AQUATIC PREDATOR AND COMPETITOR MINIMIZATION PLAN
FOR THE PRADO WETLANDS

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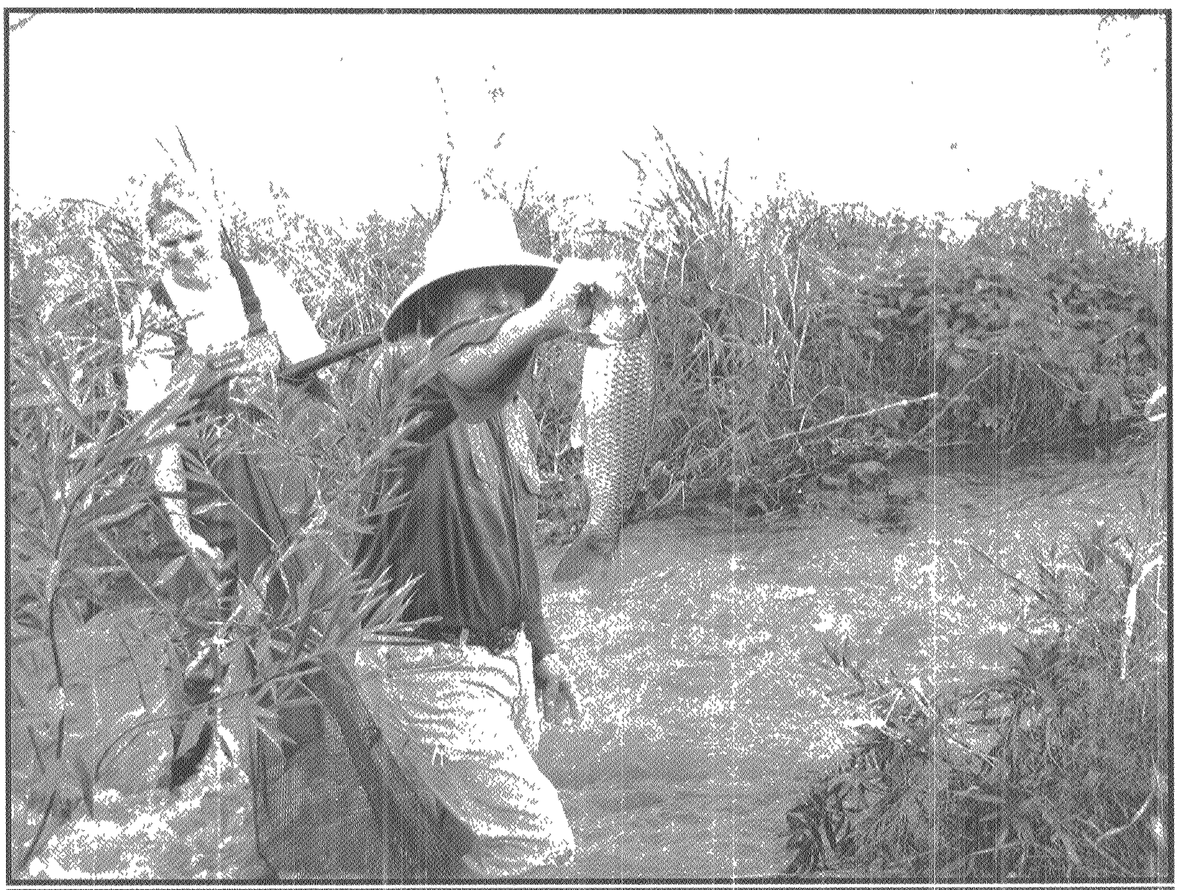

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1.0 INTRODUCTION

The Santa Ana Watershed is a diverse collection of streams and creeks that covers an area of approximately 3200 square miles. The watershed drains into the Santa Ana River and provides a year round source of water downstream in Riverside and Orange Counties. While traveling down the river, this water receives input from a variety of sources, including storm run-off, groundwater upwelling, urban run-off, agricultural run-off, and tertiary treated wastewater. All of these inputs affect the water quality and quantity. However, the creation of the Prado Dam in 1941 and additional flood control enhancements had the most drastic affects on the river (see Figure 1).

The Santa Ana River historically flowed from the upper watershed and meandered through Riverside County. The Santa Ana Canyon acted as a natural "bottleneck" in the river. After this bottleneck, the river continued its meandering and spread-out through much of Orange County, ranging from as far south as the Newport Back Bay and as far north as Los Alamitos. The Prado Dam was constructed in 1941 to control the river's storm flows. The dam not only slowed the flow of the Santa Ana River, it stopped the sediment. Sand originating from the upper watershed that once made its way down to the Orange County coast now reached a barrier. Impounding the water behind the dam caused the river to drop its load of sand, depositing in the river channels and on the banks. The once cobblestone and boulder-lined river bottom was converted into a flat-bottomed shifting sand substrate. Many of the native aquatic species that depended upon the river to feed and spawn suffered drastic decreases in numbers as a result.

What used to be a freely meandering stream with an ephemeral pool that formed at the narrows, became much more aquatic with a big lake and pools consistently present just behind the dam. The habitat there, in the Prado Flood Control Basin had become ideal for the proliferation of non-native aquatic species. They were released or 'introduced' into the river system and even the terrestrial environment both intentionally and accidentally. Most of these non-indigenous or non-native species were unable to form self-sustaining populations. However, a significant number of these species did become established and are thriving, adversely affecting native populations. Non-native species out-compete, prey upon, or bring diseases or parasites to ecologically valuable native species, further altering the ecosystem in the process.

This Aquatic Predator and Competitor Minimization Plan (Plan) has been prepared by the Orange County Water District (OCWD) to address the control of non-indigenous aquatic predatory species along portions of the Santa Ana River within the Prado Basin. As shown in Figure 2, this includes the river reach extending from River Road Bridge downstream to Prado Dam within portions of Riverside and San Bernardino Counties. The Plan has been developed in part to satisfy mitigation commitments made by OCWD as outlined in the Prado Basin Water Conservation Feasibility Study (ACOE, 2005) and to comply with stipulations contained in the Biological Opinion for the project (USFWS, February 2000).

