Chapter 8
Cumulative Impacts

Introduction

This chapter addresses the potential cumulative effects of the DFG's Program as required by CEQA and NEPA.

State CEQA Guidelines and NEPA regulations require that the cumulative impacts of a proposed project or program be addressed in an EIR or EIS, or both, when the cumulative impacts are expected to be significant (40 CFR 1508.25[a][2], State CEQA Guidelines Section 15130[a]). Cumulative impacts are impacts on the environment that result from the incremental impacts of a proposed action when added to other past, present, and reasonably foreseeable future actions (40 CFR 1508.7; State CEQA Guidelines Section 15355[b]). Such impacts can result from individually minor but collectively significant actions taking place over time. Section 15130 of the State CEQA Guidelines states that the discussion of cumulative impacts need not provide as much detail as the discussion of effects attributable to the project alone. The level of detail should be guided by what is practical and reasonable. In this respect, the broad geographic range of the DFG's Program, involving numerous hatcheries and stocking locations, is better suited to a discussion of impacts by subject area (e.g., dams and water diversions) with representative examples of major projects rather than mention of all possible cumulative projects.

Approach to Impact Analysis

The CEQA guidance for assessing cumulative impacts was used in this EIR/EIS. The cumulative impact assessment requirements under CEQA provide specific guidance and are consistent with and more stringent than those under NEPA. Therefore, this assessment focuses on meeting the requirements of CEQA as discussed in the State CEQA Guidelines.

Legal Requirements

As discussed above, State CEQA Guidelines (Section 15130) provide guidance regarding an adequate discussion of significant cumulative impacts. CEQA Guidelines section 15130(b) recommends either:

- the list approach, which entails listing past, present, and reasonably anticipated future projects producing related or cumulative impacts, including those projects outside the control of the agency; or
- the projection approach, which uses a summary of projections contained in an adopted general plan or related planning document designed to evaluate regional or area-wide conditions.

NEPA provides guidelines for assessing cumulative impacts. Although a requirement to consider cumulative effects was not included in the original NEPA statute of 1970, CEQ regulations implementing NEPA issued in 1973 and revised in 1978 clearly state a requirement to consider cumulative impacts for all projects undergoing NEPA analysis.

The CEQ regulations implementing NEPA (40 CFR Section 1508.7) define a "cumulative impact" for the purposes of NEPA as follows:

> Cumulative impact is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of which agency (federal or non-federal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time.

The following criteria were used to determine which other related actions merited further analysis relative to cumulative effects:

1. Reasonably foreseeable (actions that are likely to happen)—CEQ regulations describe the analysis of cumulative effects in terms of "actions," rather than "proposals" (Council on Environmental Quality 1997). The CEQ regulations state that a cumulative effects analysis commonly only includes those plans for actions that are funded or for which other NEPA analyses are being prepared.
2. Relevance (actions that relate to the DFG Program)—*Considering Cumulative Effects Under the National Environmental Policy Act* (Council on Environmental Quality 1997:19) also states, "In general, actions can be excluded from analysis of cumulative effects if the action will not affect resources that are the subject for the cumulative effects analysis."
3. Magnitude/threshold of significance—Significance is a function of the context and the "intensity" of an action (40 CFR Section 1508.27). As part of an agency's determination as to the intensity of an impact, numerous factors should be considered, including:
    - the unique characteristics of the geographic area; and
    - whether "the action is related to other actions with individually insignificant but cumulatively significant impacts" (40 CFR Section 1508.27[b][7]).

An action is considered "significant" if "it is reasonable to anticipate a cumulatively significant impact on the environment." In addition, significance cannot be avoided by terming an action temporary or by dividing it into small component parts.

Activities and projects described in this analysis are those that produce impacts on biological and other resources that are cumulative to those of DFG Program and occur in the same geographic area. The geographic scope of the analysis is necessarily broad because of the wide-reaching effects of hatchery operations. In terms of rearing and planting of trout, numerous inland locations are potentially affected. Rearing of anadromous salmon and steelhead in DFG hatcheries and subsequent releases also encompass a large geographic area because of the considerable migration distances between hatcheries and the sea. For anadromous hatcheries and related operations, the main geographic areas include the Sacramento and San Joaquin River watersheds and recipient water bodies (the Delta and San Francisco Bay), the Russian River watershed, the Eel River watershed, the Mad River watershed, and the Klamath-Trinity River watersheds.

Description of Broad Geographic Cumulative Effects

The broad geographic range of the potential impacts from the DFG Program means that a considerable number of other past, present, and reasonably foreseeable future activities may interact to produce cumulative impacts, principally on biological resources (Table 8-1). The study area for the Program overlays a diverse mosaic of landscapes and land uses—from stocking

relatively pristine high mountain lakes that realize little human presence to stocking and rearing operations in lowland rivers bordered by urban, agricultural, or other intensive human uses.

In the foreseeable future, the DFG Program would not include the construction of any new or expanded facilities, and physical activities at the DFG hatchery facilities would only include maintenance and upgrades of facilities and equipment within the bounds of the current facilities' footprints. Thus, the potential for cumulative impacts from continuation of the Program would be largely limited to water use and discharge by the existing facilities, stocking of trout and anadromous salmonids, and other emissions or wastes generated by the facilities (e.g., greenhouse gases). Because the Program provides fish for recreation and mitigation, changes in rearing and stocking practices also could affect recreation and associated economies.

A number of past, current, and foreseeable activities could cumulatively affect the environment in the study area. The following activities focus on those activities or conditions that also could affect native aquatic species, water quantity and quality, and the associated secondary effects from these cumulative actions.

As described in the previous chapters, the greatest potential for impacts of the DFG Program are to native, sensitive, or legally protected fish and wildlife species and include genetic (loss of fitness and diversity), ecological (predation, competition, and disease transmission), or harvest-related effects (incidental take of non-target species).

Activities cumulatively affecting these potential impacts are discussed below.

Table 8-1. Other Activities (Past, Existing, and Proposed) that May Cumulatively Affect Resources of Concern for the DFG Hatchery and Stocking Program

Description	Potential cumulative impacts
Past Stocking and Other DFG artificial propagation programs	Ecological
Non-DFG artificial propagation programs	Genetic, ecological
Water diversions	Ecological
Climate change	Ecological
Dams	Genetic, ecological
Urbanization	Ecological
Introductions of nonnative species	Ecological
Mining	Ecological
Timber harvest	Ecological
Agriculture	Ecological
Streambed alteration	Ecological
Recreational, commercial, and subsistence fisheries	Harvest
Wildfire, fire suppression, and fuels management	Ecological
Effluent pollution	Ecological
Habitat restoration and conservation	Positive

Past and Other Existing DFG Artificial Propagation and Stocking Programs

As described in Chapter 2, breeding and stocking of fish (principally salmonids) in California by DFG and its precursors began around 1870 (Leitritz 1970, 11). Historic fish stocking is likely to have cumulatively affected native fauna and contributed to existing conditions, along with other factors such as habitat alteration. Between 1870 and 1960, nearly 170 public hatcheries and egg-collecting stations existed or had existed at one time in California, the majority of which were owned and operated by the State (Leitritz 1970, 10). The numbers of fish produced and stocking locations are generally not available but since early times fish produced in the hatcheries were distributed around the state, potentially affecting native fauna. For example, Grinnell and Storer (1924) qualitatively described the apparent effect of trout stocking on mountain yellow-legged frog early in the 20th century:

> It is a commonly repeated observation that frogs, in tadpole form at least, do not occur in lakes which are stocked with trout. Adult frogs are sometimes found around the margins of such lakes and they occur in numbers along the shores of streams inhabited by trout, but the advent of fish in a lake sooner or later nearly or quite eliminates the frogs. It seems probable that the fish prey upon the tadpoles, so that few or none of the latter are able to reach the stage at which they transform.

As described in Chapter 2, 30 hatcheries and egg-collection stations were in operation in 1920–1922 and produced nearly 41 million trout fry and 18 million salmon fry. Leitritz (1970, 52) noted that fingerling production was increased each year until 1930, when 27 hatcheries stocked 62 million trout and over 10 million salmon fry. State production up until the 1930s mostly focused on fingerlings but subsequently shifted to include fish of catchable size (Leitritz 1970, 50). Hatchery construction and production increased greatly in 1947, with trout stocking to provide more opportunity for recreational fishing and salmon and steelhead stocking mostly to provide mitigation for habitat lost behind dams (see Chapter 2). Production data for some of the hatcheries existing in the 1960s were provided by Leitritz (1970); in some cases, hatcheries that existed at that time and continue to exist to the present day have increased production (e.g., San Joaquin Hatchery increased production from 165,000 pounds to almost 430,000 pounds in 2004–2008) whereas others have decreased production (e.g., production at Mount Shasta Hatchery is currently around 60,500 pounds but was 100,000 pounds in the 1960s).

DFG, USFWS, and the Forest Service are engaged in efforts to reestablish the native Paiute cutthroat trout (*Oncorhynchus clarki seleneris*) to the full extent of its historic range. This involves various stocking efforts that will entail the capture of wild fish from Paiute putative pure populations from within the Silver King watershed , as well as piscicide treatment (rotenone) to remove nonnative rainbow trout (*Oncorhynchus mykiss*) that may compete and hybridize (or already have hybridized) with Paiute cutthroat trout (Moyle et al. 2008). Rotenone use could potentially affect native species such as fishes, invertebrates, and ESA candidate amphibian species (Sierra Nevada yellow-legged frog [*Rana sierra*] and Yosemite toad [*Bufo canorus*]) in the immediate area where the treatment is utilized and would reduce fishing opportunities within the defined treatment area of the stream.

The potential impacts of stocked anadromous salmonids from DFG hatcheries on native fauna in the Delta system may be cumulatively augmented by the effects of striped bass (*Morone saxatilis*) stocking and rearing activities in the same geographic area. DFG, in association with private aquaculturists, released 11 million striped bass fingerlings and yearlings from 1981 to 1991, in an attempt to offset declining abundance. Following termination of the hatchery-rearing program

because of concerns regarding predation by striped bass on listed species, striped bass juveniles were salvaged from the State Water Project diversion in the south Delta, reared for 1 or 2 years in net pens, and then released into the San Francisco Bay estuary. The striped bass net pen program was halted in 2001 as a condition of the Striped Bass Conservation Plan (Moyle 2002). DFG no longer stocks or permits striped bass stocking in the Delta. It has been estimated that the predatory effects of a population of 3 million adult striped bass would increase the probability of quasi-extinction (i.e., three consecutive spawning runs of fewer than 200 adults) of winter-run Chinook salmon (*Oncorhynchus tshawytscha*) to 55%, compared with probabilities of 28% with 512,000 striped bass adults or 30% with 700,000 adults (Lindley and Mohr 2003.) DFG's Central Valleys Hatchery (established in 1937, now closed) was the only state-operated warmwater fish hatchery and allowed breeding and release of sunfishes (e.g., largemouth bass, smallmouth bass, white crappie, spotted bass, bluegill, redear sunfish, and white crappie), catfishes (e.g., channel catfish), and forage fishes (e.g., golden shiner and fathead minnow) (Leitritz 1970, 68–71). Introductions of warmwater fish have been implicated in the decline of native fishes (Moyle 2002).

Non-DFG Artificial Propagation Programs

California's two Federal anadromous fish hatcheries should be considered regarding potential cumulative effects on biological resources: Coleman National Fish Hatchery (Coleman NFH) and Livingston Stone National Fish Hatchery (Livingston Stone NFH). Both facilities are operated by USFWS. Coleman National Fish Hatchery was constructed at its current location on Battle Creek in 1942 to partially mitigate the effects of habitat loss due to the construction of Shasta and Keswick dams. Livingston Stone National Fish Hatchery was constructed in 1997 at the base of Shasta Dam to assist recovery efforts for endangered winter-run Chinook salmon. This facility is also involved in conservation efforts for the threatened delta smelt.

The Livingstone Stone NFH program produces endangered winter-run Chinook salmon and is considered a recovery action. Many important conservation benefits are obtained from this hatchery program that is designed, managed, and monitored to maximize genetic and ecological compatibility. The winter-run Chinook supplementation program and captive broodstock programs were both recommended in the Proposed Recovery Plan for Sacramento River Winter-run Chinook Salmon (NMFS 1997) as actions that would help to prevent further population declines and assist recovery of the winter-run Chinook population. Hatchery propagation of winter-run Chinook was one of the key conservation measures implemented through the "Ten Point Plan," a cooperative agreement that CDFG, USBR, USFWS, and NMFS agreed would assist in rebuilding the winter-run Chinook population. Within the Ten Point Plan, the agencies agreed to voluntarily pursue a series of restoration measures to protect and rehabilitate the winter-run Chinook salmon population. Subsequent to formal listing of the species under ESA, program at Livingston Stone NFH has been authorized by NMFS through a Section 10 ESA Permit. Regular monitoring and assessments of the winter-run Chinook supplementation program have provided a wealth of scientific evidence to demonstrate that hatchery-origin fish are contributing to the number of natural spawners, and that hatchery-origin fish mimic the natural winter-run Chinook population in most phenotypic parameters and life history attributes. Genetic monitoring of the program is intensive. Positive genetic identification is made on every adult used in the program and genetic assessments are also made prior to the release of juveniles in an attempt to reduce genetic impacts from the program. Additionally, the recovery of coded-wire tagged hatchery-origin winter-run Chinook in the ocean commercial and recreational fisheries has provided harvest information that has helped assess and manage ocean fishery regulations and assisted in stock protection.

