Appendix H

Supporting Documentation Related to Biological Resources - Fisheries

H.1 Descriptions of Special-Status Fish Species Known to Occur in the Project Area

Chinook Salmon

The Central Valley supports four distinct runs of Chinook salmon: fall-run, late fall-run, winter-run, and spring-run (Yoshiyama et al. 1998, Moyle 2002). Runs are named for the season in which the adults migrate to freshwater for spawning and adults die soon after spawning (semelparous). Adults and offspring in each run have distinct patterns of natal stream residence time, spawning, and outmigration. Healy (1991) divided Chinook salmon into two life-history strategies, stream and ocean. Stream-type Chinook salmon have adults that immigrate to natal streams before they reach full maturity, in spring and summer, and juveniles that spend a relatively long time (usually >1 year) in fresh water. Ocean-type Chinook salmon have adults that spawn soon after entering fresh water, in summer and fall, and juveniles that spend a relatively short time (3-12 months) rearing in fresh water (Moyle 2002). A small portion of male Chinook salmon may complete their entire life cycle in freshwater, spawning within their first or second year (precocious). Chinook salmon in the San Joaquin basin generally rear in fresh water for a year or less due to higher summer temperatures as compared to other rivers in their range. Chinook salmon thrive in well-oxygenated, cool (8-12.5°C) waters. This includes run, riffle, and pool stream habitats (Moyle 2002).

Although passage is partially blocked at the HFB (river mile 118.5) and several additional barriers exist throughout the Restoration Area, the San Joaquin River Restoration Program (Restoration Program) has planned a series of activities using fall- and spring-run Chinook salmon for fall 2012 and spring 2013. The Restoration Program has released and plans further release of fall- and spring-run Chinook salmon above the barrier to continue to learn how the different runs behave in the San Joaquin River and study survival and habitat use in the river. These near-term activities will rely on a variety of methods and techniques to overcome current channel capacity and fish passage impediments. As of the time of this document, both spawning activity and juvenile rearing of Chinook salmon have been observed during state and federal fisheries surveys (CDFW, pers. comm.).

Fall- and late fall-run

Both the Central Valley fall- and late fall-run are state and federal species of special concern (64 FR 50394). According to Moyle (2002), the fall-run are an unambiguous ocean-type Chinook salmon adapted for spawning in lowland reaches of big rivers and their tributaries and occur in the Sacramento and San Joaquin River basins and tributaries east of Carquinez Strait. Fall-run adults immigrate from the ocean in late summer through early fall in mature condition and typically spawn within a few days or weeks of arriving on the spawning grounds (see Chapter 6, Table 6-3). Juveniles typically emerge from the gravel from mid-winter through spring and move downstream within a few months, to rear in mainstem rivers or estuaries before heading to the ocean (Cramer Fish Sciences 2012; Miller et al. 2010). Late

fall-run Chinook salmon are mostly a stream-type salmon largely confined to the Sacramento River today (Moyle 2002). They are the largest and most fecund salmon in California because they historically immigrated as 4- and 5-year-old fish (Moyle et al. 1995; Fisher 1994). Late fall-run adults commonly spawn after residing in cold, deep reaches of mainstem rivers for about one to three months. Juveniles enter the ocean after 7-13 months rearing in fresh water, considerably larger and older than fall-run Chinook salmon (Moyle 2002).

Spring-run

Spring-run Chinook are typically considered a stream-type salmon. Central Valley spring-run Chinook ESU is currently listed as Threatened under both the California Endangered Species Act (CESA) and the federal Endangered Species Act (ESA) (64 FR 50394). This ESU includes both naturally spawned populations and hatchery fish that have not had their adipose fin clipped in the Sacramento River and tributaries (NMFS 2012a). Critical habitat is designated as the Upper Sacramento and Trinity rivers as well as the Sacramento-San Joaquin Delta (70 FR 52488). Historically, spring-run were found in the larger tributaries of the Sacramento, San Joaquin, Eel, and Klamath rivers. Adult spring-run Chinook salmon leave the ocean to begin their immigration in late January and early February and enter the Sacramento River between March and September, primarily in May and June (Yoshiyama et al. 1998, Moyle 2002). Spring-run Chinook are sexually immature when they enter freshwater and gonads mature during the summer holding period. Adults may hold in natal tributaries for up to several months before spawning begins in September (Moyle 2002). Typically, spring-run Chinook salmon utilize mid- to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature (Yoshiyama et al. 1998). Spring-run have been observed to hold in deep pool habitat during summer months in high densities in rivers across their range (Wampler 1986; Barnhart and Hillemeier 1994; Moyle 2002; Massa et al. 2010). It is generally assumed that adults move out of holding pools into upper reaches to spawn or remain and spawn in the tail areas of holding pools (Moyle et al. 1995). Spring-run Chinook have been observed to exhibit net downstream movements from holding pools to spawning areas, but only over short distances (Ward et al. 2003).

