0	0
Total	2	0	1	0	0

Source: Jackson 2007.

Impact BIO-196: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on South-Central California Coast Steelhead DPS (Less than Significant)

DFG does not stock steelhead within the range of the south-central California coast steelhead DPS, but other hatchery operations do release steelhead that could be caught by recreational fishers within this DPS. For example, the Monterey Bay Salmon and Trout Project released steelhead into the San Lorenzo River, which is not within the same ESU but could have provided fish by straying. Also, San Lorenzo River-origin steelhead were planted into the North Fork Pajaro River, which could have resulted in steelhead being caught within the south-central California coast steelhead DPS. Almost 80% of steelhead collected in a region broadly encompassing the DPS were of wild origin (with just under 1% of wild-origin fish being kept), according to Steelhead Report Card return annual averages for 2003 to 2005 (Table 4-8).

Recreational fishing, with a five fish limit, is proposed to be allowed on the lower Nacimiento River. This fishery is proposed to let anglers to remove past stocked rainbow trout. There is a potential for the take of juvenile steelhead in this stream. However, this impact would be less than significant.

Table 4-8. Average Annual Recreational Fishing Effort, Harvest, and Release of Steelhead in Regions including the South-Central California Coast Steelhead DPS, as Summarized from 2003–2005 Steelhead Report Card Returns

Location	Trips	Wild Kept	Wild Released	Hatchery Kept	Hatchery Released
San Lorenzo River to Salinas	139	0	55	0	23
Carmel River	70	1	15	1	1
Carmel River to San Luis Obispo	57	0	28	0	1
SLO to Pt Conception	2	0	2	0	0
Total	268	1	100	1	25

Source: Jackson 2007.

Impact BIO-197: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on Central California Coast Steelhead DPS (Less than Significant)

The Central California Coast Steelhead DPS potentially suffers incidental mortality from sport anglers targeting hatchery fish from the DFG hatchery at Warm Springs and the Monterey Bay Salmon and Trout Project facility on Big Creek (Scott Creek watershed). Regulations do not allow the retention of wild steelhead as identified by an intact adipose fin. The average annual reported number of hatchery-origin fish caught (kept or released) from 2003–2005 was almost 650 , compared to 400 wild-origin fish (Table 4-9). A small percentage (2.5%) of wild-origin steelhead was kept by anglers, whereas almost 41% of hatchery-origin fish were kept. The potential mortality of wild fish that are released by anglers targeting hatchery fish was not considered high enough to adversely affect the central California coast steelhead DPS. This impact would be less than significant.

Table 4-9. Average Annual Recreational Fishing Effort, Harvest, and Release of Steelhead in Regions including the Central California Coast Steelhead DPS, as Summarized from 2003–2005 Steelhead Report Card Returns

Location	Trips	Wild Kept	Wild Released	Hatchery Kept	Hatchery Released
Russian River	1,089	4	115	249	204
Russian to SF Bay	66	0	52	3	15
Bay Tributaries	29	1	15	1	1
Bay to San Lorenzo River	111	1	49	4	11
San Lorenzo River	429	4	159	3	150
Total	1,724	10	390	260	381

Source: Jackson 2007.

Impact BIO-198: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on Central Valley Steelhead DPS (Less than Significant)

The Central Valley steelhead DPS occupies waters stocked with steelhead from the DFG hatcheries on the Feather River, American River (Nimbus Fish Hatchery), and Mokelumne River, as well as the federal Coleman National Fish Hatchery. The annual average number of steelhead reported as caught (kept or released) by anglers was quite similar for hatchery-origin (3,952) and wild fish

(4,336), but the percentage of hatchery-origin fish kept (18.5%) was tenfold higher than the percentage of wild fish kept (1.7%) (Table 4-10). Moyle et al. (2008) noted that incidental mortality from catch and release of wild-origin Central Valley steelhead may become more important as numbers of wild-origin fish continue to decline, leading to a greater percentage of the remaining wild origin fish being caught. All hatchery produced steelhead in California are adipose fin-clipped to allow retention in sport fisheries. Retention of non-adipose fin-clipped steelhead is not allowed in Central Valley steelhead fisheries. Incidental mortality by anglers that target hatchery fish was not considered high enough to warrant a determination of significant impact. The impact would be less than significant.

Table 4-10. Average Annual Recreational Fishing Effort, Harvest, and Release of Steelhead in Regions including the Central Valley Steelhead DPS, as Summarized from 2003–2005 Steelhead Report Card Returns

Location	Trips	Wild Kept	Wild Released	Hatchery Kept	Hatchery Released
Upper Sacramento River*	445	11	344	37	124
Mid-Upper Sacramento River	271	4	237	31	96
Mid-Lower Sacramento River	126	2	43	15	38
Lower Sacramento River	59	1	16	9	9
Feather River	1,667	20	562	262	1,297
Yuba River	767	2	1,046	10	172
American River	3,542	31	1,809	359	1,440
Putah Creek	2	0	0	0	0
San Joaquin	7	0	7	1	0
Merced River	24	0	20	1	3
Tuolumne River	8	0	11	0	0
Stanislaus River	110	1	41	1	20
Mokelumne River	92	2	81	4	20
Calaveras River	34	0	45	1	2
Total	7,154	74	4,262	731	3,221

Source: Jackson 2007.

Impact BIO-199: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on Northern California Coastal Summer and Winter Steelhead DPS (Less than Significant)

The northern California coastal summer and winter steelhead DPS occupies waters stocked by the DFG Mad River Hatchery. Annual average data for 2003–2005 from the Steelhead Report Card suggest that the total number of hatchery-origin steelhead kept or released per year was almost 2,200 fish (Table 4-11). The apparent influence of the Mad River hatchery on the average annual steelhead catches detailed from Steelhead Report Cards was clear, with nearly 2,000 hatchery steelhead kept or released in the Mad River (Table 4-11). The average annual reported number of wild steelhead released in the Mad River was 257, with 3.5% of the total number caught being reported as kept. For the DPS as a whole, about 2% of the wild-origin fish reported as captured were kept, compared to 32% of hatchery-origin fish. Incidental mortality by anglers that target hatchery fish was not considered high enough to warrant a determination of significant impact. The impact would be less than significant.

Table 4-11. Average Annual Recreational Fishing Effort, Harvest, and Release of Steelhead in Regions including the Northern California Coastal Summer and Winter Steelhead DPS, as Summarized from 2003–2005 Steelhead Report Card Returns

Location	Trips	Wild Kept	Wild Released	Hatchery Kept	Hatchery Released
Klamath River to Mad River	190	2	219	13	23
Mad River	1,244	9	248	650	1,320
Mad to Eel River	23	0	5	9	31
Eel River	111	3	130	5	31
Van Duzen River	74	1	67	1	6
SF Eel River	250	4	265	2	30
MF Eel River	20	1	23	1	1
Eel River to Mattole River	10	0	15	0	0
Mattole River	132	10	173	1	4
Mattole River to Noyo River	65	0	42	1	1
Noyo River	12	0	9	0	0
Noyo River to Navarro River	14	0	14	1	2
Navarro River	104	0	105	0	9
Navarro River to Gualala River	164	2	195	1	9
Gualala River	316	2	231	4	13
Gualala River to Russian River	17	0	2	3	2
Total	2,746	34	1,743	692	1,482

Source: Jackson 2007.

Impact BIO-200: Salmon and Steelhead Stocking Program Non-Target Harvest Effects on Klamath Mountains Province Summer and Winter Steelhead DPS (Less than Significant)

The KMP summer and winter steelhead DPS occupies waters stocked with steelhead from the Iron Gate, Trinity River and Rowdy Creek (Smith River) hatcheries. The annual average catch data in the Steelhead Report Card returns for 2003–2005 indicate that steelhead anglers in the Smith River watershed kept a much greater proportion of wild steelhead (26%) caught than in any other DPS; the proportion of hatchery steelhead kept was similar to other DPSs (41%) (Table 4-12). The Smith River is the only region in California from which wild steelhead can be legally harvested. Data for the Klamath and Trinity River watersheds were more in keeping with other DPSs: 1.3% of wild-origin steelhead were kept, compared to 12.5% of hatchery origin steelhead.

Moyle et al. (2008) described the fishery for steelhead within the Klamath River: "Currently, sport fishing regulations prohibit take (*retention*) of wild winter steelhead and do not allow fishing of summer steelhead, although the fishing season for Chinook salmon in the Klamath and Trinity Rivers overlaps with summer steelhead distributions, thus subjecting the latter fish to possible fishing pressure. The effects of the fishery on steelhead populations are not known but are assumed to be small compared to other [negative] factors."

Incidental mortality by anglers that target hatchery fish was not considered high enough to warrant a determination of significant impact in the Trinity and Klamath rivers. Fishery regulations in the Smith River appear to be adequate to limit the impact of wild fish retention to a level that does not adversely impact the population. The impact would be less than significant.

Table 4-12. Average Annual Recreational Fishing Effort, Harvest, and Release of Steelhead in Regions including the Klamath Mountains Province Summer and Winter Steelhead DPS, as Summarized from 2003–2005 Steelhead Report Card Returns

Location	Trips	Wild kept	Wild released	Hatchery kept	Hatchery released
Smith River	3,783	623	1,355	537	687
NF Smith River	78	13	32	5	16
MF Smith River	965	129	494	104	174
SF Smith River	705	116	567	56	126
Smith to Klamath	55	4	67	13	42
Upper Klamath River	1,936	31	3,188	105	867
Shasta River	10	1	5	2	1
Scott River	116	0	199	1	2
Salmon River	121	0	227	0	6
Lower Klamath River	1,232	24	2,012	104	909
SF Trinity River	115	8	97	9	38
Hayfork Creek	26	1	28	2	0
Trinity River	5,296	55	2,974	606	3,968
New River	53	0	49	1	1
Total	14,491	1,005	11,294	1,545	6,837

Source: Jackson 2007.

Effects of Invasive Species and Pathogens Released through Stocking Salmon and Steelhead

Potential impacts associated with invasive species and pathogens are analyzed for "Impacts of the Trout Stocking Program," under the subheading "Effects from Introduction of Invasive Species and Pathogens." Those impacts are substantially the same with regard to the salmon and steelhead hatchery program.

Impact BIO-201: Impacts of Introducing Pathogens to Native Fish Populations as a Result of the Salmon and Steelhead Stocking Program (Less than Significant)

As detailed in the analysis of "Impacts of the Trout Stocking Program," under the subheading "Effects from Introduction of Invasive Species and Pathogens," existing precautions are substantially adequate to prevent introduction of pathogens to native fish populations via stocking program activities. This impact would be less than significant.

Impact BIO-202: Impacts of Introducing Pathogens to Native Amphibian Populations as a Result of the Salmon and Steelhead Stocking Program (Less than Significant with Mitigation)

As detailed the analysis of "Impacts of the Trout Stocking Program," under the subheading "Effects from Introduction of Invasive Species and Pathogens," there is potential for fish stocked under the salmon and steelhead stocking program to convey potentially epizootic pathogens to sensitive amphibian species, causing a substantial adverse impact on those amphibians. This impact is significant with regard to all amphibians listed in Table 4-1 that potentially occur in waters stocked under the salmon and steelhead stocking program. In response and to reduce this impact to less than significant, DFG shall implement Mitigation Measure BIO-107, described in the Trout Stocking impact section. With mitigation, this impact would be less than significant.

> **Mitigation Measure BIO-107: Implement Monitoring and Best Management Practices Program to Minimize Risk of Disease Transmission to Native Amphibian Populations**
>
> This mitigation measure is described in the trout stocking impact discussion, for Impact BIO-107.

Impact BIO-203: Impacts of Introducing Aquatic Invasive Species into Native Ecosystems as a Result of the Salmon and Steelhead Stocking Program (Less than Significant with Mitigation)

As detailed in the analysis of Impact BIO-10, the only aquatic invasive species currently known to be at risk of distribution via the stocking program is the NZMS, which has not yet been found at any salmon or steelhead hatchery. Nonetheless, as discussed in the analysis of Impact BIO-10, AIS are regarded as a substantial concern in hatchery operations at nearly all DFG hatcheries, but the current invasive species management approach at DFG hatcheries is not consistent between hatcheries. In particular, some hatcheries have adopted formal plans to monitor and respond to invasive species threats, while others have not done so. These plans are known as hazard analysis and critical control point (HACCP) plans.

HACCP plans provide a measured and appropriate response to the need for invasive species monitoring and control. Invasive species constitute a potentially significant risk to sensitive biological resources at every DFG hatchery. To address this impact and reduce it to less than significant, DFG shall implement Mitigation Measure BIO-10. With implementation of this mitigation measure, the potential impact of invasive species dissemination through salmon and steelhead stocking would be less than significant.

Genetics Effects from Interbreeding with Stocked Salmon and Steelhead

Hatchery salmon and steelhead do not hybridize with non-salmonid species; therefore, no genetic impacts are expected for green sturgeon, Owens tui chub, Goose Lake tui chub, Arroyo chub, Modoc sucker, Santa Ana sucker, Owens sucker, Cui-ui, hardhead, Owens speckled dace, Santa Ana speckled dace, eulachon, delta smelt, longfin smelt, river lamprey, Kern brook lamprey, unarmored three-spined stickleback, Sacramento perch, and tidewater goby.

Wild Native Trout Populations

Salmon and steelhead hatcheries stock native salmon (coho and Chinook) and steelhead within Central Valley and coastal rivers and streams that empty to the ocean, but some stocking of coho, Chinook, and kokanee occurs in lakes or reservoirs. Although under less anthropogenically affected

conditions, such as might be found outside the influence of hatcheries, wild populations of native trout may subsist with minimal, if any, negative interactions with salmon and steelhead in rivers and streams, many spawning populations consist of a high proportion of hatchery fish to naturally produced fish, which increases the potential for genetic interactions to occur.

General genetic effects are discussed in "Genetic Changes from Interbreeding with Stocked Trout." In addition, large numbers of hatchery fish returning to anadromous rivers and streams probably limit the success of naturally produced fish, even if successful interbreeding that could lead to genetic effects does not occur. This could result from some later-spawning hatchery fish disturbing the redds of naturally-produced fish, from some larger hatchery fish displacing smaller naturally-produced fish from good spawning habitat, or from some hatchery females diverting the reproductive effort of naturally-produced males (Flagg et al. 2000). If the population density is high enough, substantial percentages of fish may die without spawning at all, as happened in recent years with fall-run in several Central Valley streams with high escapements; Battle Creek is an extreme example, with almost 90% pre-spawning mortality in 2002 (Williams 2006). The potential level of genetic effects for native trout species is discussed below.

Impact BIO-204: Genetic Effects on Coastal Cutthroat Trout from Stocking Salmon and Steelhead (Less than Significant)

As described previously in the analysis of "Genetic Changes from Interbreeding with Stocked Trout," coastal cutthroat trout are susceptible to hybridization and introgression with closely related species such as *O. mykiss* (i.e., rainbow trout and steelhead). There are three salmon and steelhead stocking locations (Klamath, Mad, and Eel Rivers) within the coastal cutthroat trout's distribution (Figure 4-31). Note that, while the Eel River program has been discontinued, the facility made a single release of 9,524 juvenile steelhead in 2005; within the timeframe of this analysis.

Hybridization does occur between coastal cutthroat and steelhead trout (Baumsteiger et al. 2005), and studies have demonstrated a loss of fitness in the wild following hatchery rearing (e.g., Araki et al. 2008). However, because hatchery steelhead are stocked in a small proportion of coastal cutthroat trout watersheds, and because steelhead are managed as a recreational game fish to produce a substantial fishery, the genetic interactions with stocked steelhead are not expected to have a substantial adverse effect on coastal cutthroat trout. Such a conclusion is consistent with the findings of the NMFS's status review of coastal cutthroat trout in Washington, Oregon and California (Johnson et al. 1999), which attributed the decline of coastal cutthroat in Californai primarily to habitat degration associated with agriculture, flood control, logging, road building local development and irrigation withdrawals in larger rivers. This impact is thus considered to be less than significant.

Impact BIO-205: Genetic Effects on Lahontan Cutthroat Trout from Stocking Salmon and Steelhead (Less than Significant)

There are no anadromous salmon and steelhead hatchery stocking locations within the Lahontan cutthroat trout distribution (Figure 4-29). Thus, there is no potential for hybridization with this species, and the potential effects on genetic fitness and diversity of native Lahontan cutthroat trout associated with salmon and steelhead planting would be less than significant.

Impact BIO-206: Genetic Effects on California Golden Trout, Little Kern Golden Trout, Paiute Cutthroat Trout, McCloud River Redband Trout, Goose Lake Redband Trout, Warner Valley

Redband Trout, Eagle Lake Rainbow Trout, and Kern River Rainbow Trout from Stocking Salmon and Steelhead (Less than Significant)

Salmon and steelhead are not stocked into watersheds within the currently managed range of the California golden trout, Little Kern golden trout, Paiute cutthroat trout, McCloud River redband trout, Goose Lake redband trout, Warner Valley redband trout, Eagle Lake rainbow trout, and Kern River rainbow trout (Figures 4-29 through 4-33), which eliminates the potential for genetic impacts from salmon and steelhead stocking (California Department of Fish and Game 2008a). Since salmon and steelhead stocking does not occur within the range of these species, the potential effects on genetic fitness and diversity of the Little Kern golden trout, Paiute cutthroat trout, McCloud River redband trout, Goose Lake redband trout, and Warner Valley redband trout associated with salmon and trout planting would be less than significant.

Wild Salmon and Steelhead Populations

The anadromous salmon and steelhead portion of the DFG Program captures, spawns, rears and releases anadromous populations of salmon and steelhead in California's north coastal and Central Valley rivers. All aspects of hatchery programs have the potential to adversely affect the long-term genetic fitness and diversity of wild populations of salmon and steelhead that occupy these waters. Because of this potential to affect wild populations, HGMPs are developed for all hatchery programs. Two distinct evolutionarily significant units (ESUs) of coho salmon, five ESUs of Chinook salmon and six distinct population segments (DPSs) of steelhead occupy the waters affected by the Program (Table 4-1).

The term wild is used to describe fish that are born and spend their entire life cycle in nature regardless of their parentage and wild populations are groups of interbreeding fish born in nature—a substantial portion of their parents may be hatchery strays. Also, a distinction is made regarding where spawning occurs by the terms hatchery spawning, of which a portion of the fish spawned (brood stock) in the hatchery may be of wild origin, and natural spawning, of which a portion of the fish spawning in nature may be of hatchery origin.

The principal mechanisms by which the anadromous hatchery and stocking programs may affect the genetic integrity of native fish include the capture of native fish that might otherwise spawn in natural waters, the rearing of fish in artificial channels and ponds that cause a preferential selection for traits beneficial in the hatchery environment but that reduce their ability to survive in natural conditions in their streams of origin, and the interbreeding of fish exhibiting hatchery-selected genetic traits with the wild fish population. These mechanisms may result in two types of genetic hazards to wild salmon and steelhead populations: loss of genetic diversity within and among populations, and reduced fitness of a population affecting productivity and abundance. Araki et al. (2008) summarized a number of studies that reported a loss of reproductive success ("fitness") of hatchery fish in nature. Araki et al. (2009) further investigated the effects of interbreeding of hatchery fish with wild populations and concluded a loss of fitness of the receiving wild population, suggesting a loss of genetic fitness of the population. Some populations may be more affected than others due to a variety of factors such as the length of exposure to the hatchery environment, the use of non-local stocks in the hatchery brood stock, the degree of habitat fragmentation, the degree of interbreeding, and the reproductive success of hatchery fish in the wild population.

The impact of hatchery programs on the genetic integrity and fitness of the wild populations comprising each DPS or ESU has been assessed using methods recommended by the Hatchery Scientific Review Group (HSRG) (Mobrand et al. 2004), described below. The HSRG approach

incorporates some elements of assessment procedure recommended by Lindley et al. (2007) for Central Valley salmon and steelhead, but also differs from that approach in two major ways. First, the HSRG approach focuses on three parameters:

- the percentage of hatchery brood stock derived from wild adults (pNOB);

- the effective percentage of hatchery-origin spawners that spawn in the wild (pHOS); and

- the "proportionate of natural influence" (PNI), defined as PNI = pNOB/(pNOB + pHOS).

The Lindley and HSRG approaches both recognize the importance of keeping pHOS low to limit gene flow from the hatchery to the wild population. Both approaches also recognize that pHOS can be reduced by reducing hatchery production and/or by increasing harvest on hatchery fish. The approaches diverge in the importance ascribed to pHOS for "segregated" versus "integrated" hatchery programs. An integrated program is defined as one in which the intent is for the local natural environment to drive the adaptation and fitness of a composite population of fish that spawns both in a hatchery and in nature (Mobrand et al. 2005). This is achieved by including wild (i.e., fish that spent an entire life cycle in nature) in the hatchery brood stock. The intent of a segregated (a.k.a., isolated) program, on the other hand, is for the hatchery population to be reproductively isolated from wild populations. Wild adults are purposely excluded from the hatchery brood stock. Segregated programs attempt to minimize genetic interactions between hatchery and wild fish by minimizing pHOS, while integrated programs increase the genetic similarity between hatchery progeny and wild fish by maximizing pNOB and minimizing pHOS. The PNI represents the degree to which natural selection drives the evolution of the integrated stock; a PNI value of 0.5 indicates equal natural and hatchery influence while a value of 1.0 indicates all influence is from the natural environment (i.e., that pHOS is zero). Therefore, an integrated program can have a pHOS greater than 5% and still pose a low risk so long as pNOB is high enough to maintain a high PNI. Lindley et al. (2007) did not r include PNI and did not quantify the degree to which genetic risk decreases as wild fish make up a larger proportion of the brood stock. Therefore, risk assessments under the Lindley approach are couched only in terms of maximum permissible pHOS, regardless of the type of hatchery and the proportion of wild fish in the brood stock. Risk assessments under the HSRG approach depend very much on whether the hatchery program is integrated or segregated, with integrated and segregated programs being evaluated in terms of PNI and pHOS, respectively. However, these approaches converge when evaluating hatchery strays between populations. Hatchery fish from an integrated program straying to other populations are evaluated strictly based on the pHOS criteria in both approaches.

The second major difference between the HSRG methodology and the approach described by Lindley et al. (2007) concerns the permissible duration of a hatchery program. Lindley et al. assumed that genetic impacts become at least "moderate" after four generations of hatchery production, regardless of the quality of brood stock in terms of pNOB, local donor stock, and other hatchery best management practices. The HSRG approach, on the other hand, is based on a genetic model (Ford 2002) that assumes that fitness impacts increase to an asymptote over time. Estimates of genetic fitness impacts are made after the genetic equilibrium has been reached. It should, however, be noted that AHA-based numerical estimates of abundance and productivity were not used in the analysis presented in this document. Instead, the model was used to estimate pHOS and PNI values, which were used to make the impact assessment.

The criteria described by Lindley et al. (2007) to evaluate potential genetic impact- were not used in this analysis. The Ford (2002) model and criteria developed by the HSRG (Mobrand et al. 2005;

Hatchery Scientific Review Group 2009) provide a more accurate and useful understanding of genetic interaction between hatchery and wild origin fish. Specifically, the HSRG model provides more information about viable ways to mitigate hatchery impacts, because it assumes fitness impacts can be reduced by increasing the proportion of wild brood stock.

To facilitate analyses of this kind, the HSRG developed a biometric application called the "All H Analyzer" or simply "AHA". Originally developed to compare the effects of various hatchery management options on the long-term sustainability of native salmonids, the application is here used to evaluate impacts of the DFG anadromous hatchery and stocking program on the wild salmon and steelhead populations. This application is described in detail in Appendix F. Information on the abundance, productivity, spatial structure and diversity of the various wild populations that make up each ESU and DPS was gathered or estimated based on extrapolation of data as input to the analysis (see Appendix F for more detail). Also, detailed information has been obtained on the number and location of hatchery releases, and the survival and straying rates of hatchery-reared salmon and steelhead. The assessment generates results that are similar but not identical to the four Viable Salmon Population (VSP) parameters of abundance, productivity, diversity, and spatial structure as defined by NOAA (McElhany et al. 2000). The AHA-based indicators of abundance and productivity used in this analysis are analogous to, but not the same as, the measures defined by NOAA for establishing recovery goals (Table 4-13).

