Science Foundation Chapter 3
Appendix 3.1 – Case Study
California Grunion (*Leuresthes tenuis*)

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DESCRIPTION OF THE SPECIES

California grunion *Leuresthes tenuis* is found only along the outer coast of California and Baja California. It is a relatively small atherinid fish that spawns at high tide on sandy beaches; the eggs incubate out of water until the next semilunar high tide. The main habitat range is between Ensenada, Mexico, and Pt. Conception, California.

CRITERIA FOR SELECTION OF THE SPECIES

San Francisco Bay is the type locality for this endemic species (Ayres, 1860), although none was seen there again until 2001 (Skinner, 1962; Jahn, 2004). From 2001 to 2008, California grunion was present throughout the year in San Francisco Bay and spawned on multiple beaches. Grunion formed a substantial part of the diet of Least Terns nesting at the Alameda colony during this time (Elliott et al., 2007).

OTHER INFORMATION ABOUT THE SPECIES

California grunion abundance was monitored by the CA Department of Fish and Wildlife's San Francisco Bay study and found throughout the Central and South areas of the bay between 2001-2007. Dropped fish were identified by PRBO Conservation Science at the Alameda Least Tern Colony. Beaches that were used as spawning sites included Chrissy Field Beach in the Golden Gate National Recreation Area, Crown Memorial State Beach in Alameda, Albany Bulb, Oakland Middle Harbor, Emeryville, Foster City, Seaplane Lagoon at the Alameda Naval Station, and Roberts Landing in San Leandro. Beaches were monitored for spawning runs by Grunion Greeters from 2005 on (Martin et al., 2007). Spawning runs occurred from May to August during semilunar high tides.

No California grunion were observed on the outer coast around San Francisco Bay. It appears that San Francisco Bay was colonized from southern California in 2001 and that individuals remained within the bay throughout their lives (Johnson et al., 2009).

Within San Francisco Bay, mature California grunion were smaller in length and mass than those from southern California, and egg diameters and clutch volumes were significantly smaller. Few in this population appeared to survive more than one year and spawning season, however farther south they may survive two to four years.

California grunion feed on zooplankton throughout life (Horn et al., 2006).

REVIEW OF CLIMATE CHANGE EFFECTS ON SPECIES

During ENSO and other regional climate cycles, one would expect a return of California grunion to San Francisco Bay during warmer phases. Even if the outer coastal waters remained cooler, this species can complete its life cycle within the bay.

It is likely that northern bays are thermal refuges for California grunion (Johnson et al., 2009). In 2005, California grunion colonized Tomales Bay, a northern range extension (Roberts et al., 2007). This population was observed spawning on the beach each year through 2009, but not since. California grunion has also appeared in Monterey Bay sporadically through the past 60 years (Phillips, 1943; Spratt, 1981; Yoklavich et al., 2002).

Rising sea levels will cause changes in coastal ecosystems including sandy beaches, the critical spawning habitat of this species. Armored shorelines increase the threat of habitat loss for sandy beaches. Areas where managed retreat is possible will be crucial for maintaining potential spawning habitat in the future. Within San Francisco Bay, the beaches where California grunion spawned are public shorelines, managed for recreation. The sandy substrates were artificially placed and are variable in grain size but all these beaches are relatively narrow at high tide.

OTHER STRESSORS

California grunion tolerates salinity fluctuations in brackish water above approximately 16 ppt but does not survive in extremely low or high salinities (Reynolds et al., 1976; Matsumoto and Martin, 2008), as could occur with changes to freshwater flows into San Francisco Bay or increased evaporation on shore.

California grunion is prey for many species of marine teleosts, elasmobranchs, and shorebirds (Gregory, 2001).

California grunion is sensitive to many different anthropogenic chemicals including oil spills, and the larvae have been used in bio-assessments of toxicity (Valentine and Soulé, 1973; Winkler et al., 1983; Hose and Puffer, 1984; Newton et al., 1985; Borthwick et al., 1985; McCoy, 1998). If waters outside the bay are too cold for this species, grunion may be unable to escape unhealthful levels of chemicals even if they are only present temporarily.

Sandy beaches are necessary for spawning habitat. The eggs incubate buried in sand, completely out of water, and remain vulnerable to human activities while developing.

California grunion is subject to a recreational fishery (Walker, 1952). The closed season, April through May, was set for southern California populations and does not protect the primary spawning period for grunion in San Francisco Bay. Smaller runs and smaller clutch sizes indicate that recreational fishing should be closed throughout the spawning season for this species within San Francisco Bay.

FACTORS THAT MAY AFFECT SPECIES RESILIENCE

Resilience is low at the northern limits of the habitat range at this time, but may improve with warming.

LIKELY CLIMATE CHANGE IMPACTS AND RISKS

The most likely climate effects include sea surface temperatures inducing northern shifts in habitats, changes in salinity on spawning beaches from increased rainfall, and loss of critical habitat with sea level rise on sandy beaches, particularly in areas with large amounts of armoring.

MANAGEMENT ACTIONS TO BE CONSIDERED

Full closure of the recreational fishery is recommended, along with management practices that maintain the upper beach above the mean high tide, avoidance of mechanized maintenance or vehicles over spawning sites (Martin et al., 2006).

UNCERTAINTY AND KNOWLEDGE GAPS

It is likely California grunion will return to San Francisco Bay, but uncertain when that will occur. The effects of sea level rise on the width and slope of the man-made beaches within the bay are not known. Increased sand transport into the bay may enhance beach resilience.

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