Final

SALTON SEA SPECIES CONSERVATION HABITAT

Desert Pupfish Protection and Relocation Plan

Prepared for
California Department of Water Resources

February 2017

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CHAPTER 1
Introduction

1.1 SCH Project Overview

The Salton Sea (Sea) is currently maintained by inflows of agricultural return water but has been shrinking in size as inflows are reduced as a result of water conservation and other water management actions. A rapid and substantial increase in salinity and reduction in the size of the Sea is expected as a result of inflow reductions associated with Imperial Irrigation District's (IID) Water Conservation and Transfer Project (Water Transfer Project), which entails water conservation and transfer transactions pursuant to the Agreement for Transfer of Conserved Water executed by IID and the San Diego County Water Authority in 1998, and supplemented by the 2003 Quantification Settlement Agreement and related agreements (QSA). Declining water inflows will hasten the collapse of the Sea's fish population due to increasing salinity (expected to exceed 60 parts per thousand [ppt] by 2018) and other water quality stresses, such as temperature extremes, eutrophication, and related anoxia and algal productivity. The most serious and immediate threat to the Sea's ecosystem is the loss of fishery resources that support piscivorous birds.

The Salton Sea Species Conservation Habitat Project (SCH Project) is located along the southern shore of the Sea in Imperial County. The Project is sponsored by the California Natural Resources Agency (CNRA), and implemented through their departments of Fish and Wildlife (CDFW) and Water Resources (DWR). The SCH Project’s purpose is to provide replacement for near-term habitat losses (U.S. Army Corps of Engineers [Corps] and CNRA 2011). The SCH Project’s target species are those piscivorous bird species that use the Sea and are dependent on shallow saline habitat for essential habitat requirements within their western geographic range.

The Project objectives include:

1. Provide appropriate foraging habitat for piscivorous bird species.
2. Develop physical structure and microhabitat elements required to support piscivorous bird species.
3. Support a sustainable, productive aquatic community.
4. Provide suitable water quality for fish.
5. Minimize adverse effects on desert pupfish.
6. Minimize risk of selenium toxicity.
7. Minimize risk of disease/toxicity impacts.

The creation, maintenance, and long-term monitoring of 3,770 acres of shallow saline ponds is designed to reduce the scientific uncertainty of identified long-term Sea restoration plans and partially reduce the aforementioned ecological hazards by providing a range of aquatic habitats, over a 75-year period, that will continue to support fish and wildlife species that are dependent on the Sea. The constructed ponds are designed to provide habitat that will support piscivorous bird species and sustainable aquatic communities, provide suitable water quality for fish species, minimize the risk of the bioaccumulation of selenium, and minimize the risk of disease and toxicity to wildlife and plants. Likely fish candidates to be established in the ponds include one or more varieties of tilapia, which are an important forage species for fish-eating birds. California Mozambique hybrid tilapia (*Oreochromis mossambicus x O. urolepis hornorum* hybrid) is the species once abundant in the Salton Sea.

1.2 Purpose of Document

Desert pupfish (*Cyprinodon macularius*) occur in the Project area. This small fish is protected as an endangered species under the federal and state Endangered Species Act. This species may be affected by Project construction, operation and maintenance activities, as disclosed in the EIR/DEIS (Corps and CNRA 2011) and Biological Opinion (BO) (USFWS 2013). Habitat conditions in the SCH ponds are expected to be suitable for desert pupfish, although the primary purpose of the SCH project is to provide forage fish for the piscivorous birds, not as a pupfish refuge.

Four conservation measures (USFWS 2013) will be implemented as part of the project to protect desert pupfish:

1. Monitor the depth of water during maintenance of the Sea pump station. If the water depth is 6 feet or less, the dredging footprint will be surrounded by netting, and desert pupfish will be trapped out of this enclosed space before suction dredging is performed. If salinity levels are beyond the tolerance of desert pupfish (approximately 68 ppt), avoidance and minimization measures would not be required as desert pupfish would not be present.

2. Prepare and implement a desert pupfish inoculation plan if pupfish do not naturally repopulate the ponds 1 year after ponds are filled with water.

3. Prepare and implement an adaptive management and monitoring plan to provide for the monitoring of desert pupfish relative abundance and distribution in the SCH ponds and desert pupfish connectivity from drains around the ponds.

4. Prepare and implement a desert pupfish protection and relocation plan.

This document serves as the SCH Desert Pupfish Protection and Relocation Plan (Protection and Relocation Plan), consistent with the requirements of conservation measure 4.

CHAPTER 2
SCH Project Description

2.1 Location

The SCH Project is located on the southern shore of the Sea, north of Westmorland in Imperial County, California. The Project site is bounded by Poe Road to the west and Hoskins Road to the east on approximately 4,098 acres of open water, exposed playa, shallow shoreline, and agricultural irrigation ditches and canals, of which 1,750 acres are managed by the US Fish and Wildlife Service (USFWS) as part of the Sonny Bono Salton Sea (SBSS) National Wildlife Refuge (NWR).

2.2 Project Elements

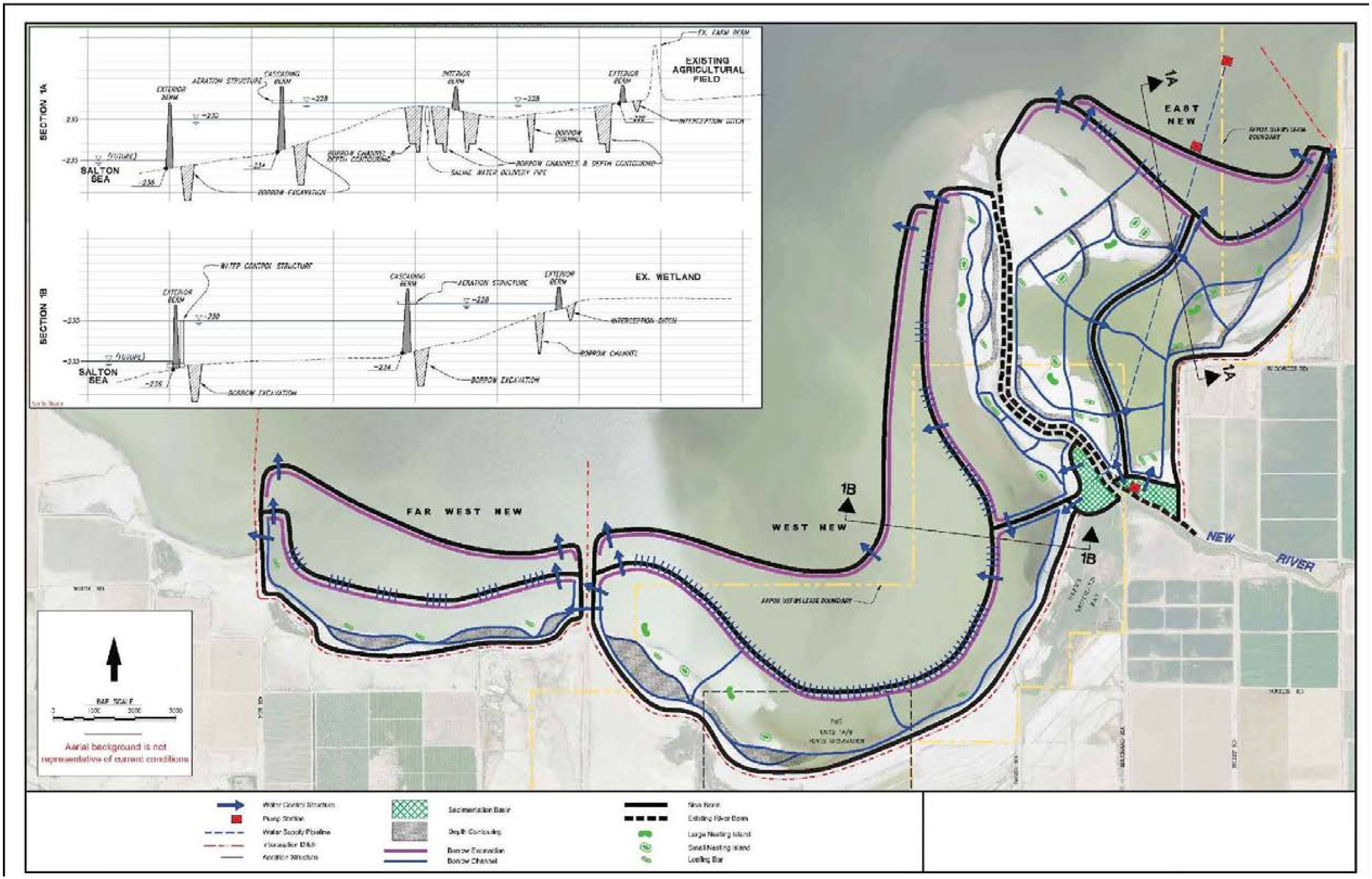
The goal of the SCH Project is to create saline impoundments on the exposed playa to support fish and wildlife dependent on the Sea. The ponds will provide near-term habitat and serve as a proof-of-concept for future phases of the SCH Project.