The Coleman NFH is the largest Central Valley salmonid hatchery, with total production approaching 14 million (Table 8-2). The potential genetic and ecological impacts of these operations may be similar to those identified for DFG facilities. An assessment of impacts attributable to Coleman hatchery operations was made by the Technical Review Panel (2004). The risk to restoration of Battle Creek populations attributable to domestication varied from intermediate in late-fall Chinook salmon to high in fall-run Chinook salmon and steelhead (Oncorhynchus mykiss) (note that fall-run Chinook are not presently a recovery objective in Battle Creek). In relation to adaptedness and genetic diversity impacts beyond domestication, Coleman hatchery operations were judged to have low to intermediate risks to restoration of Battle Creek populations. The risk to successful restoration caused by competition at all life stages between hatchery-reared fish from Coleman and natural populations was generally assessed to be low or intermediate (but was potentially high for fall-run Chinook salmon), although the panel acknowledged that there were considerable gaps in the knowledge required for a more thorough evaluation. Substantial uncertainties also precluded a full evaluation of the potential for hatchery-reared fishes to prey upon native fishes, but release schedules and relative sizes of individuals were deemed very important. Risks were assessed to be low for natural populations of Battle Creek steelhead and spring- and winter-run Chinook salmon because released hatchery fish would be of similar size to natural fish. Risks to natural fall-run and late fall–run Chinook salmon fry may be intermediate or high because of hatchery releases of late-fall and fall juveniles, respectively; spring- and fall-run Chinook salmon also may be at high risk from adult hatchery steelhead. Indirect predation, the attraction of increased numbers of predators by hatchery releases, may negatively affect native populations. The Technical Review Panel (2004) noted that cumulative indirect predation effects of the operations at Coleman and Livingston Stone hatcheries, combined with the DFG-operated hatcheries, should be monitored and assessed. Based on results from other geographic areas, the effects could be appreciable.

However, extensive efforts have been made to reduce impacts. Coleman NFH operations have been subject to long-term review of potential impacts to natural-origin salmon and operational considerations have been put in place to reduce those impacts. The NMFS's hatchery policy (50 CFR 37204, June 28, 2005) indicates that it is inappropriate to make universal conclusions about all hatchery stocks without consideration of the multitude of possible differences between hatchery programs (e.g., hatchery objectives, founding stock, size of the propagation programs, isolated or integrated operations, spawning/mating strategies, rearing strategies, release strategies, etc.) that can and do result in substantive differences to the threats (and benefits) conferred upon naturally produced fishes. Programs at Coleman NFH have been under review by NMFS through ESA consultations since 1993. In 2001, a Biological Assessment was produced that followed the Hatchery and Genetic Management Plan format.

The programs at Coleman NFH are operated as integrated hatchery programs. Integrated hatchery programs incorporate a prescribed percentage of natural origin broodstock to produce fish whose genetics are guided by selective processes favoring fitness in the natural environment, thereby attempting to reduce genetic impacts of the propagation programs. The Hatchery Science Review Group identified the principal goal of integrated programs to be "maintaining the genetic characteristic of a natural population among hatchery-origin fish." To this end, specific numbers of natural-origin late fall-run Chinook salmon and steelhead adults are attempted to be incorporated into the spawning matrix. As all hatchery-origin late fall-run Chinook salmon and steelhead are marked, natural-origin and hatchery-origin late fall-run Chinook salmon and steelhead can be differentiated by the presence/absence of an adipose fin. Natural-origin late fall-run Chinook salmon to be incorporated into the spawning matrix at Coleman NFH are captured at the Keswick Dam fish

trap while natural-origin steelhead are collected from Battle Creek at the hatchery. The number of natural-origin fall Chinook salmon incorporated into the spawning matrix at Coleman NFH is estimated at about 10% based, thus far, on limited and variable marking data. As greater and consistent proportions of hatchery fall Chinook salmon have been marked though the constant fractional marking program, the estimated percentage of natural-origin fall Chinook salmon incorporated into the spawning matrix at Coleman NFH will be refined. Other broodstock management and genetic considerations include collecting large numbers of broodstock from all segments of the spawning run, including all age classes in spawning operations, and mating 1 male to 1 female.

Releases of juveniles from Coleman NFH are conducted at times, locations, and fish sizes believed to reduce the opportunity for ecological interaction between hatchery and natural-origin fish. For example, time of release and size of juveniles released is generally consistent with time periods that promote rapid outmigration, reducing opportunity for freshwater interaction with naturally-produced juveniles. Also, almost all salmon from Coleman NFH are released on-site (i.e., not trucked) to reduce likelihood of straying upon their return as adults. With respect to the potential risk to natural populations from pathogens associated with fish reared at, and released from, hatchery facilities (see Chapter 4), Foott et al. (2006) reported in a study designed to assess disease transmissibility that asymptomatic infection of the Sacramento River strain of IHNV can occur in Chinook salmon fry after environmentally-relevant low virus challenges; progression to a disease state was quite infrequent. Additionally, cohabitation studies of natural smolts with infected hatchery parr did not result in measurable disease transmission. Horizontal transmission of IHNV from infected hatchery smolts to natural cohorts was therefore deemed a low ecological risk. Incidence of disease and, therefore, likelihood for transmission to wild fish, has been even further reduced at Coleman NFH following the completion of an ozone water treatment plant. No cases of infectious hematopoietic necrosis virus (IHNV), which previously caused substantial losses during epidemics, have been observed at the facility since 1999.

Coleman NFH continues to modify practices and infrastructure to integrate the facility and programs into the highly visible Battle Creek Salmon and Steelhead Restoration Project. The facility's barrier weir and fish ladders have recently (2008) been modified to improve fish passage management at this site. The facility's water supply intakes are also in the process of being screened to reduce potential for impacts on naturally-produced aquatic species in the Battle Creek watershed (construction activities began in early 2009). Also, as part of the Restoration Project, an adaptive management plan (AMP) will be developed for Coleman NFH , along with pilot studies in attempt to continue to further assess and reduce impacts of facility operation on natural-origin salmonids in the Battle Creek watershed and Sacramento River system.

Another USFWS fish hatchery, the Lahontan National Fish Hatchery (NFH), was authorized as part of the Washoe Project in 1956 to re-establish the fisheries in Pyramid Lake, http://www.fws.gov/lahontannfhc/images/hatch_page_hatchery.jpg and began producing fish in 1967. The hatchery serves as part of the Lahontan National Fish Hatchery Complex (LNFH Complex) which includes the Nevada Fisheries Resource Office and the Marble Bluff Fish Passage Facility, a facility also constructed under the Washoe Project Act.

The Lahontan NFH provides a strain of Lahontan cutthroat trout (LCT) for numerous programs for lake habitats in the Western distinct population segment (DPS) of LCT (Truckee, Carson, and Walker River basins of California-Nevada). Propagation of catchable size LCT is an important purpose for converting recreational fishing from the non-native trout to the native species of trout. This

eventually will minimize or eliminate one source of interspecific non-native trout hybridization and competition. The hatchery houses a captive broodstock numbering 9,000 LCT, and produces about 700,000 LCT per year. The hatchery provides all age classes from eggs to 10-inch "catchables" in support of Lahontan NFH Complex fishery management activities. Currently the hatchery produces fish for Pyramid Lake (NV), Walker Lake (NV), the Truckee River, Fallen Leaf Lake; in addition to June Lake (Mono County, CA) and Gull Lake (Mono County, CA) outside the native range of any trout.

The Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*) was federally-listed as endangered in 1970, and was reclassified to threatened in 1975. A special rule under ESA section 4(d) was published in conjunction with the down-listing rule to facilitate management by the States and allow State-permitted sport harvest.

To manage the complexity of issues related to recovery of LCT, basin-specific interagency and interdisciplinary teams, including public stakeholders, were established for developing LCT recovery efforts. In 1998, USFWS organized a Management Oversight Group to address LCT recovery range-wide. Interagency teams were then organized by geographic area to develop strategies for LCT restoration and recovery efforts in their respective watersheds. In 1998, the Truckee River Basin Recovery Implementation Team was formed, followed by the Walker River Basin Recovery Implementation Team in 1999, and the Northwest distinct population segment (DPS) and Humboldt DPS Teams in 2000. The Tahoe Basin Recovery Implementation Team was formed in 2007 for recovery activities in the Lake Tahoe watershed. The teams each meet several times a year to discuss recovery activities and work plans aimed to coordinate recovery of LCT. Additionally, a range-wide LCT meeting is held every year to disseminate information collected (i.e., research, population monitoring, project status) to all those working to recover LCT.

Captive propagation of imperiled fish stocks is a conservation tool intended to restore extirpated populations in historical habitats and provide important life history information on poorly understood species (Rakes et al. 1999). This is particularly true for the LCT in the Western Lahontan Basin where all but one of the lacustrine populations were extirpated by the 1940's, and very little was documented about their life history strategies. Currently, hatchery production is the only mechanism by which LCT are maintained in Pyramid, Walker, and Fallen Leaf lakes. Much of that production goes toward supporting recreational harvest and has not historically been intended or designed to establish self-sustaining recovery populations.

Captive propagation of stocks locally adapted to these watersheds is one strategy available to reestablish these wild populations into historical lake habitats in the Western Lahontan Basin (U.S. Fish and Wildlife Service 2009a). The success of captive propagation and reintroduction programs for recovery depends upon a number of conditions, including an appropriate donor population, genetics planning, management and monitoring, restoration of the receiving habitat appropriate to life history traits, and political support from management agencies and the public. An important public concern would be the potential for a new regulatory burden associated with the need for permits authorizing incidental "take" of hatchery LCT on private property. This concern could be addressed by development of a "safe harbor" approach to protect private interests whose activities may affect hatchery LCT stocked into areas where human activities could result in incidental take.

There are well-funded and focused efforts to restore watershed connectivity from Walker Lake to the Walker River, from Pyramid Lake to the Truckee River, and for habitat restoration and native fish management in Lake Tahoe. With the full development and readiness of the Pilot Peak broodstock at the Lahontan National Fish Hatchery Complex, USFWS now has an available source of

the lacustrine form known to have originated from the Tahoe-Truckee-Pyramid Lake watershed (Peacock and Kirchoff 2007).

Beginning in spring 2009, the Lahontan National Fish Hatchery Complex Pilot Peak broodstock program will achieve a target number of 1,600 spawning age females (U.S. Fish and Wildlife Service 2009a). This will provide 500,000–600,000 eggs to meet the needs of a variety of new and emerging propagation programs identified by the Western Lahontan Basin's three Recovery Implementation Teams. This broodstock has been used in the Truckee River for streamside incubation of fry in an effort to imprint and establish a natural spawning population from Pyramid Lake. Excess broodstock have also been used to evaluate movement patterns using radio-telemetry tags in the mainstem Truckee River. Larger-scale efforts are underway in Fallen Leaf Lake with a more rigorous assessment of the impacts of nonnative trout and identification of measures to reduce or eliminate those impacts to benefit LCT reintroduction. Fundamental to the success of these programs in the Walker Lake, Pyramid Lake/Truckee River, and Lake Tahoe watersheds will be the expansion of production capabilities of the Pilot Peak strain. Increased production of Pilot Peak fish would be needed to meet the growing demand for recreational LCT fishing in lieu of nonnative fish management, in concert with recovery programs intended to establish self-sustaining lacustrine LCT populations. To that end, a Hatchery Management Plan will be formed to develop, coordinate, and implement production programs of Pilot Peak strain LCT.

Table 8-2. Production and Release Data for Chinook Salmon and Steelhead in the Central Valley for Non-DFG Hatcheries

Hatchery	Species/Run	Annual Production Goal (millions)	Size and Month of Release	Release Location
Coleman National Fish Hatchery	Chinook/fall	12 (smolts)	90/pounds, April	Battle Creek
Coleman National Fish Hatchery	Chinook/late fall	1 (smolts)	13–14/pounds, November–January	Battle Creek
Coleman National Fish Hatchery	Steelhead	0.6 (smolts)	~4/pounds, January	100% Sacramento River at Bend Bridge
Livingston Stone National Fish Hatchery	Chinook/winter	0.2 (smolts)	~85 millimeters, January	Sacramento River at Redding
Source: adapted from Williams (2006).				

A number of smaller rearing projects operate or have operated within the state, many of which are in association with DFG (Table 8-3). Although some of these may not affect the same populations as the DFG-run hatcheries, there may be cumulative impacts on other populations within the same ESU.

