CHINOOK SALMON – SACRAMENTO RIVER WINTER-RUN ESU, CENTRAL VALLEY SPRING-RUN ESU, AND CENTRAL VALLEY FALL AND LATE FALL-RUN ESU

Oncorhynchus tshawytscha
USFWS: Endangered (Winter); Threatened (Spring); Candidate (Fall/late-Fall)
CDFG: Endangered (Winter); Threatened (Spring); Species of Concern (Fall/late-Fall)

Species Account

Status and Description. The Chinook salmon is the largest and least abundant species of Pacific salmon (Behnke 2002). The Chinook salmon, along with other salmonids, is anadromous (a migratory fish that is born in fresh water and spends a portion of its life in the sea before returning to fresh water to spawn). Unlike steelhead, Chinook salmon are semelparous (*i.e.*, they die following a single spawning event).

Pacific salmonids are divided into Evolutionarily Significant Units. An Evolutionarily Significant Unit (ESU) is a distinctive group of Pacific salmon, steelhead, or sea-run cutthroat trout (NMFS 2002). Chinook salmon that are expected to occur in Solano County originate in the Sacramento-San Joaquin River system. Three Chinook salmon ESUs may occur within the Solano HCP/NCCP area: 1) Sacramento River winter-run ESU; 2) Central Valley spring-run ESU; and 3) Central Valley fall and late fall-run ESU.

The Sacramento River winter run Chinook salmon ESU was listed as an endangered species on January 4, 1994 (NMFS 1994). The Sacramento River winter-run Chinook salmon ESU includes populations of winter-run Chinook salmon in the Sacramento River and its tributaries in California (NMFS 1994).

The Central Valley spring-run Chinook salmon ESU was listed as a threatened species on September 16, 1999 (NMFS 1999). This ESU includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries in California (NMFS 1999).

The Central Valley fall and late fall-run Chinook salmon ESU was designated as a candidate for listing on September 16, 1999 (NMFS 1999). This ESU includes all naturally spawned populations of fall-run Chinook salmon in the Sacramento and San Joaquin River Basins and their tributaries, east of the Carquinez Strait, California (NMFS 1999).

Spawning adult Chinook salmon generally measure 75-80 cm SL (9-10 kg.) and are olive brown to dark maroon (Moyle 2002). The black gums of the lower jaw distinguish Chinook salmon from other Pacific salmon (Moyle 2002). In addition, Chinook salmon have black spots that are highly irregular in size and shape; these spots occur on the body only above the lateral line, as well as on the dorsal and caudal fins (Behnke 2002). Chinook salmon have 10-14 major dorsal fin rays, 14-19 anal fin rays, 14-19 pectoral fin rays, 10-11 pelvic fin rays, 130-165 pored lateral line scales, and 13-19 branchiostegal rays on each side of the jaw (Moyle 2002). Chinook salmon generally live 3 to 6 years. Chinook salmon feed on aquatic and terrestrial invertebrates and salmon eggs in freshwater. In intertidal areas Chinook salmon feed on amphipods, insects, and fish larvae. During the oceanic life stage, Chinook salmon feed on fish, large crustaceans, and squid (Behnke 2002).

Range, Populations and Activity. The current range of Central Valley Chinook salmon extends up the Sacramento River to the Keswick Dam (a flow-regulating dam located 9 miles downstream of Shasta Dam). In addition, the range of Central Valley Chinook salmon extends up many of the Sacramento River tributaries up to significant migrational barriers. They are known to occur in the Feather River up to the Oroville Dam, the Yuba River up to Englebright Dam, and the American River up to Nimbus Dam.

The Sacramento River winter-run Chinook salmon historically occurred upstream as far as the headwater reaches in the Upper Sacramento, Pit, McCloud, and Calaveras Rivers. Following the construction of dams on these rivers in the 1940s, these populations were limited to areas below the Shasta Dam. The Fall River, one of the premier salmonid streams in California, also supported spawning habitat for Chinook salmon prior to the construction of the Shasta Dam (NMFS 2003). Currently, the Sacramento River winter-run Chinook salmon occur as far upstream as the Keswick Dam and depend on cold water releases from the Shasta dam (located 9 miles upstream of Keswick Dam) to allow them to hold for several months until they spawn in early summer (Behnke 2002). This run is currently limited to the 70 miles below Keswick Dam (Moyle 2002). The run size in 1969 was approximately 120,000, whereas run sizes averaged 600 fish from 1990 to 1997 (Moyle 2002).