The SCH Project area encompasses 3,770 acres of exposed playa at the mouth of the New River, at the southwest end of the Salton Sea (**Figure 1**). Three independent pond units, Far West New, West New, and East New will be constructed and supplied with a combination of water from the New River and the Sea and blended to maintain an optimal salinity range. The SCH ponds will average 2-6 feet deep and have the following approximate maximum areas and volumes:

- Far West New: 514 acres, 2,305 acre-feet
- West New: 1,731 acres, 6,783 acre-feet
- East New: 1,139 acres, 2,870 acre-feet

The initial implementation phase will construct and operate two ponds (320-acres each, designated East Pond and West Pond) to create a total of 640 acres of saline pond habitat in the East New River section of the Project area (**Figure 2**). Each pond will have its own water supply infrastructure that can be operated independently, to allow manipulation of hydrologic parameters such as salinity and residence time as experimental “treatments.” The SCH Project will test different operating regimes (varying salinity and residence time) between the ponds and monitor physical and biological outcomes during the first 10 years.

Figure 1 - Salton Sea Species Conservation Habitat Project Area



Source: Corps and CNRA 2011

Figure 2 - SCH Project - East New River, West Pond and East Pond

Section 2.4.1 and *Appendix D* of the DEIS/EIR provides a more detailed description of key project features (Corps and CNRA 2011). Key Project components include: pond berms, pump stations, inflow and outflow structures, water control structures, a sedimentation basin, in-pond habitat features, and an irrigation drain interception ditch. These Project features are shown on Figure 2-8 of the EIR/EIS and described in Appendix D of the EIR/EIS. Berms will be constructed to create the necessary pond size, shape, and bottom configuration to provide a range of in-pond aquatic habitats. Interior berms will form smaller impoundments within the ponds and exterior berms will be constructed to separate the ponds from the Sea. Exterior berms will be aligned to not interrupt the flowpath of occasional stormflows from the watersheds that drain into the Sea.

Near the west end of Bowles Road, water from adjacent irrigation drains is currently pumped into an interception ditch, which provides connectivity for pupfish. At completion of construction and pond filling, the agricultural drain water will be pumped directly into the SCH ponds, which will provide extensive pupfish habitat.

2.3 Operations and Maintenance

The new ponds are expected to go through physical and chemical changes following wetting of the playa sediment and initial filling, as described in the *SCH Monitoring and Adaptive Management Plan* (MAMP) (CNRA 2015). Filling the ponds for the first time after construction is expected to take about three months using the designed pumps, and less time if portable pumps are also used. Both ponds will be filled and maintained at 30 ppt salinity prior to acceptance of construction by the contractor. Initially, the ponds will be allowed to "season" for a period of several weeks to months while undergoing various stages of chemical and biological succession. Water chemistry will likely fluctuate as compounds leach from the newly wetted soils and microbial communities are initiated. Once phytoplankton, zooplankton and other invertebrates are established and salinity is within target range, then fish (forage species for piscivorous birds) will be introduced to the ponds, starting with sailfin mollies and mosquitofish, then tilapia.

The ponds will be operated to allow for different combinations of storage, salinity, and residence times (operations scenarios) to investigate how these factors could be adjusted to provide the best conditions for fish and birds. Water will be diverted from the New River and the Sea and blended to achieve the optimal salinity within the ponds. Water from the Sea will be pumped to the ponds via a 24-inch pipe. Water will enter the New River pump station via a 4'x2' box culvert, where it will then be pumped via a 28-inch pipe to the sedimentation basins and to the ponds via habitat channels. Water from the ponds will return to the Sea via a weir outflow structure.

The SCH Project will be operated during the initial 10-year proof-of-concept period under scenarios designed to test which salinity regime results in the best combination or balance of invertebrate and fish productivity, bird use, seasonal fish survival, and selenium ecorisk minimization (Corps and Resources Agency 2011, 2013). The target salinity range will be 20-40 ppt, occasionally ranging from 0 ppt to 60 ppt. Scenario 1, the first operational scenario to be implemented, will test the lower (20 ppt in West Pond) and upper (40 ppt in East Pond) extremes of the operational range, to increase the likelihood of measuring the effect of salinity on Project performance. Each pond will be operated at the same replacement rate with a different salinity.

Scenario 1 will maintain salinity constant through the year. This scenario will be run for at least two years.

Other operations scenarios could be tested during this 10-year implementation period, depending on management goals and feedback from monitoring. Scenarios 2 and 3 would increase inflow 10 percent or 20 percent, respectively, over the replacement rate. This would produce outflow from the pond and thus reduce the residence time, at the cost of additional pumping. With more information from monitoring, operation scenarios can be adapted to improve Project performance.

Ongoing maintenance will include periodic dredging of the sedimentation basins; maintenance of interior and exterior berms, protective riprap, and pumps; and vegetation, erosion, and vector control. Material excavated from the sedimentation basin will be used to construct habitat features or add to the berms. The pumped diversion from the New River will be maintained to keep the diversion facilities free of sediment. The river bed elevation will also be monitored to detect any downcutting that may occur as the Sea's water level drops. The Sea pumping facilities will be maintained to reduce fouling caused by the hypersaline water flowing through the pumps. Draining the ponds will not be a routine maintenance activity, but may be required if a berm failed or under another type of emergency situation.