The impact analyses below focus on hatchery impacts on the abundance, productivity, diversity, and spatial structure of wild populations. Each of the principal mechanisms of effect, to varying degrees, changes these four parameters. Abundance is the average number of adult salmonids of wild origin present in the population at the time of spawning. Higher abundance implies higher viability. In this analysis, the indicator of abundance is the projected average number of adult wild recruits in the natural spawning escapement. Productivity is the inherent rate of increase a population will exhibit, especially at low abundance level. It is a measure of the rate at which a population will recover from a depressed state. Productivity impacts are expressed in terms of changes to the Beverton-Holt productivity parameter, which quantifies the maximum possible adult recruitment rate (adult progeny per spawner). More specifically, productivity impacts across alternative management strategies are compared in terms of the projected "adjusted productivity", the reduced productivity of the wild population after fitness (due to hatchery influence) and harvest impacts are taken into consideration. It is intuitively obvious that larger and more productive populations are less likely to go extinct than those that are smaller and/or less productive.

Table 4-13. Comparison of Primary Variable Definitions for Salmon and Steelhead Population Viability

Variable	NOAA Definition	AHA Analog	Citation
Abundance	The average number of adults on the spawning grounds per year. Estimation method may vary based on the assessment method.	The projected average number of wild adult spawners in the population. AHA reports the average number of wild spawners (NOS).	McElhaney et al. 2000; Mobrand et al. 2005
Productivity	Population growth rate (i.e., productivity over the entire life cycle).	The inherent rate of increase a population will exhibit at low abundance levels. Specifically a measure of the rate at which a population will grow in the absence of density dependent effects. AHA reports adjusted productivity which includes harvest and fitness effects.	McElhaney et al. 2000; Mobrand et al. 2005
Spatial Structure	The number, size and geographic distribution of spawning aggregations.	The number, size and geographic distribution of spawning aggregations/populations within an ESU/DPS/MPG.	Hatchery Scientific Review Group 2009
Diversity	Preservation of local variability in such life history parameters as run timing, age structure, fecundity, etc. to the maintenance of the environmental conditions that support such life history variability and to the nature and degree of interbreeding between populations.	The proportion of hatchery origin spawners (pHOS) and the proportionate natural influence (PNI) are measures of interbreeding between wild and hatchery origin fish. Diversity within a population likely decreases with higher pHOS or lower PNI because the more uniform hatchery environment is driving population diversity compared to the more diverse natural environment.	Hatchery Scientific Review Group 2009

Spatial structure and diversity relate to the capability of a population to cope with environmental variability. Spatial structure refers to the number, size and geographic distribution (relative to the historical distribution) of spawning aggregations. Populations with many large spawning aggregations distributed over different watersheds are less vulnerable to local catastrophes and are thus more viable. While the AHA application doesn't specifically compute spatial structure affects, outputs are used to reach conclusions about the nature of the spatial structure as it affects population viability for each MPG. Diversity refers to preservation of local variability in such life history parameters as run timing, age structure, and fecundity to the maintenance of the environmental conditions that support such life history variability, and to the nature and degree of interbreeding between populations.

A primary reason for using the AHA application is that it organizes information pertinent to the populations and hatchery programs and permits a quantitative comparison of the effects of hatchery straying on wild population productivity and abundance that can be compared between alternatives.

Whether a hatchery is operated as an integrated or segregated program is important when evaluating impacts with AHA. Most hatchery programs operated by DFG are operated as integrated hatcheries. Integrated programs are evaluated on the basis of how strongly the natural environment drives the heritable adaptations of the wild population. The proportionate natural influence, or PNI, indicates the fitness of a population with respect to the natural environment; the larger the PNI, the greater the influence of the natural environment on the population and the higher the fitness of the composite (hatchery + wild) population in nature. When PNI is 0.5, the natural and hatchery environment exert equal influence on the population. Thus, PNI must exceed 0.5 if the natural environment is to dominate selection. For populations of high biological significance, the HSRG (2009) has suggested that a PNI of at least 0.67 (halfway between 0.5 and 1.0) is desirable to better ensure the long-term fitness of the population. These two reference points (0.5 and 0.67) for PNI are used here to index differences in the fitness impacts of integrated programs on wild populations with which they are associated.

Segregated programs are maintained with hatchery-origin brood stock only. The goal of a segregated program is generally harvest augmentation, but may also be for conservation as a gene-bank or for reintroduction into areas where native populations have been extirpated. There are just a few segregated programs operated by DFG. The Monterey Bay Chinook net pen program is an example of a segregated program. This program is based on hatchery brood stock from the Central Valley. In this case there are no nearby wild populations of Chinook to interbreed with hatchery adults. The fitness of a wild population is threatened when it interbreeds with hatchery fish from segregated programs, and the degree of impact is proportional to the extent of interbreeding. In this analysis, pHOS is used to index the degree to which the fitness of the wild population might decline because of loss of adaption to the natural environment from segregated programs or integrated programs from different populations. Following the HSRG approach, two pHOS reference points are used, less than 5% (low impact to fitness) and less than 10% (moderate impact), to indicate critical thresholds for the impact of segregated hatchery programs on wild populations and the interbreeding of hatchery adults from integrated hatchery programs not associated with the wild population (i.e., between population hatchery strays).In this analysis, the following terminology has been adopted to indicate the PNI and pHOS fitness categories achieved. The term "supporting" (of rebuilding) is used when PNI is greater than 0.67 (integrated hatchery programs/populations) or pHOS is less than 5% (hatchery strays from segregated or out-of-population integrated programs). If the PNI for an integrated program/population is between 0.5 and 0.67, it is considered to be "consistent" with population rebuilding. Similarly, wild populations with pHOS values between 5 and 10% (hatchery strays from segregated programs or out-of-population integrated programs) are considered to be "consistent" with stock rebuilding. Programs for which neither of these conditions pertains are considered to be "not consistent" with stock rebuilding.

Based on results of the AHA analysis and previous hatchery evaluations (Moyle et al. 2008; National Marine Fisheries Service 2004a; Joint Hatchery Review Committee 2001a), the potential level of genetic effects are discussed below. A separate analysis is presented for each of the ESUs and DPSs considered at risk due to the current DFG Program.

Only three ESUs (Central Valley spring-run Chinook salmon, Central Valley winter-run Chinook salmon and Central Valley fall/late-fall Chinook salmon) were analyzed using the AHA application.

Critical input data were lacking for the other ESUs and all DPSs. All other ESUs and DPSs were analyzed using the concepts of pHOS and PNI, and criteria described, but without using the AHA application.

Determination of Significance

The significance of genetic impacts is assessed differently for individual populations and for an ESU or DPS. The use of the parameters pHOS, and PNI to quantify the relative strength of natural versus artificial selection on a specific population, and therefore the significance of impact, has already been described. The means of determining the significance of an impact on an ESU consisting of numerous populations is necessarily different.

Significant impacts at the ESU or DPS level are based on the concepts of *representation* and *redundancy*, whereby "in the most general terms, ESU [or DPS] viability increases with the number of populations, the viability of these populations, the diversity of the populations, and the diversity of habitats that they occupy" (Lindley et al. 2007). "Representation" refers to the distribution of wild production over historical production areas and particularly over areas that differ in environmentally significant ways. For example, Lindley et al. (2007) speak of "diversity groups" within an ESU, and describe four diversity groups within the Central Valley spring-run Chinook ESU: the "basalt and porous lava" diversity group at the northern end of the Central Valley surrounding Lake Shasta, the Northern Sierra Nevada diversity group, the Southern Sierra Nevada diversity group and the Northwestern California diversity group. These production areas supported spring Chinook production in the past and differ from each other in terms of the frequency of cool, spring-fed streams, the importance of summer snowmelt to the hydrograph, and in other climatological, geological and hydrological ways. Life history diversity reflects habitat diversity, and an ESU comprising a wide variety of life history patterns is better able to cope with environmental fluctuations and to persist over time than an ESU that either naturally or as a result of past human impacts has low life history diversity and a resulting elevated sensitivity to alteration of the diversity of its physical habitat. Thus, the significance of adverse impacts increases as their distribution over diversity groups increases.

"Redundancy" refers to the abundance of self sustaining populations within a diversity group (Lindley et al. 2007). It is intuitively obvious that the viability of a diversity group is increased as the number of self-sustaining populations within it increases. In this sense, a self-sustaining population is equivalent to an "independent population" as defined by NMFS (2004a). Independent populations are viable without any immigration from other populations, and have been characterized as being geographically isolated (more than ~50 km from the nearest neighbor), relatively large (watershed area > 500 km^2) and representing substantial genetic and/or environmental variability within the ESU. "Dependent populations," on the other hand, are defined by NMFS (2004a) as "populations that would not exist without immigration from neighboring populations, but that contribute to viability by linking other populations and by containing valuable genetic traits."

Thus, in the context of independent and dependent populations, impact to an ESU/DPS is considered to be significant when any one or more of the following statements is true:

● Two or more independent populations in different diversity groups are impacted.

● A majority of independent populations within a single diversity group are impacted.

● The sole independent population within a diversity group is impacted.

● Any population is impacted in a diversity group that does not contain any independent populations.

● Existing hatchery operations represent a substantial loss of opportunity to increase representation and/or redundancy within an ESU/DPS.

Impact BIO-207: Genetic Effects on Central Valley Spring-Run Chinook Salmon ESU from Stocking Salmon and Steelhead (Significant and Unavoidable)

Historically, there were 19 independent populations and eight dependent populations of spring-run Chinook salmon in the Central Valley (National Marine Fisheries Service 2004a). Now, there are four independent[11] (Butte, Mill, Deer and Yuba) and six dependent (Antelope, Big Chico, Clear, Thomes, Cottonwood/Beegum, and Stony) populations remaining, along with one "other" integrated hatchery-wild population in the Feather River and an "other" population in the Sacramento River below Keswick Dam (Figure 4-39) (National Marine Fisheries Service 2004a). All of these populations, including Feather River wild and hatchery fish, are included in the ESU. Historically there were four diversity groups in the Central Valley spring-run Chinook ESU (Lindley et al. 2007). Spring-run Chinook are extirpated from the basalt and porous lava group and the southern Sierra Nevada group. Mill, Deer, Big Chico, Antelope, Butte, Yuba and Feather populations are in the northern Sierra Nevada diversity group and Clear, Cottonwood/Beegum, Thomes, and Stony populations are in the Northwestern California group.

The single hatchery program in this ESU, the Feather River Hatchery (operated by DFG with funding from California DWR), released an average of 2,461,557 smolts annually over the years 2004–2008. Approximately half of the releases were made in San Pablo Bay (1,017,092) and half (1,444,467) in the Feather River, below Gridley over these years.

The naturally spawning population in the Feather River is something of an anomaly. NMFS (2004a) state that Feather River spring-run Chinook are independent from the spring-run Chinook salmon populations in southern Cascade streams, as indicated by several genetic studies (Banks et al. 2000; Kim et al. 1999; Hedgecock 2002). Hedgecock (2002) found small, but statistically significant allele frequency differences between Feather River spring-run Chinook salmon and fall-run Chinook salmon, and that spring-run Chinook salmon captured in the river formed a homogeneous group with spring-run Chinook salmon captured in the hatchery. David Teel of the NWFSC (unpublished data cited in Good et al. 2005:156) used allozymes to show that Butte and Deer creeks spring-run Chinook salmon are not closely related to sympatric fall-run Chinook salmon populations or the Feather River Hatchery spring-run Chinook salmon stock. Feather River Hatchery spring-run Chinook salmon, putative Feather River wild spring-run Chinook salmon, and Yuba River spring-run Chinook salmon fell into a large cluster composed mostly of wild- and hatchery-origin fall-run Chinook salmon. Hedgecock (2002) interpreted these data as indicating that the historical Feather River spring-run Chinook salmon evolved from an ancestral Feather River fall-run population, following the pattern seen in Klamath River Chinook salmon but different from the pattern seen in Deer, Butte, and Mill Creeks. Hedgecock also surmised that the Feather River fall-run and Feather River spring-run populations have merged.

There is, however, considerable evidence that the genetic similarities between Feather River spring- and fall-run Chinook are the result of hybridization between the runs. Behavioral evidence of interbreeding is also found in the fact that that many hatchery fish released as spring-run returned

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[11] ICF Jones & Stokes analyzed Mill and Deer Creek as two independent populations.

with the fall run, and that many putative fall-run fish have returned with the spring-run (California Department of Fish and Game 1998). This hybridization is not entirely from hatchery operations. Some interbreeding between runs may have begun prior to construction of Oroville Dam due to early hydropower and agricultural diversions blocking upstream access (Joint Hatchery Review Committee 2001a). Interbreeding was exacerbated by the inability of the Feather River Hatchery to collect and hold spring-run adults when they first arrive in the watershed (April–June) due to high pre-spawn mortality rates (Lindley et al. 2007). In past years, spring-run brood stock was collected during their spawning period of August–October. Because fall-run Chinook begin to enter the hatchery during September, an unknown proportion of physically indistinguishable fall-run spawners were undoubtedly collected as spring-run brood stock. Procedures were revised such that Feather River Chinook salmon entering the hatchery prior to June 30 are marked and released back into the river. Only marked fish are used during the spring-run brood stock collection period.

Although Good et al. (2005) do not believe Feather River spring-run Chinook should be included in the ESU, the TRT argued for their inclusion because they may be all that is left of an important component of the ESU.

Interbreeding of Feather River Hatchery spring-run fish with wild spring-run fish in other basins has also been a concern (Joint Hatchery Review Committee 2001a). The practice of releasing Feather River Hatchery spring-run Chinook in San Pablo Bay to improve survival and reduce competition and predation impacts in-river increases the incidence of straying likely because of poor imprinting to their home hatchery waters (see Joint Hatchery Review Committee 2001b). Stray rates for all Chinook released from the Feather River Hatchery were estimated to be 54% for those released in the Sacramento/San Joaquin River Delta as opposed to 8% for those released in-river (Dettman and Kelley 1987, as reported in Joint Hatchery Review Committee 2001b). From 1984 to 2002, a majority of smolts were released off-site in most years to maximize survival (Sommer et al. 2001). In order to reduce the risk of straying and interbreeding with wild populations, the hatchery now releases about half of its annual production within the Feather River and the remainder in San Pablo Bay (Joint Hatchery Review Committee 2001b).

ICF Jones & Stokes independently assessed stray indices[12] of Central Valley spring-run Chinook over a period including the most recent recoveries (1987–2007). The assessment was based on coded-wire tag recovery data posted to the Regional Mark Information System. ICF Jones & Stokes queried the database for recoveries at hatcheries or on spawning grounds and grouped recoveries by population (e.g., Feather River fall-run Chinook recoveries consisted of recoveries made at Feather River Hatchery, in the Feather River, and in the so-called high- and low-flow reaches of the Feather River). Based on tagging rates, each recovered tag was expanded to an estimate of the total number of tagged fish in the sample strata. The straying analysis assessed each tag code individually and determined the estimated number of tagged fish from a given hatchery and release location that were recovered in different streams. These numbers were then converted to percentages by tag code, thus adjusting for differences in the number of marked fish released. Only releases with expanded total recoveries greater than 100 fish were included in the analysis.

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[12] Stray indices are computed based on the number of tagged adults recovered not at the hatchery divided by the total number of tagged adults recovered (strays plus fish recovered at the hatchery).

Of the spring-run Chinook released in the Feather River, tag recoveries suggested that the great majority of spawners (over 98%) returned to the Feather River (Table 4-14) and 47% of these fish were recovered at the hatchery. A small proportion of spawners originating from on-site releases were also recovered in Battle Creek (0.02%) and the Yuba River (1.7%). Spring-run Chinook that were released from San Francisco Bay (including San Pablo Bay) strayed to a greater extent. According to tag recoveries, about 85% of those that survived at sea returned to the Feather River and 30% of these fish (26% overall) were recovered at the hatchery. Other recovery locations for off-site releases of Feather River Hatchery spring-run Chinook included the Yuba River (8%) and the Sacramento River (6%).

Table 4-14. Estimated Percentages of Feather River Hatchery Spring-Run Chinook Salmon Returning to Various Central Valley Streams[a]

	Release Location	
Recovery Location	**Feather River**	**San Francisco Bay**
Feather River	98% (46%)	85% (26%)
American River	0%	0.2%
Battle Creek	0.02%	0.8%
Butte Creek	0%	0.03%
Merced River	0%	0.03%
Mokelumne River	0%	0.07%
Sacramento River	0%	6%
Tuolumne River	0%	0.01%
Yuba River	2%	8%

[a] Based on coded-wire tag recovery data from the Regional Mark Information System Database. Also shown is the percent tags recovered at the Feather River Hatchery (in parenthesis).

Other wild populations in the ESU potentially affected by Feather River Hatchery strays include Deer, Mill, Clear and Antelope Creeks. Table 4-15 summarizes coded-wire tag data collected in these streams since 1988.

Table 4-15. Summary of Coded-Wire Tags from Spring-Run Chinook Salmon Collected in Mill, Deer, Clear and Antelope Creeks, 1988–2008

Stream	Period of Record	No. Survey Years	No. Years Tagged Fish Observed	Percent of Fish with Tag[a]	Origins of Tagged Fish[b]
Mill Creek	1989-2008	18	0	0	
Deer Creek	1992-2008	12	0	0	
Clear Creek	2003-2008	6	3	0.03 (0.02-0.04)	Feather River Hatchery, Butte Creek (wild)
Antelope Creek	1993-2008	8	0	0	

[a] Average and range (in parentheses) of annual number of ad-clipped or coded-wire tagged fish observed as a percentage of the total number of fish examined.

[b] Dominant hatchery sources.

Source: Unpublished data, Colleen Harvey-Arrison, California Department of Fish and Game; Matt Brown, U.S. Fish and Wildlife Service.

Hatchery spring-run Chinook salmon were detected in Clear Creek in half the years that surveys were conducted. Four of the 160 carcasses examined (0.03%) in 2003, 2004, and 2008 had an adipose-clip or coded-wire tag (CWT). Coded-wire tags were detected in two of these fish, one of which originated from Butte Creek (wild) and the other from Feather River Hatchery (San Pablo Bay release). No tagged spring-run salmon have been observed in Mill, Deer, and Antelope Creek. Subject to the caveat that sampling effort was low, the total lack of observations of tagged spring-run Chinook in Mill, Deer, and Antelope Creek over 8 to 18 years of surveys suggests that the degree of hatchery influence on these populations is negligible.

AHA Results

Using the pHOS and PNI criteria described in the methods and stray assumptions from coded-wire tag recoveries, results from AHA indicate that nine of the twelve wild populations were not affected by interbreeding with hatchery strays while hatchery strays to three of the twelve populations were high enough to bring their pHOS into the range (>10%) that reduced the population's rating down to *not consistent with rebuilding* (Table 4-16). The single integrated spring-run DFG hatchery program (Feather River Hatchery) within the spring-run Chinook ESU had a PNI less than 0.50 due to low inclusion of wild fish in the brood stock and high percentage of hatchery strays to the wild population bringing the population's rating down to *not consistent with rebuilding*.

Table 4-16. Populations Comprising the Central Valley Spring-run ESU that Support Rebuilding, Are Consistent with Rebuilding, or Are Not Consistent with Rebuilding under Current Conditions

Population	Population Designation[1]	Population Supports Rebuilding	Population Consistent with Rebuilding	Population not Consistent with Rebuilding	PNI[2]	pHOS[3]
Butte Creek Spring Chinook (Wild)	Independent	X			NA	0%
Deer Creek Spring Chinook (Wild)	Independent	X			NA	0%
Mill Creek Spring Chinook (Wild)	Independent	X			NA	0%
Yuba River Spring Chinook (Wild)	Independent			X	NA	38%
Antelope Spring Chinook (Wild)	Independent	X			NA	0%
Battle Creek Spring Chinook (Wild)	Independent			X	NA	12%
Beegum-Cottonwood Spring Chinook (Wild)	Dependant	X			NA	0%
Big Chico Spring Chinook (Wild)	Dependant	X			NA	0%
Clear Cr Spring Chinook (Wild)	Dependant	X			NA	0%
Stony Cr Spring Chinook (Wild)	Dependant	X			NA	0%
Thomes Spring Chinook (Wild)	Dependant	X			NA	0%
Feather River Spring Chinook (Integrated)	Independent			X	0.05	91%
Sacramento River Spring Chinook (Wild production above Red Bluff Diversion Dam)	Independent			X	NA	52%

Source: AHA modeling results.

[1] per National Marine Fisheries Service (2004a).

[2] Proportionate natural influence—applies only to integrated hatchery/wild populations.

[3] Percent hatchery spawners in wild population.

Because of the clear negative impact to the Feather River wild population, the impact to the ESU could be considered significant on the basis of impacts on the Feather and Yuba populations (i.e., redundancy) within a diversity group (northern Sierra Nevada) . Although Lindley et al. (2007) did not assign the Sacramento main stem above Red Bluff to any particular diversity group, its environmental distinctiveness and size suggest it might reasonably be considered to be a separate diversity group. The impact of the Feather River Hatchery, would be significant at the ESU level when considering impacts on the diversity of the ESU.

The results of our analysis are broadly comparable to the analysis of Moyle et al. (2008) in which genetic risk to Central Valley Spring-run Chinook salmon was rated as a 2 on a scale of 1 (very high risk) to 5 (very low risk). Moyle attributed the genetic risk to relatively small population size and the potential for inbreeding during successive years of poor returns, and to hybridization of the Feather River population with fall-run Chinook. Our results are also consistent with Good et al. (2005) and the Joint Hatchery Review Committee (Joint Hatchery Review Committee 2001a). In the 2005 NOAA Fisheries Status Review of West Coast Salmon and Steelhead (Good et al. 2005), the continued operation of the Feather River Hatchery was cited as one of the three major threats to the ESU, the others being loss of historical habitat and habitat degradation. The Report of the Subcommittee on off-site release and straying of hatchery produced Chinook Salmon (Joint Hatchery Review Committee 2001a) concluded that the only way to reduce the risk of fitness loss to existing spring-run Chinook salmon is "to minimize interactions between hatchery and wild populations," either by "decreased hatchery production or selective harvest strategies," or "by reducing the numbers of fish released off-site."

The Feather River spring-run Chinook hatchery program thus has the potential to cause significant adverse impacts on the genetic fitness of this ESU. DFG shall implement Mitigation Measure BIO-139. With mitigation, impacts would remain significant and unavoidable.

Impact BIO-208: Genetic Effects on Chinook Salmon, Central Valley Fall-/Late Fall–Run ESU, from Stocking Salmon and Steelhead (Significant and Unavoidable)

This ESU includes all naturally spawned populations of fall-run and late fall-run Chinook salmon in the Sacramento and San Joaquin river basins and their tributaries, east of Carquinez Strait (Figure 4-38). DFG describes the fall-run as migrating from July to December, with spawning taking place from October to December and late fall-run as migrating from October to late December with spawning occurring between January and mid-April. NMFS classified the ESU as a Species of Concern on April 15, 2004, primarily because of uncertainty regarding the status of the naturally spawning populations. Except for Central Valley winter-run Chinook, which are largely restricted to the main stem Sacramento River between Keswick Dam and Red Bluff Dam, the existing Central Valley fall-run Chinook population is unique among North American Chinook salmon ESUs in having little or no detectable geographically-structured genetic variation (Williamson and May 2005; Banks et al. 2000). The degree of geographically structured genetic diversity in the historical population is unknown, although it was almost certainly much greater than at present, unless highly variable hydrologic conditions prevented the establishment of local adaptations (Lindley et al. 2009). Although Central Valley late fall-run Chinook are genetically distinguishable from fall-run Chinook, they are still closely related and have been included in the same ESU (Myers et al. 1998).

Historically, fall-run Chinook salmon likely spawned in all gravel-bed reaches of the main rivers and tributaries of the valley and foothills below about 1000 ft elevation, and even in intermittent streams as long as flows in November and December permitted adult access (Yoshiyama et al. 1998). Williams (2006) reports that fall-run Chinook also spawned at higher elevations in such Sacramento tributaries as the McCloud River. Late-fall Chinook probably spawned further upstream than fall-run, in reaches with water temperatures low enough to permit juveniles to rear through the summer. Yoshiyama et al. (1998) state that late-fall run fish spawned in the main stem Sacramento River and major tributary reaches now blocked by Shasta Dam, in the upper main-stem reaches of other Sacramento Valley streams (Fisher 1994) such as the American River (Clark 1929), and perhaps in the upper third of the main stem San Joaquin River. Much of the historical fall-run habitat is still accessible and still is used to varying degrees, because dams are generally located

upstream of fall-run spawning areas. However, most of the historical late fall-run habitat has been lost, and current production is limited primarily to the main stem Sacramento above Butte Creek, to Battle Creek below Coleman NFH, and possibly to Butte Creek itself (Yoshiyama et al. 1998; Williams 2006).