1.1 BACKGROUND

Within the Prado Flood Control Basin, OCWD owns approximately 2,100 acres and operates 500 acres of constructed wetlands for the purpose of water quality enhancement. The Santa Ana River supplies the water to these wetlands via a diversion channel that takes about half the flow of the river. The fish within the river enter the wetlands as well. In these ponds, only the fish that are adapted to shallow, slow moving water survive. All others are out-competed or preyed upon. Since the native fish of the Santa Ana River are not well adapted to this type of habitat, they do not do well in this system. However, exotic species tend to thrive under these conditions. Thus, the OCWD Wetlands tend to concentrate these exotic species and act as a source for further non-native invasion of the river system. This is perpetrated when water is impounded behind the dam and the non-natives gain ready access to the Santa Ana River and the three creeks that confluence with the river in the Basin.

In order to ensure the survival of the native fish and amphibians in the river, populations of these exotic species must be controlled. Many of these species out-compete the native species for important resources such as food and breeding habitat. In many cases, these species act as predators on the native fish, and have a distinctly unnatural advantage. The intent of this document is to provide a plan to eliminate or significantly reduce exotic species within the basin, and more specifically, in the constructed wetland system. Eradication of these species may not be economically feasible; however, their numbers may be significantly decreased with the implementation of a well thought out program, enhancing the chance for survival of the natives.

1.2 OBJECTIVES

The primary objectives of this plan are to determine the most effective and efficient means of reducing or eliminating the exotic fish, invertebrates, reptiles, and amphibian species from the Prado wetlands, implementing control adaptively, and constantly evaluating and reporting results. There is a variety of techniques and methods that can be used either singly or in combination to control exotic species. The relative effectiveness of these practices will vary with the nature of the habitat, the target species, and the intensity of the control effort.

While eradication of target species and minimization of impacts to non-target species is the primary goal of any control effort, other important considerations include cost-effectiveness of the practice(s), and the time frame over which re-treatment/reapplication is necessary (Holland 2000). These and other considerations will be part of the regular evaluation of the effectiveness of the control plan. Obviously, there exists a potential to invest a very large amount of money, time and other resources into efforts to control exotics. Given the nature and extent of the problems, there is a very real possibility that these efforts will be inadequate or ineffective in the short- and long-term unless considerable care is given to defining the functional goals of the effort(s), providing a rigorous means for periodically assessing the degree of success (and revising methods if necessary), and allocation of sufficient resources to accomplish the defined goals (Holland 2000).

2.0 NATIVE AQUATIC SPECIES OF THE PRADO BASIN

There are seven species of fish endemic to the Santa Ana River, but only three are still found today. The Santa Ana sucker (*Catostomus santaanae*), now federally listed as threatened, the Santa Ana speckled dace (*Rhinichthys osculus* ssp.), and the arroyo chub (*Gila orcutti*). Of these three species, only two, the sucker and the chub, have been collected on the Santa Ana River near the OCWD wetlands. Native amphibians include the western toad (*Bufo boreas*) and the Pacific tree frog (*Psuedacris regilla*). Red-legged frogs (*Rana aurora*) were once detected in the Prado Basin (Zembal et al 1985), but have not been documented since. Aquatic reptiles include the California red-sided garter snake (Thamnophis sirtalis infernalis) and past reports (Zembal et al. 1985) indicated that western pond turtles (*Clemmys marmorata*) were present although they have not been seen in recent years.

The following (see Table 1) is a summary of the various indigenous species currently found in the river system, in or near the Prado Basin. A more detailed account of each species is provided below in Section 8.

TABLE 1
NATIVE AQUATIC SPECIES DETECTED WITHIN THE PRADO BASIN AND SURROUNDING AREA

COMMON NAME	SCIENTIFIC NAME	FEDERAL/STATE STATUS
FISH		
Santa Ana sucker	*Catostomus santaanae*	T/SSC
Arroyo chub	*Gila orcutti*	N/SSC
Santa Ana speckled dace	*Rhinichthys osculus ssp*	N/N
AMPHIBIANS		
Western toad	*Bufo boreas*	N/N
Pacific tree frog	*Psuedacris regilla*	N/N
California red-legged frog	*Rana aurora draytonii*	E/T
REPTILES		
Western pond turtle	*Clemmys marmorata*	N/SSC
Red-sided garter	*Thamnophis sirtalis infernalis*	N/SSC

E – Endangered Species
T – Threatened Species
SSC – Species of Special Concern
N - None

3.0 NON-NATIVE AQUATIC SPECIES IN THE PRADO BASIN

For the purposes of this document, exotic species are defined as "non-indigenous species that have been introduced, either knowingly or accidentally, to the Santa Ana River or the Prado Wetlands." In other words, these species have been added to the river for economic purposes, sport fishing, or for the purpose of disposal.

Exotic species surveys were conducted at the diversion structure, in the diversion channel, and within the ponds by a contract ichthyologist, Camm Swift (1999-2000), as well as OCWD staff. Results of these surveys are summarized in Table 2. More detailed information on each species is provided below in Section 9 of this report.

TABLE 2
NON-NATIVE AQUATIC SPECIES DETECTED WITHIN THE PRADO BASIN AND SURROUNDING AREA

COMMON NAME	SCIENTIFIC NAME	IMPACT
FISH		
Goldfish	*Carassius auratus*	Habitat disturbance
Common carp	*Cyprinus carpio*	Habitat disturbance, may feed on native eggs
Fathead minnow	*Pimephales promelas*	Competition with arroyo chub
Black bullhead	*Ameiurus melas*	Feed at night on small fish
Yellow bullhead	*Ameiurus natalis*	Feed at night on small fish
Inland silverside	*Menidia beryllina*	May feed on native larvae
Mosquitofish	*Gambusia affinis*	Aggressive, competition for food, preys on native eggs and fry
Mozambique tilapia	*Oreochromis mossambicus*	Territorial, competition for habitat
Inland prickly sculpin	*Cottus asper ssp.*	Competition for habitat
Green sunfish	*Lepomis cyanellus*	Territorial, competition for habitat
Bluegill	*Lepomis macrochirus*	Territorial, competition for habitat, very prolific reproducer
Largemouth bass	*Micropterus salmoides*	Predation on smaller fish and amphibians
AMPHIBIANS		
Bullfrog	*Rana catesbeiana*	Fierce predator
African clawed frog	*Xenopus laevis*	Opportunistic predator
REPTILES		
Spiny softshell turtle	*Apalone spinifera*	Competition for native turtles
Red-eared slider	*Trachemys scripta elegans*	Competition for native turtles
American alligator	*Alligator mississippiensis*	Predator, habitat destruction
INVERTEBRATES		
Red swamp crayfish	*Procambarus clarkii*	Predation and very prolific reproducer

4.0 POTENTIAL CONTROL METHODS

It is anticipated that a combination of active techniques, such as electro-fishing and seining and passive techniques, such as gill netting and trapping will be used to control aquatic predators. In addition it may be advantageous to utilize a combination of these active and passive techniques concurrently to maximize potential synergistic effects. The techniques contemplated for use in this program include diversion design and operation, exclusion with barriers including fencing and inlet structures, de-watering, seining, electro-shocking, trapping, shooting, and gigging.