Maintenance will typically involve construction equipment such as an excavator at the New River and suction dredging equipment at the pump stations. The sedimentation basin will be constructed and operated in a manner that is unsuitable for desert pupfish. Additionally, desert pupfish do not occur in the New River where the pump intake is proposed.

2.4 Long Term Monitoring and Maintenance

The SCH Project includes a MAMP to obtain and refine information to inform future restoration efforts and define optimal parameters to support a sustainable, productive aquatic community (CNRA 2015). The main parameters subject to change include salinity, residence time, and depth. The parameters will be controlled by changing the amount and salinity of water delivered to the constructed ponds, the outflow to the Sea, and the total storage in the ponds. The MAMP will help guide post-implementation actions and assess project performance during the 10-year proof-of-concept period.

The MAMP outlines a monitoring framework to evaluate the effectiveness of the SCH Project and guide adaptive management. The MAMP describes project objectives, defines expected or desired outcomes, and describes monitoring activities to track progress toward objectives and compliance with regulatory permits during the initial implementation phase. The MAMP also outlines the assessment and decision-making process that will guide adaptive management, including potential management responses that may be triggered by monitoring.

Indicators of SCH Project performance include measures of habitat (e.g., area, depth, physical structure, aquatic plant species/cover, and water quality), target species (e.g., richness, diversity, abundance, habitat use), trophic function (e.g., composition and density of forage species), and stressors (e.g., water quality and selenium concentrations). Key monitoring elements include the following:

- Physical Habitat - flow rate, depth, wetted area, islands, snags, submerged vegetation, and other habitat elements;
- Water Quality - salinity, temperature, dissolved oxygen, nutrients;
- Aquatic Biota - algae, plankton, invertebrates, fish community (species, distribution, abundance);
- Birds - species, abundance and distribution, use of habitat features, breeding and nesting, sick or dead birds; and
- Contaminants - selenium concentrations in water, sediment, bird eggs, and other biota (invertebrates, fish).

For detailed information, see the SCH MAMP.

CHAPTER 3
Desert Pupfish Status and Ecology

3.1 Status and Critical Habitat

The desert pupfish, listed as endangered in 1986, is a small fish, less than 3 inches long, belonging to the Cyprinodontidae family of fishes (Moyle 2002). This species is native to southeastern California, southern Arizona, northern Baja California, and Sonora, Mexico. Naturally occurring populations of desert pupfish are now restricted in the United States to California in the Salton Sea Basin: the Salton Sea, three tributary streams, shoreline pools and irrigation drains to the Sea (Lau and Boehm 1991, Keeney 2016). This species is found in Mexico at scattered localities along the Colorado River Delta and in the Laguna Salada basin (Hendrickson and Varela-Romero 1989, Minckley 2000).

Critical habitat was designated in 1986 along portions of the San Felipe Creek, and two of its tributaries, Carrizo Wash and Fish Creek Wash, in Imperial County, California (USFWS 1986). The areas designated as critical habitat include approximately 11 miles of a channel along San Felipe Creek and all of its tributaries and a riparian buffer zone of 100 feet on both sides of the stream channel. A total of approximately 770 acres of critical habitat were designated. The desert pupfish reproduces successfully in San Felipe Creek. These stretches provide adequate food and cover. They are at least partially isolated from predatory and exotic fishes. Recent observations by CDFW indicate that mosquitofish are the most abundant non-native fish. Tilapia were abundant in San Felipe Creek in 2013-2015 but much reduced in 2016, and sailfin mollies have not been seen since the 1990’s (Keeney 2016).

3.2 Population Status and Genetics

3.2.1 Populations

According to the USFWS 5-Year Review (USFWS 2010), there are collectively 11 extant populations of desert pupfish known in the wild in California (5 populations), Arizona (1), and Mexico (5) (Tier 1 populations in the Recovery Plan). Although many re-introductions have been attempted, approximately 16 transplanted populations of the desert pupfish exist in the wild at present, all in Arizona (Tier 2 populations in the Recovery Plan). There are 46 captive or refuge desert pupfish populations comprised of 27 in Arizona, 14 in California, and 4 in Sonora, Mexico (USFWS 2010, Keeney 2016). The range-wide status of desert pupfish is poor but stable. The fate of the species depends heavily upon future developments in water management of the Salton Sea and Cienega de Santa Clara in Mexico.

Five natural populations persist in California: San Felipe Creek, Salt Creek, Salton Sea, Salton Sea irrigation drains, and Hot Mineral Spa Wash (USFWS 2010). Historically, desert pupfish were abundant along the Sea's shoreline through the 1950s (Barlow 1961). During the 1960s, the numbers declined, and by 1978 they were noted as scarce and sporadic (Black 1980). Currently, desert pupfish numbers in the Sea are relatively low and patchily distributed in Salt Creek and San Felipe Creek, at the mouths of the New, Alamo and Whitewater rivers, within the mouths of irrigation drains that discharge directly to the Sea, and along the southern and northern shoreline of the Sea in shoreline pools (USFWS 2010; Keeney 2013 and 2016). The desert pupfish population in Salt Creek was stable to increasing, and had few non-native species (USFWS 2010; Keeney 2010). However, in the last several years lower Salt Creek has dried completely during summer and water quality has become more problematic (Keeney 2016). San Felipe Creek also has had a stable to increasing population, according to the 5-Year Status Review (USFWS 2010), but in recent years non-native fish have been found here (Keeney 2016) and no non-native fish have been found in recent surveys.

There are 36 irrigation drains within the action area that have been monitored by CDFW, USGS and IID over the last 25 years; these desert pupfish populations fluctuate seasonally, but have persisted. While populations in irrigation drains entering the Sea can be abundant (Keeney 2010 in USFWS 2010), fish populations there are still dominated by non-native fish (Martin and Saiki 2005). These drains allow connectivity to shoreline pools, at least seasonally, and may be necessary to prevent desert pupfish from becoming stranded within drain habitats that periodically dry out (Sutton 2002; Keeney 2013). Maintaining these populations and connections in the long-term has been determined to be necessary for the recovery of the species (USFWS 1993). Based on current understanding, this includes maintaining the drain populations and providing for desert pupfish movement between individual drains (USFWS 2010).

In addition to the naturally occurring populations, this species also occurs in several refuge locations (Tier 3 populations) within the action area. The 14 refuge populations in California occur at Anza Borrego State Park (2), Oasis Springs Ecological Reserve (1), Dos Palmas Reserve (4), Living Desert Museum (4), University of California Riverside (1), Imperial Irrigation District grass carp facility (1), and Borrego Springs High School (1) (Keeney 2016). There was a desert pupfish refuge population at Salton Sea State Recreation Area, but desert pupfish no longer occur there, likely due to bird and raccoon predation as well as lack of soft substrate for fish to burrow into for escape (Keeney 2016). CDFW monitors and maintains these refuge populations.

