5.2 Pond Turtle

Like the arroyo toad, the pond turtle was historically more widespread and abundant in San Diego County as well as within the San Diego MSCP (Table 3). The below monitoring and management suggestions are proposed as a means to sustain and improve pond turtle populations within the San Diego MSCP. Increasing these populations and expanding them into other suitable areas should be a part of the MSCP management goals and may be achieved by increasing habitat quality, removing non-native turtles and non-native predatory species and restoring a more natural hydrologic regime within the drainages that contain pond turtles. The following suggestions should benefit the pond turtle and improve the understanding of this declining species within the study area. Very few populations of pond turtles remain within the MSCP, thus aggressive actions will be necessary to effectively manage for this species.

5.2.1 Minimize Disturbance and Take

Due to the low number of females detected, the lack of juvenile detections and the low population sizes, the pond turtle populations within the MSCP are at increased risk due to human activities that may lead to disturbance and take of pond turtles (e.g., recreation, collection, and roads). MSCP reserve lands should be managed to prevent or minimize disturbance to pond turtles and/or their habitat resulting from on-site activities (e.g., fishing, non-native turtles). This includes restricting access to pond turtle upland and breeding habitats to help prevent disturbance to all pond turtle life history stages (egg, juveniles and adults). This will be especially important at sites such as 4S Ranch, where the pond turtle population is surrounded by development and the remaining corridor of habitat is designated for human recreation and Los Peñasquitos Canyon Preserve, which is heavily recreated and possibly impacted by the network of dirt and paved roads that parallel and bisect Los Peñasquitos Creek.

5.2.1.1 Human Recreation

Human access, especially recreation, should be limited in wetland and upland habitats used by pond turtles in order to minimize disturbance and take. Non-consumptive recreation, such as hiking, dog walking, and fishing, can potentially trigger problems for native turtles if the recreational activities interfere with any aspect of the turtle's life history requirements. For instance, Garber & Burger (1995) found a 100% decrease in two wood turtle (*Glyptemys insculpta*) populations within 10 years of a wildlife reserve being opened up to recreation (fishing, hiking and dog walking). Recreation can lead to removal of turtles, road kills, handling

by recreationists, increased predation as a function of increased food waste resulting in an increase in predators (raccoons, coyotes) (see also Joslin & Youmans 1999), and disturbance by dogs (Garber & Burger 1995). The effects of human recreation on the pond turtle are of concern because all pond turtle locations within the study area, except for Sycuan Peak Ecological Reserve, Sweetwater River, are heavily recreated.

Fishing is of concern for pond turtles because they can be attracted to bait and subsequently hooked and released, possibly with the hook still embedded in the mouth or esophagus, or the turtles may be taken for consumption or as a pet. In this study, non-native turtles removed from a heavily fished area of the San Diego River (FSDRIP) excreted fish hooks after capture and an x-ray radiograph of a red-eared slider specimen from this site revealed a fish-hook was deeply embedded in its esophagus (Figure 16) and a red-eared slider from Lake Miramar had a perforated esophagus most likely due to a fish-hook (USGS NWHC, unpublished data). In a similar USGS pond turtle study in Orange County, an x-ray of a red-eared slider found dead at a heavily fished site also revealed that a fish-hook was embedded in its esophagus and another red-eared slider at the same site was found dead with fishing line entangling its front legs (USGS NWHC, unpublished data). It is uncertain if the embedded fish-hooks caused impaired feeding, starvation or metal poisoning and it was also uncertain if the fishing line entangled turtle had drowned because of the fishing line or if the fishing line had become entangled postmortem. Pond turtles occurring in heavily fished areas are likely to be similarly affected by fishing and it is also possible that fishing may be one of the many factors in the overall decline of this species (Holland 1991). Holland (1991) noted that pond turtles captured from a fishing site in the Sierra Nevada had either obvious trauma due to hook removal, had hooks in place or were found dead with hooks embedded in their esophagus and that similar records of injury or death from fish-hooks suggest that this situation was widespread and frequent. Pond turtles have also been fished and taken for consumption from San Dieguito River near Lake Hodges (K. Thomas, personal communication). Jennings and Hayes (1994) suggested that fishing with barbed hooks be regulated in areas containing pond turtles.