In order to minimize recruitment and re-colonization, the eradication efforts will begin where water first enters the system at the diversion structure and continue down through the system. Isolated areas that can easily be defended will also be treated if warranted to efficiently reduce the number of exotics in the pool feeding the diversion pipes. A large seine will be used to capture the majority of the large fish and other exotics. The diversion design and fish barriers (fish exclusion devices) will also be incorporated to keep exotics from entering the diversion channel. The difficulty will be designing a barrier that will keep small exotics out and will not easily clog with floating debris. Additionally, care will be taken in this area because of the potential for the presence of both suckers and chubs.

Some of the invasive species will make it into the diversion channel. Minimizing their abundance and interfering with breeding will be done with a combination of seining, electro-fishing, and traps. In addition, gill nets will be set in the upper end where the water is deep enough and shooting and gigging will be conducted to eradicate bullfrogs along the channel. Since suckers were detected in the old diversion channel, care will be taken to avoid any potential take of the species.

Finally, any unwanted aquatic species that do make it into the pond system will periodically be denied their most essential habitat requirement, water. The ponds will be dried in a sequential order starting from the eastern-most ponds. The ponds will be dewatered and then thoroughly seined. Fish barriers will be placed around each pond until adjacent ponds have been cleared. Care will be taken to ensure that red-sided garter snakes and native amphibians are not excluded from their habitat particularly foraging areas. Trapping, shooting, and gigging will also be employed on the ponds. The difficulty in the pond system will be the frequent inundation of the ponds from backwater held behind the dam. Additionally, high flows on the Santa Ana River often result in over-banking and eventual flooding of the pond system. The procedures discussed above will be part of the ongoing program. Each of the control methods intended for immediate use is described below. It should be noted that additional techniques could certainly be added as the program adaptively evolves.

4.1 Seining

Seining involves the dragging of nets through the water systematically and repeatedly enough to capture most of what is in the pond. This is an effective way to capture large numbers of fish and is relatively harmless to many of the fish, amphibians, and invertebrates. The length and mesh size of the seine used depends upon the target species. For smaller fish such as mosquitofish, a ⅜ inch or even ¼ inch mesh may be used, while for adult bass or other large species a 1-2 inch mesh might be used. The size of the mesh constrains the length of the net, as does the nature of the watercourse. Use of a very small mesh seine beyond 20-25 feet in length becomes very difficult due to the drag of the net, and the tendency to collect mud and other debris from the substrate adding the weight difficulty. Also, the extreme drag and slow haul speed with such a net allows many of the more rapidly swimming fishes to escape. Larger mesh seines, on the other hand, may be easier to haul but miss many if not most of the smaller species and individuals (Holland 2000). Seining is a useful control method, especially when used in combination with other techniques such as dewatering and electro-shocking.

4.2 Electro-shocking

Electro-shocking involves the use of pulsed direct current from a backpack-mounted shocker. The electrical current causes two types of reactions in fish. The first type is referred to as taxis. In this reaction, fish are both attracted to, and repelled from the electric field. Fish can be "herded" into nets by applying a low voltage current that is used to guide them into the nets. This method is extremely effective and can be done with little damage to the fish. The other reaction is referred to as tetany. This reaction results in the paralysis of the fish. This condition usually occurs when the fish is too close to the anode or if the voltage is too high. Tetany usually is believed to cause damage to the fish especially in the vertebrates. Since the overall goal is to eliminate the fish in the system, this option may be more effective than simple taxis. However, if it is done in areas where native fish are present, then undue harm may occur to those species.

4.3 Dewatering

Dewatering of ponded water can be a very effective (up to 100%) method to control fish. This method involves shutting off the flow to the area and allowing the pond to dewater. As pools of water form, seines can be pulled through them to capture the large amounts of fish that have concentrated in these areas. Periodic drying of the ponds can assist in eliminating new recruitment into the pond systems. Dewatering tends to have little effect on species that can migrate on land. Crayfish and bullfrogs can travel great distances if water sources become scarce. Dewatering will be an effective means of reducing fish in the constructed wetland system, but the river and diversion channel will not be able to be fully dewatered. When water is returned to the area, it must be free of exotic species or recruitment will occur quickly. Nets and screens will be placed at the entrance of each pond.

4.4 Gill netting

Gill netting involves the placement of a net across a watercourse. Gill nets capture fish and hold them in place. The fish are captured by the gills or the operculum, and since the fish cannot swim and move water over the gills, the fish dies. Gill nets can be effective for some species but tend to allow smaller specimens through. In addition, there is a high probability of non-target mortality. This includes not only native fishes, but also diving birds. Non-target mortality will be minimized by monitoring the nets closely when working sensitive areas. Gill nets may work in the diversion channel and near the weir boxes of the ponds, but would not be applicable in most of the ponds.

4.5 Traps

A variety of traps are sold that are used to capture fish, amphibians, and invertebrates. Costs per trap can be as high as $1,000 or more. Traps need to be of the appropriate size and configuration for the target species. Traps will be baited and placed in specific areas and checked in the morning and afternoon. Trapping can be very effective in small areas, but the effectiveness is proportionate to the number of traps in large areas. Winter flood flows will warrant the temporary removal of traps and replacement after water levels subside.

4.6 Shooting/Gigging

Shooting and gigging can be very effective means of control bullfrogs. For adult bullfrogs, use of shotguns is recommended, given the conditions under which animals are observed and the variability in the skill of the gunman. Existing data indicates an approximate 99% kill ratio for adult bullfrogs when using shotguns. For metamorphic bullfrogs, use of pistols with shot shell is recommended due to the decreased costs and the often very large number of small frogs in a given area. Shooting can be a highly effective means of removing both sub-adult and adult bullfrogs, however, it is fairly costly per animal removed, and does not deal with their early life-history stages (eggs and larvae).

Gigging involves the use of a hook-like tip attached to a long pole. This method would involve less training of staff and would be a less costly control measure then shooting. Groups of volunteers, such as local boy-scout troops, will be used to implement this method.