3.2.2 Genetic Units

As discussed in the 5-Year Status Review (USFWS 2010), much of the research on desert pupfish since the 1993 recovery plan addresses genetics issues and the taxonomy of the *C. macularius* group. Since the isolated nature of desert pupfish populations reduces the flow of genes between sites, inbreeding and genetic drift can be reasonably expected to occur without intervention (Turner 1983, Echelle et al. 2007, Koike et al 2008, Loftis et al. 2009). Based on their work on the natural populations, Loftis (2007) and Echelle et al. (2007) recommended five management units for *C. m. macularius*: Laguna Salada, Cerro Prieto, Cienega de Santa Clara/El Doctor, San Felipe Creek, and the rest of the Salton Sea system (Echelle et al. 2007, Loftis et al. 2009). Recent genetics studies indicate that the three naturally occurring populations in the Salton sink–San Felipe Creek, Salt Creek, and Salton Sea (including irrigation drains)–should be treated as one genetic unit (Echelle 1999, Echelle et al. 2007).

3.3 Ecology and Habitat Requirements

This description of ecology and habitat requirements is based on descriptions and reviews in the desert pupfish recovery plan (USFWS 1983), critical habitat designation (USFWS 1986), 5-Year Status Review (USFWS 2010), and the project's Biological Opinion (USFWS 2016).

The desert pupfish has a tolerance for high temperatures, high salinities, and low dissolved oxygen concentrations that exceed the levels known for other freshwater fishes (USFWS 1986, 1993). Carveth et al (2006) reported an upper lethal tolerance of 42.4 degrees Celsius (C), plus or minus 0.2 degrees C, when acclimated to a temperature of 30 degrees C. Schoenherr (1990) reported CTMax as high as 42.6 and 42.7 degrees C, and a CTMin of 4.4 degrees C. They have been reported to survive oxygen levels as low as 0.1 to 0.4 parts per million (Lowe et al., 1967), and salinities nearly twice that of seawater (Barlow 1958). They are also capable of surviving extreme fluctuations in temperature (Lowe and Heath 1969) and daily salinity changes of as much as 10 to 15 parts per thousand (Kinne 1960). Desert pupfish populations also experience significant temporal fluctuations in distribution and abundance (Varela-Romero et al. 2002).

Although desert pupfish are extremely hardy in many respects, they prefer quiet water with aquatic vegetation (Schoenherr 1992), as long as it is not too dense (Keeney 2016). Habitats include clear, shallow waters with soft substrates associated with cienegas, springs, streams, margins of larger lakes and rivers, shoreline pools, and irrigation drains and ditches. Pupfish typically prefer shallow water, but can occur at greater depths. CDFW captured pupfish in gill nets set at 7-8 feet in the mid-2000s. In San Felipe Creek, pupfish often utilize pools having depths of 3 feet (Keeney 2016). Pupfish seem to prefer a little flow, compared to areas with dense emergent vegetation and/or stagnant areas which often are preferred by sailfin mollies (Keeney 2016). Examples of suitable habitat are shown in **Appendix A**.

Physical habitat characteristics that are generally favorable to desert pupfish (Black 1980, Moyle 1976, Soltz and Naiman 1978, Schoenherr 1992, Keeney 2013 and 2016) include:

- sand-silt substrate, or other soft or unconsolidated substrate such as pea-sized gravel, with some topographic variability
- abundance of filamentous algae and rooted aquatic plants such as widgeon grass (*Ruppia maritima*) and chara, or muskgrass (*Chara spp.*) to provide food, cover and structure for pupfish and their invertebrate prey
- relatively shallow water (1 foot or less in depth), with a range of depths from 0.5 inches gradually sloping to approximately 3 feet
- minimal surface water velocity (< 1 foot per second)
- water temperatures above freezing during the winter

- salinity less than 68 ppt
- channel or pond bottom not completely filled in with emergent vegetation

When desert pupfish were abundant in the shoreline pools of the Salton Sea, Barlow (1958, cited in Sutton 1999) noted that pupfish of all ages moved in and out of shallow areas in shoreline pools during the day, apparently to avoid temperatures higher than 36 degrees Celsius. They spent the nights in the shallowest, coolest areas of the pools. During the winter pupfish did not move into the shallows until mid-afternoon, where they remained into the night (Barlow 1958 cited in Sutton 1999).

Desert pupfish mature rapidly and may produce up to three generations per year. They become sexually mature at 0.6 inches (15 millimeter [mm]) total length, but most do not breed until their second summer when they reach 3 inches (75 mm) total length (Moyle 2002). Spawning occurs throughout the spring and summer months, about late February through late September (Matsui 1981 cited in Lau and Boehm 1991). Spawning males typically defend a small spawning and feeding territory in shallow water. The eggs are usually laid and fertilized on a flocculent substrate and hatch within a few days. After a few hours, the young begin to feed on small plants and animals. Desert pupfish are omnivorous, feeding on small invertebrates and algae, as well as detritus, macrophytes and occasionally their own eggs. Individuals typically survive for about a year (USFWS 1986).

Desert pupfish are vulnerable to competition or predation and thus can be displaced by non-native fishes (Martin and Saiki 2009). Schoenherr (1992) reported behavioral interference by sailfin mollies and Zill's tilapia (*Tilapia zilli*) during mating and spawning. That said, desert pupfish were unusually dominant in the U.S. Bureau of Reclamation (Reclamation) ponds, where mosquitofish, sailfin mollies and *Tilapia zilli w*ere also present (Saiki et al. 2011). USGS sampled the Reclamation ponds with minnow traps in water averaging 7-18 inches deep, with the deepest area 47 inches (Saiki et al. 2011). Pupfish were the dominant species collected from the Reclamation ponds, in contrast to the irrigation ditches where non-native species were most dominant (Saiki et al. 2008).

3.4 Occurrence and Status at Project Area

Surveys for the desert pupfish were not conducted as part of the planning for the SCH Project, but past occurrences of the species are documented in the California Natural Diversity Database (Corps and CNRA 2011). Based on ongoing monitoring by CDFW, desert pupfish are presumed extant in the project area (USFWS 2013). Additionally, because desert pupfish move between the irrigation drains and the Sea (Sutton 2002), desert pupfish could be present anywhere within the edge of the Sea containing suitable habitat and within drains that are tributary to the Sea.

Habitat quality in some irrigation drains has been degraded due to overgrown emergent vegetation that chokes out open habitat and impedes pupfish movement. While IID is responsible for maintaining the drains by clearing sediment and vegetation, it appears that most of these drains have not been maintained regularly, especially in the lower portions (Keeney 2016). There is little, if any, connectivity to the Sea, and what connectivity remains typically occurs during the spring. Many drains have so much dense vegetation in the lower sections that pupfish are no longer able to swim above or below this barrier. Some once-abundant populations in drains and shoreline pools on the south Salton Sea shoreline and northeast of the project site (Vail 6 Drain, mainly the lower portion which is the shoreline pool located at Lack and Lindsey Roads; and the shoreline pool known as McKendry Pond) have disappeared in recent years due to excessive vegetation and lack of water (Keeney 2016).