Historically, spring-run Chinook salmon occurred up to elevations of approximately 1,500 feet. If these fish spawned early in the season, they occurred at elevations up to approximately 2,500 to 3,000 (NMFS 2003). The Sacramento River drainage is reported to have supported more than 100,000 spring-run Chinook in many years through the 1940s (Moyle 2002). The installation of the Shasta Dam in 1945 prevented access by Chinook salmon to over 250 kilometers of the Sacramento River drainage (Moyle 2002) thereby causing a tremendous decline in their population numbers. Between 1969 and 1997, the mainstem Sacramento River was estimated to support a range of 3,700 to 21,000 spring-run Chinook salmon per year (Moyle 2002). However, since 1990, the average Chinook salmon run size per year has dropped to 2,500.

Historically, it is estimated that fall and late fall-run Chinook salmon occurred at elevations up to 1,000 feet based on known records from the McCloud River (NMFS 2003). This run was historically the most abundant in the Central Valley. The fall and late fall run occurred in all the major tributaries in the Sacramento-San Joaquin drainage, however it is unclear how far upstream Chinook salmon reached (Moyle 2002). Currently, hatchery fish are believed to augment this run by 10 to 65 percent (Behnke 2002). Fall-run spawning escapements averaged 217,000 between 1952 and 1959 in the mainstem Sacramento River (Behnke 2002). Fall-run spawning in the mainstem Sacramento River averaged 48,000 fish from 1990 to 1997 (Behnke 2002).

Chinook salmon observations in tributaries to the San Francisco Bay Delta began to increase in the mid-1980s (Leidy *et al* 2003). It is unclear whether the Chinook salmon observed are naturally-spawned fish or hatchery-derived fish that have begun to spawn in Bay Delta tributaries.

Habitat Use. Chinook salmon tend to spawn in the mainstems of rivers (or larger tributaries) in areas of gravel and cobble substrate. Before spawning, Chinook salmon tend to hold for a period of time following their arrival to natal streams (Behnke 2002). Chinook salmon primarily spawn at depths between 25 and 100 centimeters and velocities of 30-80 centimeters per second (Behnke 2002). Optimal conditions for embryo survival include water temperatures between 5 and 13 degrees Celsius and oxygen levels must be close to saturation (Behnke 2002).

Population Levels and Occurrence in Plan Area. Chinook salmon are mainly associated with the open water portions of the Freshwater Marsh and Streams/Sloughs within the Plan Area's Riparian, Streams, and Freshwater Marsh Natural Community. The species can also be found in open water areas of within the Coastal Marsh Natural Community. Historical information regarding Chinook salmon populations and occurrence in Solano County is limited. Leidy *et al.* (2003) reported that a 1973 California Department of Fish and Game document noted that a possible run or population of Chinook salmon occurred in Suisun Creek. Based on current conditions, Leidy *et al.* (2003) determined that a current run or population of Chinook salmon may exist in the Suisun Creek watershed, however no observations have been made of this species. NMFS reported that spawning Chinook salmon or redds have been observed in Green Valley Creek (1999). Chinook salmon were also observed in December 2003 in Putah Creek.

The lower stream reaches of most streams in Solano County flow through major agricultural and urban areas. These reaches of the streams would be used primarily as migration habitat because the summer temperatures are typically too warm for Chinook salmon. The upper reaches of the streams in the western portion of the County, however, may provide suitable conditions for spawning.

Migrating Chinook salmon also occur in the waterways of Suisun Marsh and Delta region of the County.

Dispersal. Adult Chinook salmon migrate upstream to natal streams to spawn. The winter-run migrates upstream between December and July, with peak migration occurring in March. Spring-run Chinook salmon migrate upstream between March and July, with peak migration occurring in May and June. Fall-run Chinook salmon migrate upstream between June and December, with peak migration occurring in September and October. Late fall-run Chinook salmon migrate upstream between October and April, with peak migration occurring in December. Chinook salmon that may be present within Solano County would have a brief freshwater residence as juveniles and would use the marsh areas as nursery habitat. Sacramento-San Joaquin system Chinook salmon generally migrate downstream to the ocean as smolts within a year (Bryant 1997). They may also use the Solano County marshes as nursery habitat.