The genetic homogenization of Central Valley fall-run Chinook salmon has often been attributed to the long history of hatchery stocking and to frequent stock transfers between hatcheries (Yoshiyama et al. 1998 ; Williamson and May 2005; Lindley et al. 2009). Annual releases of hatchery juveniles generally exceed 20 million from DFG hatcheries and another 13 million fish are released from the Coleman National Fish Hatchery (USFWS), together representing an annual release of 33 million fish (Table 4-17). Over half of these fish (~17 million) are released from locations far downstream of their natal hatchery, often from locations in the lower Sacramento River, San Francisco Bay and San Pablo Bay. These fish are trucked directly from the hatchery to release facilities, without contact with stream water between the hatchery and the release facility. This type of release has been shown to lead to a high incidence of straying in the Columbia Basin (Pascual et al. 1995; Quinn 1997).

The Joint Hatchery Review Committee (Joint Hatchery Review Committee 2001b) examined the level of straying associated with off-site releases. They summarized results of a number of studies for a variety of hatchery programs in the Central Valley. The general import of all of these studies is that on-site releases typically result in stray indices on the order of 5% to 10% while off-site releases result in straying indices as high as 90%, with higher indices as the distance from release point to hatchery increases.

Table 4-17. Hatchery Programs Operating in the Central Valley Fall-/Late Fall–Run Chinook ESU

Population (Diversity Group)	Race	Hatchery Type	Hatchery Purpose	Hatchery Name	Operator (Funding Agency)	Average Annual Release (2004–2008)	Release Locations 2004–2008
Battle Creek (none defined)	Fall-run	Integrated	Harv	Coleman National Fish Hatchery (on Battle Creek)	USFWS (Bureau of Reclamation)	12,000,000[1]	Battle Creek (however in 2008 1.4 million fish were released from San Pablo Bay)
	Late Fall-run	Integrated	Harv		USFWS (Bureau of Reclamation)	1,000,000	Battle Creek
Feather River (none defined)	Fall-run	Integrated	Harv	Feather River Hatchery and the Thermalito Annex	DFG (California DWR)	9,564,092	Most (94%) were released from locations in San Francisco Bay and San Pablo Bay, 5% of the release was from locations in the Sacramento River, and the remaining 1% was experimental releases

Population (Diversity Group)	Race	Hatchery Type	Hatchery Purpose	Hatchery Name	Operator (Funding Agency)	Average Annual Release (2004–2008)	Release Locations 2004–2008
American River (none defined)	Fall-run	Integrated	Harv	Nimbus Hatchery	DFG (Bureau of Reclamation)	4,417,250	San Francisco Bay and San Pablo Bay
Mokelumne River (none defined)	Fall-run	Segregated	Harv	Mokelumne River Hatchery	DFG (East Bay MUD)	6,029,596	54% from locations in the Mokelumne River, 42% from locations in San Francisco Bay and San Pablo Bay, and 4% where released from net pens on the coast
Merced River (none defined)	Fall-run	Integrated	Harv	Merced River Fish Facility	DFG (California DWR)	707,392	65% from locations in the Merced River, 28% from locations in the main stem San Joaquin River, and the remainder experimental releases from locations in the Stanislaus and Tuolumne rivers.

Sources: Williams (2006); California Fish and Game 2008a (Hatchery Information System Database).

[1] Chinook release number from the Coleman National Fish Hatchery represents production goals; actual release data were unavailable.

For this analysis, ICF Jones & Stokes conducted an independent assessment of stray indices of Central Valley fall-run Chinook, including data from the most recent releases (1987–2007). Coded-wire tag recoveries were based on data posted to the Regional Mark Information System (RMIS). The database was queried for recoveries at hatcheries or on spawning grounds and recoveries grouped by hatchery program and release group. Each tag recovered was expanded by the reporting agency to an estimated number of tagged fish in the survey represented by that tag (Johnson 2004); the estimated number was used to assess straying. For each tag code, the percentage of estimated numbers recovered in the different populations (locations) was calculated. The straying analysis assessed each tag code individually and determined the estimated number of fish from a given hatchery and release location that were recovered in different streams. The estimated numbers were then converted to percentages by tag code, thus accounting for differences in the number of tagged fish in each tag code. The percentage of hatchery-origin adults returning to the natal stream that subsequently returned to the natal hatchery was calculated as the estimated number of tagged hatchery-origin fish that were recovered at the hatchery divided by the sum of estimated number of tagged fish recovered at the hatchery and on the spawning grounds. Only tag codes with total estimated recoveries of more than 100 fish were included in the calculation. The pattern of straying for Central Valley Fall-Run hatchery Chinook salmon varied by hatchery and release location.

Feather River Hatchery Strays

Of the fall-run Chinook salmon raised at the Feather River Hatchery and released into the Feather River, the tag-recovery data indicated that almost 97% of those surviving to reenter the Central Valley as spawners returned to the Feather River, and just under half (43%) of these fish were recovered at the hatchery itself. Several streams other than the Feather River received Feather River Hatchery strays from on-site releases, with the Yuba River receiving the largest percentage (3%). Stray indices for Feather River Hatchery fish released outside the Feather River were higher than for on-site releases, and tended to increase with increasing distance (in river miles) from the hatchery. Expressed in terms of returns to the Feather River (hatchery and river recoveries), stray indices for fish released in the Sacramento River below the Feather River confluence, in San Francisco Bay or Suisun Bay ("Bay releases") or from experimental releases in the Mokelumne River were 5%, 22% and 54%, respectively. For the same release points, recoveries at the hatchery were 41%, 28% and 38%, respectively. Stray indices to watersheds other than the Feather River also increased for off-site releases, with Battle Creek receiving 1% to 4% of the recoveries for Sacramento and Bay releases and 53% of the recoveries for Mokelumne River releases. Other watersheds receiving significant proportions of Feather River Hatchery fish released off-site included the Yuba River (2% for Bay releases, 3% for Mokelumne releases), the Sacramento main stem (8% for Bay releases) and the American River (4% for Bay releases).

Nimbus Hatchery Strays

All Nimbus Hatchery fall-run Chinook have been released in San Francisco Bay or San Pablo Bay in recent years. Nearly all (97%) of the tag recoveries from these releases occurred inside the American River, but only 17% were recovered at the hatchery. Although Nimbus Hatchery strays were recovered in a fair number of watersheds outside the American River (Battle and Butte creeks and the Feather, Merced, Mokelumne, Sacramento, Stanislaus, Tuolumne and Yuba rivers), the percent of recoveries for all of these locations was less than one percent.

Mokelumne River Fish Hatchery Strays

The tag-recovery data indicated Mokelumne Hatchery fall-run Chinook released on site returned to the Mokelumne River in fair numbers (64% of total recoveries), but were also found in the American River (26%), the Merced River (4%), the Sacramento River (2%), the Stanislaus River (1%), the Feather River (1%), and a variety of other locations in the Central Valley. In addition, only 26% of the fish that returned to the Mokelumne River were recovered at the hatchery. Like Feather River Hatchery fish, Mokelumne Hatchery fall-run Chinook released off site (San Francisco Bay) strayed at higher rates than fish released on site. Only 6.5% of the tags from San Francisco Bay releases were recovered in the Mokelumne River, and only half of these fish were recovered at the hatchery. Other watersheds receiving strays from off-site releases of Mokelumne River Hatchery fall-run Chinook included the American River (31%), the Merced River (20%), the Stanislaus River (15%), the Tuolumne River (11%), the Feather River (10%), Clear Creek (4%), Battle Creek (2%), and Butte Creek (1%).

Merced River Hatchery Strays

Most Merced River Hatchery fall-run Chinook released on site returned to the Merced River (approximately 93% of the tags recovered), with smaller proportions recovered in the Tuolumne River (5%), the Feather River (1%), and several other locations (<1%). About 25% of the tags recovered in the Merced River were recovered at the hatchery. Once again, however, stray indices

were considerably higher for off-site releases. Less than half (48%) of the tagged Merced River Fish Facility fall-run Chinook released into the San Joaquin River were recovered in the Merced River, with sizeable recoveries occurring in the Tuolumne River (22%), the Stanislaus River (10%), the American River (8%), the Feather River (8%), the Sacramento River (2%), the Mokelumne River (2%), and Butte Creek (1%). As with on-site releases, about 25% of Merced River recoveries of fish released in the San Joaquin River were at the hatchery.

Williamson and May (2005) and Lindley et al. (2009) suggested hatchery fall-run Chinook have "replaced" locally adapted populations. The stray indices reported here would suggest a significant gene flow from the hatchery stocking programs to the wild, as would reduced abundance of less productive wild fish under a mixed stock harvest rate that exceeded 60% until the 1990s (Myers at al. 1998). In this regard, it is significant that a study of otoliths of salmon captured in the California coastal fishery indicated that wild fish comprised only 10% (plus or minus 6%) of the catch (Barnett-Johnson et al. 2007). Assuming roughly equivalent survival of hatchery and wild fish from the fishery to the spawning grounds, these results imply that currently ~90% of the return could consist of hatchery fish. This is far more than the 33% estimated by Cramer (1989) for brood years 1978–1987, or the 10% to 65% estimated by Fisher et al. (1991) for brood years 1970–1984. However, the study by Barnett-Johnson et al. (2007) was based on a small sample size in a single year of harvest, so results may not be representative of hatchery composition in all years. Better estimates will be available in the coming years from a recently implemented, more extensive CWT tagging program of fall-run Chinook.

Straying of hatchery-origin fish and their relative contribution to naturally spawning populations of fall-run salmon was further investigated by requesting the following information from DFG and USFWS biologists who are currently conducting adult salmon and steelhead escapement surveys in tributaries of the upper Sacramento River:

- Number of adipose fin-clipped or CWT fish observed as a proportion of the total number of fish examined during annual surveys

- Number of years that adipose fin-clipped or CWT fish were observed

- Hatchery origins of CWT fish

- Professional judgment as to the proportion of hatchery-origin spawners in these runs (<5%, 5%–25%, 25%–50%, etc.)

Recoveries of CWT fall-run Chinook salmon were available for several upper Sacramento River tributaries where annual carcass surveys have been conducted since 1988 (Mill, Deer, Clear, and Antelope Creeks). These data are summarized in Table 4-18.

Table 4-18. Recoveries of CWT Fall-Run Chinook Salmon in Mill (1988–2008), Deer (1988–2008), Clear (1988–2007), and Antelope (1988–1993) Creeks[a]

Stream	Period of record	No. survey years	No. years tagged fish observed	Percent of fish with tag[b]	Origins of tagged fish[c]
Mill Creek	1988-2008	14	8	1.3 (0-6.3)	CNFH, FRH, MRFF
Deer Creek	1988-2008	12	6	1.0 (0-7.7)	CNFH, FRH, MRFH
Clear Creek	1988-2007	19	19	0.7 (0.04-1.9)	FRH, CNFH, MRFF
Antelope Creek	1988-1993	4	0	0	

[a] Data source: Unpublished data, Colleen Harvey-Arrison, California Department of Fish and Game.

[b] Average and range (in parentheses) of annual number of ad-clipped or CWT fish observed as a percentage of the total number of fish examined.

[c] Dominant hatchery sources: CNFH = Coleman National Fish Hatchery, FRH = Feather River Hatchery, MRFF = Merced River Fish Facility, MRFH = Mokelumne River Fish Hatchery.

Hatchery-origin salmon were detected in all of the years that surveys were conducted in Clear Creek and in at least half the years that surveys were conducted in Mill and Deer Creek (Table 4-18). All recovered fish were tagged as fall-run Chinook salmon. The proportion of tagged fish averaged about 1% of the total number of fish examined in these streams. A review of the data indicate that the largest sources of strays are Feather River Hatchery fish released in San Pablo Bay and Coleman National Fish Hatchery fish released in Battle Creek. No tagged fish were observed in Antelope Creek during the four years that surveys were conducted.

The available data suggest that hatchery strays have contributed to natural spawning escapement in Mill, Deer, and Clear Creeks for at least 20 years (Table 4-18). However, the contribution of hatchery fish to these spawning populations is uncertain. While CWT salmon composed a small fraction of the fish observed on the spawning grounds, these data are not considered representative of the actual contributions of hatchery fish in these runs. Factors that can contribute to uncertainty in the estimation of hatchery contributions include low and often variable marking rates (ranging from 0 to 10%) among release groups, brood years, and hatcheries; differential survival of hatchery fish associated with variable hatchery practices and release locations; and inadequate sampling of fish on the spawning grounds.

An analysis of hatchery influence by population was made using the AHA application. This analysis was based the average number of fish released from 2002–2004, program specific assumed survival of hatchery fish back to the Central Valley, and the previously described stray indices by hatchery program and release location. Stray indices used were adjusted based on the proportion of the program release on- and off-site. The AHA analysis estimated total number of hatchery fish returning for each population. Populations were defined based on those described in the DFG Grand Tab worksheet. Populations included in the analysis were those reported in the last 5 years to have fall-run Chinook.

The AHA analysis lead to the conclusion that pHOS either pHOS exceeded 10% or PNI was less than 0.50 for all populations and hence all populations were classified as *not consistent with rebuilding* (Table 4-19).

Table 4-19. Central Valley Fall-Run/Late Fall–Run Chinook Salmon Populations That Support, Are Consistent with, or Are Inconsistent with Rebuilding of Wild Populations

Population	Population Supports Rebuilding	Population Consistent with Rebuilding	Population Not Consistent with Rebuilding	PNI[1]	pHOS[2]
Sacramento Populations					
Sacramento River Fall Chinook (Wild)			X	NA	38%
Clear Creek Fall Chinook (Wild)			X	NA	40%
Cow Creek Fall Chinook (Wild)			X	NA	32%
Cottonwood Creek Fall Chinook (Wild)			X	NA	59%
Battle Creek Fall Chinook (Integrated)			X	0.06	81%
Battle Creek Late Fall Chinook (Integrated)			X	0.06	73%
Mill Creek Fall Chinook (Wild)			X	NA	18%
Deer Creek Fall Chinook (Wild)			X	NA	48%
Butte Creek Fall Chinook (Wild)			X	NA	21%
Feather River Fall Chinook (Integrated)			X	0.06	82%
Yuba River Fall Chinook (Wild)			X	NA	36%
American River Fall Chinook (Integrated)			X	0.06	84%
San Joaquin Populations					
Merced River Fall Chinook(Integrated)			X	0.07	67%
Tuolumne River Fall Chinook (Wild)			X	NA	31%
Stanislaus River Fall Chinook (Wild)			X	NA	31%
Mokelumne River Fall Chinook (Segregated)			X	NA	NA

Source: AHA results.

[1]Proportionate natural influence—applies only to integrated hatchery/wild populations.

[2]Percent hatchery spawners in wild population

Central Valley Fall/Late Fall-Run ESU Chinook salmon have not been listed under the ESA, although they are a state species of special concern because of uncertain but probably very low proportions of wild-origin fish in the populations (Barnett-Johnson et al. 2007]). Because it has not been listed, this ESU has not been subdivided into distinct Diversity Groups that can be used to determine representation and redundancy. Nevertheless, the ESU is clearly experiencing a significant impact at the ESU level. Excessive hatchery adults have been demonstrated or are probable in all areas currently supporting at least some wild production of fall-run or late fall-run Chinook salmon.

The fall-run Chinook hatchery programs described above thus have the potential to cause significant adverse impacts on the genetic fitness of this ESU. This impact would be significant. DFG shall implement Mitigation Measure BIO-139. With mitigation, impacts would remain significant and unavoidable.

Impact BIO-209: Genetic Effects on Chinook Salmon, Sacramento River Winter-Run ESU, from Stocking Salmon and Steelhead (Less than Significant)

National Marine Fisheries Service (2004a) state that the historical winter-run Chinook population spawned exclusively in larger spring-fed streams in the South Cascades, generally above 500 m elevation. The restriction of winter-run Chinook to a single physiographic region is based on the spring and mid-summer spawning time of the run: only the South Cascades, because of its permeable basalt geology, contains spring-fed streams that are cool enough for winter-run spawners and eggs. National Marine Fisheries Service (2004a) estimate that four independent populations of winter-run Chinook existed in the South Cascades before construction of Shasta and Keswick Dams. These populations were the Hat Creek and Fall River population (Pit River tributaries), the Little Sacramento River population, the McCloud River population and the Battle Creek population. The populations were based on historical accounts of presence, on the fact that each population inhabited a drainage with more than 500 km^2 of watershed above 500 m elevation[13], and on the fact that the downstream boundary of each population was at least 50 river kilometers from its nearest neighbor[14]. No historical dependent populations were identified. Currently the ESU consists only of a single (necessarily independent) population spawning in the main stem Sacramento between Keswick Dam and Red Bluff Dam (Figure 4-40). This population exists only because hypolimnetic discharges from Shasta Reservoir reduce main stem water temperatures enough to permit spawning and incubation, and because the spawn timing between winter-run and the abundant fall-run population do not overlap (Williams 2006).

The only hatchery targeting the existing winter-run population is Livingston Stone National Fish Hatchery, located at the base of Shasta Dam. The genetic impacts of this program were evaluated for winter-run Chinook even though this program is not a DFG hatchery program and thus not included in this EIR. This was done to address potential cumulative impacts from this program.

The Livingston Stone hatchery was constructed in 1997 for the sole purpose of supporting the winter-run Chinook salmon conservation program. Prior to 1997 the program was operated from the Coleman National Fish Hatchery on Battle Creek (Myers et al. 1998). The current hatchery program is an integrated conservation program, and releases up to 250,000 fingerling pre-smolts (90 mm) in January in the Sacramento River at Redding (RM 298). The production goal has, however, not been met in any year due to brood stock constraints (Good et al. 2005). Brood stock is collected at Keswick Dam and, if necessary, at Red Bluff Dam as well. All juveniles released are adipose-clipped and coded-wire tagged. Brood stock protocols allow no more than 10% of the brood stock to consist of adipose-clipped hatchery fish. Furthermore, no more than 15% of the run can be used for brood stock, with a maximum of 120 fish. All potential brood stock are also subjected to DNA analysis, and only those determined to be winter-run are retained. Excess winter-run adults are returned to the river, and non-winter-run hatchery fish are sacrificed for tag recovery. Natural spawning is monitored for contribution of hatchery-origin adults. The percentage of hatchery-origin winter-run Chinook spawning in nature averaged 12.4% in return years 2001-2006 (USFWS 2007a).

The PNI of the combined hatchery and wild winter-run Chinook population was estimated to be 0.80 to 0.90. This is based on the percent hatchery fish spawning in nature (pHOS) ranging from 10 to 20% and the proportion wild fish in the brood stock (pNOB) of 90%–95%. According to the pHOS

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[13] NMFS (2004a) assumed that water temperatures would be cool enough for winter-run Chinook spawning above 500 m elevation in the South Cascades, and that a minimum watershed area of 500 km^2 is necessary to support a population large enough to be viable.

[14] NMFS (2004a) also assumed that natural straying rates fall to very low levels for recipient streams more than 50 km distant from donor streams.

and PNI criteria described in the methods section, this population *supports rebuilding.* Thus, the existing hatchery program is a less than significant impact on the ESU.

Impact BIO-210: Genetic Effects on Chinook Salmon, California Coast ESU, from Stocking Salmon and Steelhead (Less than Significant)

This ESU includes all naturally spawned populations of Chinook salmon occurring in streams and rivers of the California coast south of the Klamath River to, and including, the Russian River (Figure 4-38). The ESU was divided by NMFS into three categories: "Functionally Independent Populations," "Potentially Independent Populations," and "Dependent Populations." The Functionally Independent and Potentially Independent categories both represent populations with a high probability of persisting in isolation for 100 years, but the Potentially Independent category was considered too strongly influenced by immigration from neighboring populations to exhibit independent population dynamics. The Dependent Population category consisted of populations with a substantial probability of going extinct in a 100-year time period because of low abundance, but that received sufficient immigration to alter their dynamics and reduce extinction risk. For the purpose this analysis the Functionally Independent and Potentially Independent populations were combined into a single category of Independent Populations.

NMFS described the historical ESU as consisting of 15 independent and 17 dependant populations (Bjorkstedt et al. 2005). Geographic, genetic, and environmental factors were used to assign a population-status to each subpopulation. Of the 32 historic populations defined by the Technical Recovery Team, 14 independent populations and 4 dependent populations are believed by NMFS to be in existence today (National Marine Fisheries Service 2005a).

The California Coast Chinook salmon ESU is listed as threatened. Primary causes for concern are low abundance, reduced distribution (particularly in the southern portion of the ESU's range), and generally negative trends in abundance, especially for spring-run Chinook (Myers et al. 1998). Although data for this ESU are sparse and of limited quality, the NMFS Biological Review Team (BRT) considered degradation of the genetic integrity of the ESU to be of minor concern and to present less risk for this ESU than for other ESUs.

Seven hatchery programs were operating in this ESU before 2004: 1) Freshwater Creek (Humboldt Fish Action Council), 2) Yager Creek, 3) Redwood Creek, 4) Hollow Tree, 5) Van Arsdale Fish Station, 6) Mattole Creek (Mattole Salmon Group), and 7) Mad River Hatchery fall-run Chinook hatchery programs. Many of these small-scale conservation hatcheries were funded by grants from DFG. Table 4-20 provides details bearing on the genetic impact of these programs. Chinook salmon production at all of the hatcheries ceased in 2004, except for the Hollow Tree Creek program. A small-scale cooperative hatchery operates on Hollow Tree Creek but low flows in recent years have made adult collections difficult and smolt production has been below 30,000 fish (Good et al. 2005).

An additional concern with these programs is the propagation of relatively high number of juvenile Chinook from few parents (Table 4-20). The Ryman-Laikre effect (Ryman and Laikre 1991) describes the risks of using small numbers of brood stock to generate a large pool of hatchery offspring relative to the number of natural origin offspring produced or surviving in a system. When small numbers of brood stock are used, a few families can become overrepresented in the next generation. This results in a loss of genetic diversity due to reduced effective population size in the combined wild and hatchery population. Small numbers of hatchery fish were used annually to supplement some streams within the California Coastal Chinook ESU. These programs produced

relatively few juveniles, although the relative contribution of those juveniles to combined wild and hatchery production is not known.

Table 4-20. Non-DFG Hatchery Programs within the California Coast Chinook Salmon ESU

Hatchery Program	Currently Operated (Y/N)	Affected Population	Program Size	Program Type and Purpose	Brood stock	Hatchery Origin Spawners
Yager Creek Hatchery	N	Eel River	~12 females, ~40,000 fingerlings at capacity	Integrated Conservation	Only wild-origin	No data
Redwood Creek Hatchery	N	Eel River	~12 females, ~40,000 fingerlings at capacity	Integrated Conservation	Only wild-origin	No data
Hollow Tree Creek Hatchery	Y	Eel River	<30,000 fingerlings	Integrated Conservation	Only wild-origin	No data
Mattole Salmon Group	N	Mattole River	~40,000 eggs, 10 females; hatchbox program	Conservation	no data	No adult data; 17% of outmigrants were hatchery-origin 1997–2000a
Van Arsdale Counting Station	N	Eel River	~60 males and females	Integrated Conservation	Wild Origin included	30% hatchery-origin at Van Arsdale counting station
Freshwater Creek Hatchery	N	Freshwater Creek (Humboldt Bay)	no data	Integrated Conservation	Wild Origin included	30-70% hatchery-origin 1997–2001

Source: Good et al. (2005) except where indicated.

In the 2005 Status Update of the ESU (Good et al. 2005), the BRT concluded that "it is likely that artificial propagation and degradation of genetic integrity do not represent a substantial conservation risk to the ESU." They based this conclusion on the fact that existing programs minimized genetic risks by releasing relatively few fish such that no independent population was dominated by hatchery production, and by including only wild fish in the brood stock. Because the proportion of wild origin brood stock (pNOB) is 100% in the one remaining programs, PNI cannot be less than 0.5 regardless of the proportion of hatchery-origin spawners in the wild (pHOS). If pHOS is on the order of the 30% observed at the Van Arsdale counting station, PNI would be approximately 0.80. It is concluded that that the impact of hatchery programs on this ESU would be less than significant.

Impact BIO-211: Genetic Effects on Chinook Salmon, Upper Klamath/Trinity Rivers ESU, from Stocking Salmon and Steelhead (Significant and Unavoidable)

This ESU includes all naturally spawning Chinook in the Klamath and Trinity river basins upstream of the confluence of the Klamath and the Trinity Rivers (Figure 4-39). Because the 1998 Status Review of West Coast Salmon and Steelhead (Myers et al. 1998) determined that the Upper Klamath/Trinity Chinook salmon ESU was not at significant risk of extinction nor likely to become

so in the foreseeable future, NOAA has not defined independent and dependent populations within this ESU. Fall, late-fall, and spring-run Chinook spawn and rear in the Trinity River and in the Klamath River upstream of the mouth of the Trinity River. In the Trinity River, Chinook salmon spawn in the main stem as far upstream as Lewiston Dam, the North and South forks, Hayfork Creek, New River, and Canyon Creek. In the Klamath River, Chinook salmon once ascended into Upper Klamath Lake, Oregon, to spawn in the major tributaries to the lake (Williamson, Sprague, and Wood Rivers), but access to this region was blocked in 1917 by Copco Dam. Today Chinook are known to spawn in the main stem Klamath River, Bogus Creek, Shasta River, Scott River, Indian Creek, Elk Creek, Clear Creek, the Salmon River (spring-run), Bluff Creek, Blue Creek, and the lower reaches of some of the other smaller tributaries to the main stem river.