Table 8-3. Non-DFG Artificial Propagation Programs that Have Raised Listed Salmonids

Species	Location	Watershed/ Basin	Operator	Comments	Reference
California coastal Chinook ESU	Freshwater Creek	Humboldt Bay	Humboldt Fish Action Council/DFG	All spawners from Freshwater Creek, only wild brood stock used	Bjorkstedt (2005)
California coastal Chinook ESU	Yager Creek	Eel River	Pacific Lumber Company	Approximately 12 female (natural brood stock)	Bjorkstedt (2005)
California coastal Chinook ESU	Redwood Creek	Eel River	Not listed	Approximately 12 female (natural brood stock)	Bjorkstedt (2005)
California coastal Chinook ESU	Hollow Tree Creek	Eel River	Not listed		Bjorkstedt (2005)
California coastal Chinook ESU	Mattole River	Mattole River	Mattole Salmon Group	Approximately 40,000 eggs from 10 female	Bjorkstedt (2005)
Northern California steelhead ESU	Yager Creek	Eel River	Pacific Lumber Company	All natural brood stock (unless natural abundance is low)	Boughton and Bjorkstedt (2005)
Central California coast steelhead	Big Creek	Scott Creek	Monterey Bay Salmon and Trout Project (Kingfisher Flats Fish Hatchery)	Brood stock from Big/Scott Creeks released into Scott Creek; also raise San Lorenzo steelhead for in-basin release	Boughton and Bjorkstedt (2005)
South central California steelhead ESU	Whale Rock Reservoir	Old Creek	Whale Rock Steelhead/DFG	Now raised at Fillmore Hatchery	Boughton (2005)
Southern Oregon/Northern California Coho ESU	Rowdy Creek	Smith River	Kiwanis Club of Smith River	Reared yearling Coho from 1995–2000, approximately 10,000–13,000	Spence et al. (2005); Rowdy Creek Fish Hatchery (n.d.)

Species	Location	Watershed/ Basin	Operator	Comments	Reference
				fish/year; no longer producing Coho	
Central California Coast Coho Salmon ESU	Big Creek	Scott Creek	Monterey Bay Salmon and Trout Project (Kingfisher Flats Fish Hatchery)	Commenced 1976, solely in-basin releases	Spence and Bjorkstedt (2005)
Coastal Cutthroat Trout	Stone Lagoon	Stone Lagoon	Humboldt State University/DFG	Fishery enhancement	Johnson et al. (1999)

Other Fishing Management Activities

The California Fish and Game Commission sets fishing regulations, including closing waters to fishing. Declining populations of anadromous salmonids, some of which have been listed by the California Fish and Game Commission or the NMFS as threatened or endangered, have resulted in restrictions or closures on commercial and sport fishing for some species in recent years. For example, commercial and sport fishing for Coho salmon has been closed since 1996 (Pacific Fishery Management Council 2009). Rivers and creeks south of Redwood Creek in Humboldt County have been closed to Chinook salmon fishing since 2000 (Jong pers. comm.). Various tributaries of the Trinity and Klamath Rivers have been closed to steelhead fishing since in the late 1990s and there has been a prohibition on take of wild steelhead from all waters except the Smith River. Commercial and ocean sport fishing for Chinook salmon has been restricted nearly to the point of closure since 2008 (Pacific Fishery Management Council 2009).

Fishing restrictions and closures reduce regional economic activity. Directly affected industries include commercial fishers and retailers who serve anglers. Key affected retailers include charter and party boat operators, sporting goods stores, grocery stores, restaurants, motels, and gas stations. Declining sales by these businesses are amplified through the regional economy as they, in turn, reduce purchases from suppliers and as value added by fish processors, wholesalers, and retailers diminishes.

The north and central coast regions, and in particular port communities such as Crescent City, Eureka, Fort Bragg, San Francisco, and Monterey, have been most strongly affected by closures and restrictions on anadromous salmonid fishing. The north coast region was historically heavily dependent on the forest sector, as well as the fishing and tourism sectors. Declining forest sector production levels, especially since the northern spotted owl was listed in 1991, have had substantial adverse economic impacts, to which the region has only partially adjusted (Charnely et al. 2008).

Water Diversions

Water diversions may cumulatively affect natural resources in addition to the effects of the hatchery-reared fish from the DFG Program. Water diversion effects are numerous and include removal of fish from a water body that results in death (entrainment mortality), impingement on water-diversion screens resulting in death or injury, dewatering of stream reaches, changes in water temperature (e.g., due to decreased water volume or because of return flows from fields), and hydrologic changes such as flow reductions. These effects occur throughout California and may be a result of diversions for agricultural irrigation, municipal water supply, electricity generation, and other uses.

The situation observed in the Delta is particularly illustrative of the cumulative impact of water diversions. The State Water Project and Central Valley Project pumping facilities together divert approximately 10,000–12,000 cfs (U.S. Fish and Wildlife Service 2008c). Kimmerer (2008) suggested that losses of fish at these facilities increased with increasing diversion by these facilities. He estimated that, depending on flows, up to 10% of Sacramento River Chinook salmon are killed (assuming 80% pre-screen mortality) and that 1%–50% and 0%–25% of adult and larval/juvenile Delta smelt (*Hypomesus transpacificus*), respectively, are killed. Kimmerer (2008) noted that the variability in these estimates was high. Recent court orders have reduced the diversion by these facilities in an attempt to reduce take of listed species, in particular Delta smelt (U.S. Fish and Wildlife Service 2008). The State Water Project and Central Valley Project are similar to other diversions in that, in addition to mortality by entrainment, losses due to predators in their vicinity may be appreciable (National Marine Fisheries Service 2008a). In sum, National Marine Fisheries Service (2008a) estimates that only 16%–35% of fish entrained at State Water Project and Central Valley Project pumping facilities survive the process (Table 8-4).

Table 8-4. Overall Survival of Fish Entrained by the Export Pumping Facilities at the Tracy Fish Collection Facilities (Central Valley Project) and the John E. Skinner Fish Protection Facilities (State Water Project)

Estimate of Survival for Screening Process at the State Water Project and Central Valley Project		
	Percent survival	**Running Percent Survival**
State Water Project		
Pre-screen survival (after entry to Clifton Court forebay)	25% (75% loss)	25%
Louver efficiency	75% (25% loss)	18.75%
Collection, handling, trucking, release survival	98% (2% loss)	18.375%
Post-release survival (predation only)	90% (10% loss)	16.54 %
Central Valley Project		
Pre–screen survival (in front of trash racks and primary louvers)	85% (15% loss)	85%
Louver efficiency	46.8% (53.2% loss)	39.78%
Collection, handling, trucking, release survival	98% (2% loss)	38.98%
Post-release survival (predation only)	90% (10% loss)	35.08%
Source: adapted from National Marine Fisheries Service 2008a.		

Herren and Kawaski (2001) enumerated more than 3,300 diversions in a study area including the Delta, the Sacramento River, portions of the San Joaquin River and some tributaries, and Suisun Marsh. Approximately 98.5% of the diversions were unscreened or inadequately screened, and only 0.6% met DFG screening criteria in the Delta. Cramer and Demko (1993) estimated that the Wilkins Slough and Boyer's Bend diversions removed nearly 55,000 fall-run Chinook salmon smolts in spring 1992, which could have survived to become 270–1,400 adults. Losses of fish at diversions depend on the density of fish in the vicinity of the intake and increase with increasing pumping rates (Cramer and Demko 1993), although not necessarily in strict proportion (Hanson 2001). Water diversions for power generation (once-through cooling) may cause appreciable losses of fish and other aquatic organisms (California Energy Commission 2005). Proportional losses differ by species (e.g., Newbold and Iovanna [2007] estimated a 30% reduction in striped bass population size attributable to power plants in California, but only a 0.03% reduction for American shad [*Alosa sapidissima*]).

Climate Change

Climate change is predicted to bring profound changes to California's natural environment. Hayhoe et al. (2004) describe the results of four climate change models: compared with 1960–1991, by 2070–2099 statewide average annual temperatures will be 2.3°C–5.8°C higher, average annual precipitation will be reduced by >100 millimeters, sea level will have risen 19.2–40.9 centimeters, snowpack will have declined by 29%–89%, and change in annual inflow to reservoirs will decline by >20%. (One model predicted slight increases in precipitation, snowpack, and reservoir inflow.)

Changes in vegetation are also predicted (e.g., substantial decreases in the extent of alpine/subalpine forest, evergreen conifer forest, mixed evergreen woodland, and shrubland; and increases in mixed evergreen forest and grassland [Hayhoe et al. 2004]). Climate change is likely to cumulatively affect native fishes and amphibians by increasing water temperatures (hence reducing DO), reducing stream flows, and increasing the likelihood of drought-related fires. A rise in sea level would lead to increasing rates of erosion, sedimentation, flooding, and inundation of low-lying coastal ecosystems. With reductions in snowmelt runoff, peak flows may come earlier as rainfall contributes more, which could affect species such as Central Valley spring-run Chinook that have evolved their life history based on predictable runoff patterns (Williams 2006). Increasing temperatures may increase metabolic needs of fish predators and increase predation (Lindley et al. 2007). Moyle et al. (2008) qualitatively assessed the potential for climate-related impacts on California's native salmonids (Table 8-5). Their analysis indicated that the majority of taxa (18 of 29, 62%) were vulnerable in all or most of the watersheds inhabited; no taxon was invulnerable to climate change.

Table 8-5. Qualitative Assessment of California Salmonids' Vulnerability to Climate Change

Vulnerability	Taxon
Vulnerable in all watersheds inhabited	Klamath Mountains Province summer steelhead[SSC]; northern California coastal summer steelhead[FT, SSC]; central California coast steelhead[FT]; south-central California coast steelhead[FT, SSC]; southern steelhead[FE, SSC]; upper Klamath–Trinity Rivers spring-run Chinook salmon[SSC]; Central Valley late fall–run Chinook salmon[SC, SSC]; Sacramento winter-run Chinook salmon[FE, SE]; Central Valley spring-run Chinook salmon[FT, ST]; southern Oregon–northern California coastal Coho salmon[FT, ST]; central California coast Coho salmon[FE, SE]; McCloud River redband trout[SSC]; Eagle Lake rainbow trout[SSC]; Lahontan cutthroat trout[FT]
Vulnerable in most watersheds inhabited (possible refuges present)	Central Valley steelhead[FT]; upper Klamath–Trinity Rivers fall-run Chinook salmon; California coast Chinook salmon[FT]; Goose Lake redband trout[SC]; coastal cutthroat trout[SSC]
Vulnerable in portions of watershed inhabited (e.g., headwaters and lowermost reaches of coastal streams)	Northern California coastal winter steelhead[FT]; Central Valley fall-run Chinook salmon[SC]; California golden trout[SC, SSC]; Little Kern golden trout[FT]; Kern River rainbow trout[SC, SSC]; Paiute cutthroat trout[FT]; mountain whitefish
Low vulnerability due to location, cold water sources, or active management	Klamath Mountains Province winter steelhead; resident coastal rainbow trout; southern Oregon–northern California coastal Chinook salmon
Not vulnerable to significant population loss due to climate change	None
Notes: **FE =** endangered (federal). **FT =** threatened (federal).	

SE =	endangered (state).
ST =	threatened (state).
SC =	species of concern (federal).
SSC=	species of special concern (state).

Source: Moyle et al. 2008.

Amphibians and reptiles will likely also be affected by climate change through a variety of mechanisms, including changes in local habitats, the timing of hydrologic cycles as they relate to life-history needs, and the synergistic effects of other stressors. A more detailed assessment of climate change effects in the context of the Program's contribution to climate change is provided in the section on "Summary of Cumulative Effects by Resource Area" below.

Dams

Most hatcheries for anadromous salmonids were commissioned to mitigate habitat losses caused by dam construction. Cumulative impacts on biological resources due to dams consist of reductions of habitat area (i.e., isolation from historic spawning and rearing grounds), reduced recruitment of gravel to potential downstream spawning areas, and flow-related effects such as anomalous temperatures and reduced flows as necessitated by seasonal flooding and water storage issues. For example, 80%–95% of historic Central Valley steelhead habitat has been lost behind dams (Moyle et al. 2008). Pulsed flows from dams may be carried out for the purposes of: (1) generating electricity, (2) flushing streambeds, (3) facilitating human recreation (whitewater rafting), (4) providing additional water for downstream diversion to meet demands, and (5) preventing reservoirs from flooding (Klimley et al. 2007). Fishes may move laterally to the margins of streams to resist increased flows and then be stranded as the water level subsides (Klimley et al. 2007). In addition to permanent dams, temporary summer dams in California coastal streams cause disturbance through increased suspension of fine sediments during installation and removal, reduction of flows to incubating eggs, rapid changes in stream flow, reductions in habitat diversity, increases in temperature, and conditions conducive to nonnative piscivores (National Marine Fisheries Service 2001).

Opportunities to change dam operations for the benefit of aquatic living resources are foreseeable with Federal Energy Regulatory Commission–mandated relicensing. For example, the operating licenses of some 46 projects in California will expire between 2009 and 2030 (Federal Energy Regulatory Commission 2009). Many of these projects have the potential for alterations that would improve habitat conditions for anadromous fish in particular. A good example of such change is the relicensing of PacifiCorp's Klamath Hydroelectric Project, which will include several modifications to Iron Gate Dam and its environs: (1) improved fish passage from fish ladders to be installed by 2014; (2) increased below-dam DO levels from new turbine venting technology; (3) gravel augmentation to increase spawning below the dam (National Marine Fisheries Service 2007).

Urbanization

California's human population is projected to increase by over 50% from 2010 to 2050, with some counties estimated to almost triple in population (California Department of Finance 2007) (Table 8-6). Accompanying these increases will be increased demand for water, among other resources.

Increased urbanization tends to be accompanied by a number of cumulative impacts on aquatic resources, including increased impervious surface levels (leading to greater runoff and stream flashiness) and contaminants. Bilby and Mollot (2008) demonstrated a significant decline (75%) in incidences of Coho salmon spawning associated with increasing urbanization (50% more urban or industrial use) from 1986 to 2001 in several tributary streams of Puget Sound, Washington. Larger human populations may place a greater pressure on waters for recreation, with associated effects such as disturbance of stream beds and erosion of banks by recreational vessel wakes.