Other forms of recreation, such as hiking and dog walking, also need to be considered as potential causes of pond turtle population decline due to the possible disturbance and take that may result from these activities. Hikers or joggers may disrupt pond turtle behavior such as basking, foraging or mating and may encounter nesting females and disrupt nesting or collect them as pets. With the slightest disturbance, females may abandon a nesting attempt and head back to the water (Holland 1994; Goodman 1997a). Turtles may also be encountered while they are heading to or returning from upland aestivation or overwintering sites, and young may be encountered as they disperse from nests to wetland habitats. Dogs, especially those that are off leash and allowed to go off-trail, can also disturb or harm nesting females, turtles heading to or returning from upland aestivation or overwintering sites, and dispersing young. Dogs may also dig up nests with eggs or overwintering young or may dig up overwintering or aestivating adult turtles.

As public usage of the MSCP reserve areas increases, there will likely be an increase in the number of people recreating (hiking, biking, dog walking and fishing), both legally and illegally, in areas where pond turtle populations exist. In the Garber and Burger (1995) study on wood turtles (*Clemmys insculpta*), they found a negative correlation between wood turtle population size and human population size in the surrounding area- as human populations increased wood turtle populations declined. Pond turtles may be similarly impacted by the

growing population of San Diego. Possible solutions to help prevent future pond turtle decline due to human population growth and increased recreation include gaining a better understanding of pond turtle population dynamics and habitat requirements, better fencing of reserves, limiting off-trail travel, requiring dogs to be leashed, improved signage, improved outreach and public education, and increased patrols. Protecting females and juveniles will be especially important, because few or no females and no juveniles were detected in the pond turtle populations during this study.

5.2.1.2 Collection

As mentioned above, with increased human access there is a greater possibility of humans encountering pond turtles and collecting them. Pond turtles are small and relatively easy to collect, yet much work to maintain in captivity (as are all water turtles). There are several reported cases of collection of pond turtles in southern California and certainly many unreported cases. Bury (1982) noted collection of over 500 pond turtles from a lake in southern California in the 1960's and Holland (1991) noted known collection of approximately 10 turtles (all recovered by reserve personnel) in a period of three years at the Santa Rosa Plateau Ecological Reserve. Incidental collection could be very detrimental to the small populations within the MSCP reserve. Due to the low number of females and absence of juveniles detected during this study, the collection of females and juveniles could have a significant impact on the viability of the MSCP pond turtle populations. Signage within the MSCP reserve should encourage people to enjoy the wildlife experience, but to leave what they encounter in place. However, signs should not call attention to the turtles, as this may increase collection.

5.2.1.3 Roads

Higher road densities near pond turtle populations are a concern due to increased likelihood of turtles being injured or killed due to encounters with vehicles and due to other effects of roads such as runoff, pollution and changes in temperature. Greater road densities are associated with turtle populations that are predominantly male, because females are more susceptible to road mortality due to their higher frequency of upland movements associated with nesting (Marchand & Litvaitis 2004; Steen & Gibbs 2004; Gibbs & Steen 2005). Greater road densities are also associated with turtle populations containing a higher proportion of adults (Marchand & Litvaitis 2004; Steen & Gibbs 2004), indicating reduced recruitment which is possibly a result of the reduction of females in the population. Gibbs and Shriver (2002) used computer simulation to predict that road density >2 kilometers of roads/km^2 with traffic volumes of >200 vehicles/lane/day would increases adult mortality in turtles. In addition to causing animal mortality, roads also change soil density, temperature, soil water content, light levels, dust levels, surface waters, patterns of runoff, sedimentation, and they add heavy metals (especially lead), salts, organic molecules, ozone, and nutrients to roadside environments (Trombulak & Frissell 2000).

Mitigation measures should be taken to prevent negative effects of roads on pond turtles, and should include monitoring run-off and water quality and creating structures, such as barrier fences or wildlife ecopassages (Boarman et al. 1997; Barichivich & Dodd 2002) that will divert turtles from roads. Barichivich and Dodd (2002) recorded a 41% decrease in traffic related wildlife mortality, including a dramatic decline in the number of road-killed turtles, after a

wildlife ecopassage and wildlife barriers were created under a busy highway. Similarly, results in Boarman et al. (1997) suggest that barrier fences can reduce wildlife mortality, but the barriers must include a means for animals to safely cross the roads, such as culverts, in order to prevent an increase in population fragmentation. Creating an ecopassage with wildlife barriers will be especially important for the pond turtle population at 4S Ranch, because there is now a road (or roads) bisecting Lusardi Creek between the two large cattle ponds. Turtles may cross the road to migrate between the ponds or females may cross the road while in search of a nest site. The pond turtles at Los Peñasquitos Canyon preserve might also benefit from ecopassages with wildlife barriers, especially at the Black Mountain Road crossing and the Poway Road Crossing which prevents the pond turtles from safely moving between the Los Peñasquitos Creek Pond and the Chicarita Creek Pond. Protecting females and juveniles will be especially important, because few or no females and no juveniles were detected in the pond turtle populations during this study.