4.7 Chemical Control

Chemicals such as rotenone can be added to the water to eliminate some of the exotics. The chemical works by blocking the uptake of oxygen through the gills, which results in suffocation. This product is effective on fish and some stages of amphibians. It does not work well with species that can disperse or are not tied to the water for oxygen. Rotenone naturally breaks down over the course of 1-2 weeks, so it could only be used in isolated ponds. Use of Rotenone is restricted and it can only be applied by certified applicators. Petroleum/hydrocarbon based additives may be mixed in and persist much longer in the environment, potentially contaminating the drinking water supply.

5.0 TIMING OF CONTROL EFFORTS

This Plan has been prepared in the wake of the winter 2004-2005 storms which resulted in widespread flooding and damage to OCWD's Constructed Wetlands within the Prado Basin. This plan will be implemented concurrently with the reconstruction of the wetlands because of the efficiencies gained by controlling the exotics as water is re-introduced to the wetlands.

The timing of control efforts is critical for several reasons. First, sensitive species (such as the eggs and/or larvae of Santa Ana sucker) may be present in some target areas. Thus, control efforts should be timed to minimize or eliminate disturbance (and possible take) of non-target species. Sometimes this may not be possible. However, in relation to the potential benefits of removing exotics (which may prey on these species), the loss or diminution of a particular cohort may be an acceptable trade-off (Holland 2000).

Secondly, some species of exotics undergo significant natural reductions in population size and local distribution over the course of the year. Control efforts will be timed to take advantage of this, minimizing cost and maximizing effectiveness. For example, mosquitofish populations seem to be significantly reduced (up to 90+%) in many watercourses following flood events. Immediately following flood events, the amount of habitat in need of control efforts is often minimized with fish concentrated in the remaining flowing-water areas and small overflow pools lateral to the watercourse. Removal of mosquitofish (if done prior to the onset of normal breeding activity and following floods) may be cost-effective. Prompt control efforts are of particular importance for this species, given the rapidity with which mosquitofish mature (3+ weeks) and their ability to produce several generations within a very short period of time (Holland 2000).

And finally, it is important to capitalize on vulnerable points in the life history of the various species. Largemouth bass for instance, reproduce relatively early, as water temperatures reach 10° C (50° F), whereas green sunfish, the bullheads, and mosquitofish need water temperatures of 15° C (60° F) or warmer. At least a portion of our control efforts for these species will focus on removing adults before they have an opportunity to spawn (Holland 2000).

6.0 IMPLEMENTATION PLAN

Major effort will be initiated concurrently with the re-introduction of water to the wetlands following their reconstruction. This will be an ideal time for control work while a number of the ponds are already dry hence there are fewer exotics with which to deal. Many of the other ponds will be dewatered and excavated as part of the reconstruction effort. The diversion channel is presently full of sediment and will have to be reestablished. Preventive control measures such as exclusion devices will be installed in these areas before water courses through them. If possible, gill nets will be set when water is released back into the ponds or diversion channel, to keep fish and amphibians from invading. This won't do anything for eggs and larvae, nets fine enough to capture them would constantly clog or get blown out.

Once the ponds are back online, the first line of defense will still be exclusion devices installed to keep exotics out of the system. The wetland dikes and berms will be reinforced during re-construction reducing the chances of breeching or over-banking of the river that would reintroduce exotics. The dewatering schedule for the ponds will be used to efficiently coordinate maintenance requirements and exotic control.

Low Barrier fences of shade cloth will be placed strategically around the edges of cleared ponds to keep re-invaders out. However, one potential problem is that fencing may not work to control bullfrogs since they have been known to climb over 6 foot fences. We will continue to field-test various designs and strive for one that works. Care will be taken to ensure that red-sided garter snakes and native amphibians are not excluded from essential habitat areas.

This control program is a long term management strategy. Complete elimination of all undesirable exotic species is not likely since the source water contains exotics and the inundation episodes will re-infest the wetland system. Every time the system is inundated or the river breeches, exotics will be re-deposited in the wetlands. However, we will strive for maximal reductions of non-native populations and will begin trials with control techniques in 2006.

Beginning in 2006 a detailed implementation plan for the following year will be included in the annual report. As control efforts continue, beginning with trials in 2006 efficiencies of the various techniques will become more apparent and the implementation strategy for the following year will reflect what has been learned. In the short term a more detailed strategy will be developed to minimize the re-introduction of non-natives to the wetlands when they come back online. As currently scheduled they will be operational in 2007. Longer term goals and implementation strategies will be developed adaptively thereafter.

7.0 RE-INTRODUCTION OF NATIVE SPECIES

Successful reduction of exotic organisms in the basin will result in the short-term loss of resources. Although non-native, some of the exotic species provide an important food source for a variety of wildlife in the wetlands and also serve as agents of vector control (presently, mosquitofish are captively bred and released into the Prado basin and surrounding area by several vector control agencies to help control/eliminate mosquito larvae.) A native fish breeding program will be developed in the basin in an effort to compensate for these losses.

Two small ponds have been constructed behind the OCWD trailers. These ponds will be used to breed arroyo chubs and/or stickleback for introduction into the ponds and the diversion channel. Arroyo chub were chosen because, one they tolerate warmer and lower gradient water than speckled dace and Santa Ana sucker, two it is believed that they will be a good vector control agent for mosquitoes throughout the wetland system, and finally they are hardy breeders and can multiply quite rapidly. The stickleback would be important in mosquito control within the pond areas dominated by dense cattails, whereas the chub feed in more open water. There are a few locations in the upper watershed where stickleback still occur, that could serve as sources of these fish.

These captively raised fish will be released into an "exotic free" experimental pond in the wetland system. They will be evaluated on their ability to adapt to the warm, shallow water and their effectiveness to control mosquito larvae. If the experiment is successful, they will be introduced into other ponds throughout the wetland system.

Chub and stickleback make the most sense for re-introduction into the Prado system and there is a strong interest from the University of California at Riverside to partner in the implementation of these efforts.

Because the fish will be reared under monitored conditions before introduction to the ponds, they should be considered part of an experimental population and an adaptive research program that will eventually lead to their proliferation. Enough of these native fishes would need to be introduced that they have a high chance of survival and when the ponds are drained for maintenance, the fish will be seined and moved to temporary refugia in the artificial stream or into adjacent ponds. Care will be taken to capture and move as many fishes as possible but if the program is successful, there may be some losses during maintenance operations. This should be considered insignificant if the program is successful but this and other potential issues will be worked out with the wildlife agencies prior to implementing this part of our strategy.