Currently, one irrigation drain labeled Salton Sea Sump (SS-8) on the IID drain map book, discharges into the interception ditch at the Phase 1 Project area, east of the New River delta at the west end of Bowles Road. CDFW conducted surveys in 2013 and 2015, but no pupfish were captured or seen (Keeney 2016). On October 11, 2016, a CDFW survey found both the SS-8 drain and the playa where the Phase 1 SCH ponds will be constructed were dry and did not provide suitable habitat for desert pupfish. However, a return survey on November 6 found both water and fish in the SS-8 drain, including desert pupfish, mosquitofish, sailfin mollies and tilapia. Habitat quality was low, given the intermittent flows and lack of established food resources. CDFW staff surmise that a nearby private reserve is the source of some of this drain water in the SS-8 drain.

CDFW staff also surveyed the New River on October 11, 2016. Trapping was conducted (6 minnow traps for 2 h) in microhabitat that was the most suitable available but still poor quality for pupfish. Only one western mosquitofish was collected, although others were observed in the river (Keeney 2016). Desert pupfish are not known to occur nor are they expected to occur in the New River because of the high sediment loads, excessive velocities, and presence of predators (Crayon 2013).

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CHAPTER 4
Protection and Relocation (CC-4)

4.1 Purpose

Construction and maintenance activities in the "wet" and around the pond margins have the potential to disturb or harm desert pupfish. This section describes protocols for pre-construction or pre-maintenance surveys, capture, and relocation of fish to minimize potential impacts.

4.2 Methods

4.2.1 Timing Windows

Desert pupfish spawning occurs throughout the spring and summer months. Construction or maintenance in shallow shoreline areas and in the drain mouths/channels may be conducted from November through February with minimal effects on spawning.

4.2.2 Protection: Screening Sea Intake

Maintenance of a 0.25 inch mesh screen on the Sea water intake would involve brushes being run over the surface of the mesh and/or the screen being removed from the water. This could potentially minimally affect desert pupfish if they are in the Sea near the intake. However, by the time the screen is built (expected 2019) and the SCH ponds are operational, salinity in the Sea is projected to exceed 68 ppt and desert pupfish will no longer be present near the intake. Therefore, no further protection measures will be required for the Sea water intake.

4.2.3 Capture and Relocation

Consultation with CDFW would occur prior to relocation since conditions may change between plan preparation and implementation. All activities during capture and relocation will be directed by a fisheries biologist approved by CDFW ("directing biologist"). Appropriate measures will be taken at all times to ensure safety of the field crew. Potential hazards include working around heavy equipment and unstable footing on soft wet substrate.

Site Assessment and Preparation

Visual assessments of work areas will be conducted prior to construction or maintenance activities in the drains/drain channels, along the shoreline in the "wet," and around the restored ponds margins to determine suitability as pupfish habitat, as described above (*Section 3.3*).

If the area is deemed suitable habitat for pupfish and/or pupfish are observed, then efforts will proceed for capture, transport, and release.

If an area is to be dewatered, the work area will be isolated by cofferdams and fish removal conducted within the isolated area. If the area is not being dewatered, block nets (mesh <0.25 inch) will be setup around the work area to exclude pupfish. Keep in mind that block nets will need supports like T-posts to be hung from, and maintaining a good seal at the bottom of the net will be essential (secured with weights or rocks).

Capture Methods

Capture will follow CDFW protocols for desert pupfish sampling. The preferred capture method is baited minnow traps, specifically Gee's minnow trap (9 inch by 17.5 inch, with 1.25 inch mesh and double funnel-mouth entrances) of galvanized steel wire. The traps are baited with perforated plastic bags, each filled with 1 ounce of canned, fish-flavored, cat food. The traps are typically deployed in water at least 9 inches deep, sufficient to cover the entire trap.

Traps are set only during the day. The preferred duration of trap sets is 1-2 hours, although traps can be checked and emptied, then reset for another 1-2 hours. Overnight sets may result in pupfish mortality due to changes in water quality and sometimes water quantity, presence of too many fishes in traps, vandalism, theft of traps, storm events, and other possible causes. Pupfish are active during the day, not at night. Spacing can be variable due to difference in habitats surveyed, but in the drains, traps are generally spaced 25-50 feet.

Dip netting can also be used, especially in isolated small areas. Seining is less effective, due to underwater snags and difficulties landing a seine, as well as pupfish escape behavior of diving into soft sediment under the seine's lead line (Keeney 2016). To be most effective and to minimize stress and risk of injury to fish (including stranding), the directing biologist will coordinate fish capture operations with plans for dewatering or flow diversion. Water depths will likely become very shallow. As such, "aquarium" nets may be a better, more effective choice.

Handling and Data Collection

Fish handling will be kept to the minimum necessary to remove fish from the isolated work area. Fish capture and removal operations will be planned and conducted to minimize the amount and duration of handling. Biologists will maintain captured fish in water to the maximum extent possible during trapping/netting, handling, and transfer for release. Individuals handling fish will ensure that their hands are free of harmful products, including but not limited to sunscreen, lotion, and insect repellent.

Captured fish will be placed in lidded coolers (preferred), buckets or holding tanks that are fitted with aerators. Tanks/buckets should be placed in the shade if possible to prevent increases in water temperature. Non-native fish will be placed in a separate holding tank/bucket to avoid predation on captured pupfish, and species and number will be recorded.

Desert pupfish numbers and lengths will be measured. If conditions are stressful (i.e., very high temperatures), biologists may discontinue length measurements, especially for the more vulnerable juvenile pupfish. Once the fish have completely removed, the species and total length (cm) will be recorded and then the fish will be released.

The directing biologist will document and maintain accurate records of the operations onto data sheets (**Appendix A**). Conditions to be recorded include: specific locations of capture and release, date and time trap was set and pulled, water depth, water temperature, salinity, number of fish species captured, and observations of substrate type and vegetation. If directed by USFWS or CDFW, species' identification, numbers, and lengths (of the first 30 individuals) for fish species of interest will also be recorded during holding and prior to relocation and release. During data collection for native species, for any non-native fish species captured their approximate numbers will be estimated as well as an estimate of their approximate ranges in lengths.

Biologists will ensure that water quality conditions are adequate in the buckets, coolers, or holding tanks used to hold and transfer captured fish. Biologists will use aerators to provide for clean, cool, well-oxygenated water. Consider using containers that are dark-colored, lidded, and fitted with a portable aerator; small coolers meeting this description are preferred over buckets. Containers should be well-rinsed and free of any chemicals or detergent residues. The directing biologist will ensure that conditions in the holding containers are monitored frequently and operations adjusted appropriately to minimize fish stress.

Transport and Release

Holding and transport time will be minimized and conditions will be continuously monitored to minimize stress to captured fish. Diseased fish should not be translocated (note that visibly diseased fish are not commonly observed, Keeney 2016) All transported fish will be moved to pre-determined relocation areas outside of the project work site for release. Other fishes captured during dewatering of the area within the cofferdams will be transported to suitable release locations on either side of the project work site as appropriate.

At the release locations, all captured fish will be released to ambient conditions similar to their capture site water quality. If water quality conditions are substantially different (e.g., water temperature differ by more than 3 degrees Celsius, salinity differs by more than 3 ppt), then water from the release site will be gradually mixed into the transport container to acclimatize the fish prior to release. Note that pupfish can tolerate certain water quality extremes well, such as dissolved oxygen above 1.0 mg/l and abrupt changes in salinity and temperature (Keeney 2016).