Myers et al. (1998) noted that Spring-run Chinook salmon were once the dominant run type in the Klamath-Trinity River Basin, comprising over 100,000 of the estimated 168,000 to 200,000 Chinook salmon of all runs during historical times (California Department of Fish and Game 1965). Current spring-run production is sparsely scattered over the ESU although small spawning aggregations (150 to 1,500) occur in the Salmon River and Wooley Creek (Campbell and Moyle 1991; Barnhart 1995). Over the entire Klamath Basin, a mean of 6,668 spring-run Chinook were estimated to have spawned annually over the years 1991-2005 (Trinity Adaptive Management Work Group 2007), about one sixth of the geometric mean of 48,000 for all runs reported by Myers at al. (1998) for the years 1992–1996. NMFS includes spring-run Chinook salmon in the Klamath/Trinity ESU even though they differ from fall-run fish genetically and in terms of life history (Myers et al. 1998).

Hatchery operations in the Klamath-Trinity Basin include the Iron Gate Hatchery on the Klamath River and the Trinity River Hatchery on the Trinity River. Iron Gate Hatchery is operated to mitigate for lost salmonid production between Iron Gate Dam and Copco Number 2 Dam; Trinity River Hatchery mitigates for fisheries losses caused by the construction of Trinity Dam. Iron Gate Hatchery releases about five million fingerling fall-run Chinook and one million yearling fall-run Chinook annually. Trinity River Hatchery releases about two million fall-run Chinook fingerlings, one million fall-run Chinook advanced fingerlings and one million spring-run Chinook yearlings annually (Table 4-21). Both programs were founded with endemic brood stock and both are maintained by hatchery returns. Another small, privately funded hatchery operates nearby on Rowdy Creek in the Smith River basin. The Rowdy Creek Hatchery attempts to produce up to 250,000 fingerling Chinook smolts each year for release into Rowdy Creek but, due to uncertain funding, production is often lower (185,000 in 2007).

Table 4-21. Hatchery Program Information for DFG Hatchery Programs at Iron Gate Hatchery and Trinity River Hatchery. Also Shown is Hatchery Program Information for the Non-DFG Rowdy Creek Program

Hatchery	Species /Run	Production Goal (millions)/Life stage	Actual Releases 2004–2008	Marks	Operator (Funding Agency)	Size and Time of Release	Release Location
Iron Gate Hatchery	Fall-run Chinook	5 / fingerling; 1 / yearling	5,310,763	Goal of 25 % CWT	DFG (Pacific Power and Light Company)	May–Jun (77 mm); November (165 mm)	On-site, forced (fingerlings); On- site, forced (yearlings)
Trinity River Hatchery	Fall-run Chinook	2 / fingerling 1 / advanced fingerling	2,074,210 (fingerling) 1,073,874 (adv fingerling)	Goal of 25 % CWT	DFG (Bureau of Reclamation)	Jun 1–15 (78 mm) Oct 1–15 (102 mm))	On-site, volitional (fingerlings and advanced fingerlings)
	Spring-run Chinook	1 / yearling	1,286,911 (advanced fingerling)	Goal of 25 % CWT		November (151 mm)	On-site
Rowdy Creek Hatchery	Fall-run Chinook	0.25/fingerling	180,000 (fingerling)	100% adipose fin-clipped	Smith River Kiwanis Club	Data unavailable	On-site

Source: California Department of Fish and Game 2008a.

Adults from both hatchery programs have been shown to return to areas outside the watershed of release and to spawn with wild fish inside the release watershed at increasing rates. The proportion of hatchery returns to total escapement in the Klamath Basin has increased from 18% in 1978-82 to 26% in 1991–1995 and 29% in 2001–2006 (California Department of Fish and Game 2006b; Myers et al 1998). Aguilar (1995) reported that 11.2% of the spring-run escapement and 31.2% of the fall-run escapement in the Trinity River main stem in 1994 were hatchery fish. The Trinity Adaptive Management Work Group (Trinity Adaptive Management Work Group 2007) reported spawner survey data showing that hatchery fish comprised 58.9% of the spring-run spawning escapement on the Trinity River over the years 1991–2005 and that the proportion of hatchery fish in the fall-run escapement for the same period was 55.3%. Jong and Mills (1992) monitored straying of fall-run Chinook into the South Fork of the Trinity River, which does not support a hatchery. Between 1984 and 1991 hatchery strays comprised between 3.8% to 28.8% of the South Fork natural spawning escapement, with the largest contribution coming from Trinity River Hatchery followed by Iron Gate Hatchery and a handful of small-scale regional hatcheries outside the watershed.

NMFS did not consider the Upper Klamath/Trinity Rivers Chinook Salmon ESU to be threatened with extinction because of the relative abundance of the fall-run population, although the depressed status and loss of historical habitat of the spring-run population was a serious concern. However, the previously reported information suggests the hatchery stocking program has an adverse impact on the fitness of the wild Chinook salmon populations in the Trinity/Klamath watershed. This conclusion is based on the fact that the proportion of hatchery fish in the spawning escapement exceeds the criteria for significance for all or virtually all populations within the ESU.

The Upper Klamath/Trinity Rivers Chinook hatchery programs described above thus have the potential to cause significant adverse impacts on the genetic fitness of this ESU. This impact would be significant and unavoidable. DFG shall implement Mitigation Measure BIO-139. With mitigation, impacts would remain significant and unavoidable.

Impact BIO-212: Genetic Effects on Coho Salmon, Central California Coast ESU, from Stocking Salmon and Steelhead (Less than Significant)

The central California coast coho salmon ESU includes all naturally spawned populations of coho salmon from Punta Gorda in northern California south to and including the San Lorenzo River in central California (Figure 4-34). This ESU is listed as endangered under both the federal and state Endangered Species Acts. Populations in tributaries to San Francisco Bay, excluding the Sacramento-San Joaquin System, are also included as part of the ESU. Fish produced by the Don Clausen Fish Hatchery Captive Broodstock Program, Scott Creek/King Fischer Flats Conservation Program, Scott Creek Captive Broodstock program, and the Noyo River Fish Station Egg-take Program are included in the ESU.

NMFS (Bjorkstedt et al. 2005) has defined 12 independent and 62 dependant populations that historically made up this ESU. Information on abundance and populations structure of the ESU is extremely limited but the available information points to a declining trend in abundance (Good et al. 2005). Of the 74 populations defined, 12 of the independent populations and 33 of the dependent populations are believed by DFG to still have coho (Haney 2009).

The Russian River Coho Salmon Recovery (Captive Broodstock) Program initiated by DFG, NMFS , and USACE in 2001, has a production target of 110,000 yearling coho for release into Russian River tributaries. The goals of this program are to prevent extirpation of Russian River coho salmon. Over the years 2004–2008 production has varied widely, ranging from 6,000 to 72,000 advanced fingerlings, with a average of approximately 30,000. The Scotts Creek program has a goal to capture 35 females and 45 males for an egg-take of ~60,000. Low numbers of returning adults have made it difficult for the Scotts Creek program to collect brood stock sufficient to release more than 1,000-2,000 yearling coho in recent years. All artificial production programs within the geographic bounds of this ESU attempt to produce fish that are genetically and ecologically similar to wild populations by operating as integrated programs that include naturally produced adults in the brood stock as available.

Despite the limited data, it appears that both conservation hatchery programs are well integrated and are consistent with criteria for pHOS and PNI. It is concluded that the impact of hatchery programs on this ESU would be less than significant.

Impact BIO-213: Genetic Effects on Coho Salmon, Southern Oregon/Northern California Coast ESU, from Stocking Salmon and Steelhead (Significant and Unavoidable)

The southern Oregon/northern California coast (SONCC) coho salmon ESU includes all naturally spawned populations of coho salmon in coastal streams between Cape Blanco, OR and Punta Gorda, CA as well as three artificial propagation programs: the Cole M. Rivers Hatchery, Trinity River Hatchery, and the Iron Gate Hatchery (Figure 4-34) (National Marine Fisheries Service 2006).

NOAA (National Marine Fisheries Service 2006) has defined 45 wild populations that were historically part of this ESU. Twenty-nine of these populations are or were independent populations while 16 were considered dependant. Of the 45 populations defined, 27 of the independent

populations and 11 of the dependent populations are believed by DFG to still have coho (Haney 2009).

Historical production in the ESU was estimated in The California Fish and Wildlife Plan (California Department of Fish and Game 1965), which reported 8,000 coho salmon spawned in the main Klamath River and tributaries, in addition to 5,000 in the Trinity River and 800 each in the Scott, Salmon, and Shasta Rivers. In 1979, the USFWS estimated a population size of 23,500 to 28,000 coho salmon in the Klamath River Basin, of which 8,000 spawned in the Trinity River watershed. Current production was estimated by Brown and Moyle (1991), who reported that 45% of the streams in Del Norte County, consisting primarily of Klamath River tributaries, had extirpated or severely depressed coho salmon populations. Wahle and Pearsons (1987) and Brown et al. (1994) reported a historic decline of the Klamath River coho population from 15,400 (California Department of Fish and Game 1965) to 3,400 and 1,860, respectively. Overall, the California coho salmon population in the 1980s was 6% of the 1940 population (200,000 to 500,000) and 70% less abundant than the 1960s estimate of 100,000 fish. Although coho salmon abundance within the Klamath River Basin is currently unknown, the best information available indicates a slight resurgence in presence by occurrence in the 1990s. Regardless of these data, status reviews conclude that the collective population of SONCC coho salmon is unable to recover from stochastic environmental and/or variation in habitat conditions (Brown and Moyle 1991; Weitkamp et al. 1995)

Currently, three hatchery programs collect brood stock and release hatchery progeny within the geographic bounds of this ESU: 1) Iron Gate Hatchery, 2) Trinity River Hatchery, and 3) Cole M. Rivers Hatchery on the Rogue River in Oregon. The Cole M. Rivers Hatchery program is included in this assessment because it is part of the determination of significance at the ESU level. The annual production goals for the Iron Gate, Trinity River and Cole M. Rivers Hatcheries are 75,000 yearlings, 500,000 yearlings and 200,000 yearlings, respectively. Actual production over the years 2004-08 averaged 89,844 for Iron Gate Hatchery and 511,822 for Trinity River Hatchery. All three hatchery programs release smolts on site, use volunteers as brood stock, include unclipped fish as brood stock and use various combinations of fin clips to mark their production. The proportion of wild origin recruits used as brood stock varies by hatchery and year: the proportion of wild brood stock at Cole M. Rivers Hatchery over the years 1995 to 1998 ranged from 24% to 72% with a mean of 40%, while the proportion of wild brood stock at Iron Gate Hatchery from 1998 to 2004 ranged from 8.8% to 48.3%, with a mean of 23.6% (Kostow et al. 1998). Coho salmon from Cole M. Rivers Hatchery and Trinity River Hatchery commonly stray to Iron Gate Hatchery.

The proportion of hatchery-origin coho in the natural spawning escapement in the Klamath/Trinity portion of the SONCC ESU is unclear, but in the opinion of DFG (2002), most natural spawners are hatchery fish. The following studies summarized in Good et al. (2005) corroborate the opinion of DFG. Good et al. note that 80% of the coho returning to Iron Creek hatchery in 2001 were clipped hatchery fish, although the significance of this observation is unclear because of the location of the hatchery at the upstream end of the anadromous corridor. Good et al. also noted that hatchery fish comprised from 63% to 86% of the total fish harvested in the Yurok tribal coho harvest between 1997 and 2000. Iron Gate Hatchery fish represented 8% or less of the harvest of hatchery fish, but Trinity River Hatchery fish accounted for 87% to 95% of hatchery fish harvested in 1998–2001, and 40% of the hatchery fish captured in 1997. Finally, Goode et al. noted that between 1997 and 2002, hatchery fish constituted between 89% and 97% of the fish (adults plus grilse) returning to the Willow Creek weir in the lower Trinity River (Sinnen 2002).

A large number of naturally spawning of hatchery-origin adults is corroborated by three studies that estimated relative wild/hatchery smolt abundance in the lower Klamath and Trinity Rivers. A USFWS study monitored relative smolt abundance in the Klamath River at Big Bar, above the confluence of the Trinity River, over the years 1995 to 2003. The study found that hatchery smolts comprised from zero to 66.7% (mean of 30.3%) of all captured coho salmon yearlings, reflecting the Iron Gate Hatchery production. A comparison of lower Klamath screw trap and estuary seining data in 2002 indicated hatchery smolts resided for 1.5 to 2 months above Big Bar and then moved rapidly to the estuary and ocean. Wild origin fish made up 28.4% of all coho salmon caught in the Klamath River estuary from 1998 through 2002, and 70% in 2003. The estuary study also analyzed hatchery mark data from collected smolts and determined that Trinity River Hatchery and Iron Gate Hatchery fish comprised 65% and 6.6%, respectively, of the total catch (California Department of Fish and Game 2003c in Spence and Bjorkstedt 2005) Between 1998 and 2000, Yurok Tribal Fisheries operated a downstream migrant trap in the lower Klamath River, below the confluence of the Klamath and Trinity rivers. The Yurok study estimated marked Trinity River Hatchery smolts comprised 91%, 97%, and 65% of the catch in 1998, 1999, and 2000, respectively (Good et al. 2005). In 1998, a second trap was operated on the lower Trinity River. Only 9% of the smolts captured at this trap were naturally produced. Assuming that this proportion accurately reflected the relative contributions of naturally produced and hatchery Trinity River Hatchery fish to total catch at the Lower Klamath trap, the percent of hatchery fish exiting the Klamath River proper (above the Trinity confluence) was approximately 58%.

NMFS (2004a) concluded that Iron Gate Hatchery, Cole M. Rivers Hatchery and the Trinity River Hatchery contribute to coho salmon abundance within the ESU, but hatchery contribution to diversity, spatial structure and productivity were neutral or unknown. However, the Salmon and Steelhead Hatchery Assessment Group Report concluded that both the Iron Gate and Trinity River hatcheries were moderately divergent from the local wild population (National Marine Fisheries Service 2003), likely because of non-local sources for the original brood stocks (non-local brood stock has never been used in the Cole M. Rivers Hatchery). The Iron Gate Hatchery was founded with Cascade Hatchery stock from Oregon. Importation ceased in 1976, after which all brood stock was collected from adults returns to the hatchery trap. The Trinity River Hatchery also began its program with Cascade Hatchery stock, as well as fish and eggs from the Noyo River, the Alsea River and the Eel River. The Trinity River Hatchery has also ceased all importations, and has collected all of its brood stock since 1970 from fish that swim voluntarily into the hatchery.

The information available indicates that the influence of the hatchery stocking program on the genetic fitness of wild coho populations in the Klamath and Trinity Rivers is significant. Moreover, because the Klamath and Trinity watersheds represent a large proportion of spawning and rearing habitat in this ESU, it is concluded that hatchery impacts are significant at the ESU level. DFG shall implement Mitigation Measure BIO-139. With mitigation, impacts would remain significant and unavoidable.

Impact BIO-214: Genetic Effects on Steelhead, California Central Valley DPS, from Stocking Salmon and Steelhead (Significant and Unavoidable)

The California Central Valley steelhead DPS includes all naturally spawned populations of steelhead and their progeny in the Sacramento and San Joaquin Rivers and their tributaries, but excluding steelhead from San Francisco and San Pablo Bays and their tributaries (Figure 4-35). The DPS also includes artificially propagated steelhead stocks from Coleman National Fish Hatchery on Battle Creek and from the Feather River Hatchery. Other anadromous hatchery steelhead stocks

propagated within but not included in the DPS are the Nimbus Hatchery program (American River) and the Mokelumne River Hatchery program.

Lindley et al. (2006) estimated the historical number of independent populations by a multiphase modeling process. In the first phase, they used existing geomorphological and hydrological databases to identify the stream reaches meeting habitat suitability criteria in terms of gradient, mean annual flow and temperature. The mean annual flow criterion was 1 cfs, the gradient criterion was less than 12% and the temperature criterion was a mean August air temperature less than 24° C. Lindley et al. (2006) described all of these criteria as defining the environmental boundaries for existing populations of California steelhead. In the second phase of their analysis, Lindley et al. (2006) drew upon the analysis of Knapp (1996), who identified western Sierra Nevada streams that were historically fishless because of glaciation and natural passage barriers. The final step consisted of the elimination of streams and stream segments that were less than 10 km in length, or that were within an assumed natural staying radius of 35 km, measured in river kilometers from the downstream ends of the 24° C isotherm. The result of these analyses was the identification of 81 independent steelhead populations and almost 25,000 km of habitat believed to have existed in historical times. The analysis did not identify dependent populations.

On the basis of the rough historical abundance estimates of Central Valley Chinook salmon reported by Yoshiyama et al. (1998); McEwan (2001) speculated that between one and two million steelhead may have once spawned in the Central Valley, with the bulk of production coming from the Sacramento system. This estimate is based on the observation that steelhead are generally found in almost all systems supporting spring-run Chinook, and the fact that steelhead can also use much smaller and steeper streams than spring-run Chinook salmon. Therefore, it is likely that there was more steelhead habitat than spring-run Chinook habitat historically. On the other hand, steelhead productivity is generally lower because of the extra one or two years of juvenile rearing before smolting. As a consequence, it is not unreasonable to propose that both historical steelhead and spring-run Chinook salmon populations numbered in the one to two million range.

Currently, most of the historical steelhead production areas are inaccessible, primarily because of dams. Lindley et al. (2006) estimate that 80% of the historical habitat they identified is now behind impassable dams, and 38% of the populations identified by their modeling have lost all of their habitat. Anadromous *O. mykiss* populations may have been extirpated from their entire historical range in the San Joaquin Valley and from most of the larger basins of the Sacramento River. The roughly 52% of watersheds with at least half of their historical area below impassable dams are all small, low elevation systems, often in the tailrace below storage reservoirs that release cool, hypolimnetic water. McEwan and Jackson (1996) estimated that ~40,000 steelhead returned to the Central Valley and San Francisco Bay tributaries in the 1950s, and that by the 1960s the population had declined to ~27,000. The mean annual passage of steelhead spawners at Red Bluff Dam before 1993, when steelhead ladder counts ceased because of the necessity to leave dam gates open to aid winter-run Chinook passage, was less than 10,000 fish. The most recent estimate of wild steelhead production in the Central Valley (Good et al. 2005) is a female population between 363 and 3,628 and, assuming an equal sex ratio, a total wild population between 726 and 7,256. This estimate is based on the relative abundance of juvenile hatchery (ad-clipped) and wild (unclipped) steelhead in the Chipps Island trawl between 1998 and 2000, known release numbers of hatchery steelhead, an assumed wild fecundity of 5,000 eggs/female and an egg-to-smolt survival rate ranging from 1% to 10%.

From the 81 historical independent populations, steelhead production has dropped to 33 spawning aggregates, 27 in the Sacramento Basin and six in the San Joaquin Basin. Good et al. (2005) do not identify any of the existing populations as viable and independent.

Four Central Valley steelhead hatcheries collectively produce about 1.5 million yearling steelhead annually when they reach their production goals (California Department of Fish and Game 2008). Although all four hatcheries were originally constructed to mitigate for habitat lost to dam construction, Coleman National Fish Hatchery modified its operations to emphasize conservation in 1998 (U.S. Fish and Wildlife Service 2001). All of these hatcheries release yearling smolts (approx. 4 fish/lb) at downstream locations in January and February during the natural outmigration window. Table 4-22 summarizes hatchery production affecting the Central Valley Steelhead DPS .

Table 4-22. Summary of Hatchery Program inside the Geographic Area of the Central Valley Steelhead DPS

Population/ Hatchery Program	Race	Type	Purpose	Hatchery Name	Operator (Funding Agency)	Production Goal (millions) / Life stage	Release Location
Battle Creek, upper Sacramento River	Winter	Integrated	Harvest	Coleman National Fish Hatchery (on Battle Creek)	USFWS, (Bureau of Reclamation)	0.6 / yearlings	75% Sacramento River at Bend (RM 225), 25% on-site
Feather River	Winter	Integrated	Harvest	Feather River Hatchery	DFG(California DWR)	0.45 / yearlings	Feather River near Gridley
American River, Sacramento River	Winter	Integrated	Harvest	Nimbus Hatchery	DFG, (Bureau of Reclamation)	0.4 / yearlings	Sacramento River below American River (Garcia Bend)
Mokelumne River, Sacramento River	Winter	Integrated	Harvest	Mokelumne River Hatchery	DFG, (East Bay MUD)	0.25 / yearlings	lower Mokelumne River

The lack of functional adult steelhead monitoring facilities since 1993 and, until 1998, the fact that very few hatchery steelhead were marked, makes accurate estimates of the proportion of hatchery-origin spawners in the natural spawning escapement impossible. Hallock et al. (1961), however, reported that the wild-origin portion of Central Valley steelhead spawning escapements for the 1953–1954 through 1958–1959 returns ranged from 82% to 97% (mean = 88%). It is significant that only the Coleman and Nimbus hatcheries were operational during this period.

Since 1998 and the inception of 100% marking of hatchery steelhead, the proportion of hatchery-origin smolts sampled in the Chipps Island trawl survey has ranged between 60 and 80% (U.S. Bureau of Reclamation 2008). There is some evidence that this proportion may also approximate the proportion of hatchery-origin steelhead adults in the spawning escapement, at least in the streams with long-running hatchery programs: Battle Creek and the Feather, American and Mokelumne Rivers. Hatchery-origin fish likely comprise the majority of the fish spawning in nature in all four of these watersheds and Nobriga and Cadrett (2003) used Delta fish monitoring data to estimate that the overall Central Valley spawning escapement currently is comprised of 63% to 77%

hatchery-origin fish. In the American River, the natural spawning escapement appears to be overwhelmingly comprised of hatchery-origin spawners. Hannon and Deason (2008), estimated a spawning escapement ranging from 160 to 480 adults for the years 2002 to 2007 in the American River. NMFS (U.S. Bureau of Reclamation 2008) estimated that the number of wild-origin spawners during these years was "on the order of tens". In Battle Creek, the U.S. Fish and Wildlife Service (2001) estimated that more than 90% of the spawning escapement consisted of hatchery fish. Moreover, hatchery returns comprised an average of 59% (range of 23% to 100%) of the spawning escapement in the entire Sacramento River above Red Bluff Diversion Dam during the 10-year period of 1984 to 1993, the last ten years that steelhead could be counted at the Red Bluff Diversion Dam fish ladder (U.S. Fish and Wildlife Service 2001). A first-time steelhead redd survey in the Feather River in the 2003-04 spawning season detected 75 steelhead redds in the uppermost reach below the dam leading to an estimate of 163 natural spawners. The contribution of hatchery fish to the natural spawning escapement could not be estimated, but was probably high since the concurrent hatchery escapement was 2,999.

There may, however, be a number of populations that are not dominated by hatchery-origin spawners. No adipose-clipped steelhead were observed during 2003 to 2007 kayak and snorkel surveys in Clear Creek, for which mean escapement during those five years was estimated to be 290 (U.S. Fish and Wildlife Service 2007b). Of 12 steelhead observed in a counting weir on the Stanislaus River in the 2006-07 counting season, only one was observed to be adipose-clipped (Anderson et al. 2007). The Central Valley Technical Recovery Team has not identified steelhead populations within the DPS, but has speculated that "Existing wild steelhead stocks may be confined to upper Sacramento River tributaries (i.e., Antelope, Deer, and Mill Creeks) and the Yuba River, and they may also reside in Big Chico and Butte Creeks."

The brood stocks at Nimbus Hatchery and the Mokelumne River Hatchery represent highly introgressed mixtures of various stocks (McEwan and Jackson 1996). Over the period 1957 to 1993 nearly three million eggs and juveniles were transferred to Nimbus Fish Hatchery from the Snow Mountain Egg Collecting Station and Cedar Creek Hatchery, Eel River, CA; the Coleman National Fish Hatchery, Battle Creek, Sacramento River tributary; Warm Springs Hatchery, Dry Creek, Russian River, CA; and Mad River Hatchery, Mad River, CA, as well as summer-run fish from the Washougal River (Skamania stock) in Washington and the Siletz River in Oregon (Lee and Chilton 2007; U.S. Bureau of Reclamation 2008). The Mokelumne River hatchery is non-sustainable because of poor smolt-to-adult survival. Accordingly, it imports up to 250,000 eggs from the Feather River Hatchery if it cannot otherwise meet its production goals.