Table 8-6. Projected Changes in California's Human Population by County, 2010-2050

County	2010	2050	Change	County	2010	2050	Change
Alameda	1,550,133	2,047,658	32.10%	Orange	3,227,836	3,987,625	23.54%
Alpine	1,369	1,377	0.58%	Placer	347,543	751,208	116.15%
Amador	40,337	68,487	69.79%	Plumas	21,824	28,478	30.49%
Butte	230,116	441,596	91.90%	Riverside	2,239,053	4,730,922	111.29%
Calaveras	47,750	80,424	68.43%	Sacramento	1,451,866	2,176,508	49.91%
Colusa	23,787	41,662	75.15%	San Benito	64,230	145,570	126.64%
Contra Costa	1,075,931	1,812,242	68.43%	San Bernardino	2,177,596	3,662,193	68.18%
Del Norte	30,983	56,218	81.45%	San Diego	3,199,706	4,508,728	40.91%
El Dorado	189,308	314,126	65.93%	San Francisco	818,163	854,852	4.48%
Fresno	983,478	1,928,411	96.08%	San Joaquin	741,417	1,783,973	140.62%
Glenn	30,880	63,586	105.91%	San Luis Obispo	269,734	364,748	35.23%
Humboldt	134,785	152,333	13.02%	San Mateo	736,667	819,125	11.19%
Imperial	189,675	387,763	104.44%	Santa Barbara	434,497	534,447	23.00%
Inyo	19,183	25,112	30.91%	Santa Clara	1,837,361	2,624,670	42.85%
Kern	871,728	2,106,024	141.59%	Santa Cruz	268,016	333,083	24.28%
Kings	164,535	352,750	114.39%	Shasta	191,722	331,724	73.02%
Lake	67,530	106,887	58.28%	Sierra	3,628	3,547	–2.23%
Lassen	37,918	55,989	47.66%	Siskiyou	47,109	66,588	41.35%
Los Angeles	10,514,663	13,061,787	24.22%	Solano	441,061	815,524	84.90%
Madera	162,114	413,569	155.11%	Sonoma	495,412	761,177	53.65%
Marin	253,682	307,868	21.36%	Stanislaus	559,708	1,191,344	112.85%
Mariposa	19,108	28,091	47.01%	Sutter	102,326	282,894	176.46%
Mendocino	93,166	134,358	44.21%	Tehama	65,593	124,475	89.77%
Merced	273,935	652,355	138.14%	Trinity	15,172	30,209	99.11%
Modoc	10,809	24,085	122.82%	Tulare	466,893	1,026,755	119.91%
Mono	14,833	36,081	143.25%	Tuolumne	58,721	73,291	24.81%
Monterey	433,283	646,590	49.23%	Ventura	855,876	1,229,737	43.68%
Napa	142,767	251,630	76.25%	Yolo	206,100	327,982	59.14%
Nevada	102,649	136,113	32.60%	Yuba	80,411	201,327	150.37%
Total	39,135,676	59,507,876	52.06%				
Source: California Department of Finance 2007.							

Introductions of Nonnative Species

Introductions of non-native fishes and other taxa may cumulatively affect native aquatic fauna in conjunction with hatchery-raised fish. Discharges of ballast water from foreign ships entering the San Francisco Bay and Delta has probably introduced several species. The introduced clam *Potamocorbula amurensis* appears to have greatly depleted stocks of plankton upon which fish and other species depend (Kimmerer 2002). Yellowfin goby (*Acanthogobius flavimanus*) and shimofuri goby (*Tridentiger bifasciatus*) are well-established in several coastal regions and may compete with native fauna, prey upon them, or be preyed upon by them (Moyle 2002; Workman and Merz 2007). A number of fish species have been introduced to enhance recreational fishing, either as targets for harvest (e.g., striped bass, brown trout, and largemouth bass [*Micropterus salmoides*]) or else as bait (e.g., inland silverside [*Menidia beryllina*]) (Moyle 2002). Inland silversides may prey upon eggs and larvae of Delta smelt (*Hypomesus transpacificus*) and compete with juveniles (Bennett 2005). Species introduced for rearing as food include the common carp (*Cyprinus carpio*), which was subsequently blamed for habitat destruction by its bottom feeding activity and for which many eradication attempts have been made (Dill and Cordone 1997). Several introductions have been made in attempt to biologically control undesirable organisms. Of these, the use of western mosquitofish (*Gambusia affinis*) to limit mosquito populations is longstanding and is mostly effective in artificial water bodies; negative effects of their introduction on native fishes, invertebrates, and amphibians in California include direct predation of small individuals and harassment of adults that limits breeding (Moyle 2002). Illegal introductions of fish and other animals (e.g., from the aquarium trade or for recreational fishing) is another pathway that may cumulatively affect native species. Efforts to remove undesirable nonnative species may cumulatively affect native aquatic resources. For example, eradication of northern pike (*Esox lucius*) illegally introduced to the Feather River watershed (Lake Davis) involved reservoir drawdown and rotenone application (Entrix 2007).

Two species of particular interest 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, potentially clogging water intake structures, aeration devices, pipes, and screens. Once established within hatcheries, these species may be released downstream with effluent waters. In addition to the NZMS and the Quagga mussel, fish hatchery and aquaculture activities present numerous potential opportunities for accelerating the spread of zebra mussels (*Dreissena polymorpha*) to new locations. Although the zebra mussel has not successfully infested any known U.S. hatcheries to date, its presence was confirmed in California waters at San Justo Reservoir on January 10, 2008. Zebra mussels, like the closely related and ecologically similar Quagga mussels, are voracious filter-feeding organisms. Within new environments, these invasive mollusks have the potential to colonize with extraordinary population densities.

Mining

The legacy effects of gold mining operations that began in the middle of the 19th century are reflected in the diminished numbers of fish, particularly salmonids, that currently exist in many of California's aquatic systems (Lichatowich 1999). These mining activities released great quantities of sediment into streams and removed large amounts of fish habitat, including spawning gravel and shoreline vegetation. Some projects are underway to alleviate legacy effects of mining. Heavy metal and acid waste pollution into the Sacramento River from Iron Mountain Mine has been greatly reduced, but more work remains to be done (Moyle et al. 2008). Present-day mining operations

include suction-dredging, which Harvey and Lisle (1998) noted may have several cumulatively negative effects on stream fauna: entrainment of organisms, habitat alteration (e.g., excavation of banks, deposition of tailings, and removal of coarse woody debris), and suspension of sediments (increasing turbidity and reducing visibility, which may affect feeding [Moyle et al. 2008]). Gravel extraction has also left long-lasting cumulative effects similar to those of other mining operations.

Timber Harvest

Timber harvesting has affected anadromous and land-locked fishes and other aquatic organisms in California since the mid-19th century. Loss of shade can increase stream temperatures, while removal of trees may accelerate erosion of sediments into streams (filling in cool refuge pools) and reduce the amount of large woody debris that can enter streams to form habitat for fish and other aquatic life (Moyle et al. 2008). Associated infrastructure, such as roads, may cumulatively increase the initial effects, as is the case for other activities such as mining. Some forest–management entities (industrial timberland owners) are planning to prepare habitat conservation plans (HCPs) for listed species. Modern forest practice regulatory programs generally have high compliance and effectiveness and, together with voluntary programs, such as forest certification, provide benefits to biodiversity (California State Board of Forestry and Fire Protection Monitoring Study Group 2006).

Agriculture

Since the 19th century, agriculture, including the cultivation of crops and rearing of livestock, has cumulatively affected native aquatic organisms within many areas that may be affected by the DFG Program. Moyle et al. (2008:213) describe the cumulative effects of livestock grazing on California golden trout, although their description is apt for the effects on many other species: “Basically, grazing reduces habitat by reducing the amount of streamside vegetation, collapsing banks, making streams wider and shallower, reducing bank undercutting, polluting the water with feces and urine, increasing temperatures, silting up spawning beds (smothering embryos), and generally making the habitat less complex and suitable for trout.” Cultivated areas may contribute non-point pollution to water bodies such as sediment, fertilizers, and pesticides. Straightening of natural streams to form drainage channels, along with removal of wood to improve drainage, also disrupts fish habitat. Degraded habitat also predisposes aquatic animals to disease by increasing stress, and by increasing habitat for pathogens. For example, tubifex worms which are involved in whirling disease transmission thrive in slower waters with high organic content.

Streambed Alteration

Alterations to streambeds have been numerous historically, and it is reasonable to foresee that many will occur in the future, potentially affecting habitat for fishes and other aquatic organisms. The 2006 governor’s emergency proclamation for California’s levees entailed numerous bank reinforcement activities, such as the Sacramento River Bank Protection Program. These activities may cumulatively affect fish by removal of riparian habitat and in-stream woody material to allow installation of riprap. Depending on levee repair designs, the cumulative effects may be reduced in the long term by replanting vegetation, installing anchored woody debris, and restoring off-site mitigation areas.

Fish Harvest

Cumulative impacts may occur as the result of fish harvest, which may be from recreational fishing, commercial fishing, subsistence fishing, or illegal fishing (poaching). Long-term cumulative effects of overfishing and habitat loss beginning in the mid–late 19th century are manifested in greatly reduced stocks today (Lichatowich 1999). In 2007, more than 1.5 million pounds of Chinook salmon valued at nearly $7.8 million were landed at California ports (California Department of Fish and Game 2008a). Over 1.7 million recreational anglers spent nearly $2.4 billion in California in 2006, with 2001 data indicating that retail sales attributable to freshwater angling generated nearly twice the income of saltwater fishing (Alkire 2008). For Central Valley Chinook, overall harvest removed an average of 59% of adult production between 1962 and 2007; of this average, commercial ocean harvest made up 38%, recreational ocean harvest comprised 14%, and in-river fisheries contributed 7% (Anadromous Fish Restoration Program 2008). Spring- and fall-run Chinook landed by the Yurok and Hoopa tribes in the Klamath River basin for subsistence purposes form about 75%–90% of their average annual catches (Pacific Fishery Management Council 2008). Fisheries may increase overall mortality by release of non-landed fish: For example, non-landed mortality averaged about 1.8% of total annual in-river runs of fall-run Chinook salmon in the Klamath and Trinity Rivers from 1978 to 2007 (Pacific Fishery Management Council 2008). In response to considerably lower returns of fall Chinook salmon to the Central Valley than expected, all ocean harvesting (commercial and recreational) of Chinook off California in 2008 and 2009 was prohibited. Moyle et al. (2008) described poaching as being a very important factor limiting Klamath Mountains Province summer steelhead because they are easy to catch during the summer in canyon pools where they are conspicuous, aggregate in pools, and cannot leave because of low stream flow.

Wildfire, Fire Suppression, and Fuels Management

Forest fires may produce a variety of cumulative impacts on native fish and amphibians (Table 8-7). Lindley et al. (2007) demonstrated that a geographically limited race, Central Valley spring-run Chinook salmon, is at appreciable risk of a wildfire that could affect the headwaters of some or all streams that it inhabits: a 30-kilometer-diameter fire (sufficient to affect the headwaters of the population's three main tributaries) has a 10% annual chance of occurring somewhere in the watersheds of Central Valley rivers. Forestry and fire-management activities may affect the severity of wildfires (e.g., planted stands of trees in the Western Klamath mountains are much more likely to have large wildfires than natural forests) (Odion et al. 2004). The National Fire Plan of 2001 has increased efforts by federal agencies and their collaborators to decrease the amounts of potential fuel for fires, mostly by use of prescribed burning, mechanical removal, thinning, and logging (Pilliod et al. 2003), which may affect aquatic environments by altering habitat (with site-specific positive or negative effects). Fire roads and firebreaks may disrupt habitat and increase sedimentation. Chemical application during fire-suppression activities may introduce toxic substances into water bodies such as ammonia-based fire retardants and surfactant-based foams (Pilliod et al. 2003).

Table 8-7. Predicted Negative (-) and Positive (+) Effects of Fire on Amphibians and Their Aquatic Habitats Relative to Time Since Burning

Condition	Predicted Effects			Examples
	Short-term (up to 1 year after fire)	Mid-term (>1 to 10 years after fire)	Long-term (>10 years after fire)	
Channel scour	-	-	-	Mortality, habitat loss
Combustion	-			Mortality of all life stages
Debris flow and woody debris inputs	-	-/+	+	Mortality, habitat loss (–); increased habitat complexity (+)
Decreased cover	-	-/+	+	Mortality from desiccation, increased vulnerability to predators, increased temperatures (–); longer hydroperiods (+)
Hydroperiod	+	+		Increased surface water
Increased nutrients	-	+		Mortality (–); increased food supply and rates of growth and development (+)
Increased temperature	-	-/+	+	Mortality, habitat loss (–); increased food supply and rates of growth and development (+)
Sedimentation	-	-	-	Mortality of eggs, habitat loss, changes in stream channel morphology
Ash and fine silt in runoff from burned area.	+			Mortality of fish and eggs.
Source: modified from Pilliod et al. 2003.				