5.2.2 Education and Outreach

Educational kiosks or signs should be installed at trailheads to educate and inform the public of any restrictions and the importance of not releasing unwanted pets, especially turtles. This is particularly important at all locations where pond turtles occur, especially those sites heavily recreated or easily accessed by humans such as Los Peñasquitos Canyon Preserve and 4S Ranch. People frequent Los Peñasquitos Canyon Preserve for use as a recreational outlet and 4S ranch is currently undergoing development for housing. Hence, the likelihood of unwanted pet turtles being released into these sites is higher than at a more remote site, such as Sycuan Peak Ecological Reserve. At a minimum, these informative displays should provide information such as the following: 1) any restrictions for the site (e.g., no fishing), 2) the importance of not disturbing or molesting any wildlife they may encounter, 3) the potential danger(s) of handling and collecting wild animals, 4) the ramifications of releasing pet turtles and other non-native pets and emphasizing that it is also illegal (California Fish and Game Code Section 2121 and California Penal Code 597s), and 5) contact information for organizations that will accept unwanted pet turtles, such as the San Diego Turtle and Tortoise Society.

Similar to that discussed for the arroyo toad in section 5.1.2, educational pamphlets, outreach, and educational programs can be used to promote the value of pond turtles and native ecosystems as well as the negative effects of non-native species. Partnerships should be established with organizations such as the San Diego Turtle and Tortoise Society and the San Diego Herpetological Society to educate the public on the negative impacts of releasing pets and offer alternative ways of getting rid of unwanted pets. The San Diego Turtle and Tortoise Society has expressed interest in helping this cause (K. Thomas, personal communication). In addition, an outreach program should be initiated with local pet stores to educate consumers and possibly establish and unwanted turtle return policy. Educational programs may also be initiated or incorporated with currently existing school programs (elementary through high school) throughout San Diego County. Again, education and outreach may be coordinated by the already established MSCP Outreach Committee in conjunction with landowners.

5.2.3 Enforcement of Rules and Restrictions

Similar to that discussed for the arroyo toad in section 5.1.3, patrols of MSCP lands will need to be increased or management plans may not be as effective.

5.2.4 Additional Surveys

In order to get a better understanding of the size, status, and habitat requirements of pond turtle populations occurring within the San Diego MSCP, surveys using the methods carried out in this study should be repeated and expanded to examine upland habitat use, adult and juvenile wetland habitat requirements, recruitment and population viability. More intensive surveys are necessary to better illuminate the demographic structure and life history requirements of the remaining pond turtle populations in the MSCP. Historic locations or possible historic locations with suitable habitat should also be resurveyed to further verify pond turtles are absent. Additionally, causes for the low number of females and the absence of juveniles should be investigated and measures should be taken to protect and increase the number of females and increase successful recruitment.

5.2.4.1 Habitat Assessment

At sites with known pond turtle populations, more detailed habitat assessment should be conducted in order to gain a better understanding of the habitat requirements of San Diego MSCP populations. From thereafter, all pond turtle habitat should be periodically assessed to determine the extent and quality of habitat (upland and wetland) and to establish whether it is increasing or decreasing throughout the reserve (every five or more years). In addition to the general habitat characteristics that were collected during the habitat assessment conducted in this study, more detailed data should be collected and should include: more precise measurements of percent of canopy cover and pool size (possibly using digital orthophotographs), pool depth, substrate types (both wetland and upland), and percent of basking site coverage. Results of the habitat assessment may be used to establish criteria for habitat restoration or creation or to establish which criteria are essential when choosing a site for population reestablishment, all of which may be necessary to sustain pond turtle populations within the MSCP.

5.2.4.2 Water Quality Assessment

Another measure of habitat quality that should be taken into account is water quality. In coordination with cities and water agencies, water quality should be monitored and if necessary, improved in areas where pond turtles occur. Water quality measurements that should be taken during future habitat assessment should at a minimum include: dissolved oxygen, pH, turbidity, nitrate and phosphate levels. In highly urbanized areas lead and aluminum should also be monitored.

