

Incidence of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) predation by green sunfish (*Lepomis cyanellus*)

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Adverse effects of invasive piscivores have been cited as contributing to the declining abundances of inland California fishes, particularly in the Central Valley (Moyle and Marchetti 2006). Habitat alterations are also commonly cited, and the San Joaquin River Restoration Program has been established to promote both environmental and biological restoration within the San Joaquin River drainage. However, biological restoration efforts are often hampered due to an abundance of invasive piscivores that impede re-establishment or recruitment of native species (Portz and Tyus 2004). As a result, it is important to understand system-specific predator-prey relationships in order to set management priorities regarding invasive species control or eradication efforts. This understanding is of particular importance when invasive species are new to a system, or when interactions between native and non-native species are not well understood (Mack et al. 2000).

Green sunfish (*Lepomis cyanellus*) are native to North America east of the Continental Divide and west of the Appalachians, from the Great Lakes region south to the gulf coast states and into northeastern Mexico (Sublette et al. 1990), and were likely first introduced to California at Lake Cuyamaca, San Diego County in 1891 (Dill and Cordone 1997). Since introduction, they have become well established throughout the state in most suitable habitats (Moyle 2002).

Green sunfish are omnivorous foragers, and are equipped with a characteristically larger mouth when compared with other fishes within the Genus *Lepomis*. Dietary items include a variety of insects, mollusks, crustaceans, vascular plants, and are known opportunistic picivores. In Utah, fish comprise approximately 10% of total dietary intake (Wydoski and Whitney 2003), and are speculated to suppress native fish populations in North Carolina (Lemly 1985), Arizona (Dudly and Matter 2000), Colorado (Lohr and Fausch 1996), New Mexico (Paroz et al. 2010), and California (Moyle and Nichols 1974; Smith 1982). Effects of green sunfish predation on salmonid populations is elusive (Moyle 2002; Bonar et al. 2004; Grossman et al. 2013) and remains largely undocumented.

Juvenile Chinook salmon and green sunfish populations were historically geographically isolated from each other. Within the San Joaquin River they occur

sympatrically and are likely restricted to similar habitat types defined by warm shallow water, low flow, with complex structures (ex. vegetation, woody debris, and rock weirs) as the San Joaquin River currently lacks continuous Chinook salmon (*Oncorhynchus tshawytscha*), habitat (Hallock and Fry 1967). The river has been channelized and is subject to major anthropogenic disturbances within the study area (eg., mining pits and diversion dams) that reduce flow and may cause an overlapping of habitat between the two species. In addition to anthropogenic disturbances, in 2015 the river experienced critically low water, reducing the volume and flow of water released from Friant Dam, which may have further reduced the ability of juvenile Chinook salmon to access suitable habitat and elude predators.

While conducting 2015 spring juvenile Chinook salmon trap and haul efforts (Portz et al., 2015) a series of V-shaped fence mesh weirs with tandem catch boxes were used to capture juvenile Chinook salmon. Potential juvenile Chinook salmon predators found in catch boxes were opportunistically gastrointestinally examined. Of green sunfish examined with a total length ranging from 74 to 210 mm ($n = 36$), four were found to contain juvenile Chinook salmon. One individual at Highway 99 (119° 56' 00" E, 36° 50' 31" N) and three individuals at Milburn (119° 52' 40" E, 36° 51' 20" N; Figure 1).

We are unable to discern if the predation events occurred in the catch boxes or within the river, and as such, it is unknown if the predation events are a valid reflection of free ranging predator-prey interactions within the system or the result of anthropogenic artifact as influenced by the weir.

To our knowledge, this is the first report of a Chinook salmon predation by green sunfish. Future efforts to understand factors associated with predator-prey relationships that drive successful reintroduction or successful recruitment in native salmonids should not exclude green sunfish.



FIGURE 1.—Green sunfish (*Lepomis cyanellus*) captured in the San Joaquin River, Milburn unit, Fresno, California, USA, on 21 April 2015. Fork length was 147 mm. Individual was gastrointestinally examined to determine dietary items. Items recovered included six sunfish (*Lepomis* spp.) and one Chinook salmon (*Oncorhynchus tshawytscha*, pictured). Photograph by authors.

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