Effluent Pollution

Many water bodies subject to potential cumulative impacts from the DFG Program are also affected by a variety of point and nonpoint types of pollution. California's 2006 list of water-quality-impaired water bodies, submitted to the U.S. EPA as required under section 303(d) of the CWA, includes 779 water bodies requiring the development of TMDL action plans to improve water quality, 220 water bodies for which action plans have been developed, and eight water bodies where means other than TMDLs are being employed to improve water quality (State Water Resources Control Board 2007). The main pollutants contributing to the listing of water bodies are pesticides (20.4% of all pollutants listed), metals/metalloids (19.0%), pathogens (14.5%), and nutrients (13.6%). The insecticides chlorpyrifos, diazinon, or malathion may negatively affect listed salmonids and other fishes through

runoff, leaching, drift, deposition from precipitation, or consumption of insects (National Marine Fisheries Service 2008b). Each insecticide can potentially impair nerve cell transmission in fishes and reduce survival, growth, reproduction, swimming ability, olfactory-mediated behaviors (e.g., homing and predator avoidance), and prey survival (National Marine Fisheries Service 2008lb).

Relevant Restoration and Conservation Programs and Plans

Several regional restoration and conservation programs and plans may modify the impacts of the DFG's Program, principally in watersheds containing anadromous fish hatcheries (Table 8-8). Actions resulting from these efforts include habitat restoration/creation, removal of barriers to fish migration, enhancement of stream flows, screening of water diversions, eradication of nonnative species, reductions in pollutants, research and monitoring of important aquatic organisms, and sustainable management.

Table 8-8. Major Legislation and Resulting Restoration Programs in Regions with DFG Anadromous Hatcheries

Legislation	Resulting Major Restoration Programs
Trinity River Restoration Act (amended by Trinity River Basin Fish and Wildlife Management Reauthorization Act)	Trinity River Restoration Program
Klamath River Basin Fishery Resources Restoration Act	Klamath River Basin Conservation Area Restoration Program
Central Valley Project Improvement Act	Anadromous Fish Restoration Program
California Bay–Delta Authority Act	Ecosystem Restoration Program (California Bay–Delta Authority) Environmental Water Account Bay Delta Conservation Plan
Executive Order S-17-06	Delta Vision

The following descriptions of related or similar restoration projects listed above include those that are under active consideration, have been proposed, or have some form of environmental documentation complete. In addition, these projects have the potential to affect the same resources and fall within the geographic scope designated for cumulative assessment of those resources. In particular, those resources are biological resources (riparian habitat and wildlife disturbance), water quality, and economics.

Trinity River Basin Fish and Wildlife Management Act (Amended by Trinity River Basin Fish and Wildlife Management Reauthorization Act)—Trinity River Restoration Program

The Trinity River Basin Fish and Wildlife Management Act [Public Law 98-541 (98 Stat. 2721, enacted October 24, 1984)] required the secretary of the interior to develop and implement a

program to restore fish and wildlife to levels existing prior to the construction of the Trinity River division of the Central Valley Project. It also established the Trinity River Basin Fish and Wildlife Task Force to advise the secretary and authorizes funding for design and construction, and operations and maintenance activities.

Subsequent amendments to the act made several changes to the original legislation. The secretary of the interior is mandated to consult with the secretary of commerce, where appropriate, in formulating and implementing fish and wildlife management programs for the Trinity River Basin. The 1996 reauthorization act also expands the scope of habitat restoration activities to include the Klamath River and redefines the role of the Trinity River Hatchery. The amendments mandate that Trinity River Basin Fish and Wildlife Task Force activities be coordinated with the Klamath River Basin Fisheries Task Force and the Klamath Fishery Management Council. The secretary of the interior is mandated to report to Congress detailing expenditures associated with the program. (U.S. Fish and Wildlife Service 2009b).

Klamath River Basin Fishery Resources Restoration Act—Anadromous Fish Restoration Program

The Klamath River Basin Fishery Resources Restoration Act, as amended in 1988, requires the Secretary of the Interior to develop and implement a 20-year program to restore and maintain anadromous fish populations of the Klamath River basin. It provides for the formation of a council responsible for developing a comprehensive long-term management plan and policy for in-river and ocean harvest; in addition, it established a task force to assist in the development, coordination, and implementation of the program. Amendments to the act in 1992 allow for future increases in the size of the Klamath River Basin Fisheries Task Force as the program expands in geographic size. (U.S. Fish and Wildlife Service 2009b.)

Central Valley Project Improvement Act—Anadromous Fish Restoration Program

Enacted in 1992, the Central Valley Project Improvement Act mandated changes in the management of the Central Valley Project in the areas of protection, restoration and enhancement of fish and wildlife. The targeted areas of change include: fish and wildlife habitat protection, enhancement and restoration in the Central Valley and Trinity River basins; addressing impacts of the project on fish, wildlife and associated habitats; improving the Project's operational flexibility; increase water–related benefits provided by the project through expanded use of voluntary water transfers and improved water conservation; contribution to the effort to protect the San Francisco Bay/Sacramento–San Joaquin Delta Estuary; attain a balance among competing demands for use of project water, including needs of fish and wildlife, agriculture, municipal, and industrial and power contractors. (U.S. Department of the Interior Bureau of Reclamation 2009.)

California Bay–Delta Act—Ecosystem Restoration Program (California Bay–Delta Authority), Environmental Water Account, and Bay Delta Conservation Plan

The California Bay–Delta Act of 2003 established the California Bay–Delta Authority as CALFED's governance structure and charged it with providing accountability, ensuring balanced implementation, tracking and assessing program progress, ensuring the use of sound science to guide decision-making, encouraging public involvement and outreach, and coordinating and integrating related government programs. Program directives are to improve the Bay-Delta

ecosystem quality and ensure reliability of California's water supplies and the integrity of channels and levees in the Bay-Delta (State of California 2007a).

Executive Order S-17-06—Delta Vision

The Delta Vision initiative was establish through Executive Order S-17-06 in September 2006 with the overarching goal to develop a durable vision and strategic plan for sustainable management of the Delta's multiple uses, resources, and ecosystem. Long-term objectives include the restoration and maintenance of identified functions and values that are deemed to be important to the environmental quality of the Delta and to the economic and social well-being of the people of California. The initiative is overseen by a number of teams: the governor–appointed Blue Ribbon Task Force is tasked to prepare the vision and strategic plan and recommend future actions necessary for sustainable management of the Delta, a Delta Vision Committee (composed of agency secretaries) is in place to guide the initiative, and a Stakeholder Coordination Group facilitates public involvement and informs the task force. (State of California 2007b.)

Summary of Cumulative Effects by Resource Area

The following is an analysis of the cumulative impacts for those resource areas where cumulative effects could occur. The scope considered for each of these resources is outlined in the table below.

Table 8-9. Geographic Scope for Resources with Potential Cumulative Effects

Resource	Geographic Scope
Water quality/hydrology	Downstream of hatchery discharges and at stocking locations
Biological resources	Statewide hatchery and stocking locations
Economics/recreation	Statewide in the vicinity of hatcheries and stocking locations
Cultural	Hatchery locations
Climate change	Global

Hydrology, Water Supply, and Water Quality

Cumulative Hydrology and Water Supply Impacts

Based on the potential Program-specific hydrologic effects of hatchery operations identified in Chapter 3, "Hydrology, Water Supply, and Water Quality," the potential cumulative hydrologic impacts of potential concern include water supply availability and deliveries, erosion, and flooding. With respect to water supply, the Program-related diversions are largely non-consumptive in that water diverted to the hatcheries is not irretrievably lost to evaporation or to groundwater. The Program-related diversions and discharge would continue in the future and not be expected to change appreciably relative to existing conditions. Therefore, because Program-related operations are not expected to change, and because the majority of water used for hatchery operations is returned to surface water bodies, the effects of hatchery-related diversions and discharges to reduced water supply conditions and the related indirect environmental effects, would not be cumulatively considerable.

With respect to flooding and erosion, this cumulative impact assessment is based on the assumption that future stream conditions, as influenced by past, present, and reasonably foreseeable future projects, will generally be similar to existing conditions. As described in Chapter 3, some hatchery facilities are located within floodplains and have been subject to flood damage. Other hatcheries are located in areas where flooding conditions are actively managed via facilities, management plans, and emergency evacuation alert and response systems. On a statewide basis, flooding and erosion are substantial concerns, and millions of dollars are invested annually to control and limit flooding and erosion. Additionally, hatchery discharges via defined outfall structures, and contributions to increases in net flow, have the potential to affect localized areas of in-channel erosion and sedimentation. As such, the localized hatchery discharges may contribute incrementally to the flooding, erosion, and sedimentation conditions. However, the localized Program-related effects are minimal compared with the natural and much larger watershed-scale processes of rainfall, snowmelt, and runoff that primarily dictate the magnitude and severity of seasonal flooding events, erosion, and sediment transport. Because Program-related operations are not expected to change, and Program-related effects are minimal compared with watershed-scale processes, the Program-related contributions to flood flows and erosion would not be cumulatively considerable. Additionally, the Program is not expected to expose people and property to flooding and flood hazards, inundation of structures located in floodplains, or damage to structures as a result of flooding, erosion, and sedimentation, with any greater frequency than occurred historically. For this reason, the exposure of people and structures to flooding or inundation is not considered cumulatively considerable.

Cumulative Water Quality Impacts

This section addresses the potential for cumulative impacts on water quality in the affected water bodies as influenced by the past, present, and reasonably foreseeable future projects. As described in Chapter 3, water quality constituents of concern in the Program-related hatchery water discharges to localized areas of receiving waters consist of: temperature, total suspended solids (TSS), turbidity, pH, DO content, salinity, nutrients (nitrogen and phosphorus), and treatment chemicals and drugs. Program-related hatchery water discharges to receiving waters would continue in the future and are not expected to change appreciably relative to existing conditions. As a result of future population growth in California, water quality conditions in receiving water bodies where Program hatcheries are located may be affected by increased waste discharges from point sources (e.g., wastewater discharges) and nonpoint sources (e.g., urban runoff, agriculture, forestry, and mining).

As noted in Chapter 3, Table 3-5, a number of the receiving water bodies where hatcheries are located are identified on the state's CWA Section 303(d) list of water quality limited (i.e., impaired) streams. The 303(d) list identifies water bodies where applicable water quality objectives are currently being exceeded. The following 303(d) listings include stream segments that may be affected by the hatcheries and are impaired by one or more of the constituents that hatcheries discharge: Klamath River (Iron Gate Hatchery), Mad River (Mad River Hatchery), Russian River (Warm Springs Hatchery), American River (Nimbus/American River Hatcheries), Pit River (Crystal Lake Hatchery), Napa River (Silverado Fisheries Base), and Tuolumne River (Moccasin Creek Hatchery). For 303(d)-listed streams, the RWQCBs must develop TMDL programs to reduce the contaminant loading to restore the assimilative capacity of the stream and achieve compliance with applicable water quality objectives. Ultimately, water quality conditions in the 303(d)-listed water bodies would be improved in the future as the TMDL programs are completed.

As evaluated in Chapter 3, most of the hatcheries discharge to relatively large rivers that provide dilution and assimilative capacity for the constituents of concern. Thus, the effects of the hatchery discharges on receiving water quality conditions are localized to initial zones of mixing, and water quality effects are minimal downstream of the discharges after complete mixing in the river has occurred. Additionally, the frequency with which undiluted hatchery discharges exceed regulatory objectives is generally low for all of the constituents of concern such that water quality effects are minimal, even in smaller receiving waters where less dilution is available. When considered in conjunction with other past, present, and reasonably foreseeable discharges that might affect the same receiving waters, the Program-related discharges are not anticipated to contribute considerably to the potential cumulative water quality conditions. Regional waste loading contributions tend to be responsible for water quality impairments that warrant 303(d) listing status, and the Program-related contributions are very minor. Nevertheless, TMDL programs will be developed for 303(d) water bodies that will establish the allowable and reduced constituent loads necessary to resolve the water quality impairments. Hatchery discharges may be included in these TMDL programs, as warranted, and thus may be required to contribute to the fair-share reduction in constituent loads in these water bodies. Consequently, the Program-related effects on water quality would not be cumulatively considerable.

Biological Resources

Numerous factors have cumulatively affected native aquatic fauna as outlined above. However, because there would be no additional construction of facilities associated with the Program, the mechanisms for contributing to cumulative impacts of the DFG Program to aquatic species are limited to localized water quantity and quality effects associated with hatchery operations (described below in the "Hydrology, Water Supply, and Water Quality" section) and factors related to effects on native fauna from stocking of trout and anadromous salmonids.

The potential effects of fish stocking by DFG hatcheries identified in Chapter 4 include:

- predation and competition of stocked fish to native fish and amphibians;
- non-target harvest of native fishes;
- invasive species and pathogens released during stocking to fish and amphibians;
- genetic effects on salmon, steelhead and trout;
- the effect of unintentional releases of trout and anadromous salmonids on fish and amphibians; and
- the effect of anglers at fishing sites.

In the near term, salmon, steelhead and trout stocking programs will continue to contribute to the cumulative impacts on native fish and amphibian populations. Several mitigation measures included in this EIR/EIS are included to reduce the cumulative effects of the Program on native fish and amphibians.