One site that requires immediate attention is 4S Ranch, where the smell and appearance of the water at the westernmost pond suggest that it is polluted. The source of contamination at this pond should be identified and resolved immediately. It is possible that pond turtles were not detected in the westernmost pond due to the poor water quality, because otherwise the habitat appears suitable. It will be important to monitor the water quality of this site as the development at 4S Ranch progresses and increased run-off (including pesticides and fertilizers) and erosion occurs.

5.2.4.3 Recruitment and Population Viability

It appears that successful recruitment is low or possibly not occurring within the MSCP pond turtle populations, and it is important that future studies determine: 1) whether recruitment is occurring and at what level, 2) what are the direct and indirect causes of reduced or absent recruitment, and 3) how can the negative pressures on recruitment be reduced or eliminated. This may involve protecting nesting females, finding and protecting nest sites throughout the year (juveniles may overwinter in the nest), protecting juveniles and assessing juvenile feeding and habitat requirements. In addition, to increase population recruitment headstarting and/or captive rearing may need to be considered (see section 5.2.10). A reduction in recruitment will reduce and may eventually eliminate pond turtle populations, so this issue should be addressed immediately. However, effective management must address and protect all life stages in order to maintain viable populations of pond turtles. High adult survival in combination with increased juvenile recruitment can boost turtle population numbers and increase the chances of population persistence into the future (Rubin et al. 2004). Long lived species, such as turtles, usually possess life history traits that limit their ability to maintain stable populations: relatively low fecundity, low nest survival, high adult survival, and as a result they require extremely high juvenile survival to maintain population stability (Congdon et al. 1993).

Radio-telemetry studies should be initiated to gather more information on the reproductive status of the pond turtle populations within the MSCP. Studies should involve tracking female pond turtles, locating and protecting nests and monitoring juvenile survival. In addition to locating nests, nest site characteristics, including soil type, cover, aspect, and distance from water should be recorded. Data collected on nest locations will benefit the management of upland habitats, by helping better understand nesting habitat requirements and also by helping determine the size of upland buffer zone required to help sustain populations. In addition to monitoring reproductive success, it is also important to assess resource availability because pond turtle reproduction appears related to resource availability (Pires 2001). The populations in most need for the type of data that can be gathered from a radio-telemetry study are at 4S Ranch, Los Peñasquitos Canyon Preserve and Sycuan Peak Ecological Reserve (possible control site).

5.2.4.4 Upland Habitat Requirements

There has been very little study of the upland movements of pond turtles in southern California and as a result little is known about the size of the upland buffer zone required to protect pond turtle populations. In a Mediterranean climate, pond turtles are known to move upland to overwinter (take refuge from winter floods), to nest and to rest for short periods (1-5 days) at terrestrial basking sites (Goodman 1997a; Rathbun et al. 2002). Studies (mostly radio-telemetry studies) of pond turtles have found pond turtles moving a maximum of 100 meters to just over 400 meters perpendicular to wetland habitats to nest (Storer 1930; Rathbun et al. 1992; Holland 1994; Goodman 1997a; Reese & Welsh 1997; Lovich & Meyer 2002; Rathbun et al. 2002). Pond turtles are known to travel as far as 500 meters into the uplands (Reese & Welsh 1998; Hays et al. 1999) and linear home ranges as long as 4263.2 meters have been reported (Goodman 1997a; Goodman & Stewart 2000). Rathbun et al. (1992) suggest that pond turtles may require a long and wide upland habitat corridor, extending at least up to 0.5 kilometer on each side of the wetland habitat and that it is important to protect these habitats year-round in order to protect eggs and overwintering hatchlings in nests. Since most of the available upland

habitat use data is for northern populations of pond turtles and upland requirements of northern populations may differ from southern populations, more study is needed for upland requirements of the southern pond turtle populations. It is possible that upland habitat is more important in the more arid southern portion of the pond turtle's range, where rivers and streams regularly dry as a result of drought and/or diversion or damming to support human water needs (e.g., drinking water, agriculture).

Radio-telemetry should be used to quantify the extent and determine the timing of pond turtle upland habitat use and to determine how large of a buffer zone will be required to protect nesting and overwintering sites. Data on nesting habitat characteristics should be collected to determine what vegetation, soil and other habitat features are important for successful nesting. These data would also provide helpful information regarding the management and possible creation of nesting sites.