The details of a plan for native fish rearing and release, to bring back the natives will be worked out with the California Department of Fish and Game and the US Fish and Wildlife Service.

8.0 NATIVE AQUATIC SPECIES ACCOUNTS

8.1 Fish

8.11 Santa Ana sucker

The Santa Ana sucker (*Catostomus santaanae*) is a member of the Catostomidae family of suckers. It is the only native member of this family found in the coastal drainages of southern California. The sucker is a relatively small sucker only reaching lengths of 6.3 inches when mature. The sucker is silvery below and darker along the back, with irregular blotches and pigmented membranes connecting the rays of the tail (Moyle 1976). The sucker is primarily a bottom feeder. The lower lip contains cartilaginous ridges that allow suckers to scrape algae, diatoms and detritus from the surface of rocks and other hard substrates. Aquatic insects make up a smaller portion of the suckers diet; however, larger fish generally feed more on insects than do the smaller ones (Greenfield et al. 1970). The Santa Ana sucker inhabits streams that are generally small and shallow, permanent streams. The streams are narrow usually only 5-8 meters wide and only about 15-30 cm deep. The Santa Ana sucker prefers streams with rocky substrate, clear and cool water, and vegetation cover on the sides. However, there has been some evidence that usable substrates may include sand. Flow must be present within the stream but it can vary from slight to swift. Native streams frequently have large flows due to flood events, and the sucker seams capable of coping with the increased flow and turbidity.

The Santa Ana sucker historically was native to the rivers and larger streams of the Los Angeles Basin: the Los Angeles, San Gabriel, and Santa Ana River drainage systems in Los Angeles, Orange, Riverside, and San Bernardino Counties (Smith 1966). Once considered common in the 1970's (Moyle 1976), the species experienced declines throughout most of its ranges (Swift et al. 1993). The species now only occurs in three non-connected populations on the lower Big Tujunga Creek (Los Angeles River Drainage), the east and north forks of the San Gabriel River, and the lower and middle Santa Ana River. A fourth population of Santa Ana suckers exists on the Santa Clara River in Ventura, but it is presumed to be an introduced population (USFWS 2000). In 1999, the USFWS proposed a threatened status for the sucker in the Los Angeles, San Gabriel, and Santa Ana Rivers (64 FR 3915). Finally, on April 12, 2000, the Santa Ana sucker was listed as threatened by the USFWS (65 FR 19686).

To this date, no suckers have been found within the pond system. During a yearlong study (Swift 1999-2000), suckers were detected within the diversion channel and at the diversion structure.

8.12 Arroyo chub

The arroyo chub (*Gila orcutti*) is a native minnow. It is a small, chunky fish that is gray-olive green on the back and has a white belly. They have fairly large eyes and small mouths. The fish can reach lengths as long at 120mm SL, but typical lengths are in the 70-80 mm range. Arroyo chubs eat algae and small insects and other invertebrates they find on plants or on the bottom.

Arroyo chubs live in slow moving or back water sections of warm to cool streams. Depths are typically greater than 40 cm. The typical substrate is composed of gravel, sand or mud. Chub attach their eggs to vegetation in slow to moderate flows at about 60 to 70° F. Most spawning is from about late March to June, often with a hiatus in summer, and then occasionally with some reproduction again in the fall (Tres 1992). During breeding season, males develop tubercles on their pectoral fins.

Arroyo chubs and smaller sucker are often found schooling together in sections of the Santa Ana River. The chub has been detected occasionally on the River near the diversion structure, but never in the diversion channel or in the ponds.

8.13 Santa Ana speckled dace

The Santa Ana speckled dace (*Rhinichthys osculus ssp*) typically have a dark olive back and side and have distinctive black speckles. Small gold specks can be seen on the back and on the sides. There is a dusky stripe along the side that continues through the eye and onto the snout. The snout is pointy and overhangs the mouth.

Speckled dace require permanent flowing streams with cool water. They are found in shallow cobble and gravel riffles. Small populations of speckled dace were detected in the past on tributaries of the Santa Ana River, but no recent sightings have been recorded on the lower Santa Ana River. Based on the higher temperatures and the sand substrate of the river in the project area, it is highly unlikely that speckled dace would survive in the area.

8.2 Amphibians

8.21 Western toad

The western toad (*Bufo boreas*) is a common toad of the Prado Basin. It is a large toad with dry, bumpy skin, two horny tubercles on its hind feet. It has distinct oval parotoid glands, and horizontal pupils. It ranges from reddish-brown to gray to olive green in color with a cream-colored stripe running down the middle of the back. The underside is yellow or cream color with dark blotches. Males are up to 4 ¼ inches in length and female are up to 5 inches. Tadpoles aggregate and are dark in color. Adults are distinct from other frogs and toads in that they walk rather than hop.

The toads are nocturnal and burrow into the soil during the day using the horny tubercles on their hind feet to assist in digging. They may hide in woody debris or in abandoned burrows of small mammals as well. Adults feed on flying insects, spiders, crayfish and earthworms. Larvae eat suspended plant material and detritus. When the toads are threatened they excrete a mild white poison from their parotoid glands and warts. Breeding can occur from February to April. Males do not have a mating call like most other frogs and toads. Females deposit eggs in two long strings of up to 2 meters in length, with an average of 12,000 eggs per clutch.

Bufo boreas has been separated into two subspecies. The California sub-species is *B. boreas halophilus*.

8.22 Pacific tree frog

The Pacific tree frog (*Psuedacris regilla*) is a small tree frog with large head and eyes, a slim waist, round pads on the toe tips. They have limited webbing between the toes. The color is variable including green, tan, brown, gray, reddish, and cream but is most often green or brown. All Pacific tree frogs will have a dark stripe through the middle of the eye, extending from the nostrils to the shoulders and often there is a Y-shaped marking between the eyes. The male's throat is darkened and wrinkled. Tadpoles are brown, up to 1 7/8 inches long (4.7 cm.)

The voice of the Pacific tree frog is distinctive and well known. It is a high-pitched, loud and two parted, typically described as rib-it, or krek-ek, with the last syllable rising in inflection. They are very loud and can be heard throughout the basin, often drowning out the sounds of other nocturnal inhabitants.

The frog is chiefly a ground dweller living among the grass and shrubs near the ponds. The large toe pads allow them to climb easily. They are both active during the day and night.