The brood stock used by Feather River Hatchery was originally derived from native Feather River fish, but Nimbus stock was imported from 1967 to 1988. Nevertheless, genetic analysis (National Marine Fisheries Service 1998) indicates that the Feather River Hatchery stock is tightly joined with the Feather River wild stock and further genetically linked with the Battle Creek population and the upper Sacramento River-Coleman group. The remaining genetic similarities between the Feather River Hatchery stock and other Central Valley stocks may be attributable to the possibility that the endemic stock had not been extirpated before the hatchery was built as perhaps was the case for American River steelhead (McEwan 2001); Gerstung 1971). It is believed that the original steelhead population in Battle Creek was extirpated or in severe decline from loss of habitat and other human-induced impacts, including the development of hydro-electric power projects within the upper Battle Creek basin (U.S. Fish and Wildlife Service 2001). The present population comprises native stock and upper Sacramento River steelhead collected from the Keswick Dam fish trap or the Red Bluff Diversion Dam, among other stocks that were introduced by the Coleman NFH steelhead

NMFS (Bjorkstedt et al. 2005) identified 108 winter steelhead and 10 summer steelhead populations that historically made up this DPS. All of the summer steelhead populations are considered to be independent, 43 of the winter populations are considered to be independent and 65 are considered to be dependent. Of the 118 populations defined, all 10 of the independent summer steelhead, 29 of the independent winter steelhead populations and 49 of the dependent winter steelhead populations still produce steelhead (National Marine Fisheries Service 2005b; Haney 2007).

The Mad River Hatchery is the only hatchery directly releasing fish into the geographic extent of this DPS. One former hatchery program, the Yager Creek program, was quite small (annual production of 5,000 smolts) and has been discontinued. Another program, the Gualala River Project, had an annual production goal of 15,000 smolts, but converted to a juvenile rescue/rearing program. The Gualala rearing/rescue program attempts to collect as many as 15,000 juveniles of all year classes during low-flows for rearing and return to Gualala River tributaries.

From 1973 to 1996 the Mad River Hatchery operated a summer-run hatchery program founded on Washougal, WA and Eel River brood stocks. The program was intended to support a sport fishery, but DFG determined that the cost of the program was greater than the fishing opportunities the program provided (California Department of Fish and Game 2006a). Summer-run fish continue to return to the Mad River albeit in reduced numbers.

The current Mad River Hatchery program collects winter-run adult returns to the hatchery with the goal of releasing 150,000 yearling smolts for into the Mad River (California Department of Fish and Game 2006a). While the Mad River hatchery collects both hatchery and wild adults, genetic differences between the Mad River hatchery fish and wild individuals, in part due to a non-indigenous founder stock, has led NMFS to conclude that the hatchery program should not be included in the DPS.

From 2004 to 2008, the Mad River Hatchery has made annual releases averaging 180,692 yearling smolts from the hatchery directly into the Mad River. No fish were released in 2005 (California Department of Fish and Game 2008a). The Hatchery Genetic Management Plan (California Department of Fish and Game 2006a) for the program states that DFG intends to limit releases to no more than 150,000 yearling smolts starting in 2007 in order to reduce potential hatchery effects on the wild population. Lowered production is intended to reduce the number of hatchery-origin adults spawning in nature. DFG will adipose-clip 100% of releases and modify sport harvest limits to focus harvest on hatchery-origin fish. These measures are intended to reduce the percent hatchery fish spawning in nature (pHOS) to 10% or less (California Department of Fish and Game 2006a). DFG also proposes to use a matrix-spawning scheme for hatchery brood stock and include wild-origin fish in the brood stock. By spawning wild-origin returns with multiple hatchery-origin returns DFG hopes to increase the genetic contribution of wild-origin fish (pNOB) to at least 10% of the hatchery brood stock.

Although the true incidence of hatchery strays from the Mad River Hatchery program are not known, NOAA's Biological Review Team concluded that the level of uncertainty about the genetic heritage of hatchery winter-run steelhead is problematic because of potential negative impacts on the wild populations. Mad River Hatchery brood stock are collected from fish exhibiting a natural run-timing (California Department of Fish and Game 2006a). This means that hatchery progeny will return and spawn at the same time as the wild population.

The information indicates that the influence of the hatchery stocking program on the genetic integrity of the wild steelhead populations is significant. This conclusion is based on the

assumptions that the Mad River winter and, especially summer steelhead populations, are significant populations within this DPS. The brood stock spawning protocol described in California Department of Fish and Game (2006a) includes hatchery-origin adults that are not indigenous to the watershed, and therefore should not be used to develop an integrated population. The Mad River steelhead hatchery program thus has the potential to cause significant adverse impacts on the fitness of this ESU. DFG shall implement Mitigation Measure BIO-139. With mitigation, impacts would remain significant and unavoidable.

Impact BIO-216: Genetic Effects on Steelhead, Klamath Mountains Province DPS, from Stocking Salmon and Steelhead (Significant and Unavoidable)

This DPS covers portions of Northern California (Klamath and Smith rivers) and Southern Oregon (Chetco, Rogue, and Elk Rivers) (Figure 4-36). NOAA Fisheries has determined that this DPS does not warrant listing under ESA (50 CFR Part 223, April 4, 2001). This analysis focuses entirely on the basins/populations and hatchery programs within California (Klamath and Smith rivers).

This Klamath Mountains Steelhead DPS includes five California populations, assumed to be independent because of their geographic isolation and/or disjunct spawning timing. These five populations are: 1) Smith River winter steelhead, 2) Trinity River summer steelhead, 3) Trinity River winter steelhead, 4) Klamath winter steelhead, and 5) Klamath summer steelhead. Summer-run steelhead in the Klamath and Trinity rivers occur primarily in the upper portions of the basins.

Hatchery stocking programs operated by DFG in this DPS include steelhead released on-station from the Iron Gate Hatchery in the Klamath River and from the Trinity River Hatchery on the Trinity River (Table 4-23). These programs collect brood stock from hatchery returns including such wild adults as enter the hatchery trap voluntarily. In addition to the two DFG programs, a third, private program, the Rowdy Creek Hatchery, occurs on the Smith River. The Rowdy Creek Hatchery is operated by the Kiwanis Club of Smith River and funded by private donations. This private program releases approximately 100,000 steelhead annually to provide fish for sport harvest.

Table 4-23. Hatchery Programs Operating in the Klamath Mountains Province Steelhead DPS

Population/ Hatchery Program	Species/ Run	Type and Purpose	Production Goal/Life stage	Actual Releases 2004–2008	Marks	Operator (Funding Agency)	Size and Time of Release	Release Location
Iron Gate Hatchery, located below Iron Gate Dam, ~River Mile 190, Klamath R	Winter Steelhead	Integrated Harvest	1,000,000/ yearling	89,844	100% CWT	DFG (Pacific Power and Light Company)	After April 1 (154 mm)	On-site,
Trinity River Hatchery, (below Lewiston Dam on Trinity R, ~River Mile 155)	Winter Steelhead	Integrated Harvest	2,000,000/ yearling	792,705	100% adipose fin clip	DFG (Bureau of Reclamation)	March 15– May 1 (228 mm)	On-site
Rowdy Creek Hatchery, Smith River	Winter Steelhead	Integrated Harvest	100,000/ yearling	106,172	100% adipose fin clip,	Kiwanis Club of Smith River	69 fpp in early June, 16 fpp in September	Lower Smith River

The following analysis of hatchery-mediated genetic impacts on wild steelhead production is based on the 2001 Status Review (National Marine Fisheries Service 2001). The proportion hatchery fish in the fall-run spawning escapement in the Trinity River ranged from 20% to 70% in the 1990s. These proportions probably reflect the hatchery contribution to the fall run only, because hatchery brood stock is drawn from the fall run. The proportion of hatchery fish in the natural spawning escapement over all portions of the run—summer, fall and winter—is likely substantially less. No evidence suggests that the spawning composition has changed since the 1990s. The proportion of Iron Gate Hatchery fish in the natural spawning escapement in the Klamath River is thought to be very low because return rates of hatchery fish are so low that the hatchery cannot meet its production goals. A low contribution of hatchery fish in the Klamath is supported by the fact that anglers reported releasing the vast majority of their catch after imposition of wild-release regulations. As with summer-run steelhead in the Trinity River, the contribution of hatchery fish to the summer-run spawning escapement in the Klamath is probably small because the Iron Gate Hatchery brood stock is drawn from winter-run adults. Based on creel censuses, the proportion of hatchery fish in the lower Smith River has been estimated to range from 27% to 37% (National Marine Fisheries Service 2001). These rates would be of some concern if they reflected spawning escapement composition (monitoring is concentrated in the lower river, ~15 miles below the Rowdy Creek Hatchery release site). Unfortunately, no data on the composition of the spawning escapement in the Smith River exists.

The California Steelhead Fishing Report-Restoration Card program (Jackson 2007) reports that, from an average annual sport catch (2003–2005) of 5,034 steelhead in the Smith and Klamath/Trinity systems, 66% (3,329 fish) were wild (unmarked) while 34% (1,705 fish) were of hatchery-origin (marked). Of the 34% hatchery-origin fish caught, 59% (1,003 fish) were released, of which a portion presumably will spawn in nature.

Based on the information above, it is concluded that the influence of the hatchery stocking program on the genetic fitness of the wild steelhead populations is significant. This conclusion is based on the fact that the Trinity River steelhead population is highly significant population within this DPS, and available evidence suggests that the proportion of hatchery fish in the spawning escapement exceeds the criteria for significance (pHOS greater than 10%). DFG shall implement Mitigation Measure BIO-139. With mitigation, impacts would remain significant and unavoidable.

Impact BIO-217: Genetic Effects on Steelhead, Central California Coast DPS, from Stocking Salmon and Steelhead (Less than Significant)

This DPS includes all naturally and artificially spawned anadromous steelhead populations below natural and manmade impassable barriers in California streams from the Russian River (inclusive) to Aptos Creek (inclusive), and the drainages of San Francisco, San Pablo, and Suisun Bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin Rivers (Figure 4-35). Tributary streams to Suisun Marsh including Suisun Creek, Green Valley Creek, and an unnamed tributary to Cordelia Slough (commonly referred to as Red Top Creek), excluding the Sacramento-San Joaquin River Basin, as well as two artificial propagation programs: 1) the Warm Springs Hatchery, and 2) Kingfisher Flats Hatchery/Scott Creek steelhead hatchery projects (Bjorkstedt et al. 2005).

NOAA (Bjorkstedt et al. 2005) identified 63 winter steelhead populations that historically made up this DPS. Thirty-seven populations are considered independent and 26 are considered to be dependent. Of the 63 populations defined, 30 of the independent populations and 18 of the dependent winter steelhead populations are believed by NMFS and DFG to still have steelhead (National Marine Fisheries Service 2005b).

A single hatchery program currently operates within the geographic bounds of the Central California Coast Steelhead DPS. The mitigation goal for the Warm Springs Hatchery (also called the Don Clausen Hatchery) on the Russian River is 200,000 yearling steelhead for release into the Russian River and another 300,000 yearling steelhead for off-station release into Dry Creek (tributary to the Russian River). The 2004 to 2008 average release of steelhead into Russian River was 181,000 fish and the Dry Creek release was 308,000 fish. . All hatchery steelhead are adipose fin-clipped prior to release and until 2008 only adipose-clipped returns are included in the hatchery brood stock (i.e. pNOB = 0%) (FishPro, Inc and Entrix Inc 2004). Unmarked, wild steelhead adults entering the brood stock holding areas are returned to the Russian River. Hatchery procedures were revised in 2008 to include an undefined portion of unmarked, wild steelhead in the hatchery brood stock (U.S. Bureau of Reclamation 2008).

Comprehensive estimates of steelhead abundance in the Russian River have never been made (Busby et al. 1996). However, in the 1990s steelhead abundance was estimated for some of the populations comprising the DPS. This estimate totaled ~7,850 adult returns but this estimate was undoubtedly incomplete (Busby et al. 1996). McEwan (2001) reported that the escapement of wild steelhead to the Russian River "probably ranges from about 1,750 to 7,000 adults".

Assuming an average annual release of 500,000 hatchery juveniles and a conservative smolt to adult return of 1%, 5,000 hatchery adults would return to the Russian River before harvest. Given these considerations, it is likely that the percent of hatchery-origin fish in the natural spawning escapement would exceed 10%. Therefore, in light of the fact that prior to 2008 the steelhead brood stock was comprised of 100% hatchery returns, it is likely that hatchery operations from 2004 to 2008 has adversely affected the fitness of the wild population. However, because this is just one population of 30 independent populations in this DPS, there are likely only minor impacts of the

hatchery stocking program on representation and redundancy of diversity groups within this DPS. This impact would be less than significant.

Impact BIO-218: Genetic Effects on Steelhead, South-Central California Coast DPS, from Stocking Salmon and Steelhead (Less than Significant)

This DPS includes all naturally spawned anadromous steelhead populations below natural and manmade impassable barriers in streams from the Pajaro River (inclusive) to, but not including, the Santa Maria River, California (71FR834) (Figure 4-37).

A paucity of data led the Technical Recovery Team (TRT) to conclude that classifying each population's status as independent or dependent would be overly speculative (Boughton et al. 2006). The TRT was able to conduct field surveys to determine whether stream systems that were historically known to hold steelhead, still had anadromous *O. mykiss* in 2002. They determined that of the 37 streams systems surveyed, 35 were observed to contain juvenile *O. mykiss* while two streams did not have fish (one stream was dry and the other no fish were observed). No determination was made for three stream systems not surveyed.

No hatchery programs currently collect steelhead brood stock or make releases of anadromous steelhead stocks below impassable barriers to any stream within the geographic extent of the South-Central Coast Steelhead DPS. This impact would be less than significant.

Impact BIO-219: Genetic Effects on Steelhead, Southern California DPS, from Stocking Salmon and Steelhead (Less than Significant)

This DPS includes all naturally spawned anadromous steelhead populations below natural and manmade impassable barriers in streams from the Santa Maria River, San Luis Obispo County, California (inclusive) to the U.S.-Mexico border (71FR834) (Figure 4-37).

A lack of data combined with an unclear understanding of population dynamics at the southern extreme of steelhead range led the TRT to conclude that classifying individual populations as to their dependence or independence would be overly speculative (Boughton et al. 2006).

The TRT was able to conduct field surveys to determine whether stream systems that were historically known to hold steelhead, still had anadromous *O. mykiss* in 2002. They determined that of the 47 streams systems surveyed, 16 were observed to contain juvenile *O. mykiss*. Of the other 31 stream systems, 27 streams either had barriers precluding anadromous steelhead or no fish were observed, and no determination was made for the other four streams (National Marine Fisheries Service 2007).

No hatchery programs currently collect brood stock or make releases of anadromous steelhead stocks below impassable barriers to any stream within the geographic extent of the Southern California Steelhead DPS. Thus, potential genetic effects associated with steelhead hatchery stocking would be less than significant.

Effects of Unintentional Releases of Hatchery-Reared Salmon and Steelhead

Impact BIO-220: Effects of Escaped Hatchery-Reared Salmon and Steelhead (Less than Significant)

All DFG hatchery culture and holding systems are designed, operated, and maintained in a manner intended to prevent escape. Prevention measures include the installation of screens of appropriate size and strength at the intake from the hatchery water source and at the tailrace of the respective raceways. At some hatcheries concrete barrier walls and shallow water levels at the discharge point make fish escape difficult. In many cases, distribution boxes and aerators at the heads of raceways provide barriers to minimize the unintentional release of hatchery fish and DFG personnel perform daily surveys of hatchery screens to ensure they are maintained and functioning. On occasion hatchery fish do escape the rearing raceways and end up in the settling ponds or other waters of the hatchery. These escapes can occur by fish being captured by predatory birds and dropped in other areas of the hatchery or nearby waters. On rare occasions, hatchery screens in fish containment ponds can fail due to unforeseen circumstances such as increased debris loads from storm events. When screen failure is detected, efforts are made to collect these fish before they are allowed to escape the hatchery water supply. Due to the minimal numbers of escaped hatchery-reared fish, it is anticipated that this would not cause increased ecological pressure to the downstream waters. Therefore, this potential impact is less than significant.

Impact BIO-221: Effects of Unintentional Releases of Hatchery-Reared Salmon and Steelhead (Less than Significant)

Unintentional releases are releases of juvenile, subadult, and adult anadromous salmonids in places, times and numbers not specified in the hatchery stocking management plan. Unintentional release can occur when fish are released due to catastrophic failure or impending failure of hatchery infrastructure. It is DFG policy that all other options be explored first before fish are released to avoid loss due to catastrophic failure. Exceptions include stocking in drainages that are not part of an anadromous rainbow trout restoration or recovery program (California Department of Fish and Game 2009). It should be noted that these releases that occur at the hatchery are on waters where the fish species were spawned and would have been released had the potential failure not occurred.

In the event of hatchery truck failure, DFG hatchery staff are instructed to not release fish into areas that are not assigned for stocking, so no fish are released inappropriately due to vehicle breakdowns.

This impact would be less than significant.

Effects of Anglers at Fishing Sites

The reader is referred to the discussion of "Impacts of the Trout Stocking Program," under the subheading "Effects of Anglers at Fishing Sites," which discusses impacts caused by anglers under the trout stocking program. Impacts relevant to the salmon stocking program are substantially the same, and differ only as noted below.

Impact BIO-222: Disturbance of Riparian Systems Due to Use of Vehicles and Foot Travel to Access Fishing Locations (Less than Significant)

The potential for disturbance to riparian habitats and associated special-status plants due to vehicle and foot traffic by salmon and steelhead anglers is much reduced from that of trout anglers. There are significantly fewer anglers accessing anadromous creeks and rivers, and boat access is typically via developed boat ramps. Most of this fishing occurs at lower elevations in less sensitive habitats. Therefore, the potential to degrade and fragment riparian habitat areas that provide essential ecosystem support to special-status fish and wildlife species would be less than significant.

Impact BIO-223: Disturbance of Benthic Aquatic Areas by Wading Anglers (Less than Significant)

Salmon, steelhead and trout anglers commonly wade in the stream. There is a risk that this activity could disturb redds of native salmon and steelhead species. Roberts and White (1992) report a Montana study of experimental trampling of eggs in the manner of an angler wading through redds. In a laboratory setting, they found that a single wading killed up to 43% of trout eggs and pre-emergent fry. While the differences in the size of the substrate material trout, salmon and steelhead choose to spawn in varies (salmon and steelhead generally spawn in areas with larger size substrate material than is optimal for trout spawning), the finding that wading by anglers through a redd can cause mortality is applicable. When recreational fishing for salmon and steelhead occurs in areas where the redds of special-status salmon and steelhead species may occur, this impact can potentially have a severe effect on redd survivorship. In order to avoid this outcome, DFG avoids stocking in areas used for spawning by salmon and steelhead and closes those areas to fishing during the periods of spawning and egg incubation. Given these precautions, the potential for a significant adverse impact to salmon and steelhead spawning grounds due to wading by anglers would be less than significant.

Impact BIO-224: Distribution of Invasive Species by Anglers (Significant and Unavoidable)

Anglers may cause a significant adverse impact on local ecosystems and their associated fish and wildlife species by introduction of aquatic invasive species and/or pathogens. DFG shall implement Mitigation Measure BIO-123 described earlier in the Trout Stocking impact discussion, but the impact would remain significant and unavoidable.

> **Mitigation Measure BIO-123: Educate Anglers to Control Invasive Species**
>
> This mitigation measure is described above, for Impact BIO-123.

Impact BIO-225: Impacts Caused by Motorized Fishing Boats (Less than Significant)

The potential impacts of operating motorized fishing boats have been discussed in "Impacts of the Trout Stocking Program," under the subheading "Effects of Anglers at Fishing Sites," earlier in this chapter. A similar risk of effect can occur from operating boats to catch salmon and steelhead. For reasons stated in "Effects of Anglers at Fishing Sites," this impact would be less than significant.

Impacts of the Fishing in the City Program

DFG's Fishing in the City program was started in 1993 to provide Californians living in the Sacramento, San Francisco, and Los Angeles metropolitan areas an opportunity to learn how to fish. Fish stocked for this program consist of hatchery-reared rainbow trout, channel catfish, and Sacramento perch purchased primarily from non-DFG sources. Rainbow trout stocked in Region 5 come from DFG hatcheries. The Fishing in the City program's introduction of hatchery-reared fish into state waters potentially impacts biological resources. The types of impacts and the impact mechanisms are very similar to those evaluated under the DFG Trout Stocking Program section earlier in this chapter. An important difference is that warm water fish (channel catfish and Sacramento perch) are often stocked, not just trout. The principal concerns are related to competition for food and space and possible predation when fish are stocked in waters occupied by decision species (Table 4-1). The impacts from genetic hybridization, non-target harvest, and angler effects described for the trout stocking program are not considered significant risks from Fishing in the City program stocking because of the urban nature of stocking locations and the prohibitions against stocking in waters occupied by wild populations of native trout.

The analysis is based on Fishing in the City program stocking information collected by the DFG regions and focuses on potential impacts on decision species. The analysis is general in nature, relying on species ranges and habitat types as overlain on stocking locations as indicators of the potential for significant effects.

Impact BIO-226: Predation and Competition Impacts from Fishing in the City Program–Stocked Fish on Sensitive, Native, or Legally Protected Fish and Wildlife Species (Less than Significant with Mitigation)

The predation and competition impact mechanism associated with stocking hatchery fish is described in detail in the section "Effects from Predation and Competition from Stocked Trout," above.

Lakes in Los Angeles, Orange and San Diego counties are stocked for the south coast region Fishing in the City program (see Table 2-8 in Chapter 2). With one exception, all events are held at urban parks or artificial impoundments. The Mammoth Lakes event does not include fish stocking. There is minimal concern associated with the stocking that occurs in the southern region program. The stocking occurs entirely in isolated waters that generally are surrounded by artificial landscapes, have a manufactured lining, and/or are bordered by lawn. With few exceptions, overflow from these planted waters is discharged into manmade flood control channels that do not provide year-round habitat for the stocked species. Furthermore, DFG biologists ensure fish stocking does not occur in waters containing listed fish and wildlife species, candidates or special-status species. Several of the stocking locations in the south coast region are within the range of species included in Table 4-1 that are not listed, candidate or special-status species, such as the common garter snake. This species is potentially affected by Fishing in the City program stocking.

The Bay-Delta region (Region 3) Fishing in the City program has supported stocking fertile and sterile rainbow trout, channel catfish and Sacramento perch in both isolated and flow-through waters (see Table 2-8). In the past 5 years, stocking has occurred in flow-through waters at a few locations and occasionally has taken place upstream of steelhead habitat. Because many of the flow-through waters do not have suitable downstream fish habitats, the unintentional establishment of

nonnative fish downstream was of little concern. When stocking locations were proposed upstream of suitable fish habitat, DFG biologists would assess risks to biological resources in both the planting location and downstream waters. However, because of concern for adverse effects on native steelhead, the DFG Bay-Delta region no longer performs Fishing in the City program stocking occurs in impounded sections of streams that have the potential to spill into waters capable of supporting steelhead populations (Rotman pers. comm.). Some of the stocking locations in the Bay-Delta region provide habitat that could support sensitive species listed in Table 4-1, including rough-skinned newt, Coast Range newt, western toad, Pacific treefrog, California red-legged frog, and common garter snake. Therefore, planting of nonnative fish could result in predation impacts on these species. The potential for negative interactions between planted fish and these species is discussed in detail in "Impacts of the Trout Stocking Program," under the subheading "Effects from Predation and Competition from Stocked Trout," earlier in this chapter. While there is the potential to affect these species, the DFG Fishing in the City program manager reviews all potential planting sites with a regional fisheries biologist (Rotman pers. comm.). The biologist ensures that the planting locations do not support populations of legally protected or sensitive native amphibians and reptiles. This internal review process minimizes the risk of having a significant impact on sensitive or legally protected species.

In the Sacramento metropolitan area, only 8 park ponds are stocked with trout or catfish through the Fishing in the City program (see Table 2-8). These ponds exist in artificial urban landscapes that are isolated from creeks and rivers. While there is no potential for impacts on legally protected fish species, the ponds have habitat that could support other decision species listed in Table 4-1, including Pacific treefrog, western toad and common garter snake. The ponds have been screened by DFG biologists for state and federally listed species, so there is minimal risk of predation or competition with these species. However, other decision species mentioned here are not routinely screened for when Fishing in the City program stocking is undertaken.