For the trout stocking program, the principal mitigation mechanism is the implementation of a pre-stocking evaluation protocol (Appendix K), which provides the basis for decisions regarding the location and magnitude of fish stocking in areas where sensitive native fish and amphibian populations may occur. The result of the implementation of the pre-stocking evaluation protocol will be reduced potential for interaction between stocked trout and populations of native species,

resulting in lowered potential for impacts associated with predation, competition, exposure to invasive species, and pathogens. Implementation of these plans also will reduce the potential for hybridization of native species with stocked trout. Although impacts from angler use to riparian ecosystems and incidental harvest would continue, angler activity is expected to diminish in specific areas where trout would no longer be stocked due to implementation of the mitigation included in the EIR/EIS. Additionally, mitigation regarding hatchery and stocking operations related to the detection and control of invasive species and pathogens should result in the decreased potential for native fish and amphibians to be exposed to these organisms.

For the salmon and steelhead stocking programs, the primary issue of concern is the continuing impact of hatchery management practices that result in the reduction of genetic diversity of many of the salmon ESUs and steelhead distinct population segments (DPSs) in the state. Hatchery practices are currently under review at both the state and federal salmon and steelhead hatcheries in California. The result of these evaluations is the preparation and implementation of hatchery genetic management plans (HGMPs), which provide guidance to reduce the loss of genetic diversity of native anadromous salmonids. Although no federally-approved HGMPs exist yet for California salmon or steelhead stocks, the approach has yielded promising results in the Columbia River Basin and has substantial potential to reduce the types of genetic effects that have been observed in California salmon and steelhead stocks. However, the proposed mitigation would not alleviate other threats to genetic integrity of California salmon and steelhead stocks, such as the legacy effects from past introductions of salmon and steelhead, or the effects that are linked to habitat decline, such as the decline and potential extirpation of native populations that are uniquely adapted to particular streams.

Economics/Recreation

Because DFG's Program does not have an adverse effect on local or state economics or recreation, there is no contribution to a cumulative effect.

Cultural Resources

Because the DFG's Program does not have an adverse effect on cultural resources, there is no contribution to a cumulative effect.

Climate Change

Existing Conditions

Activities such as fossil-fuel combustion, deforestation, and other changes in land use result in the accumulation of greenhouse gas (GHG) emissions—CO2, methane (CH4), nitrous oxide (N2O), ozone (O3), and certain human-made hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs)—in Earth's atmosphere. An increase in atmospheric GHGs results in an enhanced *greenhouse effect,* a phenomenon that keeps the earth's atmosphere near the surface warmer than it would be otherwise and allows successful habitation by humans and other forms of life. An increased greenhouse effect alters Earth's radiation budget and, therefore, results in an increase in Earth's average surface temperature, a phenomenon commonly referred to as *global warming*. The International Panel on Climate Change (IPCC) states that recently recorded increases in Earth's average surface temperature are the result of increased concentrations of GHGs in the atmosphere (International Panel on Climate Change 2007). The IPCC's best estimates are that the average global temperature

increase between 2000 and 2100 could range from 0.6°C, with no increase in GHG emissions above 2000 levels, to 4.0°C, with a substantial increase in GHG emissions (Intergovernmental Panel on Climate Change 2007). Global warming is expected, in turn, to affect weather patterns, average sea level, ocean acidification, chemical reaction rates, and precipitation rates, among other things, in a manner commonly referred to as *climate change*.

Greenhouse Gases and Their Emissions

The term "greenhouse gases" includes gases that contribute to the natural greenhouse effect, such as CO2, CH4, N2O and H2O, as well as gases that are man-made and emitted through the use of modern industrial products, such as hydrofluorocarbons (HFCs), chlorinated fluorocarbons (CFCs), and sulfurhexafluoride (SF6). These last two families of gases, while not naturally present, have properties that also cause them to trap infrared radiation when they are present in the atmosphere, thus making them greenhouse gases. These six gases comprise the major GHGs that are recognized by the Kyoto Protocol.[1] One GHG not recognized by the Kyoto Protocol is atmospheric water vapor, as there is no obvious correlation between water vapor concentrations and specific human activities. Water vapor appears to act in a feedback manner: higher temperatures lead to higher water vapor concentrations, which in turn cause more global warming.

The effect each of these gases has on global warming is determined by a combination of: (1) the volume of their emissions; and (2) their global warming potential (GWP). GWP indicates, on a pound for pound basis, how much a gas will contribute to global warming relative to how much warming would be caused by the same mass of carbon dioxide. Methane and nitrous oxide are substantially more potent than carbon dioxide, with GWPs of 21 and 310, respectively. However, these natural greenhouse gases are nowhere near as potent as sulfur hexafluoride and fluoromethane, which have GWPs of up to 23,900 and 6,500 respectively. GHG emissions typically are measured in terms of mass of CO2e emissions, which is the product of the mass of a given GHG and its specific GWP.

The most important greenhouse gas in human-induced global warming is carbon dioxide. While many gases have much higher GWPs, carbon dioxide is emitted in vastly higher quantities. Fossil fuel combustion, especially for the generation of electricity and powering of motor vehicles, has led to substantial increases in carbon dioxide emissions, and thus substantial increases in atmospheric carbon dioxide concentrations. In 2005, atmospheric carbon dioxide concentrations were about 379 parts per million (ppm), over 35 percent higher than the pre-industrial concentrations of about 280 ppm. In addition to the sheer increase in the volume of its emissions, carbon dioxide is a major factor in human-induced global warming because of its lifespan in the atmosphere of 50 to 200 years.

The second most prominent GHG, methane, also has increased due to human activities such as rice production, degradation of waste in landfills, cattle farming, and natural gas mining. In 2005, atmospheric levels of CH4 were more than double pre-industrial levels, up to 1,774 parts per billion

[1] The Kyoto Protocol to the United Nations Framework Convention on Climate Change requires parties to proceed "with a view to reducing their overall emissions of such [greenhouse] gases by at least 5 percent below 1990 levels in the commitment period 2008 to 2012." (Kyoto Protocol, Article 3, ¶1.) The treaty was negotiated in Kyoto, Japan in December 1997, opened for signature on March 16, 1998, closed for signature on March 15, 1999, and came into force on February 16, 2005. The United States is a signatory to the Kyoto Protocol, but neither President Clinton nor President Bush submitted the treaty to Congress for approval. Therefore, because the treaty has not been ratified by Congress, the terms of the treaty are not binding on the United States. (This document is available for public inspection and review at the County of Los Angeles Public Library, Valencia Branch, 23743 West Valencia Boulevard, Santa Clarita, California 91355-2191, and is incorporated by reference.)

(ppb), as compared to 715 ppb. Methane has a relatively short atmospheric lifespan of only 12 years, but has a higher GWP than carbon dioxide.

Nitrous oxide concentrations have increased from about 270 ppb in pre-industrial times to about 319 ppb by 2005. Most of this increase can be attributed to agricultural practices (such as soil and manure management), as well as fossil fuel combustion and the production of some acids. Nitrous oxide's 120-year atmospheric lifespan increases its role in global warming.

Besides carbon dioxide, methane and nitrous oxide, there are several gases and categories of gases that were not present in the atmosphere in pre-industrial times but now exist and contribute to global warming. These include CFCs, used often as refrigerants, and their more stratospheric-ozone-friendly replacements, HFCs. Fully fluorinated species, such as sulfur hexaflourode (SF6) and tetrafluoromethane (CF4), are present in the atmosphere in relatively small concentrations, but have extremely long life spans of 50,000 and 3,200 years each, also making them potent greenhouse gases.

Climate Change Impacts in California

Climate change is predicted to bring profound changes to California's natural environment in the ways listed below, among others:

- rising sea levels along the California coastline, particularly in San Francisco Bay and the Sacramento-San Joaquin Delta, as a result of ocean expansion;
- extreme-heat conditions, such as heat waves and very high temperatures, which could last longer and become more frequent;
- an increase in heat-related human deaths, infection diseases and a higher risk of respiratory problems caused by deteriorating air quality;
- reduced snowpack and stream flow in the Sierra Nevada Mountains, affecting winter recreation and urban and agricultural water supplies;
- potential increase in the severity of winter storms, affecting peak stream flows and flooding;
- changes in growing season conditions that could affect California agriculture, causing variations in crop quality and yield; and
- changes in the distribution of plant and wildlife species as a result of changes in temperature, competition from colonizing species, changes in hydrologic cycles, changes in sea levels, and other climate-related effects.

Global, National, and State GHG Emissions Inventories

Worldwide emissions of GHGs in 2004 were 26.8 billion tonnes of CO2e per year. In 2004, the United States emitted about 7 billion tonnes of CO2e, or about 24 tonnes/year/capita. Over 80 percent of the GHG emissions in the United States are comprised of CO2e emissions from energy-related fossil fuel combustion. In 2004, California emitted 0.497 billion tonnes of CO2e, or about five percent of U.S. emissions. If California were a country, it would be the 16th largest emitter of greenhouse gases in the world. This large number is due primarily to the sheer number of people in California -- compared to other states, California has one of the lowest per capita GHG emission rates in the country, which is due to California's higher energy efficiency standards, its temperate climate, and the fact that it relies on out-of-state energy generation.

In 2004, 81 percent of greenhouse gas emissions from California were attributable to carbon dioxide emissions from fossil fuel combustion, with four percent comprised of CO2 from process emissions. Methane and nitrous oxide accounted for 5.6 percent and 6.8 percent of total CO2e respectively, and high GWP gases (i.e., HFCs and PFCs) accounted for 2.9 percent of the CO2e emissions. Transportation, including industrial and residential uses, is by far the largest end-use category of GHGs in California.[2]

Regulatory Setting

The California legislature also has adopted several climate change-related bills in the past seven years. These bills aim to control and reduce the emission of GHGs in order to slow the effects of global climate change. In addition, Governor Schwarzenegger has issued several executive orders directed at global climate change-related matters.

Executive Orders

On June 1, 2005, Governor Schwarzenegger signed Executive Order No. S-3-05, which set the following GHG emission reduction targets for California: by 2010, reduce GHG emissions to 2000 levels; by 2020, reduce GHG emissions to 1990 levels; and, by 2050, reduce GHG emissions to 80 percent below 1990 levels. Executive Order No. S-3-05 also instructed the Secretary of the California Environmental Protection Agency to coordinate with other state agencies and report to the Governor and State Legislature by January 2006 (and biannually thereafter) on progress made toward meeting the specified GHG emission reduction targets and the impacts of global climate change on California.

On November 14, 2008, Governor Schwarzenegger issued Executive Order No. S-13-08, which instructs various state agencies to come up with plans on how to address the expected effects of climate change in California, particularly sea level rise. The Executive Order specifically requires the California Resources Agency, in cooperation with other agencies, to request that the National Academy of Sciences (NAS) convene an independent panel to complete (by December 1, 2010) the first California Sea Level Rise Assessment Report and initiate, within 60 days after the signing of this Order, an independent sea level rise science and policy committee made up of state, national, and international experts. In addition, by June 30, 2009, the California Resources Agency is required to develop a state Climate Adaptation Strategy. The strategy must summarize the best known science on climate change impacts to California, assess California's vulnerability to the identified impacts, and outline solutions that can be implemented within and across state agencies to promote resiliency.

On November 17, 2008, Governor Schwarzenegger issued Executive Order No. S-14-08, which establishes a 2020 Renewable Portfolio Standard target for California's retail sellers of electricity. The Executive Order also endeavors to streamline the environmental review and permitting

[2] As of 2004, fossil fuel consumption in the transportation sector was the single largest source of California's GHG emissions (41.2 percent), with the industrial sector as the second largest source (22.8 percent), followed by electrical production from both in-state and out-of-state sources (19.6 percent), agricultural and forestry (8.0 percent), and other activities (8.4 percent). (See *Climate Action Team Report to Governor Schwarzenegger and the Legislature*, California Environmental Protection Agency, available online at http://www.climatechange.ca.gov/climate_action_team/index.html (last visited February 9, 2009). (This document is available for public inspection and review at the County of Los Angeles Public Library, Valencia Branch, 23743 West Valencia Boulevard, Santa Clarita, California 91355-2191, and is incorporated by reference.)

processes for renewable energy projects by directing all state regulatory agencies to give priority to such projects.

Assembly Bill 1493

Assembly Bill 1493 (AB 1493) was chaptered into law on July 22, 2002. AB 1493 required CARB to adopt regulations, by January 1, 2005, that would result in the achievement of the "maximum feasible" reduction in GHG emissions from vehicles used in the state primarily for noncommercial, personal transportation.[3] As enacted, the AB 1493 regulations were to become effective January 1, 2006, and apply to passenger vehicles and light-duty trucks manufactured for the 2009 model year or later.

Although the USEPA traditionally regulates tailpipe emissions, CARB maintains some regulatory authority due to the severe air quality issues in California. In fact, pursuant to the federal CAA, CARB may implement stricter regulations on automobile tailpipe emissions than the USEPA, provided a waiver from the USEPA is obtained.

In September 2004, CARB adopted the AB 1493-mandated regulations and incorporated those standards into the Low-Emission Vehicle (LEV) program. The regulations set fleet-wide average GHG emission requirements for two vehicle categories: passenger car/light duty truck (type 1) and light-duty truck (type 2). The standards took into account the different global warming potentials of the GHGs emitted by motor vehicles, and were scheduled to phase in during the 2009 through 2016 model years. If implemented, these regulations would produce a nearly 30 percent decrease in GHG emissions from light-duty vehicles by 2030.