In a study of three aquatic turtles, mud turtle (*Kinosternon subrubrum*), Florida cooter (*Pseudemys floridana*) and slider (*Trachemys scripta*), Burke and Gibbons (1995) found that nesting and overwintering sites occurred exclusively beyond wetland boundaries designated under federal guidelines. Based on radio-telemetry data collected on upland habitat use, they developed two biologically-based buffer zone models to determine a buffer zone large enough to protect nesting and overwintering. A study similar to this could easily be done for the pond turtle and would provide valuable information for protecting these important life-cycle stages. The sites with highest priority for this type of study are 4S Ranch, Los Peñasquitos Canyon Preserve and Sycuan Peak Ecological Reserve.

Radio telemetry would also be useful in monitoring the upland movements of the pond turtles at 4-S Ranch until construction activities are complete. This would help prevent direct mortality associated with construction activities. Furthermore, if possible, it might be beneficial to limit large equipment operation/earth moving operations when turtles are likely to be using the upland habitats the most (during winter for overwintering and spring to early summer- for nesting) and to make sure that turtle nests and overwintering juveniles are protected.

5.2.4.5 Effects of Drought

2002 and 2003 were below normal rainfall years, thus future pond turtle presence surveys should be conducted during a period of normal rainfall in order to help confirm the absence of pond turtles at sites with potential pond turtle habitat (rated high and good quality) or sites that historically supported pond turtles or potential pond turtle habitat. Specific sites to be resurveyed include Wilson Creek, Golem Land Trust, Lake Hodges, Mission Trails Regional Park, San Diego National Wildlife Refuge, and Lusardi Creek Preserve. In addition, research investigating the effects of drought on the pond turtle (especially populations most at risk such as those below storage reservoirs) should be considered within the San Diego MSCP. Although southern populations of the pond turtle have evolved with regular periods of drought, manmade stressors (e.g., habitat loss, dam construction, introduction of non-native predatory species, pollution) may be compounding the effects of drought. In addition, drought may have played a factor in the low detection rate of gravid females and the lack of juvenile detections, as females may defer reproduction following a period of low resource availability (Pires 2001).

5.2.5 Habitat Restoration and Creation

Another management goal should be to expand the abundance and range of known populations of pond turtles through restoration or creation of wetland habitats for both adult and juvenile life stages. Habitat degradation or loss can lead to abnormal population structure in pond turtles (Dodd 1990; Reese & Welsh 1998a) and eventually result in population decline or extirpation. All known populations of pond turtles within the MSCP would benefit from habitat restoration. Hollenbeck Canyon Wildlife Area and Rancho Jamul Ecological Reserve are locations that should be considered for restoration of historic pond turtle habitat or creation of new habitat with the purpose of reestablishing pond turtle populations.

The Washington Department of Fish and Wildlife and the Oregon Department of Fish and Wildlife have set guidelines, either through pond turtle recovery plans or public outreach, for restoring or creating pond turtle habitat (Hays et al. 1999; ODFW 1999, 2000). Below are detailed descriptions of the required habitat characteristics to consider for restoration or creation of pond turtle habitats based on Bash (1999), Hays et al. (1999), ODFW (1999, 2000), Holzhauser and Work (1999), and others. Although these requirements are based on northern populations of pond turtles, they can still act as guidelines for southern populations.

Water Bodies: Water bodies should contain still or slow-moving water with some areas at least one meter, but preferably up two meters deep for adults. In addition, at least 25% of the water's edge should be less than 30.5 centimeters deep with a gentle gradient for young juveniles. Water body should also be permanent.

Vegetation: There should be emergent and submergent aquatic vegetation present, but the water body should get good sun exposure. Reese and Welsh (1998b) suggest that some cover, especially along the waters edge, may help pond turtles avoid predation and that pools receiving patchy sunshine may allow for better thermo-regulation. If the water bodies become too choked with vegetation, some vegetation should be removed.