8.23 California red-legged frog

The California red-legged frog (*Rana aurora draytonii*) is a federally listed, threatened species. It is a large brown to reddish brown frog with prominent dorsolateral folds. It has moderate size spots that sometimes have light centers. The belly and the underside of the thighs, legs, and feet are red, and some individuals may have red pigment on the all undersurfaces. The California red-legged frogs prefer dense, shrubby riparian vegetation associated with deep (0.7 m), still or slow-moving water. The riparian vegetation that structurally seems to be most suitable is that provided by arroyo willow (*Salix lasiolepis*), cattails (*Typha* sp.) and bulrush (*Scirpus* sp.). To avoid avian predators, the frog is highly nocturnal. Juveniles may be less wary and may spend much of the daytime basking in the sun. Red-legged frogs feed on other frogs and even small mammal prey.

The California red-legged frog has been decreasing in numbers due to commercial exploitation and the introduction of exotic species such as the bullfrog. Historic sightings of this species were documented in the Prado Basin in the mid eighties. However, no current sightings of the frog have been made.

8.3 Reptiles

8.31 Western pond turtle

The western pond turtle (*Clemmys marmorata*) is a moderate sized, drab brown or khaki colored turtle lacking prominent markings on its carapace. Western pond turtles have a blunt nose and black spots or blotches on the light-colored head. This differs from introduced species that have stripes or whorls on the head. Western pond turtles are aquatic but leave the water to reproduce or over winter. In southern California where winters are mild, western pond turtles may be active all year. They are often seen sunning themselves on banks or on logs to keep warm.

Western pond turtles require slack or slow water habitat. They are dietary generalists and will consume anything they are able to catch and overpower. Because of their lack of speed, their prey usually consists of slow-moving aquatic invertebrates and carrion, but vegetation may also be eaten.

Western pond turtles mate in late April or early May. Nests are dug in soils with high clay or silt content and 1-13 eggs are deposited. The young hatch and may winter in the nest. Hatchlings spend much of their time feeding in shallow water with dense emergents, feeding on Nekton.

The population of western pond turtles has rapidly declined. No sightings of the species have been made within the basin in recent years.

8.32 Red-sided garter

The red-sided garter (*Thamnophis sirtalis infernalis*) is an aquatic snake. It is dark olive to nearly black with red blotches. The head is olive with well defined eyes and a red tongue. It has a yellow mid-dorsal stripe and a lateral stripe on each side. They have a yellow-green or blue vent and the female's tail immediately constricts after it. When handled, this snake will excrete a foul smelling musk.

Red-sided garters are associated with extensive riparian areas and are closely associated with water. They are typically found near marshes, ponds, or slow moving water. They use these areas for foraging. Their diet typically includes toads, frogs, earthworms, and fish. Occasional invertebrates, mice, and small birds may be taken.

Red-sided garters are active from March to October, but may be active on warm, winter days. Otherwise, they are hibernating. Upon emerging from hibernation, they will mate and feed and then return to the hibernaculum.

Red-sided garters are found throughout the wetlands near the ponds. They are a California Department of Fish and Game Species of Special Concern.

9.0 NON-NATIVE AQUATIC SPECIES ACCOUNTS

9.1 Fish

9.11 Goldfish

The goldfish (*Carassius auratus*) is probably the most familiar species of exotic fish, since many people have had them at one time or another. These fish are deep bodied, with a long dorsal fin. They have spines at the beginning of the dorsal and the anal fin. They tend to loose the gold color in the wild, and are more often seen as an olive green color. Goldfish differ from carp by having only two barbels that are so small that they would be hard to see without careful examination.

The goldfish is a native to Eastern Asia, and is believed to be the first exotic fish introduced into America. Reports indicate that the goldfish may have been introduced in the 1600's. These fish were intentionally released by settlers who wanted to add them to the North American fauna (Dill and Cordone 1997). In the 1800's, the raising and distributing of goldfish for the aquarium trade lead to the dispersal of the fish throughout the country. Many fish were released from aquariums into the wild. The fish is now found in every state except for Alaska.

The goldfish has limited impacts on the habitat. They can reproduce rapidly and produce large populations that may compete for food and space but studies suggest that they cannot out-compete other species (Dill and Cordone 1997). They are benthic herbivores and because of their feeding activity, they may stir up debris from the bottom of the water increasing the turbidity.

9.12 Common carp

The common carp (*Cyprinus carpio*) is a deep bodied, large cyprinid that has a humped appearance. They have large dorsal fins with spines in the front. They also have a large spine on the anal fin. Carp have large scales. Some carp have only a few large scales (Mirror carp). The color is typically a greenish-bronze. Carp have two slender barbels at each corner of the mouth. They can reach up to 36 kg (80 lbs) but most fish up to a third of this weight and about 60 cm in length. Carp breed in early spring when water temperatures reach about 15-17° C (60-65° F). The eggs are attached to vegetation and hatch in about one week. Carp become sexually mature at 3-4 years and can live to 20 or more years (Holland 2000).

Carp were first introduced to the United States in 1831 and were released into the Hudson River in New York (Dill and Cordone 1997). They were first introduced into California in 1878 from imported stocks from Germany as a food fish. The fish is now recorded in all states except Alaska.

The common carp is regarded as a pest fish because of its widespread abundance. Carp destroy vegetation and increase the turbidity of water while feeding. This causes deterioration in the habitat quality for fish that require vegetation and clean water. There is some evidence that common carp prey on the eggs of other fishes (Moyle 1976). Carp have been found most abundant in streams enriched with sewage or with substantial agricultural runoff (Trautman 1981).

9.13 Fathead minnow

The fathead minnow (*Pimephales promelas*) is a small minnow that is dark olive above, with tinges of brass behind the head and tan along the sides. The head is quite blunt. During breeding season, the male will develop small bumps on the head, called tubercles. There is a dusky crossbar on the dorsal fin and dark chevron marks can be seen on the dorsal surface. The lateral line only extends down half of the body. The fathead minnow is very prolific. Spawning begins when the water temperatures reach 50-55° F and repeats monthly until the water cools down in the fall. They lay between 2 to 500 eggs per spawn. The female deposits eggs into the nest or nesting spots and after fertilization the male takes over and guards it. The eggs hatch in five days.

The fathead minnow is native to North America but was planted into California waters in 1953 as an experimental bait and forage fish. The fathead minnow forages on microscopic plants and animals and small invertebrates. The most likely impact of this species is competition with the similar species the arroyo chub.