In December 2004, these regulations were challenged in federal court by the Alliance of Automobile Manufacturers, who claimed that the regulations attempted to regulate vehicle fuel economy, a matter that lies within the exclusive jurisdiction of the federal government. In a decision rendered in December 2007, the U.S. District Court for the Eastern District of California rejected key elements of the automakers' challenge and concluded that CARB's regulations were neither precluded nor preempted by federal statutes and policy (Central Valley Chrysler-Jeep, Inc. v. Goldstone, 529 F.Supp. 2d 1751 (E.D. Cal. 2007).

While this litigation was pending, in December 2005, CARB submitted a waiver application to the USEPA. After waiting nearly two years for a decision from the USEPA, in November 2007, California filed a lawsuit alleging that the USEPA failed to consider the waiver application in a timely fashion. The USEPA's chief promised to issue a decision on the application by December 31, 2007, and, in mid-December 2007, the USEPA's chief fulfilled his promise by issuing a decision denying California's waiver application. The denial was based on the USEPA's determination that the new federal automobile fuel economy requirements would achieve what California sought to accomplish via the AB 1493 regulations.

The denial of California's waiver application precluded as many as 16 other states from implementing tailpipe emission regulations similar to those adopted by California under AB 1493. In response to this denial, California filed a lawsuit, with the support of 15 other states, challenging the USEPA's decision.

[3] AB 1493 prohibited CARB from requiring: (1) any additional tax on vehicles, fuel, or driving distance; (2) a ban on the sale of certain vehicle categories; (3) a reduction in vehicle weight; or (4) a limitation on or reduction of speed limits and vehicle miles traveled.

On January 26, 2009, President Obama issued a presidential memorandum directing the Administrator of the USEPA to reconsider California's waiver application. Accordingly, the USEPA scheduled a public hearing for March 5, 2009, and accepted public comments on the waiver application through April 6, 2009. Should the USEPA reverse its decision on California's waiver application, the state would be authorized to implement the AB 1493 regulations and secure the desired tailpipe GHG emission reductions.

Assembly Bill 32

In August 2006, California Legislature adopted the California Global Warming Solutions Act of 2006. Also known as Assembly Bill 32 (AB 32), the new law designates CARB as the state agency responsible for monitoring and regulating sources of GHG emissions and for devising rules and regulations that will achieve the maximum technologically feasible and cost-effective GHG emissions reductions. Specifically, AB 32 seeks to achieve a reduction in statewide GHG emissions to 1990 levels by 2020. While AB 32 sets out a timeline for the adoption of measures to evaluate and reduce GHG emissions across all source categories, it does not articulate these measures itself; instead, these measures are being determined in subsequent regulatory processes.

Under AB 32, by January 1, 2008, CARB was required to determine the amount of statewide GHG emissions in 1990, and set the 2020 limit equivalent to that level. In that regard, CARB determined that the 1990 GHG emissions level (and the 2020 statewide cap) was 427 million tonnes of CO2e. CARB further determined that the state must reduce its emissions inventory by 174 million tonnes of CO2e to achieve the AB 32 reduction mandate (i.e., 1990 levels by 2020). These GHG emission reductions are required to stabilize atmospheric carbon dioxide levels and, thereby, avoid dangerous climate change.[4]

CARB staff estimates that the early action measures required by AB 32 will provide approximately 42 million tonnes of CO2e reductions. It is further anticipated that an additional 30 million tonnes of CO2e reductions will be secured through the passage of anti-idling measures and implementation of AB 1493. The remaining 102 million tonnes of CO2e needed to reduce California's GHG emissions to 1990 levels will be achieved through implementation of CARB's Scoping Plan, discussed below, and other regulatory efforts.

On December 6, 2007, CARB adopted regulations, pursuant to AB 32, requiring the largest facilities in California to report their annual GHG emissions. The facilities identified in the mandatory reporting regulations account for 94 percent of California's emissions from industrial and commercial stationary sources, and the regulations cover approximately 800 separate sources (e.g., electricity generating facilities and retail providers; oil refineries; hydrogen plants; cement plants; cogeneration facilities; and industrial sources that emit more than 25,000 tonnes of CO2e per year from an on-site stationary source).

CARB also has adopted its first set of GHG emission reduction measures, known as the "discrete early action measures." These measures either are currently underway or are to be initiated by CARB in the 2007-2012 timeframe. The discrete early action measures cover a number of sectors,

[4] The atmospheric concentration of carbon dioxide is now 379 parts per million (ppm). According to some scientists, exceeding 450 ppm is a critical tipping point for global climate change. (See *Research Finds That Earth's Climate Is Approaching 'Dangerous' Point*, National Aeronautics and Space Administration, available online at http://www.nasa.gov/centers/goddard/news/topstory/2007/ danger_point.html. (last visited February 9, 2009). (This document is available for public inspection and review at the County of Los Angeles Public Library, Valencia Branch, 23743 West Valencia Boulevard, Santa Clarita, California 91355-2191, and is incorporated by reference.)

including transportation, fuels, and agriculture, and address issues such as a low carbon fuel standard, landfill methane capture, and consumer products with high global warming potentials.

As mandated by AB 32, in December 2008, CARB adopted the Climate Change Proposed Scoping Plan: A Framework For Change.[5] The Scoping Plan contains a comprehensive set of actions designed to reduce California's GHG emissions, improve California's environment, reduce California's dependence on oil, diversify California's energy sources, save energy, and enhance public health while creating new jobs and enhancing the growth in California's economy (California Air Resources Board 2008). Key elements of the Scoping Plan include: (1) expanding and strengthening of existing energy efficiency programs as well as building and appliance standards; (2) achieving a statewide renewables energy mix of 33%; (3) developing a California cap-and-trade program that links with other Western Climate Initiative partner programs to create a regional market system;(4) adopting and implementing measures pursuant to existing state laws and policies, including California's clean car standards, goods movement measures, and Low Carbon Fuel Standard; (5) creating targeted fees, including a public goods charge on water use, fees on high global warming potential gases, and a fee to fund the administrative costs of California's long-term commitment to AB 32 administration; and (6) establishing targets for transportation-related GHG emissions for regions throughout California, and pursuing policies and incentives to achieve those targets. The GHG emission reduction measures identified in the Scoping Plan adopted by the Board will be developed over the next two years and enforceable by 2012. By January 1, 2014 and every five years thereafter, CARB is required to update the Scoping Plan.

Appendix C of the Scoping Plan discusses emissions reductions strategies that will be undertaken by the state. State government has established a target of reducing its GHG emissions by a minimum of 30% below its estimated business-as-usual emissions by 2020, which is approximately 15% below today's levels. Through the combined energy diversification and increased energy efficiency expected from implementation of the Scoping Plan, the California government is predicted to reduce its emissions from gasoline by 25%, from diesel by 17%, from electricity by 22%, and from natural gas by 24%. As a state agency, DFG will be a part of this overall, state- government, emissions–reduction effort. Therefore, the emissions reduction strategies described in Appendix C are considered part of the Program for purposes of this CEQA analysis.

Senate Bill 97

With respect to CEQA, the California legislature passed Senate Bill 97 (SB 97), which addresses GHG analysis under CEQA, during the 2007 legislative session. The bill contains two components, the first of which exempts from CEQA the requirement to assess GHG emissions for the following projects: (a) transportation projects funded under the Highway Safety, Traffic Reduction, Air Quality, and Port Security Bond Act of 2006; and (b) projects funded under the Disaster Preparedness and Flood Prevention Bond Act of 2006.

SB 97's second component confirms that no CEQA guidelines presently exist to advise agencies and project applicants of whether a particular project may result in a potentially significant impact to global climate change. Accordingly, SB 97 requires that the Office of Planning and Research (OPR), by July 1, 2009, develop and transmit to the California Resources Agency guidelines for the

[5] *Climate Change Proposed Scoping Plan: A Framework for Change*, California Air Resources Board, available online at http://www.arb.ca.gov/cc/scopingplan/scopingplan.htm (last visited February 9, 2009). (This document is available for public inspection and review at the County of Los Angeles Public Library, Valencia Branch, 23743 West Valencia Boulevard, Santa Clarita, California 91355-2191, and is incorporated by reference.)

mitigation of GHG emissions and their effects. The California Resources Agency is required to adopt the regulations by January 1, 2010. (This second component of SB 97 is codified at Public Resources Code, section 21083.05.)

Notably, Governor Schwarzenegger issued a signing message when enacting SB 97 that is instructive as to the Governor's policy on global climate change, which includes a directive towards coordinating the efforts of various agencies to efficiently and fairly achieve GHG emissions reductions:

> Current uncertainty as to what type of analysis of greenhouse gas emissions is required under [CEQA] has led to legal claims being asserted which would stop these important infrastructure projects. Litigation under CEQA is not the best approach to reduce greenhouse gas emissions and maintain a sound and vibrant economy. To achieve these goals, we need a coordinated policy, not a piecemeal approach dictated by litigation.
>
> This bill advances a coordinated policy for reducing greenhouse gas emissions by directing the Office of Planning and Research and the Resources Agency to develop CEQA guidelines on how state and local agencies should analyze, and when necessary, mitigate greenhouse gas emissions.

On June 19, 2008, in light of its SB 97-mandated obligations, OPR issued a Technical Advisory, which provides lead agencies and project applicants with informal advice on how to conduct GHG emissions analysis in CEQA documents. OPR intends the Technical Advisory to be used on an interim basis only (i.e., until OPR and the California Resources Agency accomplish their SB 97 mandates).[6] The Technical Advisory's recommended approach notes that compliance with CEQA, for purposes of GHG emissions, entails three basic steps: (1) identification and quantification of GHG emissions; (2) assessment of the project's impact on climate change; and (3) identification and consideration of project alternatives and/or mitigation measures, if the project is determined to result in an individually or cumulatively significant impact.

On April 13, 2009, OPR transmitted its proposed amendments to the CEQA Guidelines to the California Resources Agency.[7] In the transmittal letter accompanying the proposed amendments, OPR noted that although the analysis of greenhouse gas emissions in environmental documentation "presents unique challenges to lead agencies," the analysis "must be consistent" with existing CEQA principles. Therefore, OPR confirmed that the proposed amendments "suggest relatively modest changes to various portions of the existing CEQA Guidelines."

Certain amendments proposed by OPR are designed to assist lead agencies in determining the significance of environmental impacts resulting from greenhouse gas emissions. Specifically, OPR proposed the addition of a new CEQA Guidelines section, tentatively entitled "Determining the Significance of Impacts from Greenhouse Gas Emissions," which reiterates the existing CEQA principle that significance determinations require the "careful judgment" of a lead agency (see Cal. Code Regs., tit. 14, §15064, subd. (b)), and should be based on "a good-faith effort." The proposed

---

[6] See *Technical Advisory -- CEQA and Climate Change: Addressing Climate Change Through California Environmental Quality Act (CEQA) Review*, Governor's Office of Planning and Research, available online at http://opr.ca.gov/ceqa/pdfs/june08-ceqa.pdf (last visited February 9, 2009). (This document is available for public inspection and review at the County of Los Angeles Public Library, Valencia Branch, 23743 West Valencia Boulevard, Santa Clarita, California 91355-2191, and is incorporated by reference.)

[7] See *CEQA Guidelines Sections Proposed To Be Added Or Amended*, Governor's Office of Planning and Research, available online at http://opr.ca.gov/index.php?a=ceqa/index.html (last visited April 15, 2009). (This document is available for public inspection and review at the County of Los Angeles Public Library, Valencia Branch, 23743 West Valencia Boulevard, Santa Clarita, California 91355-2191, and is incorporated by reference.)

section also provides that a lead agency has the discretion to determine whether to undertake a quantitative or qualitative analysis, or otherwise rely on performance based standards. Finally, the proposed section notes that a lead agency may consider the following factors when assessing the significance of greenhouse gas emissions: (1) the extent to which the project increases or reduces emission levels, when compared to the existing setting; (2) the extent to which the emissions resulting from the project exceed a threshold of significance that the lead agency determines applies to the project; and, (3) the extent to which the project complies with adopted regulations or requirements adopted to implement a statewide, regional or local plan for the reduction or mitigation of greenhouse gas emissions. Other proposed amendments recommended by OPR address mitigation measures relating to greenhouse gas emissions; the consideration of greenhouse gas emissions in the cumulative impacts analysis; the consistency of proposed projects with greenhouse gas reduction plans; and, the tierring and streamlining of environmental review through the analysis and mitigation of greenhouse gas emissions at a programmatic level.

At present time, OPR's proposed amendments are only recommendations to the California Resources Agency. The California Resources Agency will initiate a formal rulemaking process to certify and adopt the amendments, in accordance with the Administrative Procedures Act. This formal rulemaking process will include additional opportunities for public review and comment, and public hearings. This rulemaking process, pursuant to the requirements of SB 97, must be completed by January 1, 2010.

Impact Significance Criteria

At the present time, neither federal, state nor local agencies have adopted significance thresholds for the analysis of GHG emissions. (See Cal. Code Regs., tit. 14. section 15064.7(b).) While many public agencies adopt regulatory standards as thresholds, the CEQA Guidelines do not require adoption of regulatory thresholds. (*id.* at subd.(a).)