Spawning occurs in gravel beds that are often located at the tails of holding pools (Allen and Hasler 1986). Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs (NMFS 2012a). Currently, adult spring-run spawn from mid to late-August through early October, with peak spawning times varying among locations (see Chapter 6, Table 6-3). Spawning occurs progressively later in the season at lower elevations as temperatures cool (Harvey 1995, 1996, 1997, all as cited in CDFW 1998).

Juveniles rear for up to 15 months before migrating to the ocean. In the past, this life history strategy allowed them to be as abundant as fall-run Chinook by utilizing cooler areas of warm, summer waters until spawning. Dams and barriers block much of the spring-run historical range today (Moyle 2002, NMFS 2009).
The spring-run Chinook population was extirpated from the San Joaquin River, and any strays from the northern population are not likely to migrate upstream to the Restoration Area.

Central Valley Steelhead
The Central Valley steelhead DPS is listed as Threatened under the ESA (63 FR 13347. This DPS includes all naturally spawned populations of steelhead in the Sacramento and San Joaquin rivers and tributaries. Propagated stocks from Coleman National Fish hatchery on Battle Creek and the Feather River Hatchery are also included in the Central Valley DPS (CDFW 2010b). Steelhead, as currently defined, are the anadromous form of rainbow trout and have been extensively studied and used for aquaculture, fisheries, and angling (McEwan and Jackson 1996). However, the steelhead life history can be quite variable, with some populations reverting to residency or anadromy, depending on environmental conditions (Pascual et al. 2001). Adult migration from the ocean to Central Valley spawning grounds occurs during much of the year, with peak migration occurring in the fall or early winter (see Chapter 6, Table 6-3). Migration through the Sacramento River main stem begins in July, peaks at the end of September, and continues through February or March (Bailey 1954; Hallock et al. 1961, both as cited in McEwan and Jackson 1996). Central Valley steelhead are mostly 'winter steelhead'; that is, they mature in the ocean and arrive on the spawning grounds nearly ready to spawn. In contrast, 'summer steelhead', or stream-maturing steelhead, enter freshwater with immature gonads and typically spend several months in freshwater maturing before spawning.

Historically, Central Valley steelhead spawned primarily in upper stream reaches and smaller tributaries. Although in the Pacific Northwest, steelhead spawn in most available channel types in unimpounded stream reaches (Montgomery et al. 1999). Due to Central Valley water development projects, most spawning is now confined to lower stream reaches below dams. In a few streams, such as Mill and Deer creeks, steelhead still have access to historic spawning areas. Steelhead migrate up the Sacramento River nearly every month of the year, with the bulk of migration occurring from August through November, and the peak in late September (Bailey 1954; Hallock et al. 1961; McEwan 2001). While little information has been collected on migration patterns for the San Joaquin River tributaries, migration has been observed as early as August and as late as May with peaks in January and February on the lower Mokelumne River (Workman 2001). Spawning in the upper Sacramento River generally occurs between November and late April, with a peak between early January and late March (USBR 2004). Similar observations have been made on the Mokelumne River as well (Mulchaey and Setka 2007). Steelhead are generally iteroparous, so some may return to the ocean and repeat the spawning

cycle (Narum et al. 2008). The percentage of Central Valley steelhead adults surviving spawning has not been well studied, but in general the percent of repeat spawners varies annually and between stocks in the Pacific United States (5.8-53%; Withler 1966). Recent acoustic tagging studies of Coleman Hatchery kelts (spawned steelhead) indicate that reconditioned kelts released in late spring may emigrate to the Pacific Ocean within weeks to months of release and return to freshwater the following fall. Others may remain in freshwater for an undetermined time (Robert Null, personal communication). Juveniles generally remain in their natal stream for a year or more before migrating to the ocean but may emigrate within their first year (Cramer Fish Sciences 2012; Bilski et al 2010; Moyle 2002). The emigration period for naturally-spawned steelhead juveniles migrating past Knights Landing on the lower Sacramento River has ranged from late December through May (McEwan 2001). In streams south of the American River, steelhead emigration has been observed from November through July (Bilski et al. 2010; CFS 2012).