9.14 Bullheads

The black (*Ameiurus melas*) and yellow bullhead (*Ameiurus natalis*) have much of the same morphology and biology. Both species are in the catfish family. They have long barbells ("whiskers") on the chin and upper jaw and have large mouths. Both species have spines on their pectoral fins, but the yellow has a saw-toothed tip. The black bullhead has a square caudal fin and is yellow-brown to black with a light belly. The yellow bullhead has a rounded caudal fin and is yellow-brown to black with a white belly. The barbels on the chin of the black bullhead are completely dark while the yellow bullhead has white or yellow barbels.

Black and yellow bullhead breed in late spring-early summer when water temperatures reach about 18-21° C (67-70°F) when the male and female inhabit a burrow, hollow log, or the underside of an undercut bank. Both sexes can prepare the nest and, after the female deposits the eggs, one or both parents, usually the male, guard them for a week or two until they hatch out. The male continues to guard the young for a couple of weeks. Eventually the young disperse but often remain in loose schools in large pools until mid-summer or fall. These young can be active in the daytime but become more nocturnal and solitary like the adults with age. They can live to 6-8 years and are omnivorous, feeding on a wide variety of both plant and animal material (Etnier and Starnes 1993). Larger catfishes feed at night when other small fishes are often inactive and vulnerable to predation (Holland 2000).

Bullheads were intentionally introduced for sport and as food. Bullheads are known to be voracious predators of newly hatched fish.

9.15 Inland silversides

Inland silversides (*Menidia beryllina*) are small fish, but the body is relatively long and shallow, giving it a smelt-like appearance. They have flat heads with pincer-like mouths at the tip of the head, facing up. This allows them to feed on surface invertebrates. The body is translucent but has a pronounced silver band down the lateral line. Spawning occurs in May and June at 17-23° C. These fish grow fast, but only live for about 2 years.

Inland silversides are native to North America but were introduced into California without authorization to control gnats and midges. Santa Ana River populations are most likely a result of water transfers from northern California. The main impacts from these species would be the direct competition with species that are ecologically the same. It is not likely that this species would affect the two native species of fish unless they were to feed on larvae.

9.16 Mosquitofish

The mosquitofish (*Gambusia affinis*) is a small green-grey fish. Males are smaller than females who can reach 6 cm. The mosquitofish has a terminal mouth that faces upward, allowing it to eat prey at the water surface. Females can carry sperm and fertilize successive broods without mating again and they give birth to living young only after temperatures reach or exceed 20° C (Holland 2000). Females while pregnant, can get quite chubby, and give birth to as many as 300 young. Mosquitofish can tolerate a wide variety of water conditions, including slow, moving ponded water and water with low dissolved oxygen levels. They tend to stay in the shallow areas near the bank, and are rarely found in the swifter flows. Mosquitofish are wide spectrum omnivores that feed on almost anything, although they are well known for their diet of mosquito larvae.

The mosquitofish is native to the southern Midwest, but was introduced widely as a vector control agent to keep mosquito populations in check. Mosquitofish planting is part of the local vector control office's abatement program, and thousands are released into the basin every year. They are highly abundant in the still water of the constructed wetlands.

The mosquitofish is a very aggressive fish. They often displace native fish, and in some studies, have even been seen to attack, shred fins, and sometimes kill other species (Dill and Cordone 1997). Many native species tend to feed on the same invertebrates as mosquitofish, so competition for food sources is a large impact. Mosquitofish are known to prey on eggs, larvae, and juveniles of many fish. The habitat that they prefer, the sides of banks and slow-moving backwater ponds, are also the types of habitat where young fish (fry) tend to congregate. The fry of sucker and arroyo chub both inhabit these areas and could be eaten. The planting of mosquitofish into the waters of California is favored by the vector control districts because it is an alternative to pesticides and the public reaction is more favorable. However, since they are not restricted to mosquito larvae in their diet, they can have a drastic effect on native fish. In addition, many other fish will eat the larvae of mosquitoes and can be just as suitable.

9.17 Mozambique tilapia

The Mozambique tilapia (*Oreochromus mossambicus*) is a large cichlid with variable color. Typical specimens are gray-green to yellowish with red edges on the dorsal and caudal fins. Young tilapia are more silvery and have 6 to 8 bars. The breeding males are bluish, black with blue lips.

Tilapia live in warm, sluggish streams and ponds with abundant vegetation. They are primarily vegetarians. Tilapia are also mouth-brooders. Eggs are incubated in the mouth and when they hatch, the young return to the mouth for protection from predators. The males will build nests out of sticks and other vegetation and will aggressively defend it.

Mozambique tilapia were native to Africa, but were introduced for aquatic plant control in some streams. Other sources of introduction could be aquarium releases as well as some stocked for sport. Because tilapia are primarily vegetarian, they do not pose a predator threat. However, because they are so territorial, they exclude many species from the shallow edges of the bank where fry and juvenile fish tend to congregate.

9.18 Sunfish and basses

The two common sunfish found on the Santa Ana River are the Green sunfish (*Lepomis cyanellus*) and the bluegill (*Lepomis macrochirus*). The green sunfish has a moderately deep, compressed body. The mouth is relatively large and the upper jaw extends back to the middle of the eye. The pectoral fin is short and rounded. The body color is dark with iridescent blue-green markings on the body and head. It has a dark opercular flap.

Green sunfish can tolerate warm water with low dissolved oxygen. Thus, they tend to be found in shallow ponds or backwater habitats. The young feed on nearly all small invertebrate species in the shallow, well-vegetated areas. Adults are partially picivorous.

Green sunfish were accidentally introduced as bluegill or with other species and are found throughout California. They have been detected near the diversion structure and in the ponds. Green sunfish are extremely aggressive. They will stake out territories and aggressively defend them, chasing any intruding fish out of the area. Dill and Cordone (1997) found that green sunfish reduce the number of native species and were found to prey heavily on minnows.

Bluegill look much like the green sunfish. They have a blue-black opercular flap and will also have vertical bars on the side, but lack the blue-green iridescence. They have a large black spot on the back of the dorsal fin.

Bluegill tend to be more general in their feeding habits than most sunfish. In reservoirs and deep waters, they tend to utilize the offshore epilimnion water. They are extremely prolific, with each female producing nearly 50,000 eggs. Bluegill are excellent nest and fry protectors. These two factors result in rapidly expanding populations.

Bluegill were introduced for sport fishing throughout California. Like green sunfish, they are very aggressive competitors and tend to do well in shallow ponds. Because of their ability to reproduce so rapidly, they can easily dominate an area, forcing other fish out.