For purposes of this EIS/EIR, DFG has determined it is appropriate to rely on AB 32 as a benchmark as use the statute to inform its judgment as to whether the Program's GHG emissions would result in a significant impact. (See Cal. Code Regs., tit. 14, section 15064(f)(1).) Accordingly, the following significance criterion is used to assess impacts:

> Will the Program's GHG emissions impede compliance with the GHG emission reductions mandated in AB 32?

While SB 97 requires the CEQA Guidelines to be amended to address global climate change, those revisions are not required to occur until January 1, 2010 (see Pub. Resources Code, section 21083.05). As previously discussed, on April 13, 2009, OPR transmitted its proposed recommendations to the California Resources Agency, which now must initiate and complete the formal rulemaking process. Although the California Resources Agency may decide to reject or revise OPR's proposed amendments to the CEQA Guidelines, at the present time, the significance criterion identified above is consistent with OPR's proposed amendments, which recognize the discretion afforded to lead agencies to identify and apply an appropriate significance criterion.

Methods for Greenhouse Gas Emissions

In order to determine the potential impact of Program-related GHG emissions impeding compliance with the GHG emission reductions mandated by AB 32, GHG emissions from Program operations must be disclosed. DFG manages 24 hatcheries within California and is responsible for stocking fish

in the inland waters of California and issuing recreational fishing licenses as part of the Program. The current operation and maintenance of the hatcheries and the use of on-road vehicles and aircraft to transport and plant fish in water bodies across California as part of the Program requires energy and fuel consumption. Specifically, the Program runs office and non-office facilities year-round using electricity, natural gas, gasoline, diesel, aviation gasoline, liquid petroleum gas (LPG), propane, and kerosene fuels as part of facility operations. Furthermore, the Program uses on-road vehicles and aircraft using diesel and gasoline fuels to transport and plant fish.

The Climate Registry (CR) *General Reporting Protocol* emission factors for CO_2, CH_4, and N_2O per kilowatt-hour (kWh) of electricity consumed in California were used to calculate annual GHG emissions from existing hatchery facilities' consumption of electricity (The Climate Registry 2008). In addition, CR emission factors for CO_2, CH_4, and N_2O per therm of natural gas consumed were used to calculate annual GHG emissions from existing hatchery facilities' consumption of natural gas (The Climate Registry 2008). CR emission factors also were used to determine GHG emissions from gasoline, diesel, aviation fuel, propane, kerosene, and LPG (The Climate Registry 2008). Table 8-10 lists the emission factors used to quantify GHG emissions from operation of the existing Program, and Table 8-11 shows the GHG emissions from existing Program operations.

Table 8-10. GHG Emissions Factors for Energy and Fuels Used in Existing Program Facility and Planting Operations

Fuel	CO_2	CH_4	N_2O	CO_2e	Units
Aviation gasoline	8.32	0.0070	0.0001	8.50	kg/gallon
Diesel	10.15	0.0014	0.0001	10.21	kg/gallon
Electricity	398.58	0.0163	0.0036	400.04	kg/MWh
Gasoline	8.81	0.0013	0.0001	8.87	kg/gallon
Kerosene	9.76	0.0014	0.0001	9.82	kg/gallon
Liquid petroleum gas (LPG)	5.79	0.001	0.0001	5.84	kg/gallon
Natural gas	5.31	0.0005	0.00001	5.32	kg/therm
Propane	5.74	0.0001	0.0004	5.87	kg/gallon

Notes:
CO_2e = carbon dioxide equivalents.
kg = kilograms.
MWh = megawatt hour.

Table 8-11. GHG Emissions from the Use of Electricity, Natural Gas, and Other Fuels at Existing Program Facilities in 2008 (Metric Tons of CO_2e)

Fuels	Office Facilities	Non–Office Facilities	Total
Aviation gasoline	346	0.0	346
Diesel	14,437	8,066	22,503
Electricity	3,162	8,613	11,775
Gasoline	6,162,541	628,843	6,791,384
Kerosene	0.0	0.1	0.1
Liquid petroleum gas (LPG)	149,074	1,102,246	1,251,320
Natural gas	4,094	109	4,203
Propane	1,270,254	311,148	1,581,402
Total	7,600,244	2,059,025	9,659,269

Methods for Hatchery Fish Species and Native Fish and Amphibian Species

In addition to the potential impact of Program-related GHG emissions impeding compliance with the GHG emission reductions mandated by AB 32, the potential impact of the Program on hatchery fish species and native fish and amphibian species in the context of climate change in California must be disclosed. One 2004 study describing the results of four climate change models predicts that by sometime between 2070 and 2099, statewide average annual temperatures will have risen by 2.3˚C to 5.8˚C, average precipitation will have been reduced by more than 100 millimeters, sea level will have risen 19.2 to 40.9 centimeters, snowpack will have declined by 29% to 89%, and changes in annual inflow to reservoirs will have declined by more than 20% (Hayhoe et al. 2004). These environmental changes that would occur in California with climate change are discussed in terms of how they would affect the Program through direct effects upon hatchery fish survival, as well as through the effects of hatchery fish species upon wild native fish and amphibian species.

Impact Assessment

Cumulative Impact CC-1: Program Greenhouse Gas Emissions Impeding Compliance with the GHG Emission Reductions Mandated by AB 32 (Less Than Considerable)

The Program involves the planting of fish via use of on-road vehicles and aircraft, and the number of fishing licenses sold in 2008 determines the number of trout and salmon DFG must produce (CFGC Section 13007). There could be an increase in the number of on-road vehicle and aircraft trips associated with fish planting operations of DFG, and GHG emissions from gasoline and diesel fuel use for conducting these activities could increase to fully meet all the goals set forth in CFGC section 13007. This analysis conservatively assumes that predicted state population increases would probably result in an increase in licenses sold each year. The current number of vehicle trips made by licensed individuals, the types of vehicles used for such trips, and the length of such trips is unknown. There is no means of calculating how these details might change, because they are the result of independent decisions by the individual license holders. However, all things being equal (assuming no spike in fuel prices, for example) issuing additional fishing licenses would probably result in an increase in vehicle trips and, therefore, an increase in GHG emissions.

GHGs tend to accumulate in the atmosphere due to their relatively long lifespan, resulting in an enhanced greenhouse effect, which in turn results in global warming and associated climate change. Since global climate change is a serious environmental problem, statewide GHG emissions reductions are mandated by AB 32. Increased vehicle miles traveled (VMT) from fish planting operations of DFG and fishing activities of licensed individuals could contribute GHG emissions. To address this, the Governor has mandated, as discussed above, that state agencies meet the goals of AB 32 and reduce GHG emissions by a minimum of 30% below their estimated business-as-usual emissions by 2020, which is approximately 15% below today's GHG emission levels.

Even if DFG fish planting operations result in an increase in VMT, overall DFG GHG emissions would not increase, because DFG must comply with the AB 32-mandated GHG emissions reduction. Therefore, DFG would choose from a menu of options to meet the performance standard of reducing its current vehicle-specific GHG emissions by 15%. The vehicle-specific GHG emissions level from which the 15% reduction will occur is the GHG emissions from diesel and gasoline consumed in 2008, shown as metric tons (MT) of CO_2 equivalent (CO_2e) in Table 8-12.

Table 8-12. GHG Emissions from the Use of Gasoline and Diesel Fuels by the Existing Vehicle Fleet in 2008

Fuels	Metric Tons of CO_2e
Diesel	22,503
Gasoline	6,791,384
Total	6,813,887

In order to meet the 15% decrease in vehicle fleet GHG emissions, DFG may select from the following menu of options to meet the performance standard.

- When an existing vehicle needs to be replaced, require that the new replacement vehicle be at least 15% more efficient in terms of miles per gallon (mpg).
- Retrofit the existing vehicle fleet to be at least 15% more efficient in terms of mpg.
- Replace all existing vehicles with vehicles that have 15% or greater efficiency in terms of mpg.
- Carefully evaluate replacement options for vehicles to include zero-emission vehicles and low-emission vehicles as certified by the U.S. Environmental Protection Agency (EPA) or the ARB.
- Refrain from using the older, less efficient vehicles in the DFG fleet when possible.
- Use the smallest, most efficient vehicle that will still meet the needs of the proposed planting trip.
- Plan vehicle trips to limit the number of vehicle trips necessary. This can include combining trips to eliminate the need for additional separate trips.

Table 8-13 shows expected Program vehicle fleet GHG emissions with the 15% GHG reduction performance standard in place.

Table 8-13. GHG Emissions from the Use of Gasoline and Diesel Fuels by the Vehicle Fleet in 2008 if 15% GHG Reduction Standard Applied

Fuels	Metric Tons of CO_2e
Diesel	19,128
Gasoline	5,772,676
Total	5,791,804

Since 2020 Program GHG emissions related to diesel, gasoline, electricity, natural gas, and other fuels will be reduced by a minimum of 15% from the GHG emission levels presented in Table 8-11, the Program would comply with the GHG emission reductions required by AB 32. Therefore, the Program would not contribute to cumulative impacts related to AB 32 GHG emissions compliance (less than considerable).

Cumulative Impact CC-2: Program Effects on Hatchery Fish Species and Native Fish and Amphibian Species in the Context of Climate Change in California (Less Than Considerable)

The cumulative impacts resulting from climate change could adversely affect native fish and amphibians through increased water temperatures, altered stream flows, and increased likelihood of drought-related fires, all of which could change surrounding vegetation, erosion potential, and water stress. Increased water temperatures could alter the aquatic habitat as a whole (Levy 1992) and could result in a decrease in several essential conditions required for fish survival, notably reduced DO content; an increase in the metabolic needs of fish predators; and an overall increase in predation of hatchery species (Lindley et al. 2007; Vigg and Burley 1991). Reductions in snowmelt runoff might result in changes in seasonal peak flows and could affect species such as the Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*), whose life history has evolved based on predictable runoff patterns (Williams 2006). This might affect hatchery species that are part of reintroduction programs, as they are released back into native habitats. Potential increases in precipitation, coupled with a predicted elevation in sea level, may result in increased seasonal flows leading to increased erosion, flooding, and sedimentation of low-lying coastal ecosystems, potentially affecting both native and reintroduced species migrating between continental freshwater and marine habitats (Levy 1992). Increased runoff also might affect aquatic habitats negatively by washing increased amounts of organic materials through watersheds and into estuarine areas. Oxygen depletion from the decomposition of these materials may cause large-scale fish die-offs (Reid and Trexler 1996) and may affect overall fish survival rates. Decreased precipitation, however, would reduce yearly flow levels, which in turn could reduce aquatic habitats and affect the surrounding terrestrial ecosystems as vegetation types change in response to shifting moisture regimes and other environmental factors (Hayhoe et al. 2004).

Native amphibians could be affected in a similar manner because they share many of the same habitat requirements as fish. In the short term, the primary factors for amphibian survival include variability and environmental changes upon habitat, phenology of life-requisite activities, interactions with emerging pathogens and invasive species, and interactions with environmental chemicals. The interaction of these factors could determine reproductive success rates and survival to metamorphosis. Over the longer term, the frequency and duration of extreme temperature and precipitation events could likely influence the persistence of local populations, dispersal, and structure of metapopulations on the landscape (Lind 2008). Synergisms among a variety of

environmental stressors have been documented to adversely affect native amphibians, and recently amphibians have been documented as experiencing global population declines (Stuart et al. 2004).

As available moisture decreases, and disturbance factors such as fire increase, predicted changes in terrestrial ecosystems include substantial decreases in the extent of alpine/subalpine forest, evergreen conifer forest, and mixed evergreen woodland and shrubland habitats, as well as consequential increases in mixed evergreen forest and grassland habitats (Hayhoe et al. 2004). Previous and repetitive fire events have already demonstrated that increased fire frequency leads to increased erosion and debris flows in the short term and increased fish mortality, habitat destruction, and access limitation to spawning and rearing sites in the long term (Reeves et al. 1995), which all could affect survivorship of fish hatchery species. One recent study qualitatively assessed the potential for climate–related impacts on California's native salmonids and indicated that the majority of taxa (18 of 29, or 62%) were vulnerable in all or most of the watersheds inhabited and that no taxon was exempt from the effects of climate change (Moyle et al. 2008).

Effects of climate change could be very similar for native amphibians because these populations are sensitive and respond strongly to changes and variability in air and water temperature, precipitation, and hydroperiod of their environments (Cary and Alexander 2003). This is partially because of their ectothermic nature, and many amphibians require aquatic habitats for egg laying and larval development and moist environments for post-metamorphic life stages (Wells 2007; Deullman and Trueb 1986). As temperatures warm, variability in aquatic habitats could increase and amphibians could likely experience lower rates of survival to metamorphosis. Species associated with ephemeral waters, such as shallow ponds and intermittent streams, may be particularly vulnerable to altered precipitation patterns, and temperatures outside their thermal optima could cause physiological stresses and could affect overall survivorship.

As previously mentioned, DFG is a state agency subject to the Executive Orders that are directed at global climate change-related matters (see Executive Orders listed in the Regulatory Framework section above). Therefore, as part of its Program, DFG will include measures to reduce its GHG emissions to meet the goals set forth in AB 32. If global climate change alters the suitability of certain waters for stocking, DFG will follow FGC guidelines and will alter where and when fish are stocked to avoid putting fish in unsuitable waters. As such, the Program would not contribute to cumulative impacts resulting from climate change that would adversely affect hatchery fish or native fish and amphibians (less than considerable).