As noted in Chapter 2, Region 4's urban fishing program is not part of the Fishing in the City program but is very similar in intent. Some of its stocking locations are in established and approved waters, while others have similar characteristics to many Fishing in the City stocking locations in that they occur in artificial water bodies within urban parks, sports complexes, or former swimming pools.

To summarize, the Fishing in the City program stocking activities introduce short-term or self-sustaining populations of rainbow trout, channel catfish and Sacramento perch into some water bodies that may contain populations of species listed in Table 4-1. In some instances, population-level effects due to predation and competition by stocked fish would be potentially significant. Mitigation Measure BIO-226 is required to reduce this impact to less than significant.

Mitigation Measure BIO-226: Implement Private Stocking Permit Evaluation Protocol

When water bodies are proposed for stocking under Fishing in the City program, regional biologists shall review each site for the presence of the decision species included in Table 4-1, using the private stocking permit evaluation protocol detailed in Appendix K. Where decision species may occur, the biologist shall consider whether the stocking of hatchery fish would result in a substantial adverse effect, either directly or through habitat modifications, including designated critical habitat, on any species included in Table 4-1 of this document, including substantially reducing the number or restricting the range of an endangered, rare, or threatened

species. This review process shall be implemented in each region sponsoring Fishing in the City program stocking.

Impact BIO-227: Impacts of Introducing Pathogens to Wild Native Fish Populations through Fishing in the City Program Stocking (Less than Significant)

Most of the fish stocked in state waters through Fishing in the City program are reared at private aquaculture facilities that are registered with DFG. The only exception to this is in Region 5 (South Coast), where rainbow trout from DFG hatcheries are stocked for Fishing in the City program events. The owners of the private aquaculture facilities must meet the fish health requirements contained in Fish and Game Code, Division 12, Chapter 6 and the supporting regulations in Title 14, Regulation 245 of the California Code of Regulations. These regulations are designed to minimize the risk of pathogen transmission from fish reared in private aquaculture facilities to wild populations of native fish. DFG hatcheries also operate under a number of procedures that minimize risk of disease transmission. In addition, none of the fish stocked through the Fishing in the City programs are released directly into habitats occupied by wild populations of native fish species (see Table 2-8). Therefore, this impact would be less than significant.

Impact BIO-228: Impacts of Introducing Pathogens to Native Amphibian Populations through Fishing in the City Program Stocking (Less than Significant with Mitigation)

The mechanism and potential for spread of pathogens from stocked fish to native amphibians, and subsequent reduction in amphibian populations is described in detail in the Trout Stocking Program section of this chapter (see Impact BIO-107). With regard to the Fishing in the City program-related stocking, fish are released within the range of sensitive native amphibians, so the potential exists for transfer of pathogens. There is currently no protocol to examine hatchery-reared fish, either in DFG hatcheries or private aquaculture facilities, for the presence of the three amphibian pathogens of greatest concern, *Ranavirus* sp., *Saprolegnia ferax and Batrachochytrium dendrobatidis.* The amphibian species of concern for Fishing in the City program stocking include rough-skinned newt, Coast Range newt, western toad, Pacific treefrog, and California red-legged frog. While the magnitude of the risk of transfer is unknown, the effect is considered potentially significant. Mitigation measure BIO-233b (described below in the Private Stocking Permit Program section) is required. This measure will reduce the risk of transferring pathogens to native amphibians to less than significant.

Mitigation Measure BIO-233b: Implement Private Stocking Permit Evaluation Protocol

Mitigation measure BIO-233b (described below in the "Private Stocking Permit Program" section) shall be implemented prior to stocking sites proposed for Fishing in the City program stocking. If populations of any amphibians identified in Table 4-1 are discovered by DFG biologists at proposed stocking sites, the stocking will not occur.

Impact BIO-229: Impacts of Introducing Aquatic Invasive Species into Native Ecosystems Through Fishing in the City Program Stocking (Less than Significant with Mitigation)

The risk of spreading invasive species from stocking of DFG hatchery fish is discussed in detail in Impact BIO-108 in the Trout Stocking Program section of this chapter. With the invasive species control and monitoring practices used at DFG hatcheries and the requirement that the DFG Fish Health Lab monitor hatchery fish prior to stocking, the risk of transmitting invasive species is low.

There are no records of releasing invasive species from DFG hatcheries to waters of the state in the past 5 years.

The risk of transmitting invasive species through stocking of privately-cultured fish is more difficult to assess. DFG staff do not monitor all allotments of fish stocked from private facilities as part of Fishing in the City program. The private aquaculturists are responsible for insuring that their facilities are free of invasive species that might be transmitted to off-site locations through stocking. This assurance would be considered good management practice, as presence of invasive species infestations would ultimately result in a quarantine of the facility and loss of revenues due to the lack of sales. While there is no record of transmitting invasive species from private aquaculture facilities to state waters, the risk is considered potentially significant.

Mitigation Measure BIO-229: Require and Monitor Invasive Species Controls at Private Aquaculture Facilities

To avoid the spread of invasive species from Fishing in the City program-related stocking, DFG shall require invasive species monitoring and reporting at private aquaculture facilities participating in the Fishing in the City program. Quarterly monitoring shall be conducted by a qualified and acceptable company or person using DFG standard protocols. Reports shall be submitted to the DFG Fisheries Branch, Aquaculture Registration Program, and supplemental to any application for private stocking permit. Aquatic invasive species subject to monitoring currently include NZMS, quagga mussel and zebra mussel. Other species may be added to this list as warranted.

Impacts of the Classroom Aquarium Education Project

As indicated in Chapter 2, the Classroom Aquarium Education Project (CAEP) is a small educational program designed to expose students to the early life history of salmonids in California. Eggs are received primarily from DFG hatcheries (the Rowdy Creek private hatchery has provided fish in Region 1), the eggs are hatched in classroom aquaria and eventually fish are released to streams or lakes approved by DFG biologists. The types of impacts and the impact mechanisms are very similar to those evaluated under the DFG Trout Stocking Program section earlier in this chapter. The principal concerns are related to competition for food and space and possible predation when fish are stocked in waters occupied by decision species, and from the potential for genetic hybridization. The impacts from non-target harvest, and riparian habitat degradation described for the trout stocking program above are not considered to pose substantial risks relative to CAEP fish releases because the number of fish released through this program is too small, and the release locations too widely dispersed, to result in such impacts to any potentially significant degree.

Impact BIO-230: Predation and Competition Effects from CAEP-Released Fish on Sensitive, Native, or Legally Protected Fish and Wildlife Species (Less than Significant)

The potential impacts associated with this small program are similar to those of releasing hatchery-reared fish, but to a much lesser degree. Because the release numbers are small, the survival rates are low, and all releases occur in waters already occupied by the fish species being released, the risk of a significant predation or competition effect on decision species is less than significant.

Impact BIO-231: Genetic Impacts on Wild Populations of Native Salmon and Trout from Interbreeding with CAEP-Released Fish (Less than Significant)

The low relative numbers and survival rates of fish released through CAEP contribute to minimizing the potential impacts associated with genetic drift within native wild fish populations. Releases are not allowed in waters occupied by wild trout. Releases occur only in waters currently stocked by DFG and the numbers of fish released under CAEP are orders of magnitude less than the numbers of fish released under DFG trout and salmon/steelhead stocking programs. Therefore, genetic impacts on native fish populations from CAEP releases would be less than significant.

Impact BIO-232: Impacts of Introducing Pathogens and Invasive Species to Native Fish and Amphibian Populations and Their Habitats through CAEP-Released Fish (Less than Significant)

The potential for CAEP fish to be a vector for fish pathogens is low. Outbreaks of contagious fish diseases and the presence of invasive species that occur within the hatchery environment are most often the result of contaminated hatchery source waters. CAEP fish are raised in aquaria that are not using flow-through source water originating downstream of native fish and therefore exposure of the eggs/fry to fish pathogens is highly unlikely. Furthermore, eggs supplied to the program must be inspected and treated to ensure they are disease-free and free of invasive species. Fish stocked during CAEP activities are generally planted in the same waters from which the eggs came. Therefore, the potential for impacts from transfer of disease or invasive species under the CAEP would be less than significant.

Impacts of the Private Stocking Program

This section discusses the effects of stocking both native and nonnative fish species into public and private waters from privately-operated, DFG-registered aquaculture facilities. The types of impacts and the impact mechanisms operating under the Private Stocking Program are very similar to those evaluated under the DFG Trout Stocking Program section earlier in this chapter; the primary difference is that the private stocking program includes stocking of many species of fishes in addition to trout; accordingly, the program potentially affects a wider array of habitats via a greater variety of biological mechanisms. In contrast to DFG hatcheries, there is no formal program to evaluate private facilities for disease or invasive species.

The analysis is based on stocking information collected by DFG regions as part of their private stocking permit program and focuses on potential impacts on decision species, as identified in Table 4-1. The analysis is general in nature, relying on species ranges and habitat types overlain on stocking locations as indicators of the potential for significant effects. This section does not analyze the effects of operating private aquaculture facilities.

The information collected by DFG through its private stocking permit application process, the subsequent steps it takes to have qualified biologists review each proposed stocking site, and the requirements placed on private aquaculture facilities by Title 14, Section 238.5 of the California Code of Regulations regarding disease and unauthorized species control are all designed to reduce the potential for adverse effects on biological resources.

Impact BIO-233: Predation and Competition Impacts from Fish Released Under Private Stocking Permits on Sensitive, Native, or Legally Protected Fish and Wildlife Species (Significant and Unavoidable)

A detailed description of the potential predation and competition interactions between stocked fish and decision fish and wildlife species is presented above in the Trout Stocking Program impact section. Because private stocking occurs in nearly all regions of the state, in all types of aquatic habitats, there is the potential for privately stocked fish to impact populations of decision species through competition for food and space and through predation.

The DFG private stocking permit program does not record the exact location of all permitted stocking sites. Therefore, the ranges and habitat requirements of the decision species (Table 4-1) were compared with the available information on private stocking locations and with the types of habitats that are likely to exist where private stocking can occur without DFG review. Species that are likely exposed to risk from private stocking include (in the order listed in Table 4-1):

● Invertebrates - Shasta crayfish;

● Lamprey - River and Kern Brook lamprey;

● Freshwater and Estuarine Fish - Owens speckled dace and Owens sucker;

● Salmonid Fish – none;

● Amphibians

  ○ Salamanders – California tiger, northwestern, long-toed, Santa Cruz long-toed, California giant, and southern torrent salamanders;

  ○ Newts – rough-skinned, Sierra and Coast Range newts;

  ○ Toads – Western, Yosemite, and Woodhouse's toads;

  ○ Frogs – Pacific treefrog, northern leopard, northern red-legged, California red-legged, foothill yellow-legged, mountain yellow-legged (both DPSs), and Cascades frogs;

● Reptiles – Western pond turtle; common, mountain, western aquatic, two-striped, giant, San Francisco and south coast garter snakes.

Most of the species listed above are taken into consideration by DFG regional biologists when considering a private stocking permit application. However, some of the species are not currently legally protected or species of special concern to DFG, so they may not be screened in all instances. Because there is no standard process or set of criteria identified to screen private stocking sites throughout all of the DFG regions, there remains a potential to adversely affect these species by stocking fish within their habitats. There is a greater risk to some of these species that might occupy private ponds that do not go through a DFG review in all or parts of 37 counties (see the discussion of this exemption area in the Private Stocking Permit Program segment of Chapter 2). There is thus a substantial risk that fish stocking under the private stocking program may substantially impair populations of these species, affect designated critical habitat for these species, or affect compliance with approved recovery plans for these species. This risk is potentially significant for all species listed above and, pending action by the Fish and Game Commission as recommended in mitigation measure BIO-233a listed below, would be considered significant and unavoidable.

Mitigation Measure BIO-233a: Eliminate Private Stocking Exemption

To reduce the effect of private stocking where DFG permits are currently not required, DFG shall recommend to the Fish and Game Commission that regulations be modified to remove the exemption for private stocking permits described in Title 14, California Code of Regulations, Section 238.5, subsections (c) and (f) by December 1, 2010. The removal of this permit exemption would allow DFG staff to review each proposed stocking location in the context of site-specific information about the stocking location, including information detailing potential use of the site by decision species. With this review capability, DFG staff could screen stocking locations for decision species populations prior to stocking. This mitigation, combined with the mitigation listed below, would reduce the potential impact to less than significant. Absent this revision of Section 238.5, impacts would remain significant and unavoidable.

Mitigation Measure BIO-233b: Implement Private Stocking Permit Evaluation Protocol

When water bodies are proposed for stocking under the private stocking permit program, DFG staff will review each site for the presence of the decision species using the private stocking permit evaluation protocol included in Appendix K (Figure K-2). Where decision species may occur, the biologist shall consider whether the proposed stocking would result in a substantial adverse effect, as defined in the section of this chapter titled "Significance Criteria," on any decision species listed in Table 4-1 of this document. If a substantial adverse effect would occur, the biologist shall deny the permit.

Impact BIO-234: Impacts from Non-Target Harvest Resulting from Private Stocking Permit Fish Releases (Less than Significant)

Private stocking permit fish releases are reviewed by DFG as part of the permit review process, and the evaluation criteria screen sites that might contain populations of wild salmonid decision species. The criteria also avoid stocking where endangered species or species of special concern exist until studies have been conducted that indicate there would be no negative impacts. This screening process would avoid effects to the fish species listed in Table 4-1.

Where private stocking that is exempt from the private stocking permit requirement occurs (area shown in Figure 2-7), no DFG staff review occurs. Although mechanisms exist whereby non-target harvest could conceivably affect decision species (for instance, use of native salamanders or frogs as bait), nontarget harvest has not been documented as a factor in decline of decision species on private lands and no data has been identified documenting the potential extent of such an impact. Accordingly this impact is less than significant.

Impact BIO-235: Genetic Impacts on Wild Populations of Native Salmon and Trout from Interbreeding with Private Stocking Permit Fish Releases (Less than Significant)

DFG staff review private stocking permit applications to insure that rainbow trout stocking does not occur within waters occupied by any wild salmonid decision species. Other species stocked through this permit process are not capable of interbreeding with wild native salmon or trout. However, unpermitted private trout stocking is known to currently occur in reservoirs that seasonally discharge to waters supporting endangered steelhead (D. Maxwell pers. comm. Sep 16), and a comparable mechanism could potentially affect other salmonid decision species.

Based on DFG's experience with private stocking permits issued elsewhere in the state (in currently non-exempted counties), as well as some level of familiarity with deliveries made by aquaculturists in currently exempted counties, private stocking permits are generally pursued for isolated or semi-isolated waters for the purposes of individual fishing opportunities or for focused fishing events. Fish stocked via private stocking permit are generally to ponds or lakes that are unlikely to be occupied by wild salmonids. Accordingly, in those 37 counties where DFG does not review private stocking, there is little potential for genetic impacts on wild salmonid decision species.

This impact is less than significant.

Impact BIO-236: Impacts of Introducing Pathogens to Wild Populations of Native Fish and Their Habitats through Private Stocking Permit Fish Releases (Significant and Unavoidable)

The potential for introducing pathogens to wild native fish populations and their habitats from private stocking activities is not adequately addressed by existing regulations associated with DFG's issuance of private stocking permits. There are no requirements in applicable regulations that applicants for a private stocking permit must provide a certificate or other proof regarding the health of the fish in the facility providing the fish to be stocked. Thus, in many cases, DFG makes decisions on allowing fish stocking without current knowledge of the disease status of these fish. Accordingly, Mitigation Measure BIO-236 is required. Impacts with mitigation would be significant and unavoidable; however, if the California Fish and Game Commission chooses to enact the regulatory changes identified in the mitigation measure, impacts would be reduced to less than significant.

Mitigation Measure BIO-236: Require Aquaculture Products Stocked in Waters of the State to be Certified Free of Disease

DFG shall recommend to the Fish and Game Commission that it modify existing regulations in CCR Title 14 section 238.5 (b) which currently reads

"(b) Live aquaculture products shipped to Inyo or Mono counties must be certified by the department as disease and parasite-free before being stocked in waters in those counties."

The recommended modification to CCR Title 14, section 238.5 is as follows:

"(b) Live aquaculture products stocked into waters of the State, or reared or held in waters that discharge to waters of the State, must be annually certified by a certified laboratory or other laboratory acceptable to DFG as disease and parasite free before being stocked or reared in waters of the State. These health certifications shall be submitted to DFG as part of the application for private stocking permits."

Adoption of the proposed regulatory change would reduce impacts to less than significant.

Impact BIO-237: Impacts of Introducing Pathogens to Native Amphibian Populations and Their Habitats through Private Stocking Permit Fish Releases (Significant and Unavoidable)

The mechanism and potential for spread of pathogens from stocked fish to native amphibians, and subsequent reduction in amphibian populations is described in detail in the Trout Stocking Program section of this chapter (see Impact BIO-107). With regard to stocking from private hatchery facilities, fish are released within the range of sensitive native amphibians, so the potential exists for transfer of pathogens. There is currently no protocol to examine fish reared in private facilities for

the presence of the three amphibian pathogens of greatest concern, *Ranavirus* sp., *Saprolegnia ferax and Batrachochytrium dendrobatidis.* The amphibian species of concern with habitats potentially receiving private stocking include the following:

- Salamanders – California tiger, northwestern, long-toed, Santa Cruz long-toed, California giant, and southern torrent salamanders;

- Newts – rough-skinned, Sierra and Coast Range newts;

- Toads – Western, Yosemite, and Woodhouse's toads; and

- Frogs – Pacific treefrog, northern leopard, northern red-legged, California red-legged, foothill yellow-legged, mountain yellow-legged (both DPSs), and Cascades frogs.

Some of the private stocking within the range of these animals is not subject to review by DFG biologists, as stocking to private ponds is exempt from permitting in a 37-county area (see Figure 2-7). This exclusion increases the risk that stocked fish could carry pathogens to amphibians occupying private ponds in this area. While the magnitude of the risk of transfer is unknown, the effect would be potentially significant. Mitigation Measures BIO-233a and BIO-233b, described above, are required. Pending enactment by the Fish and Game Commission of the regulatory changes recommended in Mitigation Measure BIO-233a, impacts are significant and unavoidable.

Impact BIO-238: Impacts of Introducing Aquatic Invasive Species to Wild Populations of Native Fish and Native Amphibian Populations and Their Habitats through Private Stocking Permit Fish Releases (Significant and Unavoidable)

The risk of transmitting aquatic invasive species through stocking of privately-cultured fish is discussed above for the Fishing in the City Program. While the impact mechanism and the controls in place are similar, the private stocking program is much more widespread and a significant portion of the stocking that occurs is not reviewed by DFG staff (refer to the exemption area in Figure 2-7). Also, compared to stocking in the FIC program, the private stocking program involves many more hatchery facilities and the types of stocking locations are more varied. Therefore, the risk of transmission and the potential for habitat damage are greater. While there is no record of transmitting invasive species from private aquaculture facilities to state waters, the risk would be potentially significant. Pending enactment by the Fish and Game Commission of the regulatory changes recommended in Mitigation Measure BIO-238, impacts are significant and unavoidable. Enactment of the recommended regulatory changes would reduce impacts to less than significant.

Mitigation Measure BIO-238: Require and Monitor Invasive Species Controls for Private Stocking Permits

To avoid the spread of invasive species from private stocking permit activities, DFG shall recommend to the Fish and Game Commission that 14 CCR section 238.5 be amended to require invasive species monitoring and reporting at private aquaculture facilities planning to stock fish into waters of the State. Quarterly monitoring shall be conducted by a qualified and acceptable company or person using DFG standard protocols. Reports shall be submitted with any application for a private stocking permit. Aquatic invasive species subject to monitoring currently include NZMS, quagga mussel and zebra mussel. Other species may be added to this list as warranted.

Impact BIO-239: Disturbance of Riparian Systems Due to Use of Vehicles and Foot Travel to Access Fishing Locations as a Result of the Private Stocking Permit Program (Less than Significant)

Fish stocking that occurs under the private stocking permit program is intended to attract recreational anglers, similar to the DFG trout stocking program. Therefore, the potential to adversely affect riparian plant communities from foot travel and vehicle use is similar. A detailed description of this impact mechanism is included with Impact BIO-119 above in the trout stocking section of this chapter, and identifies the potential impact as being most severe with regard to the risk that angler activities may disturb populations of special-status plants. If such activities were to result in the extirpation of a population of a listed threatened or endangered plant species, a significant adverse impact would result.

Several factors suggest that the private stocking program would have reduced impacts on sensitive plants, compared to the trout stocking program. These include the much smaller numbers of fish stocked, the smaller number of sites stocked under the private stocking program , and the range of environments affected. Compared to most DFG stocking, a large portion of private stocking occurs in private ponds and lakes at lower elevations. Where the private stocking does occur in public reservoirs and lakes, there is typically vehicle access. Higher elevation lakes with access only by foot or horseback are seldom stocked through private stocking permits. Therefore, some of the more fragile HML and stream riparian systems are not being affected by this program. In the past 5 years, the numbers of sites stocked under private stocking permits has ranged between 129 and 160, compared to the 963 locations stocked under the DFG trout stocking program. Because of the relatively small number of sites affected and the smaller number of anglers attracted, this does not represent a substantial adverse effect on sensitive riparian plant communities. This impact would be less than significant.

A large fraction of the permittee stocking locations have been disturbed by angler activity on a regular basis for many years past, as indicated by the high fraction of renewals for these permits. In Regions 1 and 2, nearly all permits issued are renewals (Randy Benthin and Ken Kundargi, pers comm. 16-Sep). In region In region 4, about 40% of permits are renewals (Kimberley Hosley pers comm. 16-Sep). In Region 5, which issues very few permits, about half are renewals (Dwayne Maxwell pers comm. 16-Sep). Permits that are issued as renewals generally entail stocking the same fish as before at the same sites as before, and thus offer a proportionately low risk of incremental impacts to riparian habitats, compared to permits that establish new stocking locations.

Impact BIO-240: Distribution of Invasive Species by Anglers as a Result of the Private Stocking Permit Program (Significant and Unavoidable)

The potential for distribution of invasive species by anglers is discussed in detail in Impact BIO-123 in the Trout Stocking Program analysis earlier in this chapter. As that section indicates, California's Aquatic Invasive Species Management Plan (California Department of Fish and Game 2008) identifies recreational fishing as a primary vector for introduction of aquatic invasive species (AIS), noting that "Initial introductions can occur when bait buckets and live tank contents are dumped. Gear used for fishing (boats, nets, floats, anchors, wading boots, tackle, etc.) can spread AIS. For example, fly fishing gear used in waters infested with New Zealand mud snails, may be the primary vector associated with the spread of this AIS into California's rivers." Anglers may also disperse invasive species via gear such as rafts and float tubes. The anglers attracted to fishing sites by stocking from private aquaculture facilities pose this risk. In addition, because many private

stocking events are not subject to DFG review through the permit process, there is a limited chance to provide the anglers with educational material that can reduce the risk of transferring invasive species to uninfected sites. In such circumstances, anglers may cause a significant adverse impact on local ecosystems and special-status species by introduction of aquatic invasive species.

This impact would be mitigated by implementation of Mitigation Measure BIO- 123 and Mitigation Measure BIO-233a. However, residual impacts would be significant and unavoidable.

Discussion of Supplemental Evaluation Species

Assessment Methodology

Most potential impacts discussed in Chapter 4 are assessed in the context of their potential to affect decision species (Table 4-1).

As described under the *Special-Status Species* section of this chapter, a species was regarded as requiring evaluation if it was:

- known to occur in riparian, wetland, or aquatic habitat adjoining or within a few miles downstream of a fish hatchery evaluated in the EIR/EIS;

- known to occur in riparian, wetland, or aquatic habitat at sites where fish stocking is performed under one or more of the stocking programs described in this EIR/EIS; or

- known to be vulnerable to ecosystem-level impacts such as alteration of food webs by stocked fish, alteration of riparian and aquatic systems by the activities of anglers, or various other indirect mechanisms that have been reported in published studies of fisheries and aquatic ecosystems.

The distribution and ecological data required to evaluate these criteria are generally not available for supplemental evaluation species, but the lack of known species occurrences and/or research regarding these species' sensitivity to angling does not rule out the potential that they might be impacted by the Program. The 49 supplemental evaluation species are listed in Table 4-24, below. The bird species are divided into three guilds (*Fish Eating Birds, Invertebrate Eating Birds,* and *Opportunistic Feeders*), while mammal species listed in Table 4-24 are also divided into three guilds (*Aquatic or Riparian Dependent Species, Species that Utilize Both Riparian and Uplands, Upland Species*). The attributes of these guilds and a qualitative discussion of potential impacts to these species, are provided below.