The reduction in scouring flows due to water diversion or damming of a watercourse can lead to an increase in downstream vegetation (i.e., the vegetation does not get scoured away on a regular basis as with the historic natural hydrologic regime) (Williams & Wolman 1984; Ligon et al. 1995; Collier et al. 2000), thus allowing vegetation to encroach on pond turtle habitat and eventually completely shade or fill in the deep open pools adults require. This was observed in Sweetwater River below Loveland Dam and in the Otay River below Savage Dam (Lower Otay Reservoir). As a result, monitoring the presence of native or non-native plant species and their effects on pond turtle habitat (e.g., *Typha* spp. or *Arundo donax* encroaching on deep pools), should be a part of the pond turtle management plan. It may be necessary to remove native and non-native species in areas that are too shaded or have become choked with vegetation. These sites should then be monitored to determine the effectiveness of removal and to measure benefits to pond turtles. Early removal of known problem species, especially non-natives, can be more cost effective than delaying removal until an impact on the turtles is clearly detectable.

Aquatic Refugia: If not present, aquatic refugia such as plants, rock, pieces of wood, or roots wads should be added for turtles to retreat or hide.

Basking Sites: If not present or too few in number, aquatic basking sites, such as logs, rocks or root wads should be added to water bodies to provide safe basking areas for pond turtles. In addition, floating basking rafts can be anchored away from land to provide basking sites that are safe from land predators (this would be especially helpful for the population at 4S Ranch, because basking sites are currently restricted to the shoreline).

Hatchling Habitat: Native plants and small root wads or tree branches should be available in shallow areas for juveniles to take refuge.

Upland Nesting Sites: Protect upland habitats at least 500 meters from water bodies (see section 5.2.4.4), especially important are sunny areas. Nesting habitat can be improved or created by creating clear visual and travel paths between the water and large sunny areas, mowing grasses to create patches of short, sparse vegetation with bare soils, and by creating buffer zones around known nest sites and protecting these areas from grazing, human recreation and predation. It is recommended that the created nest sites be at least two by three meters in area. If the soil is too rocky or sandy, silty clay soils can be used to create three by three meter mounds that should be shaped to maximize southern exposure.

Travel Corridors: In addition to nesting corridors, travel corridors such as streams, rivers and riparian areas should allow movement between pools, ponds and populations (important for maintaining genetic diversity). In areas with roads, ecopassages with walls that divert turtles to using these wildlife corridors should be created to prevent road mortality (Barichivich & Dodd 2002).

Water Quality: Water quality must also be considered when restoring or creating habitat for pond turtles. Chemical removal of vegetation or predators should be avoided as they might affect or contaminate the pond turtle's food source. Rotenone, a commonly used pesticide for fishery management, has been documented to kill turtles and should not be used in areas where pond turtles occur (Fontenot et al. 1994; McCoid & Bettoli 1996). Pesticides in general should be avoided within the vicinity of pond turtle populations. This topic is also discussed in section 5.2.4.2.

Predators: Eliminate or control aquatic non-native predators such as bass and bullfrogs. Reduce predation of nests by providing large nesting areas, placing cages over known nest sites to exclude predators (but still allowing sun exposure and hatchling emergence), and trapping and relocating nest predators prior to or during the nesting season. This topic is discussed in more detail in section 5.2.7.

Non-native Turtles: Eliminate or control non-native turtles. Non-native turtles may compete with pond turtles for resources or spread disease. This topic is discussed in more detail in section 4.2.4 and 5.2.6.

5.2.6 Non-native Turtles

Non-native turtles were detected at many more locations in the MSCP than pond turtles, thus the management strategy for the pond turtle needs to include studies on the interspecific relationships between pond turtles and non-native turtles and the benefits of non-native turtle removal to the pond turtle. In order to better understand the probable negative relationship between non-native turtles and the pond turtle, these potential threats should be investigated. For example, pond turtles from isolated populations and populations that coexist with non-native turtles should be compared for disease and parasites to study whether non-native turtles are transmitting disease and parasites to pond turtles. See section 4.2.4 for more information regarding non-native turtles.

Non-native turtle removal should be priority over other non-native species removal and would be most beneficial at or near locations that support pond turtles. At this time, Los Peñasquitos Canyon Preserve (creek and pond), Mission Trails Regional Park- Lake Murray, and Santee Lakes are the only known locations where pond turtles and non-native turtles co-occur. In addition, non-native turtles need to be removed from sites where habitat will be restored or created with the purpose of restoring or expanding pond turtle populations.