Although passage to the Restoration Area is blocked downstream of the HFB, Chinook salmon have been observed in Reach 1 (CDFW, unpublished data). Therefore, it is possible that steelhead may occur in the Restoration Area despite the barrier. It is expected that these populations would volitionally recolonize the Restoration Area if the HFB is removed along with other passage barriers (e.g., Sack Dam, Mendota Pool) being addressed under the SJRRP. Steelhead are present in all of the broodstock collection streams.

Sacramento Splittail

Sacramento splittail is listed as a species of special concern in California (Moyle et al. 1995). Sacramento splittail is endemic to the sloughs, lakes, and rivers of the Central Valley. Splittail live 7-9 years, tolerate a wide range of environmental conditions, and have high fecundity. Adapted to living in the fluctuating conditions of the estuarine waters, Sacramento splittail were historically distributed throughout the Central Valley as far south as Friant in the San Joaquin River and north to Redding in the Sacramento River. In the Sacramento Valley, they were found in early surveys as far up the Sacramento River as Redding (below the Battle Creek Fish Hatchery in Shasta County), in the Feather River as high as Oroville, and in the American River to Folsom (Moyle et al. 2004). Today they are found most frequently in the Sacramento River below the mouth of the Feather River and become increasingly rare in an upstream direction, particularly during summer and fall. With the exception of particularly wet years, splittail largely inhabit waters in the Sacramento-San Joaquin Delta. In wet years they can be found in the Mokelumne and Tuolumne rivers as well as in Salt Slough within the Restoration Area. Splittail can often be found in waters with salinities of 10-18t, and adults can tolerate salinities as high as 29t. Splittail commonly occur in water temperatures ranging from 5 to 24°C, but can tolerate temperatures up to 29-33°C. Typically, adults migrate upstream in January and February and spawn on seasonally inundated floodplains in March and April but as late as July. Embryos hatch in three to seven days and remain in shallow, weedy areas for 10-14 days. In May the juveniles migrate back downstream to shallow, brackish water rearing grounds between

April and August, where they feed on detritus and invertebrates for 1-2 years before migrating back upstream to spawn (Moyle 2002; Moyle et al. 2004). Managing floodplains to promote frequent successful spawning is needed to keep them abundant. Additionally, it is important to provide safe migration corridors between spawning and rearing grounds as well as abundant high-quality brackish water rearing habitat (Moyle et al. 2004). Although not likely to be present at the SCARF site, Sacramento splittail may occur in the Restoration Area during wet years. They are known to occur in several of the Broodstock Collection Areas.

Green Sturgeon

The Southern green sturgeon DPS is a California species of special concern and listed as Threatened by the ESA (71 FR 17757). Apart from spawning and the first few years of rearing, green sturgeon spend most of their lives in marine waters. Green sturgeon reach maturity around 15 years of age, can live to be 70 years old, and may spawn several times during their long lives, returning to their natal rivers every 3-5 years. During spawning runs, adults enter San Francisco Bay between mid-February and early May and migrate rapidly up the Sacramento River (Heublein et al 2009). Spawning occurs in cool sections of the upper Sacramento River with deep, turbulent flows and clean, hard substrate. In fall, post-spawn adults move back down the river and re-enter the ocean. After hatching, larvae and juveniles migrate downstream toward the Sacramento-San Joaquin Delta and Estuary. After rearing in the Delta and Estuary for several years, they move out to the ocean. As adults, both green sturgeon migrate seasonally along the west coast, congregating in bays and estuaries in Washington, Oregon, and California during the summer and fall months and off northern Vancouver Island, BC, Canada during the winter and spring months (Lindley et al. 2008). While California is a major spawning location for green sturgeon, it is unlikely that green sturgeon currently spawn in the San Joaquin River. Loss of spawning habitat in California has caused a reduction in green sturgeon throughout its range, and information regarding green sturgeon life history is limited due to low abundance (Moyle 2002).

The Southern DPS has the potential to occur in the Restoration Area, although the presence of green sturgeon in the San Joaquin River has not been confirmed (NMFS 2008). Further, migration of adult sturgeon into the Restoration Area is currently blocked by the HFB and several other migratory barriers created by seasonally dry conditions. It is known to be present in some broodstock collection areas, including the Feather and Yuba rivers.