Release Locations

Locations for release of rescued desert pupfish will be identified in advance through consultation with CDFW and USFWS. Site selection should consider the following criteria:

- Nearest geographic neighbor
- Suitable habitat conditions
- Accessibility (some areas are too remote or on private land)
- Absence or low numbers of predators or competitors (note that most aquatic habitats in the Salton Sea region are already occupied by non-native fishes)

- Presence of desert pupfish in receiving waters
- Refuges in need of inoculation from wild populations to maintain genetic health

For the SCH ponds, the closest potential release sites are the irrigation drains east and west of New River. Information about habitat conditions, local desert pupfish population status, and overall fish community will be reviewed from past studies and ongoing surveys by CDFW and others (Saiki et al. 2010, Keeney 2016).

Equipment

The following equipment will be required:

- Minnow traps (25.4-cm high by 25.4-cm wide by 43.2-cm long, with 3.2-mm-square mesh and ca. 5-cm-diameter). Total number 10-20, depending on area to be cleared.
- Canned fish-flavored cat food to bait the traps, and plastic bags to hold the cat food
- Flagging for marking trap locations
- Assorted 36.35 mm (0.375- to 0.625-inch) mesh netting beach seines, 1.2-m to 1.8m (4 to 6 feet) deep by 3-m to 6-m (10 to 20 feet) long.
- Seine poles and ropes (if necessary),
- Long handled dip nets,
- Large hand-held aquarium dip nets,
- Chest or hip waders, and wading shoes,
- Several 5-gallon buckets with handles,
- Several insulated ice-chests or larger transport tanks (if necessary) with lids, and portable battery-powered aerators with air stones, with plenty of spare batteries
- Water quality field meter to measure temperature, dissolved oxygen, salinity (via electrical conductivity), pH;
- Hand held thermometers (if no water quality meter is available),
- Fish measuring board,
- Ice (as necessary),
- Data sheets,
- Notebooks with “Rite-in-the-Rain” paper.

Decontamination Protocol for Field Gear

The most effective way of minimizing spread of invasive, non-native species is to prevent their introduction. Non-native species, particularly small invertebrates (snails) and plants, are often spread via field gear or other equipment used in various water bodies. Therefore, all field gear should be scrubbed and rinsed after each use, and decontaminated before using in another water body. Special care must be taken because anything coming into contact with gear can become contaminated as well. This includes such items as vehicles (inside and outside) and clothing.

Physical methods

These methods are environmentally safe, economical and practical, and are the preferred methods for decontaminating field gear. Physical methods include but are not limited to, freezing, soaking in hot water, and drying.

Freezing: Field gear should be placed in a large, clean plastic bag, sealed and placed in the vehicle before transporting back to the office. The bag should be placed in the freezer for a minimum of six hours at a temperature of less than 0 °C, preferably -3°C.

Soaking: To prevent the spread of red-rim melania (*Melanoides tuberculate*), a non-native snail species, gear should be soaked in a bath of hot water with a temperature of 50°C (the temperature for home and commercial hot water systems) for at least five minutes (Mitchell and Brandt 2005).

Drying: To prevent the spread of Eurasian watermilfoil and other invasive plants, all field gear having contact with the water should be scrubbed and rinsed thoroughly and allowed to dry for at least five days (to the extent practicable) before using it in a new body of water (University of Minnesota 2009). Desiccation will also kill aquatic invertebrates, although some invertebrates as well as some plants, can survive for relatively long periods of time if kept in damp, cool conditions.

Chemical methods

Various chemicals can kill New Zealand mudsnails (NZMS) (*Potamopyrgus antipodarum*) and other invasive invertebrates, but may not always result in 100% mortality and may be harmful to the environment. Chemicals including rinse water must be disposed of properly.

Chemical solutions and concentrations that have been used to control the spread of NZMS include Benzethonium chloride (1,940 mg/L), Commercial Solutions Formula 409® Cleaner Degreaser Disinfectant (50 percent dilution) and copper sulfate (252 mg/L copper ion). Gear should be soaked in one of the above-referenced solutions for five minutes, and rinsed with tap water away from the water body (Oregon State University 2006).

Metaquat can also be used to treat gear. For the immersion procedure, gear is placed into a large plastic bag or other container of sufficient size to allow gear to be completely immersed in decontamination solution of 5 percent Metaquat. For the spray bottle procedure, which should only be used if the above techniques cannot be used, field gear is saturated with a decontamination solution of 10 percent Metaquat (900 ml water, 100 ml Metaquat). Gear must be soaked for a minimum of 15 minutes before being removed and inspected to ensure that all debris has been removed. Gear is subsequently rinsed with fresh water, but not from sampling site (contamination). Rinse water should not be allowed to enter a storm drain or water body. The Metaquat decontamination solution should be disposed of in a sanitary fill where it can be properly treated. Under no circumstances should the solution be dumped on the ground or disposed of down a septic system.

Roccal®-D Plus, which has been used to disinfect fishery equipment, has proven effective at killing red-rim melania. Mitchell et al. (2007) found that it killed all snails exposed to 2000 mg/l for 1 hour and to 600 mg/l for 16 hours. Other effective chemicals, concentrations and exposure periods include 24 hour treatments of Hydrothol-191 (80 mg/L), nicosamide (2 mg/L), and Virkon (1600 mg/L) (Mitchell et al. 2007).

CHAPTER 5
Reporting and Adaptive Management

5.1 Reporting

A written report will be prepared for each capture and relocation event and provided to the SCH Project sponsors (CDFW, DWR, Corps) and regulatory agency (USFWS) within 30 days. The summary report will include at minimum:

- Description of Project activity that triggered protection, capture and relocation activities
- Location of activities
- Methods and equipment
- Conditions during rescue and relocation (physical habitat, water quality, etc.)
- Fish captured (species, numbers, size/age class) and desert pupfish relocated
- Information on fish condition, including mortalities
- Release site location, condition, and rationale for selection

This information will be incorporated as part of the SCH Project's overall monitoring and adaptive management program. As described in the MAMP, an annual progress report will summarize all monitoring activities and data collected for that calendar year, update prior reports in a cumulative fashion, and include raw data as well as data analysis and comparison with compliance and performance criteria, as applicable. The annual report will describe pond operations scenario, GIS maps of sampling locations, data for each monitoring element (operations, physical, water quality, and biological), habitat conditions and environmental data during monitoring, and any recommendations for improvement of the protocol.

Data, analyses, and publications developed from this monitoring plan will be organized, stored, and made publicly accessible through a commonly distributed data management system,. Common protocols will be developed and applied when possible. All geospatial data will include full metadata and will be compliant with the Federal Geographic Data Committee (FGDC) standards. CDFW will establish and maintain the data management system. The data collected as part of all components of the broader Salton Sea restoration program will be archived and made accessible in CDFW's Biogeographic Information and Observation System (BIOS) map viewer and all documentation including metadata would be accessible to the public via metadata clearinghouses and DFW's document library.

CDFW will archive the monitoring reports. Synthesis reports will be prepared at the end of Year 5, and the end of the 10-year proof-of-concept period with final recommendations for long-term

SCH management. Data management and quality control will follow guidance in the MAMP and further directions from CDFW as developed.