Threats to the Species. The total number of Central Valley Chinook salmon returning to the Sacramento San Joaquin system to spawn decreased by more than half between 1967 and 1991 (Maragni 2000). Human-induced alteration of habitat in conjunction with natural environmental variability (*e.g.*, droughts, floods) is thought to be responsible for the decrease in Chinook salmon populations. Water diversion and dam construction pose the greatest threats to the species (Moyle 2002). The dams that have been constructed along the Sacramento-San Joaquin River system have isolated approximately 80 percent of former high-quality spawning and rearing habitat upstream of the dams (Behnke 2002). These structures have adversely altered the hydrologic regime and geomorphology downstream of the dams as well.

Critical Habitat. Critical habitat for the Sacramento River winter-run Chinook salmon ESU was originally designated on June 16, 1993 (NMFS 1993). This designated critical habitat includes the Sacramento River from Keswick Dam, Shasta County (River Mile 302) to Chipps Island (River Mile 0) at the westward margin of the Sacramento-San Joaquin Delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Suisun Bay, and Carquinez Strait, all waters of

San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 9,329 square miles in California. The following counties lie partially or wholly within these basins: Butte, Colusa, Contra Costa, Glenn, Napa, Nevada, Placer, Plumas, Sacramento, Shasta, Solano, Sutter, Tehama, Trinity, Yolo, and Yuba.

The critical habitat designation for the Central Valley spring-run Chinook salmon ESU was designated by NMFS (2005) on August 12, 2005. No streams within Solano County were designated as critical habitat.

Conservation. The primary considerations with respect to covered activities under the Solano Project HCP/NCCP are 1) the direct loss or modification of aquatic and riparian habitats, 2) changes in water quality and quantity related to discharge of surface water from impervious surfaces and landscaped areas into streams, 3) minimizing disturbance and habitat modifications during critical periods, and 4) providing adequate passage by eliminating existing barriers and not creating new barriers to upstream or downstream movement.

Streams or segments of the streams and their associated riparian corridors within much of the County have been modified to increase conveyance for flood control, minimize bank erosion, and increase areas available for development and agricultural uses. These activities typically result in a change in the natural channel geometry (i.e., loss of complexity, reduction of meanders), riparian vegetation is removed, large woody debris is lacking, and water temperatures increase. These activities eliminate or reduce the ability of the habitat to support Chinook salmon. Large woody debris (tree trunks, large limbs) is considered important for anadromous fish because it provides overhead cover, creates calm or lower velocity waters for resting, and creates greater habitat complexity. Large woody debris is typically removed from streams because it creates flooding hazards, blocks flow through culverts or damages culverts and bridges, and increases bank erosion. While some sections of the streams retain narrow, but continuous riparian corridors and some channel complexity, the characters of other stream segments, particularly in the eastern portion of the County, have been channelized.

The effects of changes in water quality and quantity are often not as visually apparent as direct habitat modification. Urbanization alters the natural infiltration capability of the land and generates a host of pollutants that are associated with the activities of dense populations, thus causing an increase in the volume of storm water runoff and amount of pollutants in storm water discharged to receiving water bodies. Urban development increases the amount of impervious surface in a watershed as farmland, forests, and meadowlands are converted into buildings, driveways, sidewalks, roads, and parking lots with virtually no ability to absorb stormwater. Stormwater runoff accumulates pollutants from parking lots and roads (oil, grease, heavy metals) and from residential areas (household and garden pesticides). The resulting storm water flows are higher in volume, higher in pollutants, and higher in temperature than the flows from less impervious areas (U.S. EPA 2000). Peak runoff is lower and pollutants are filtered from runoff that originates from areas covered by natural vegetation and soil as compared to impervious surfaces and ornamental landscaping. This can affect Chinook salmon and other aquatic species within streams, rivers, and in downstream estuaries far removed from urban areas.

Natural and man-made barriers in streams can prevent Chinook from reaching suitable spawning habitats causing the fish to breed in sub-optimal habitats where survival of the young is unlikely or creating traps where predators have easier assess to concentrations of fish. Barriers can be caused by drop structures in streams or flood control channels, under–sized or poorly designed culverts and bridges, and under-grounding of streams.

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