Another member of the sunfish family is the largemouth bass (*Micropterus salmoides*). This species can attain quite large sizes. The body is moderately deep and robust. The back is olive to dark green and mottled. Sides are greenish yellow with dark spots that form a mid-lateral stripe. The head is greenish gold. As the name implies, the mouth is large and extends beyond the back edge of the eye.

The largemouth bass prefers quiet, clear to slightly turbid streams, ponds, and lakes, often with vegetation. They were introduced throughout California for sport fishing. They are found on the Santa Ana River and within the pond system in areas of deeper water. Introduced bass affect small populations of fish through predation. They are even known to prey on tadpoles and adult amphibians.

9.2 Amphibians

9.21 Bullfrog

The bullfrog (*Rana catesbeiana*) is a large frog with lengths of 10-20 cm (snout to vent) and weights from 60-900g. The color on the back is light green to olive to brownish-green. It is often mottled with patterns of green and browns. A prominent fold of skin runs from the eye around the large eardrums (tympanum). The belly is mostly white, but can be mottled with gray. The hind feet are fully webbed. The sex of an adult bullfrog can be determined by examining the size of the tympanum relative to that of the eye. In males it is much larger than the eye. In females the tympanum is as large, or smaller than the eye. Also, during the breeding season the throat of the male bullfrog is yellow, whereas the female's is white. Bullfrogs are often seen sitting on the shore and dive into the water for protection. They are most active at night.

The bullfrog is native to the central and eastern United States. It was introduced into California via the aquaculture and the aquarium trade. Bullfrogs are frequently cultivated for food. They are also spread by aquarium releases or by escapees from landscaping projects such as ponds or stream. Bullfrogs can travel considerable distances on land and can disperse throughout entire watersheds. Bullfrogs are found throughout much of the Prado Basin and within the constructed wetlands.

Females lay from 1,000 to more than 45,000 eggs, depending upon the size of the female. Females may start depositing eggs by early April. The egg mass is large, often covering 0.5-0.8 m2, and is typically laid in warm, relatively shallow (<0.5m) water. Eggs hatch within 3-5 days (Holland 2000). Females are known to produce multiple clutches in favorable conditions. Tadpoles may take up to two years to transform. Tadpoles develop a toxin in the skin to protect them from predators.

The bullfrog will eat anything it can get its mouth around. Fish, amphibians, snakes (including the red-sided garter), birds, and even mammals make up much of the bullfrogs diet. Bullfrogs are the single largest reason for the decline in many native species and will be the biggest challenge to control in the wetland system.

9.22 African clawed frog

The African clawed frog (*Xenopus laevis*) is an olive brown frog with dark mottling. The head is wedge shaped and smaller than the body. There are no external ear drums. The frog has no tongue and no teeth. The eyes are small and on the top of the head. It has no eyelids. The back feet are fully webbed and have black claws on three of the toes. Tadpoles have a distinctive "head-down" swimming posture and whiskers at the corner of the mouth.

In California the African clawed frogs breeding season is year round. Females can produce up to 27,000 eggs per reproductive season and can produce multiple clutches per season in favorable conditions. The African clawed frog reaches sexual maturity in 6-10 months after metamorphosis and can live 10 to 15 years. African clawed frogs can lie dormant for a year if ponds dry up. They dig themselves down into small tunnels. They do not hop, but readily crawl, and can travel large distances to find water.

The African clawed frog is a relatively non-specific predator that hunts on the surface and forages on the bottom for a wide taxonomic range of prey. It feeds preferentially on aquatic insects, although it will eat fish, amphibians and birds, will scavenge on decaying debris, and will resort to cannibalism, taking its own larvae as food. Cannibalism enables it to survive food shortages and to quickly establish in newly formed ponds before prey is available and predators and resource competitors appear. The claws on its hind feet are used to tear apart larger pieces of food. Tadpoles are exclusively filter feeders.

African clawed frogs are native to Africa and are used extensively for laboratory research. These frogs were once used for pregnancy tests back in the 1940's throughout the world. Many of these were released when more efficient pregnancy tests were developed. African clawed frogs are also sold as pets and are released when owners no longer want them. They are found along the Santa Ana River and within the wetland ponds.

9.3 Reptiles

9.31 Red-eared slider

The red-eared slider (*Trachemys scripta elegans*) gets its name from the red streak along the side of its face. The turtle has yellow stripes on its head and legs. The carapace is oval and flattened with a weak keel. The markings on the shell are dark and the edges and underneath are yellow and black.

Sliders prefer quiet, soft, muddy bottomed waters with suitable basking spots such as logs, rocks, or stumps near the water. They sometimes stack on top of each other while basking. The name "slider" refers to the quick retreat from their basking site into the water when they feel even the slightest bit threatened (Gibbons 1994). Sliders will sleep at night underwater, usually resting on the bottom or floating on the surface, using their inflated throat as a flotation aid.

Sliders are very common "pet store" turtles and are sold throughout the U.S. Most of the released species are due to owners setting them "free". The impact of sliders on native turtles has not been confirmed. Adults are primarily vegetarian, while young sliders tend to be more carnivorous. Sliders are most likely competition for native turtles. They have been detected in the Prado Basin and in the constructed wetlands.

9.4 Invertebrates

9.41 Red swamp crayfish

The red swamp crayfish (*Procambarus clarkii*) is a large, fresh water crustacean. The carapace is usually dark red-brown while the abdomen is lighter with a black stripe. The crayfish has five pairs of walking legs. The first pair is called the chelipeds, and they are the pronounced claws. These claws are very large and are used for capturing prey. The carapace and the claws have spiny protuberances in the adults. Juveniles vary in color and may be gray or greenish.

Breeding typically occurs in May-June. Females carry 10 to several dozen eggs under the abdomen and aerate them with the swimmerets. The eggs hatch in 2-4 weeks, depending on water temperature. Young are small (<10 mm) and grow rapidly. Most become sexually mature within 3-4 months.

Crayfish are found in many of the backwater and shallow edges of rivers and streams. They may live in the flowing water if large boulders exist for cover. Crayfish can disperse over land, traveling from pond to pond. Crayfish are omnivores that eat plants, animals, and decaying organisms.

Red swamp crayfish are native to the coastal Florida panhandle and the Mississippi River and were most likely introduced to California for aquaculture. In addition, they are used for bait and were probably introduced by fisherman as well. Crayfish can become very numerous in ponds and creeks, especially in the backwaters. They feed on many native fish and tadpoles.

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