Table 4-24. Supplemental Evaluation Species Potentially Affected by Hatchery and Stocking Programs

Common Name	Scientific Name	Status (federal)	Status (state)
Birds			
Fish Eating Birds			
Harlequin Duck (nesting)	*Histrionicus histrionicus*	(none)	SSC
Western Grebe	*Aechmophorus occidentalis*	(none)	(none)
Clark's Grebe	*A. clarkia*	(none)	(none)
American White Pelican (nesting colony)	*Pelecanus erythrorhynchos*	(none)	SSC
Double-crested Cormorant (rookery site)	*Phalacrocorax auritus*	(none)	WL
Common Loon (nesting)	*Gavia immer*	(none)	SSC
Caspian Tern (nesting colony)	*Hydroprogne caspia*	(none)	(none)
Black Tern (nesting colony)	*Chlidonias niger*	(none)	SSC

Common Name	Scientific Name	Status (federal)	Status (state)
Green Heron	*Butorides virescens*	(none)	(none)
Invertebrate Eating Birds			
Spotted Sandpiper	*Actitis macularia*	(none)	(none)
Vermilion Flycatcher (nesting)	*Pyrocephalus rubinus*	(none)	SSC
Black Swift (nesting)	*Cypseloides niger*	(none)	SSC
Vaux's Swift (nesting)	*Chaetura vauxi*	(none)	SSC
Bank Swallow (nesting)	*Riparia riparia*	(none)	ST
American Dipper	*Cinclus mexicanus*	(none)	(none)
Yellow Warbler (nesting)	*Dendroica petechia*	(none)	SSC
Orange-Crowned Warbler	*Vermivora celata*	(none)	(none)
Warbling Vireo	*Vireo gilvus*	(none)	(none)
Summer Tanager (nesting)	*Piranga rubra*	(none)	SSC
Swainson's Thrush	*Catharus ustulatus*	(none)	(none)
Opportunistic Feeders			
Redhead (nesting)	*Aythya americana*	(none)	SSC
Least Bittern (nesting)	*Ixobrychus exilis*	(none)	SSC
Common Merganser	*Mergus merganser*	(none)	(none)
Gulls	*Larus spp.*	(none)	(none)
Great blue heron (rookery site)	*Ardea herodias*	(none)	(none)
Great Egret (rookery site)	*Ardea alba*	(none)	(none)
Snowy Egret (rookery site)	*Egretta thula*	(none)	(none)
Black-crowned Night-heron (rookery site)	*Nycticorax nycticorax*	(none)	(none)
California Black Rail	*Laterallus jamaicensis coturniculus*	(none)	ST, FP
Western Yellow-billed Cuckoo (nesting)	*Coccyzus americanus occidentalis*	FC	SE
Belted Kingfisher	*Megaceryle alcyon*	(none)	(none)
Yellow-breasted Chat (nesting)	*Icteria virens*	(none)	SSC
Gray-crowned Rosy Finch	*Leucosticte tephrocotis*	(none)	(none)
Mammals			
Aquatic or Riparian Dependent Species			
Water shrew	*Sorex palustris*	(none)	(none)
White-footed vole	*Arborimus albipes*	(none)	SSC
River otter	*Lontra canadensis*	(none)	(none)
Species that Utilize Both Riparian and Uplands			
Mojave river vole	*Microtus californicus mohavensis*	(none)	SSC
Owens Valley vole	*Microtus californicus vallicola*	(none)	SSC
Townsend's big-eared bat	*Corynorhinus townsendii*	(none)	SSC
Pallid bat	*Antrozous pallidus*	(none)	SSC
Spotted bat	*Euderma maculatum*	(none)	SSC

Common Name	Scientific Name	Status (federal)	Status (state)
Western red bat	*Lasiurus blossevillii*	(none)	SSC
Western mastiff bat	*Eumops perotis califomicus*	(none)	SSC
Fringed myotis	*Myotis thysanodes*	(none)	(none)
Western yellow bat	*Lasiurus xanthinis*	(none)	SSC
Pocketed free-tailed bat	*Nyctinomops femorosaccus*	(none)	SSC
Big free-tailed bat	*Nyctinomops macrotis*	(none)	SSC
Upland Species			
Sonoma tree vole	*Arborimus pomo*	(none)	SSC
Tulare grasshopper mouse	*Onychomys torridus tularensis*	(none)	SSC
Pygmy rabbit	*Brachlagus idahoensis*	(none)	SSC
Oregon snowshoe hare	*Lepus americanus klamathensis*	(none)	SSC
Sierra Nevada snowshoe hare	*Lepus americanus tahowensis*	(none)	SSC

Notes:

Source for species status was obtained from the California Department Fish and Game's Special Animals List (CNDDB 2009):

FC = federal candidate for listing.
FE = federal endangered.
FP = DFG fully protected species.
FPT = federal proposed: threatened.
FT = federal threatened.
SCE = state candidate: endangered.
SE = state endangered.
SSC = DFG species of special concern.
ST = state threatened.
WL = state watch list.

Impact Discussion

Impacts of Hatchery Operations

Impact BIO-241: Impacts of Predator Control at Hatcheries on Supplemental Evaluation Species (Less than Significant)

Supplemental evaluation species including double-crested cormorant, green heron, great blue heron, great egret, snowy egret, black-crowned night-heron, common merganser, belted kingfisher, Caspian tern, gulls, and river otters are known to frequent inland hatcheries to take advantage of convenient fish foraging opportunities. In order to control fish losses at hatcheries, DFG uses predator exclusion and hazing measures including netting or wires installed over the surface of ponds, raceways, and tanks; perimeter fencing; removal of dead fish that attract scavengers; acoustic harassment devices; and visual frightening devices. *Impact BIO-14: Effects of Predator Control at Hatchery Site*s, addresses this potential impact and identifies it as less than significant. These species, although potentially affected by predator control measures, would not be significantly impacted by predator control measures at hatchery sites. These species habituate to conditions around hatchery ponds and raceways. The main risk is occasional ensnarement in nets or wires, which can be fatal. The numbers of individuals lost in this manner are reported to be low, but

records are not kept. The other supplemental evaluation species are not normally predators at hatcheries and would be unaffected by predator control measures. Thus, for all supplemental species, the effects of predator control at hatcheries are less than significant.

Impact BIO 242: Impacts of Food Web Changes from Hatchery Discharges on Supplemental Evaluation Species (Less than Significant)

As discussed above under *Impact BIO-15: Effects on Food Webs from Hatchery Discharges*, water quality impacts associated with hatchery discharges can result in changes in invertebrate assemblages that can in turn affect animal groups that feed on these organisms, including birds and bats. Supplemental Evaluation Species that could be subject to these potential food web effects include insectivorous birds (spotted sandpiper, vermillion flycatcher, black swift, Vaux's swift, bank swallow, American dipper, and yellow warbler), and bats (Townsend's big-eared bat, pallid bat, spotted bat, western red bat, western mastiff bat, fringed myotis, western yellow bat, pocketed free-tailed bat, and big free tailed bat). Though summer tanager is also considered to be an insectivorous bird, changes in aquatic invertebrate assemblages would not impact this species because it is a bee and wasp specialist. As discussed in Impact BIO-15, though discharges from three DFG-operated hatcheries (Hot Creek Hatchery, Darrah Springs Hatchery, Mojave River Hatchery) were identified as having the potential to affect downstream food webs and therefore cause general changes in aquatic communities, all three hatcheries are currently implementing measures to reduce the potential for discharges to affect aquatic communities within receiving waters. Therefore, DFG hatchery operations have a less-than-significant potential to affect aquatic communities (including higher trophic species such as birds and bats) via alteration of aquatic food webs. Thus, for all supplemental species, the effects on food webs from hatchery discharges are less than significant.

Impacts of the Trout Stocking Program

Impact BIO 243: Predation and Competition Impacts from Stocked Trout on California Black Rail (Less than Significant with Mitigation)

The California black rail is a rare species in California that predominately occurs in the coastal marshes along the northern San Francisco Bay and San Pablo Bay, in Suisun Marsh, along the lower Colorado River, and in freshwater marshes in Yuba, Butte, Nevada, and Placer counties (California Department of Fish and Game 2005). California black rails are not listed under the ESA, but are listed as threatened under the CESA and are a fully-protected species under DFG code.

There are 10 trout stocking locations within the known range of the California black rail. No literature was found describing either competition or predation between stocked trout and California black rails. California black rails inhabit saltwater, brackish, and freshwater marshes at sufficiently low elevation that the associated water bodies already contain populations of fish that consume quantities of aquatic invertebrates (the predominate prey for black rails), regardless of whether stocked trout are present; thus the type of competition for flying insect prey described by Epanchin (2009) and detailed earlier in this chapter is unlikely to occur between stocked trout and California black rails. Thus, the potential for competition between California black rails and stocked trout is very low. However, stocked trout could indirectly negatively affect California black rails. Great blue herons and great egrets are predators of fish. They have also been documented to prey on California black rails (California Department of Fish and Game 2005). Populations of great blue herons and great egrets may be artificially high in areas where large numbers of hatchery fish are stocked because of the increased availability of prey.

Trout stocking has not been cited as a direct factor in decline of California black rails, however trout stocking may indirectly affect California black rails through an artificial increase in the numbers of predators where hatchery releases occur, as described above. The impact mechanism constitutes a potentially significant impact on California black rails. Accordingly Mitigation Measure 87 is required.

Mitigation Measure BIO-87: Implement Pre-Stocking Evaluation Protocol for California Black Rails

As detailed in Impact BIO-87, trout stocking may have a significant impact on California black rails. To mitigate for this impact, DFG shall implement a PSEP (see Appendix K) at each location where stocking occurs within the range of California black rails. Under the protocol, each stocking location shall be evaluated in a stepwise fashion to determine whether indirect interactions between stocked trout and California black rails may occur and to evaluate the potential for trout stocking to result in an substantial effect on California black rails. If such an impact is determined likely, then DFG shall either cease stocking at that location or develop and implement, prior to stocking at that location, a management plan that is capable of reducing potential impacts on the rail to less-than-significant levels through habitat protection and expansion as necessary to offset effects (as described in Chapter 2).

Impact BIO 244: Predation and Competition Impacts from Stocked Trout on Western Yellow-billed Cuckoo (Less than Significant)

The western yellow-billed cuckoo is a rare species in California that predominately breeds along the upper Sacramento River from Red Bluff south to Colusa and along the South Kern River from Isabella Reservoir to Canebrake Ecological Reserve. Other small, isolated populations occur along the Feather River, Prado Flood Control Basin, Along the Amargossa River, Owens River, Santa Clara River, Mojave River, and lower Colorado River (PRBO 2009). It is a candidate species under the ESA and is listed as endangered under the CESA.

There are 4 trout stocking locations within the range of the western yellow-billed cuckoo. The western yellow-billed cuckoo is a passerine (songbird) that requires large, dense tracts of riparian habitat with a well-developed understory for breeding. During the breeding season, the cuckoo is restricted to moist habitats along slow-moving rivers (California Department of Fish and Game 2005).

No literature was found describing either competition or predation between stocked trout and western yellow-billed cuckoos. Western yellow-billed cuckoos occur along streams at sufficiently low elevation that the associated water bodies already contain populations of fish that consume quantities of flying insects (the predominate prey for western yellow-billed cuckoos) regardless of whether stocked trout are present; thus the type of competition for flying insect prey described by Epanchin (2009) and detailed above is unlikely to occur between stocked trout and yellow-billed cuckoo. Thus, the potential for competition between western yellow-billed cuckoos and stocked trout is very low. Also, trout stocking has not been cited as a factor in decline of western yellow billed cuckoo. The impact of trout stocking on western yellow-billed cuckoo is less than significant.

Impact BIO 245: Predation and Competition Impacts from Stocked Trout on Bank Swallow (Less than Significant)

Bank swallow is a rare species in California. Most of the remaining breeding locations are located along the banks of Central Valley rivers, particularly along the upper Sacramento River. Bank swallows are not listed under the ESA, but are listed as threatened under the CESA.

There are 16 trout stocking locations within the range of the bank swallow. The bank swallow is smallest North American swallow species. Bank swallows are summer residents that dig their nests in the vertical bluffs or banks of rivers (California Department of Fish and Game 2005). No literature was found describing either competition or predation between stocked trout and bank swallows. Bank swallows occur along streams at sufficiently low elevation that the associated water bodies already contain populations of fish that consume quantities of flying insects (the predominate prey for bank swallows) regardless of whether stocked trout are present; thus the type of competition for flying insect prey described by Epanchin (2009) and detailed above is unlikely to occur between stocked trout and yellow-billed cuckoo. Thus, the potential for competition between bank swallows and stocked trout is very low. Trout stocking has not been cited as a factor in decline of bank swallows. Thus, the impact of trout stocking on bank swallow is less than significant.

Impact BIO 246: Predation and Competition Impacts from Stocked Trout on Fish-Eating Birds (Less than Significant)

No literature was found describing either competition or predation between stocked trout and the fish-eating birds identified as supplemental evaluation species (Table 4-24). These fish-eating bird species are relatively common in California, though the common loon and American white pelican are designated as species of special concern by DFG. These bird species generally feed on small fish and occur in aquatic habitats at sufficiently low elevation that the associated water bodies already contain populations of fish that consume small fish regardless of whether stocked trout are present; thus there is low potential for competition for fish between stocked trout and the fish-eating bird species. Additionally, it is likely, since the American white pelican is a large bird that typically consumes relatively large fish, that plantings of catchable-sized trout provide a forage base for American white pelicans, while fingerling plantings may provide a forage base for other fish-eating birds. Trout stocking has not been cited as a factor in decline of populations of these bird species, and may help to support them. Thus, the impact of trout stocking on these species is less than significant.

 Impact BIO 247: Predation and Competition Impacts from Stocked Trout on Invertebrate-Eating Birds (Less than Significant)

Species in the invertebrate-eating bird guild primarily prey on aquatic invertebrates or terrestrial insects that have an aquatic life stage and occur in the high Sierra Nevada and Cascades where trout stocking has occurred in lakes that were historically fishless and that would not continue to support fish in the absence of trout stocking. The presence of fish in these lakes and streams can have indirect effects on these invertebrate-eating birds via competition for different life stages (typically, flying adults vs. aquatic larvae) of various insect species. As discussed under Impact BIO-15, complex interactions exist between various trophic levels (e.g., plants, herbivores, and carnivores) within the aquatic environment. It has been observed that changes in invertebrate communities may lead to changes in fish and bird communities that feed on these organisms (Epanchin 2009). The abundance and breeding success of these species are most likely strongly influenced by the

availability of adequate invertebrate prey. It is therefore likely that at some locations, fish stocking of mountain lakes is either increasing the availability of trout beyond natural carrying capacity, or is perpetuating the existence of trout in waters where they would naturally disappear in the absence of stocking. This situation is thereby contributing to a reduction in availability of flying insects that would otherwise be available for use by black swifts, Vaux's swifts, and gray-crowned rosy finch; and availability of aquatic insects that otherwise would be available for American dippers and spotted sandpipers. Data are not currently available to determine the proportion of the range of these bird species that is affected by trout stocking in this manner.

Birds in the invertebrate-eating guild are relatively common within their range in California and are not classified as endangered or threatened species under either federal or state law, although DFG has designated the harlequin duck, black swift, and Vaux's swift as species of special concern. Extirpations of these species are not reported to be widespread in California and trout stocking has not been cited as a factor in the decline these birds. Thus, the impact of trout stocking on harlequin ducks, black swifts, Vaux's swifts, American dipper, spotted sandpiper, and gray-crowned ruby finch is less than significant. Implementation of Mitigation Measures BIO-73, BIO-74, and BIO-75 would further reduce this impact to these species.

No literature was found describing either competition or predation between stocked trout and the other birds in the invertebrate-eating guild (Table 4-24). These other bird species are fairly common in California, though yellow warblers and summer tanager are designated as species of special concern by DFG. These bird species generally occur along streams that occur at sufficiently low elevation that the associated water bodies already contain populations of fish that consume quantities of aquatic stages of flying insects regardless of whether stocked trout are present; thus the type of competition for flying insect prey described by Epanchin (2009) and detailed above is not likely to occur between stocked trout and these bird species. Trout stocking and competition with trout for prey have not been cited as a factor in decline of populations of these bird species. Thus, the impact of trout stocking on these species is less than significant.

Impact BIO 248: Predation and Competition Impacts from Stocked Trout on Opportunistic Feeding Birds (Less than Significant)

No literature was found describing either competition or predation between stocked trout and the birds in the opportunistic feeding guild (Table 4-24). These opportunistic feeding bird species are relatively common in California, though the redhead, least bittern, and yellow-breasted chat are designated as species of special concern by DFG. These bird species generally occur in or near aquatic habitats at sufficiently low elevation that the associated water bodies already contain populations of fish that consume quantities of aquatic invertebrates and other small fish regardless of whether stocked trout are present; thus this type of competition for aquatic invertebrates and fish does not occur between stocked trout and these bird species. Trout stocking has not been cited as a factor in decline of populations of these bird species, and may help to support them, especially those that feed to some degree on fish. Thus, the impact of trout stocking on these species is less than significant.

Impact 249: Predation and Competition Impacts from Stocked Trout on Aquatic or Riparian Dependent Mammals (Less than Significant)

The American water shrew is common in montane riparian habitats in the Sierra Nevada and Cascades where it occurs near the edges of cold mountain streams and lakes. American water

shrews primarily prey on aquatic invertebrates or terrestrial insects that have an aquatic life stage. The stocking of trout into lakes and streams that otherwise would not sustain fish populations can have indirect effects on American water shrews because of the introduced competition for different life stages of the same invertebrates. As discussed under Impact BIO-15, complex interactions exist between various trophic levels (e.g., plants, herbivores, and carnivores) within the aquatic environment. It has been observed that changes in invertebrate communities may lead to changes in fish and bird communities that feed on these organisms (Epanchin 2009). It can be inferred that the same would be true for American water shrews. The abundance and breeding success of American water shrews is likely influenced by the availability of adequate invertebrate prey. Thus fish stocking of mountain lakes potentially increases the availability of trout beyond natural carrying capacity, or perpetuates the existence of trout in waters where they would naturally disappear in the absence of stocking, and thereby contributes to a reduction in availability of food resources (aquatic invertebrates) that would otherwise be available to American water shrews. Data are not currently available to determine the proportion of trout stocking locations in the range of this species at which this situation exists. Trout have been documented as predators of water shrews (Ziener et al. 1988–1990). However, there is no data to show that trout stocking in high mountain lakes and streams has led to a significant decline of this species. Thus, the impact of trout stocking on American water shrews is less than significant.

No literature was found describing either competition or predation between stocked trout and white-footed voles. White-footed voles occur in riparian habitats and feed on plant material, so there is no competition for food between trout and this species and trout are not known to directly feed on white-footed vole. Thus, trout stocking has no evident impact on this species and the impact of trout stocking on white-footed voles is less than significant.

River otters are a semi-aquatic mammal that occurs in rivers, large streams, lakes, and other water bodies throughout northern California. River otters feed mostly on fish but also feed on aquatic invertebrates and amphibians. Stocked trout may compete with river otters for aquatic invertebrates and amphibians, but stocked trout (both fingerling and catchable sizes) provide a potentially substantial prey resource for river otters. Thus, the impact of stocking trout on river otters may be beneficial, but is less than significant.

Impact BIO 250: Predation and Competition Impacts from Stocked Trout on Mammal Species that Utilize both Riparian and Upland Habitats (Less than Significant)

The bat species in this guild (Table 4-24) all feed on flying insects. These bats generally occur at sufficiently low elevation that the associated water bodies already contain populations of fish that consume quantities of aquatic stages of flying insects regardless of whether stocked trout are present; thus the type of competition for flying insect prey described by Epanchin (2009) and detailed above is not likely to occur between stocked trout and these bat species. Trout stocking and competition with trout for prey have not been cited as a factor in decline of populations of these bat species. Thus, the impact of trout stocking on these bat species is less than significant.

No literature was found describing either competition or predation between stocked trout and Mohave River voles and Owens Valley voles. These voles occur in riparian habitats, grasslands, and marshes and feed on plant material, so there is no competition for food between trout and these species. Trout are not known to directly feed on Mohave River voles or Owens Valley voles. Thus, trout stocking has no evident predation or competition impact on these species and the impact of trout stocking on Mohave River and Owens Valley voles is less than significant.

Impact BIO 251: Predation and Competition Impacts from Stocked Trout on Mammal Species that Utilize Upland Habitats (Less than Significant)

No literature was found describing competition or predation between stocked trout and the mammals identified as upland species in Table 4-24. These species feed on plant material, so there is no competition for food between trout and these species. Trout are not known to directly feed on these species. Thus, trout stocking has no evident competition or predation impact on these species and the impact of trout stocking on upland mammal species is less than significant.

Impact BIO 252: Impacts from Introduction of Invasive Species and Pathogens on Supplemental Evaluation Species (Less than Significant with Mitigation)

As described above in Chapter 4, during trout stocking, aquatic invasive species and/or aquatic pathogens may inadvertently be introduced into native ecosystems. These impacts are of greatest concern when the transfers occur between watersheds and entail the introduction of aquatic invasive species or pathogens to which native fish and amphibian populations are highly susceptible (Pacific Northwest Fish Health Protection Committee 1989). Though the introduction of invasive species and fish and amphibian pathogens are unlikely to directly impact bird and mammal species included as supplemental evaluation species, there is potential for these species to be indirectly impacted by reduction in food sources related to fish and/or amphibian mortality associated with pathogen releases and reduction in aquatic habitat quality due to introduction of invasive species.

As described under *Impact BIO-107: Impacts of Introducing Pathogens to Native Amphibian Populations as a Result of the Trout Stocking Program*, though DFG currently has no best management practices that address the potential impacts due to the dissemination of pathogens within hatchery effluent waters to native amphibian populations, implementation of *Mitigation Measure BIO-107: Implement Monitoring and Best Management Practices Program to Minimize Risk of Disease Transmission to Native Amphibian Populations* would reduce potentially significant impacts to amphibian populations to a less-than-significant level. Additionally, as described under *Impact BIO-106: Impacts of Introducing Pathogens to Native Fish Populations as a Result of the Trout Stocking Program*, DFG currently implements the hatchery fish health program and numerous other precautions to minimize the risk of accidental pathogen introduction via DFG trout stocking. Therefore there is a less-than-significant risk with mitigation that this impact will have a substantial adverse effect on native fish populations.

With the inclusion of Mitigation Measure *BIO-107* into the program and the existence of the hatchery fish health program and numerous other precautions to minimize the risk of accidental pathogen, the potential for impacts to native fish and amphibians would be less than significant and in turn the potential for bird and mammal populations to be indirectly impacted by the introduction of pathogens is less than significant.

As described under *Impact BIO-108: Impacts of Introducing Aquatic Invasive Species into Native Ecosystems as a Result of the Trout Stocking Program*, DFG hatchery best management practices are designed to ensure stocking operations do not contribute to invasive species dissemination. Further, based on a baseline evaluation, active DFG monitoring of invasive species, and other precautionary measures currently implemented at hatcheries, the risk of invasive species introductions during trout stocking operations is less than significant. In turn, the potential for bird and mammal populations to be indirectly impacted by the introduction of invasive species is less than significant.

Impact BIO 253: Impacts of Anglers at Fishing Sites on Supplemental Evaluation Species (Less than Significant)

As described above in Chapter 4, the presence of anglers at stocking sites has potential to result in impacts to aquatic ecosystems including the fish and wildlife inhabitants. Potential impacts that could affect Supplemental Evaluation Species include the following:

● Disturbance of riparian systems that occurs when anglers access fishing locations.

● Disturbance of benthic aquatic areas due to anglers moving through aquatic areas.

● Disturbance of sensitive species due to anglers moving through aquatic areas.

● Distribution of invasive species by anglers.

● Impacts caused by motorized fishing boats.

With respect to the Supplemental Evaluation Species, the primary impact concern associated with anglers at fishing sites is disturbance of nesting birds. Since some recurring form of recreational use (fishing, swimming, bird watching, hiking, boating [motorized and non-motorized], motorized vehicle or equipment use, and others) is associated with most water bodies in California, most water-associated birds (including waterfowl, wading birds, and shorebirds) that use these areas are habituated to some level of human activity and are unlikely to experience nesting disturbance impacts via the continuation of angling at existing angling sites. Most of the trout stocking locations used by DFG are stocked on a recurring basis. Alternatively, species known to be particularly sensitive to human disturbance during nesting, such as California black rail and gray-crowned rosy finch, are unlikely to be impacted by angling at fishing sites because nests of these species are unlikely to be present. Similarly, those species that nest in habitats unlikely to occur within fishing areas, including dense riparian nesting species such as western yellow-billed cuckoo, yellow warbler, yellow-breasted chat, summer tanager, and bank nesting species including bank swallows and belted kingfishers, are also unlikely to be impacted. Implementation of *Mitigation Measure BIO-120: Minimize Disturbance in Riparian Areas*, described above with respect to *Impact BIO-120: Disturbance of Riparian Systems Due to Use of Vehicles and Foot Travel to Access Fishing Locations as a Result of the Trout Stocking Program*, would further reduce the potential for nesting disturbance to riparian nesting species.