Hardhead

Hardhead are a species of special concern in California (CDFW 2013a). They typically occupy areas of large streams with reliable flows at low to mid elevations. Hardhead tend to be found in the lower part of the water column in pools, riffles, and streams. In the San Joaquin drainage, hardhead are present throughout tributary streams, but are largely absent from the mainstem San Joaquin River as a result of periodic desiccation during the dry season. Optimal water temperatures for

hardhead range from 24-38°C; however, they require more highly oxygenated streams at higher temperatures. Populations are becoming increasingly isolated in the Central Valley, thus are more susceptible to localized extinctions. The decline in Central Valley hardhead has been attributed to habitat loss and predation by introduced fish. Hardhead remain in streams or reservoirs after emerging and mature in three years. Hardhead residing in reservoirs may migrate to tributaries during spawning season, which occurs primarily during April and May, although some populations have been found to spawn as late as August (Moyle 2002).

Hardhead are not likely to occur at the SCARF site or in the Restoration Area; however, several of the broodstock collection areas streams within the species' known range.

Kern Brook Lamprey

The Kern brook lamprey is a species of special concern in California (CDFW 2013a). It is endemic to eastern San Joaquin Valley and has been found in the lower Merced, Kaweah, Kings and San Joaquin rivers. The Kern brook lamprey prefers sand or mud substrates, temperatures below 25°C in the summer.Ammocoetes burrow into fine substrates in the margins of runs or pools. Few studies and observations have been made on Kern brook lampreys, although from the limited data available they appear to undergo metamorphosis in fall, spawn in spring, and die after spawning. Populations are distributed sparsely in the San Joaquin watershed and are therefore susceptible to local extinction and fragmentation. The primary reason for decline of this species is reduction in rearing habitat due to stream channelization, construction of dams, and regulation of stream flows. There is limited knowledge pertaining to the life history of Kern brook lampreys, but spawning season appears to begin when temperatures exceed 10°C and persists until flows are no longer suitable (Moyle 2002). Kern brook lamprey adults and ammocoetes have been observed in Reach 1 during a USFWS fish community survey (Workman, USFWS, pers. comm.). Although adults may be present in the secondary channel adjacent to the SCARF site when it is connected to the main channel during high streamflows, ammocoetes are less likely to occur in the SCARF site because of their preference for margins of runs or pools. Brook lamprey have been observed in several of the Broodstock Collection areas.

River Lamprey

The river lamprey is a state and federal species of special concern (Moyle 1995). River lampreys range from Juneau, Alaska, to San Francisco Bay. Within California, this species is most commonly observed in the Sacramento and San Joaquin rivers and in some tributaries, particularly in Tuolumne River. Spawning lampreys require gravelly riffles where they can dig saucer-like depressions for nests. Data on the River lamprey's life history has been collected in British Columbia. California lampreys likely have different timing as a result of differences in temperature and flow regimes; however, the general life history pattern is thought to be similar. Adults return to freshwater to spawn three to four months after entering the marine

environment. After building nests and spawning, the adult lampreys die. The ammocoetes remain in the river for several years until they undergo metamorphosis for 9-10 months until they are adults. At this time, the lampreys aggregate in the Delta until they enter the ocean (Moyle 2002).
While river lampreys are not currently thought to migrate as far upstream as the Restoration Area, increased flows following project implementation could encourage further upstream movement. Currently, much of the Restoration Area becomes desiccated during the dry season. In addition, the majority of the channel in the Restoration Area is composed of sandy substrate, which is unsuitable habitat for spawning. River lamprey are known to occur in several of the Broodstock Collection areas.

San Joaquin Roach
San Joaquin roach is a state species of special concern in California (CDFW 2013a). The San Joaquin roach is a subspecies of California roach. While this subspecies is still present in substantial numbers in some of the streams in its range, is has also been extirpated from many reaches it once occupied. Populations are isolated by dams, water diversions, or the presence of predatory fish populations. Roach prefer small, warm sections of mid-elevation streams in the Sierra foothills and lower reaches of coastal streams. They can tolerate high temperatures (30-35°C) and low oxygen levels (1-2mg/l), but thrive in cold, well-aerated streams, modified habitats, and river main channels. Roach exhibit substantial behavioral plasticity, and adapt to fill a variety of niches within streams based on the composition of the fish assemblage present in the area (Moyle 2002).

San Joaquin Roach is not likely to occur at the SCARF site due to unsuitable habitat conditions. However, it may occur in the Restoration Area during times of high flow. It is not likely to occur in the Broodstock Collection areas because these areas are outside of the species' known range.

Appendix H References

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