5.2 Adaptive Management

Procedures for desert pupfish monitoring, capture and relocation will be assessed following each event. Adjustments to the Protection and Relocation Plan may be recommended due to changing site conditions, additional phases of Project implementation, improved gear or methods, or other new information. Minor adjustments are expected to occur over the monitoring period to maintain completeness and feasibility of the monitoring program.

The scientists and managers responsible for the Project will regularly synthesize and analyze the monitoring data and evaluate the status and trends in target resources, and the effectiveness of Project activities. An overall review will be conducted annually to evaluate Project performance. A decision-making framework is established in the MAMP to provide recommendations to SCH managers for maintaining or adjusting operations (CNRA 2015).

Further details related specifically desert pupfish management will be described in the SCH Desert Pupfish Adaptive Management Plan (in prep.).

CHAPTER 6
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Appendix A
Suitable Habitat for Desert Pupfish

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These photographs by Sharon Keeney CDFW show examples of excellent habitat conditions for desert pupfish.

Figure A-1	San Felipe Creek, Imperial County
Figures A-2	Dos Palmas Preserve (S-1 Pond), Riverside County
Figures A-3 to A-4	Salt Creek (Upper and Lower), Riverside County
Figures A-5 to A-9	Irrigation drain channel habitat, as illustrated at Avenue 76 Drain at the northern end of the Salton Sea, Riverside County.
Figures A-10 to A-12	Microhabitat features (soft substrate, pondweed) and fishes, including desert pupfish and non-native fish (redbelly tilapia, sailfin molly), in irrigation drain habitat, Avenue 76 Drain, Riverside County.
Figures A-13 to A-14	Desert pupfish and other fishes (mosquitofish, redbelly tilapia) in irrigation drain habitat, Avenue 76 Drain, Riverside County.
Figure A-15	Spawning desert pupfish and male in breeding coloration, at Dos Palmas Preserve, Riverside County.

Figure A-1 – San Felipe Creek, Imperial County, toward south west end of the Salton Sea. This is one of three localities where desert pupfish naturally occur. Photo: Sharon Keeney, CDFW.

Figure A-2 – Dos Palmas Preserve, Riverside County, toward north east side of Salton Sea. The S-1 Pond shown here has excellent pupfish habitat. Photo: Sharon Keeney, CDFW.

Figure A-3 – Upper Salt Creek, Riverside County, one of three creeks where desert pupfish naturally occur. Photo: Sharon Keeney, CDFW.

Figure A-4 – Lower Salt Creek, Riverside County, one of three creeks where desert pupfish naturally occur. Photo: Sharon Keeney, CDFW.

Figure A-5 – Irrigation drain (Avenue 76), Riverside County, at the northern end of the Salton Sea. The drain has several outlet channels that provide diverse microhabitats. Note the slow-moving and clear water (not stagnant), sand-silt substrate, abundant (but not too dense) vegetation, including widgeon grass interspersed with open areas. A 2015 survey documented thousands of desert pupfish. Photo: Sharon Keeney, CDFW.

Figure A-6 – Irrigation drain (Avenue 76), Riverside County, with habitat for desert pupfish. Photo: Sharon Keeney, CDFW.

Figure A-7 – Irrigation drain (Avenue 76), Riverside County, with habitat for desert pupfish. Note floating and submerged vegetation, mixed with open areas, and clear water. Photo: Sharon Keeney, CDFW.

Figure A-8 – Irrigation drain (Avenue 76), Riverside County, with habitat for desert pupfish. Note floating and submerged vegetation, mixed with open areas, and clear water. Photo: Sharon Keeney, CDFW.

Figure A-9 – Irrigation drain (Avenue 76), Riverside County, with habitat for desert pupfish. Note aquatic vegetation, and clear slow-moving water. Photo: Sharon Keeney, CDFW.

Figure A-10 –Microhabitat features include soft substrate and submerged aquatic vegetation (wigeongrass) in irrigation drain (Avenue 76), Riverside County. Photo: Sharon Keeney, CDFW.

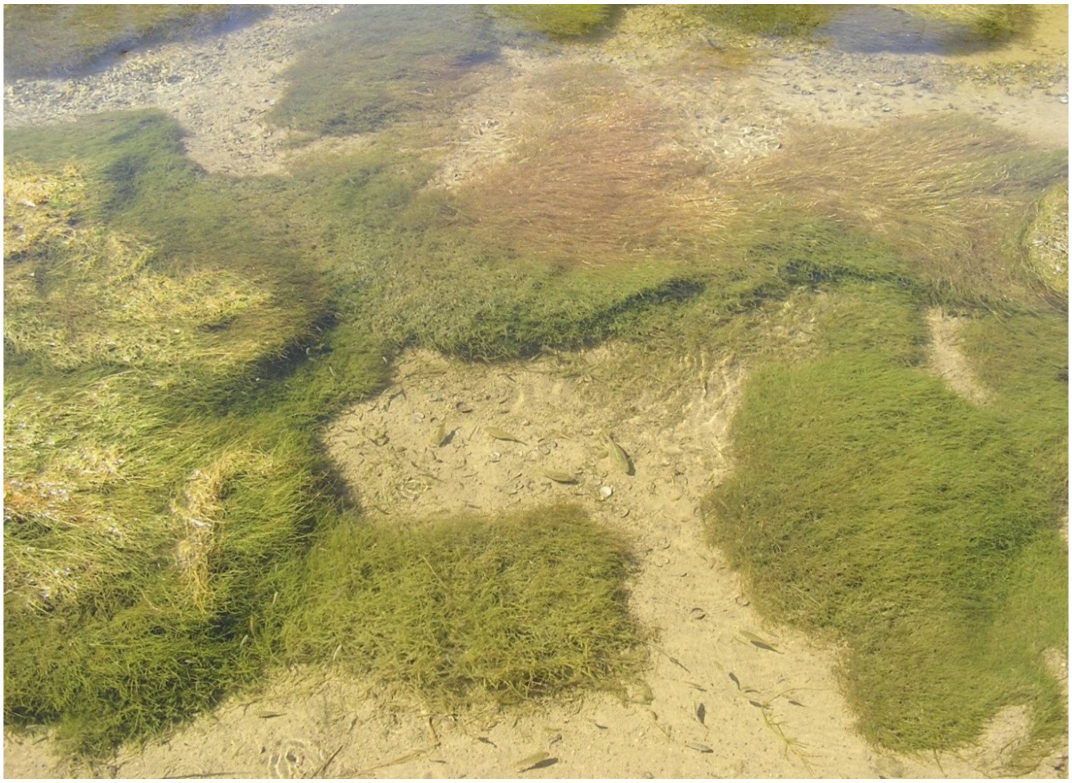

Figure A-11 – Desert pupfish and non-native fishes in drain habitat, with soft substrate and submerged aquatic vegetation (wigeongrass) in irrigation drain habitat, Riverside County. Photo: Sharon Keeney, CDFW.

Figure A-12 – Desert pupfish and non-native fishes (mostly porthole livebearer) in irrigation drain habitat, Riverside County. Photo: Sharon Keeney, CDFW.