Impact BIO-122: Disturbance of Special-Status Species Due to Anglers Moving through Aquatic Areas, discusses this impact with respect to other special-status birds including bald eagle, osprey, willow flycatcher, and southwestern willow flycatcher. This impact concludes that because bald eagles and osprey often nest near popular recreational boating areas and are habituated to such disturbance; and flycatchers nest in very densely vegetated riparian areas, which are not easily accessible to anglers; noise disturbance would be less-than-significant for these species.

Therefore, Supplemental Evaluation Species are unlikely to be impacted by anglers at fishing sites and the potential impact would be less than significant.

Impacts of the Salmon and Steelhead Stocking Program

Impact BIO 254: Predation and Competition Impacts from Stocked Salmon and Steelhead on California Black Rail (Less than Significant with Mitigation)

The California black rail is a rare species in California that predominately occurs in the coastal marshes along the northern San Francisco Bay and San Pablo Bay, in Suisun Marsh, along the lower Colorado River, and in freshwater marshes in Yuba, Butte, Nevada, and Placer counties (California Department of Fish and Game 2005). California black rails are not listed under the ESA and are listed as threatened under the CESA and are a fully-protected species under DFG code.

There are multiple salmon stocking locations within the range of the California black rail, especially in the San Pablo Bay area. The California black rail is a small bird that is a permanent resident in saltwater, brackish, and freshwater marshes predominately in northern California (California Department of Fish and Game 2005).

No literature was found describing either competition or predation between stocked salmon and steelhead and California black rails. California black rails inhabit saltwater, brackish, and freshwater marshes at sufficiently low elevation that the associated water bodies already contain populations of fish that consume quantities of aquatic invertebrates (the predominate prey for black rails) regardless of whether stocked salmon and steelhead are present. Thus, the potential for competition between California black rails and stocked salmon and steelhead is very low. However, stocked salmon and steelhead could indirectly negatively affect California black rails. Great blue herons and great egrets are predators of fish. They have also been documented to prey on California black rails (California Department of Fish and Game 2005). Populations of these great blue herons and great egrets may be artificially high in areas where large numbers of hatchery fish are stocked because of the increased availability of prey. The impact mechanism discussed above constitutes a potentially significant impact on California black rails. Accordingly Mitigation Measure BIO-87 is required. Implementation of this mitigation measure would reduce the impact to less than significant.

Impact BIO 255: Predation and Competition Impacts from Stocked Salmon and Steelhead on Western Yellow-billed Cuckoo (Less than Significant)

Salmon and steelhead stocking into the Feather River is the only instance where competition or predation could occur between this species and stocked fish. However, for the reasons stated above relative to competition and predation with stocked trout, there is unlikely to be a significant level of competition for food between these species. Thus, the potential for predation and competition effects from the stocking of salmon or steelhead is less than significant.

Impact BIO 256: Predation and Competition Impacts from Stocked Salmon and Steelhead on Bank Swallow (Less than Significant)

Bank swallow is a rare species in California. Most of the remaining breeding locations are located along the banks of Central Valley rivers, particularly along the upper Sacramento River. Bank swallows are not listed under the ESA and is listed as threatened under the CESA. The bank swallow is smallest North American swallow species. Bank swallows are summer residents that dig their nests in the vertical bluffs or banks of rivers (California Department of Fish and Game 2005).

There is one steelhead stocking location within the range of the bank swallow. No literature was found describing either competition or predation between stocked steelhead and bank swallows.

Bank swallows occur along streams at sufficiently low elevation that the associated water bodies already contain populations of fish that consume quantities of flying insects (the predominate prey for bank swallows) regardless of whether stocked steelhead are present. Thus, the potential for competition between bank swallows and stocked steelhead is very low. Steelhead stocking has not been cited as a factor in decline of bank swallows. Thus, the impact of steelhead stocking on bank swallow is less than significant.

Impact BIO 257: Predation and Competition Impacts from Stocked Salmon and Steelhead on Fish-Eating Birds (Less than Significant)

No literature was found describing either competition or predation between stocked salmon, steelhead, and the fish-eating birds identified as supplemental evaluation species (Table 4-24). These fish-eating bird species are relatively common in California, though the common loon and American white pelican are designated as species of special concern by DFG. These bird species generally feed on smaller fish and occur in aquatic habitats at sufficiently low elevation that the associated water bodies already contain populations of fish that consume small fish regardless of whether stocked salmon or steelhead are present; thus this type of competition for fish does not occur between stocked salmon, steelhead, and these bird species. Additionally, it is likely, since these birds feed on smaller fish, the planting of salmon and steelhead provides a forage base for these fish-eating birds. Salmon and steelhead stocking has not been cited as a factor in decline of populations of these bird species, and may help to support them. Thus, the impact of trout stocking on these species is less than significant.

Impact BIO 258: Predation and Competition Impacts from Stocked Salmon and Steelhead on Invertebrate-Eating Birds (Less than Significant)

Salmon and steelhead hatcheries stock native steelhead and salmon within Central Valley and coastal rivers and streams that empty to the ocean. Several of the bird species identified as supplemental evaluation species (Table 4-24), including the harlequin duck, spotted sandpiper, black swift, Vaux's swift, American dipper, and gray-crowned rosy finch primarily occur in the high Sierra Nevada and Cascades where salmon and steelhead stocking does not occur. Thus, there is no potential for the stocking of salmon or steelhead to impact these species.

No literature was found describing either competition or predation between stocked salmon, steelhead, and species in the invertebrate-eating bird guild (Table 4-24). These birds are relatively common in California, though yellow warbler and summer tanager are designated as species of special concern by DFG. These bird species generally occur along streams at sufficiently low elevation that the associated water bodies already contain populations of fish that consume quantities of aquatic stages of flying insects regardless of whether stocked salmon or steelhead are present. Salmon and steelhead stocking and competition with salmon and steelhead for prey have not been cited as a factor in the decline of populations of these bird species. Thus, the impact of salmon and steelhead stocking on these species is less than significant.

Impact BIO 259: Predation and Competition Impacts from Stocked Salmon and Steelhead on Opportunistic Feeding Birds

No literature was found describing either competition or predation between stocked trout and the opportunistic feeding birds identified as supplemental evaluation species (Table 4-24). These opportunistic feeding bird species are relatively common in California, though the redhead, least

bittern, and yellow-breasted chat are designated as species of special concern by DFG. These bird species generally occur in or near aquatic habitats at sufficiently low elevation that the associated water bodies already contain populations of fish that consume quantities of aquatic invertebrates and other small fish regardless of whether stocked salmon or steelhead are present; thus this type of competition for aquatic invertebrates and fish does not occur between stocked salmon or steelhead and these bird species. Salmon and steelhead stocking has not been cited as a factor in decline of populations of these bird species, and may help to support them, especially those that feed to some degree on fish. Thus, the impact of salmon and steelhead stocking on these species is less than significant.

Impact BIO 260: Predation and Competition Impacts from Stocked Salmon and Steelhead on Aquatic or Riparian Dependent Mammals (Less than Significant)

The American water shrew is a common shrew species that occurs in the montane riparian habitats in the Sierra Nevada and Cascades. It is restricted to the edges of cold mountain streams and lakes where salmon and steelhead stocking does not occur. Thus, there is no potential for the stocking of salmon or steelhead to impact these species.

No literature was found describing either competition or predation between stocked salmon, steelhead, and white-footed voles. White-footed voles occur in riparian habitats and feed on plant material, so there is no competition for food between salmon and steelhead, and salmon and steelhead are not known to directly feed on white-footed vole. Thus, salmon and steelhead stocking has no impact this species.

River otters are a semi-aquatic mammal that occurs in rivers, large streams, lakes, and other water bodies throughout northern California. River otters feed mostly on fish but also feed on aquatic invertebrates and amphibians. The stocked salmon and steelhead may compete with river otters for aquatic invertebrates and amphibians, though the stocked trout would also provide a prey source for river otters. Thus, the impact of stocking of salmon and steelhead on river otters would be less than significant.

Impact BIO 261: Predation and Competition Impacts from Stocked Salmon and Steelhead on Mammal Species that Utilize both Riparian and Upland Habitats (No Impact)

The bat species identified in Table 4-24 all feed on flying insects. These bats generally occur at sufficiently low elevation that the associated water bodies already contain populations of fish that consume quantities of aquatic stages of flying insects regardless of whether stocked trout are present. Salmon and steelhead stocking and competition with salmon and steelhead for prey have not been cited as a factor in decline of populations of these bat species. Thus, the impact of salmon and steelhead stocking on these species is less than significant.

Mohave River voles and Owens Valley voles occur in areas where salmon and steelhead stocking does not occur. Thus, there is no potential for the stocking of salmon or steelhead to impact these species.

Impact BIO 262: Predation and Competition Impacts from Stocked Salmon and Steelhead on Mammal Species that Utilize Upland Habitats (No Impact)

No literature was found describing either competition or predation between stocked salmon, steelhead, and the mammal species identified as upland species in Table 4-24. These species feed on

plant material, so there is no competition for food between trout and these species. Salmon and steelhead are not known to directly feed on these species. Thus, salmon and steelhead stocking has no impact these species.

Impact BIO 263: Impacts of Invasive Species and Pathogens Released through Stocking Salmon and Steelhead on Supplemental Evaluation Species (Less than Significant with Mitigation)

As described above in Chapter 4, as is the case with trout stocking, aquatic invasive species and/or aquatic pathogens may inadvertently be introduced into native ecosystems during salmon and steelhead stocking. These impacts are of greatest concern when the transfers occur between watersheds and entail the introduction of aquatic invasive species or pathogens to which native fish and amphibian populations are highly susceptible (Pacific Northwest Fish Health Protection Committee 1989). Though the introduction of invasive species and fish and amphibian pathogens are unlikely to directly impact bird and mammal species included as Supplemental Evaluation Species, there is potential for these species to be indirectly impacted by reduction in food sources related to fish and/or amphibian mortality associated with pathogen releases and reduction in aquatic habitat quality due to introduction of invasive species.

As described under *Impact BIO-202: Impacts of Introducing Pathogens to Native Amphibian Populations as a Result of the Salmon and Steelhead Stocking Program*, though DFG currently has no best management practices that address the potential impacts due to the dissemination of pathogens within hatchery effluent waters to native amphibian populations, implementation of *Mitigation Measure BIO-107: Implement Monitoring and Best Management Practices Program to Minimize Risk of Disease Transmission to Native Amphibian Populations* would reduce potentially significant impacts to amphibian populations to a less-than-significant level. Additionally, as described under *Impact BIO-201: Impacts of Introducing Pathogens to Native Fish Populations as a Result of the Salmon and Steelhead Stocking Program*, DFG currently implements the hatchery fish health program and numerous other precautions to minimize the risk of accidental pathogen introduction via DFG fish stocking. Therefore there is a less-than-significant risk with mitigation that this impact will have a substantial adverse effect on Supplemental Evaluation Species.

With the inclusion of measure *BIO-107* into the program and the existence of the hatchery fish health program and numerous other precautions to minimize the risk of accidental pathogen release, the potential for impacts to native fish and amphibians would be less than significant and in turn the potential for bird and mammal populations to be indirectly impacted by the introduction of pathogens is less than significant.

As described under *Impact BIO-203: Impacts of Introducing Aquatic Invasive Species into Native Ecosystems as a Result of the Salmon and Steelhead Stocking Program*, DFG hatchery best management practices are designed to ensure stocking operations do not contribute to invasive species dissemination. Further, based on a baseline evaluation, active DFG monitoring of invasive species, and other precautionary measures currently implemented at hatcheries, the risk of invasive species introductions during Salmon and Steelhead stocking operations is less than significant. In turn the potential for bird and mammal populations to be indirectly impacted by the introduction of invasive species is less than significant.

Impact BIO 264: Impacts of Anglers at Fishing Sites on Supplemental Evaluation Species (Less than Significant)

As described above in Chapter 4, the presence of anglers at stocking sites has potential to result in impacts to aquatic ecosystems including the fish and wildlife inhabitants. Potential impacts that could affect Supplemental Evaluation Species include the following:

- Disturbance of riparian systems that occurs when anglers access fishing locations.

- Disturbance of benthic aquatic areas due to anglers moving through aquatic areas.

- Disturbance of sensitive species due to anglers moving through aquatic areas.

- Distribution of invasive species by anglers.

- Impacts caused by motorized fishing boats.

With respect to the Supplemental Evaluation Species, the primary impact of concern associated with anglers at fishing sites is avian nesting disturbance. As described above under *Impact BIO-222: Disturbance of Riparian Systems Due to Use of Vehicles and Foot Travel to Access Fishing Locations*, the potential for disturbance to riparian habitats and associated species due to vehicle and foot traffic by salmon and steelhead anglers is much reduced from that of trout anglers. There are significantly fewer anglers accessing anadromous creeks and rivers, and boat access is typically via developed boat ramps. Most of this fishing occurs at lower elevations in less sensitive habitats. Therefore, the potential for avian nesting disturbance by anglers at fishing sites would be less-than-significant.

Impacts of the Fishing in the City Program

As described above under *Impacts of the Fishing in the City Program* section, the principal biological concerns associated with this program are related to competition for food and space and predation between stocked fish and native reptiles, amphibians and fish. The introduction of invasive species and pathogens is also considered a potential concern from this program. The impacts from angler effects at fishing sites, as described for the trout and salmon and steelhead stocking program, are not considered significant risks from Fishing in the City program stocking because of the urban nature of stocking locations. The relevance of these issues to the Supplemental Evaluation Species is discussed below.

Impact BIO 265: Predation and Competition Impacts from Fishing in the City Program on Supplemental Evaluation Species (Less than Significant)

The predation and competition impact mechanism associated with stocking hatchery fish is described in detail in the section "Effects from Predation and Competition from Stocked Trout," above.

Water bodies in Los Angeles, Orange and San Diego counties are stocked for the south coast region Fishing in the City program (see Table 2-8 in Chapter 2). These events are held at urban parks or artificial impoundments. The stocking occurs entirely in isolated waters that generally are surrounded by artificial landscapes, have a manufactured lining, and/or are bordered by lawn. There is little habitat at these locations to support the bird and mammal species listed in Table 4-24, and the events occur infrequently through year.

The Region 3 Fishing in the City program has supported stocking fertile and sterile rainbow trout, catfish and perch in both isolated and flow-through waters (see Table 2-8). However, because of

concern for adverse effects on native steelhead, Region 3 no longer performs Fishing in the City program stocking in impounded sections of streams that have the potential to spill into waters capable of supporting steelhead populations. The potential for negative interactions between planted fish and Supplemental Evaluation Species identified in Table 4-24 is discussed in "Impacts of the Trout Stocking Program," under the subheading "Effects from Predation and Competition from Stocked Trout," earlier in this Supplemental Evaluation Species section. There is the potential to affect some of these species in Region 3 through competition for food resources.

In the Sacramento metropolitan area, only 8 park ponds are stocked with trout or catfish through the Fishing in the City program (see Table 2-8). These ponds exist in artificial urban landscapes that are isolated from creeks and rivers. While there is little potential for impacts on legally protected species, the ponds have habitat that could support some of the species identified as Supplemental Evaluation Species listed in Table 4-24.

While Regions 1 and 4 do not support official Fishing in the City programs, they do periodically participate in urban fishing activities primarily aimed at youth. These programs also stock DFG-reared fish in urban water bodies. Some of these sites may support riparian habitat that is used by species contained in Table 4-24.

The ponds have been screened by DFG biologists for state and federally listed species, so there is minimal risk of predation or competition with these species. However, other decision species and Supplemental Evaluation Species are not reviewed routinely when Fishing in the City program stocking is undertaken.

To summarize, the Fishing in the City and related programs introduce short-term or self-sustaining populations of trout, catfish and perch into some water bodies that may support populations of species listed in Table 4-24. In some instances, there may be adverse effects due to competition for food resources. However, for reasons detailed in the trout stocking analysis above, the competition is not likely to have population-level effects on these species. There is no evidence in the literature that competition for food with stocked fish is having significant effects on species ranges or numbers. Therefore, this impact is less than significant.

Impact BIO 266: Impacts of Invasive Species and Pathogens Released through Fishing in the City Program Stocking on Supplemental Evaluation Species (Less than Significant with Mitigation)

Effects from introduction of invasive species and pathogens on Supplemental Evaluation Species is described above as it relates to trout stocking. Similarly, stocking fish through the Fishing in the City program could introduce aquatic invasive species and/or aquatic pathogens into water bodies located within cities. These impacts are of greatest concern when the transfers occur between watersheds and entail the introduction of aquatic invasive species or pathogens to which native fish and wildlife populations are highly susceptible (Pacific Northwest Fish Health Protection Committee 1989). Though the introduction of invasive species and pathogens are unlikely to directly impact bird and mammal species included as Supplemental Evaluation Species, there is potential for these species to be indirectly impacted by reduction in food sources related to high amounts of fish and/or amphibian mortality associated with significant pathogen releases and reduction in aquatic habitat quality due to introduction of invasive species.

Mitigation measures already identified for pathogen and invasive species effects of the Fishing in the City program would also reduce this potential impact to less than significant levels. These mitigations include Mitigation Measures BIO-229 and BIO-233b.

Impacts of the Classroom Aquarium Education Project

Impact BIO 267: Predation and Competition Impacts from the Classroom Aquarium Education Project on Supplemental Evaluation Species (Less than Significant)

The potential impacts associated with this small program are similar to those of releasing hatchery-reared fish, but to a much lesser degree. Because the release numbers are small, the survival rates are low, and all releases occur in waters already occupied by the fish species being released, the risk of a significant predation or competition effect on Supplemental Evaluation Species is less than significant.

Impact BIO 268: Impacts from Introduction of Invasive Species and Pathogens on Supplemental Evaluation Species (Less than Significant)

As discussed under *Impact BIO-232: Impacts of Introducing Pathogens and Invasive Species to Native Fish and Amphibian Populations and Their Habitats through CAEP-Released Fish,* the potential for CAEP fish to be a vector for fish pathogens is low. Outbreaks of contagious fish diseases and the presence of invasive species that occur within the hatchery environment are most often the result of contaminated hatchery source waters. CAEP fish are raised in aquaria that are not using flow-through source water originating downstream of native fish and therefore exposure of the eggs/fry to fish pathogens is highly unlikely. Furthermore, eggs supplied to the program must be inspected and treated to ensure they are disease-free and free of invasive species. Fish stocked during CAEP activities are generally planted in the same waters from which the eggs came. Therefore, the potential for impacts from transfer of disease or invasive species under the CAEP would be less than significant. In turn the potential for bird and mammal populations to be indirectly impacted by the introduction of pathogens and invasive species as a result of the CAEP is less than significant.

Impacts of the Private Stocking Program

Impact Bio-269): Predation and Competition Impacts from the Private Stocking Program on Supplemental Evaluation Species (Significant and Unavoidable)

A detailed description of the potential predation and competition interactions between stocked trout and decision fish and wildlife species is presented above in the Trout Stocking Program impact section. Because private stocking occurs in nearly all regions of the state and all types of aquatic habitats, and because private stocking involves warm water fish species that have a greater potential to establish self-sustaining populations in some water bodies, there is the potential for privately stocked fish to impact populations of Supplemental Evaluation Species identified in Table 4-24 through competition for food and space and through predation.

The DFG private stocking permit program does not record the exact location of all permitted stocking sites. The ranges and habitat requirements of the of Supplemental Evaluation Species identified in Table 4-24 were not compared with the available information on private stocking locations and with the types of habitats that are likely to exist where private stocking can occur without DFG review. Some of the species are not currently legally protected or species of special

concern to DFG, so they may not be screened in all instances. Because there is no standard process or set of criteria identified to screen private stocking sites throughout all of the DFG regions, there remains a potential to adversely affect these species by stocking fish within their habitats. There is a greater risk to some of these species that might occupy private ponds that do not go through a DFG review in all or parts of 37 counties (see the discussion of this exemption area in the Private Stocking Permit Program segment of Chapter 2). There is thus a risk that fish stocking under the private stocking program may adversely affect populations of the Supplemental Evaluation Species. This impact is not considered significant for reasons similar to those in the trout stocking analysis for Supplemental Evaluation Species above, except for the black rail. Implementation of Mitigation Measures BIO-233a and BIO-233b listed above would reduce the impact on the black rail to less than significant.

Impact BIO-270: Impacts from Introduction of Invasive Species and Pathogens on Supplemental Evaluation Species (Significant and Unavoidable)

As described above in Chapter 4, as is the case with trout and salmon and steelhead stocking, aquatic invasive species and/or aquatic pathogens may inadvertently be introduced into aquatic ecosystems. These impacts are of greatest concern when the transfers occur between watersheds and entail the introduction of aquatic invasive species or pathogens to which native fish and amphibian populations are highly susceptible (Pacific Northwest Fish Health Protection Committee 1989). Though the introduction of invasive species and fish and amphibian pathogens are unlikely to directly impact bird and mammal species included as Supplemental Evaluation Species, there is potential for these species to be indirectly impacted by reduction in food sources related to fish and amphibian mortality associated with pathogen releases and reduction in aquatic habitat quality due to introduction of invasive species.

Some of the private stocking within the range of these animals is not subject to review by DFG biologists, as stocking to private ponds is exempt from permitting in a 37-county area (see Figure 2-7). This exclusion increases the risk that stocked fish could carry pathogens to native fish and amphibians occupying private ponds in this area. While the magnitude of the risk of transfer is unknown, the effect would be potentially significant. Implementation of *Mitigation Measure BIO-233a: Eliminate Private Stocking Exemption* and *Mitigation Measure BIO-238: Require and Monitor Invasive Species Controls at Private Aquaculture Facilities* would reduce to less than significant the potential for pathogens and invasive species to be introduced into aquatic ecosystems and impact fish and amphibians, and indirectly affect Supplemental Evaluation Species populations.

Impact BIO-271: Effects of Anglers at Fishing Sites on Supplemental Evaluation Species (Less than Significant)

- As described above in Chapter 4, similar to the trout stocking program, the presence of anglers at stocking sites has potential to result in impacts to aquatic ecosystems including the fish and wildlife inhabitants. Potential impacts that could affect supplemental evaluation species include the following:

- Disturbance of riparian systems that occurs when anglers access fishing locations.

- Disturbance of benthic aquatic areas due to anglers moving through aquatic areas.

- Disturbance of sensitive species due to anglers moving through aquatic areas.

- Distribution of invasive species by anglers.

- Impacts caused by motorized fishing boats.

With respect to the Supplemental Evaluation Species, the primary impact concern associated with anglers at fishing sites is disturbance of nesting birds. Since recreational uses (fishing, swimming, bird watching, hiking, boating [motorized and non-motorized], motorized vehicle or equipment use, and others) are associated with most water bodies in California, most water associated birds (including waterfowl, wading birds, and shorebirds) are habituated to some level of human activity and are unlikely to experience nesting disturbance impacts via the continuation of angling at existing angling sites. Alternatively, species known to be particularly sensitive to human disturbance, particularly during nesting, such as California black rail and gray-crowned rosy finch, are unlikely to be impacted by angling at fishing sites because nests of these species are unlikely to be present. Similarly, those species that nest is habitats unlikely to occur within fishing areas, including dense riparian nesting species including western yellow-billed cuckoo, yellow warbler, yellow-breasted chat, summer tanager, and bank nesting species including bank swallows and belted kingfishers are also unlikely to be impacted.

Additionally, as described under Impact BIO-239: Disturbance of Riparian Systems Due to Use of Vehicles and Foot Travel to Access Fishing Locations as a Result of the Private Stocking Permit Program, as compared to the DFG stocking programs, fewer impacts are assumed to be associated with private stocking because smaller numbers of fish are stocked as well as fewer sites, and a large portion of private stocking occurs in private ponds and lakes at lower elevations when compared to most DFG stocking. Where the private stocking does occur in public reservoirs and lakes, there is typically vehicle access and higher elevation lakes with access only by foot or horseback are seldom, if ever, stocked through private stocking permits. Therefore, some of the more sensitive riparian systems are not being affected by this program. Supplemental Evaluation Species are therefore unlikely to be impacted by anglers at fishing sites under the private stocking program and this potential impact would be less than significant.