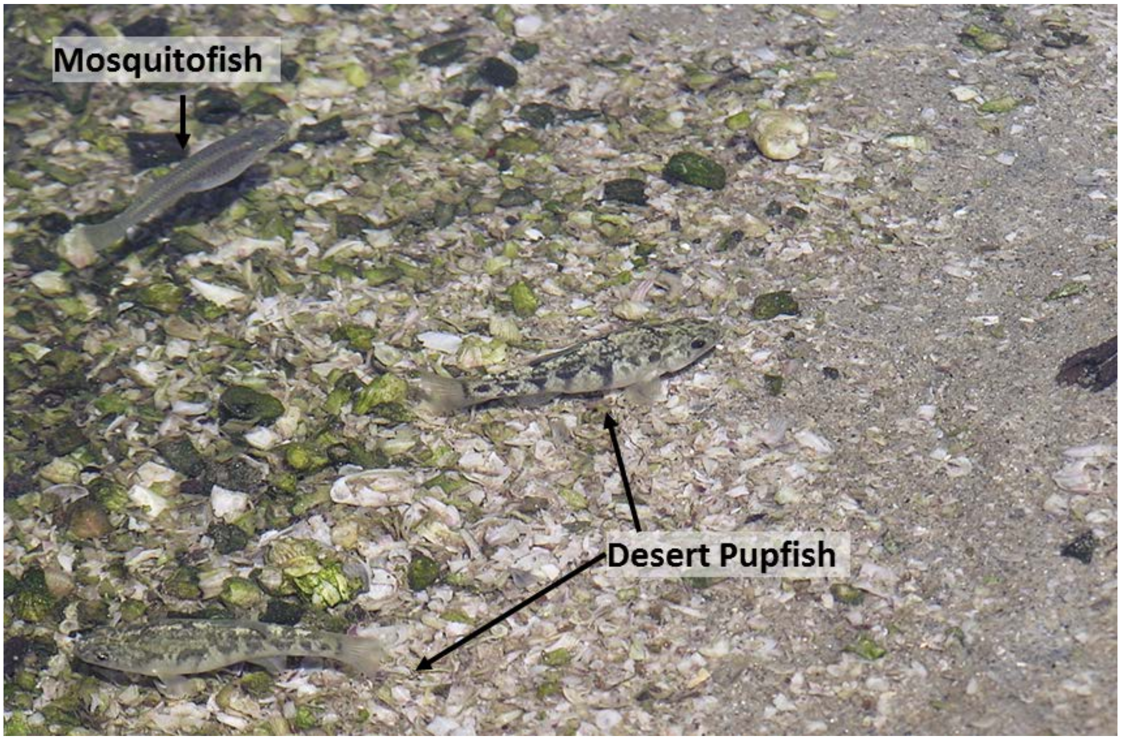

Figure A-13 – Desert pupfish and mosquitofish in an irrigation drain at the north Salton Sea (Arthur 0.5 Drain, Riverside County), showing preferred habitat (soft substrate with structure, and shallow, clear, slow-moving water). Photo: Sharon Keeney, CDFW.

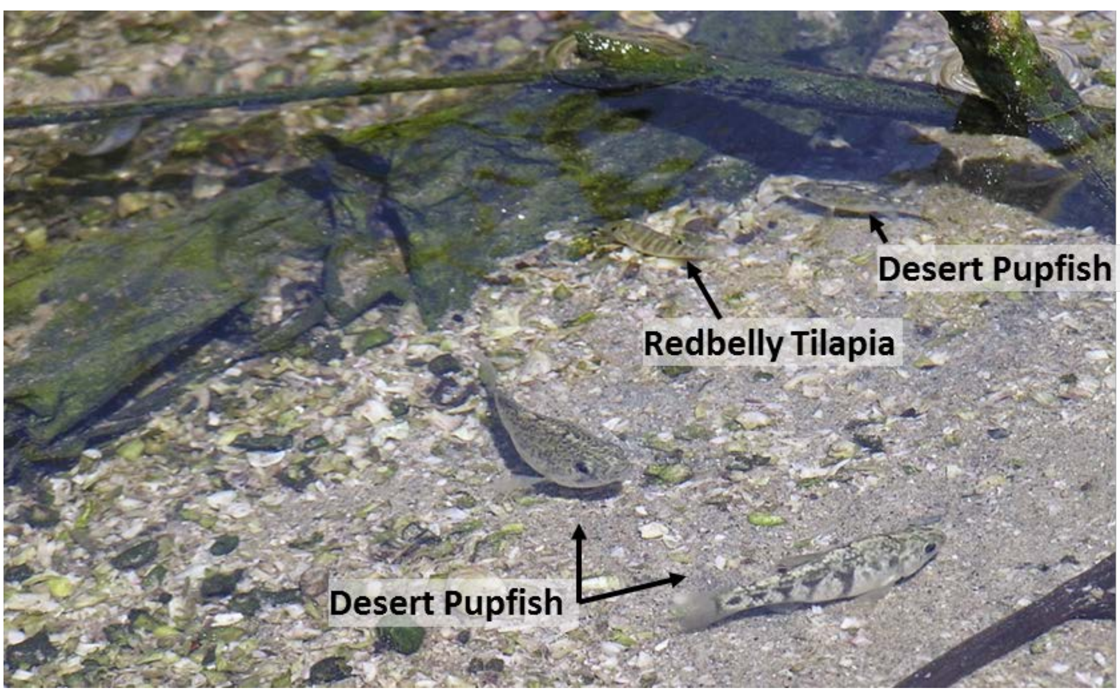

Figure A-14 – Desert pupfish and juvenile redbelly tilapia in an irrigation drain at the north Salton Sea (Arthur 0.5 Drain, Riverside County), showing soft substrate with structure and shallow, clear, slow-moving water. Photo: Sharon Keeney, CDFW.

Figure A-15 - Spawning pair of desert pupfish (above and below), and male pupfish in blue breeding coloration (right), at the Dos Palmas Preserve, Riverside County. Photos: Sharon Keeney, CDFW

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Appendix B
Datasheet

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IID Desert Pupfish Trapping Form

Observer: **Date:**

Drain Name: ______________________________

Drain Information:

Length: __________ Width: __________ Depth: __________

Vegetation: ______________________________

Vegetation Density:: ______________________________

Bank Slope*: ______________________________

Salinity: _______________ Conductivity: _______________

Temperature: _______________ TDS: _______________

Turbidity: _______________ Dissolved Oxygen: _______________

pH: _______________ Connectivity: ☐ Yes ☐ No

Water Velocity*: _______________ Substrate: _______________

Traps:

Number of Traps: ______ Spaced: ______ feet apart.

Trap #	Start Time	End Time	Desert Pupfish	Mosquitofish	Sailfin Molly	Tilapia	Red Shiner	
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Others (snails, crayfish, etc.): ______________________________

NOTES:

Map of Area

Sketch area of drain trapping. (Note where traps are located by number)

Total Fish Species:

Species	**Total Number**	**Male/Female**	**Length (range)**
Desert Pupfish			
Mosquitofish			
Sailfin Molly			
Tilapia			
Red Shiner			

*Bank Slope: Gentle, Moderate or Steep Water Velocity: Slow, Medium or High