5.2.7 Native and Non-Native Predatory Species

Introduced predators, especially bullfrogs and largemouth bass, pose potential threats to pond turtles (Holland 1991, 1994). Bullfrogs and/or largemouth bass were detected at most of the locations that were surveyed within the MSCP, including locations where pond turtles occur. In general, pond turtles are most vulnerable to predation during the younger life history stages (when they are neonates and small juveniles). When pond turtles enter aquatic systems, they are about the size of a silver dollar. Bass and bullfrogs are "gape limited" predators that have been reported to eat young pond turtles (neonates to yearlings) (Moyle 1973; Brattstrom & Messer 1988; Holland 1991, 1994). Due the threats non-native predators pose to population recruitment and because recruitment rates appear low or absent within the MSCP pond turtle populations, non-native predatory species should be removed from locations to be managed for pond turtles, the effectiveness of eradication techniques should be monitored, and the benefits to pond turtles should be measured.

In addition to non-native aquatic species, native and non-native terrestrial predators must also be monitored and controlled, if necessary. Native predators, such as raccoons (*Procyon lotor*) and coyotes (*Canis latrans*), and introduced predators, such as opossums (*Didelphis virginiana*) are more likely to injure or take females, eggs and young. Terrestrial predator removal has been shown to reduce the number of destroyed turtle nests and enhance hatchling yield (Christiansen & Gallaway 1984). The reproductive success of pond turtles is low and recruitment rates are very low or absent within the known MSCP populations, thus it is important to monitor predator populations in areas that contain pond turtles.

5.2.8 Other Non-native Threats

Other non-native species that may be detrimental to pond turtle populations, such as sunfish, carp, mosquitofish, and crayfish, were found at many locations throughout the MSCP (see Section 4.2.7). These species may indirectly affect pond turtles by changing the aquatic community, competing for prey, or spreading disease. The presence of these species may also be

beneficial, as they may serve as a prey source for pond turtles. However, controlling these species and restoring the aquatic community, especially in or near locations that support pond turtles, will likely benefit pond turtles. It will also be important to monitor the effectiveness of eradication techniques and measure benefits to pond turtles.

Non-native plant species were also detected at many locations throughout the MSCP. Non-native plants should be controlled and monitored in areas that support pond turtles.

5.2.9 Genetics

Several studies have determined that southern California populations of pond turtles are more genetically diverse than northern populations and as a result should receive increased protection (Gray 1995; Janzen et al. 1997; Spinks & Shaffer 2005). Genetic differentiation may signify deep historical splits among populations and thus indicate their individual importance (Janzen et al. 1997). San Diego pond turtle genetics has not been specifically studied, therefore it will be necessary to determine the genetic diversity within these populations to properly manage and protect this species. This will be especially important if populations are to be enhanced, restored or introduced through translocation of adults or through head starting and/or captive breeding (see section 5.2.10). USGS has been collecting pond turtle tissue within the MSCP populations with the intention of future genetic analysis.

5.2.10 Head Starting, Captive Breeding, or Translocation

After threats to pond turtles have been removed and suitable habitat has been restored or created, a reintroduction or population establishment program (using head starting, captive rearing or translocation) should be considered to maintain or enhance extant populations or to reintroduce turtles where they have been extirpated within the MSCP or to introduce new populations. The head starting, captive breeding and reintroduction programs of the Washington Department of Fish and Wildlife and the Oregon Department of Fish and Wildlife have proved that this type of program can be successful at increasing pond turtle populations (Heltzel 2000; Allen & Slavens 2002). Additionally, a population was successfully established in Orange County, California by translocating adult and juvenile pond turtles to an artificial pond that had been created for pond turtles (Harmsworth Associates & Goodman 2002, 2003).

When the number of pond turtles in the state of Washington was down to approximately 150-200 pond turtles in 1990, the Washington Department of Fish and Wildlife initiated a head starting, captive breeding and reintroduction program in association with the Woodland Park Zoo (Seattle, Washington) and later the program was expanded with the help of the Oregon Zoo (Portland, Oregon) (Bowdoin 1994; Allen 1996; McAllister et al. 1996; Dean 1999; Hays et al. 1999). This program captively rears pond turtles and releases them after they have grown large enough to prevent predation by aquatic predators such as bullfrogs. By 2001, the total number of pond turtles in Washington was estimated to be approximately 500 individuals and many of them were head started turtles that had been released through this program (Allen & Slavens 2002).

In Orange County a pond turtle population was successfully created through habitat creation and restoration and the translocation of adult and juvenile pond turtles from nearby locations (Harmsworth Associates & Goodman 2002, 2003). Pond turtles quickly adapted to the

pond, increased in size and weight, and successful recruitment occurred within the first two years (Harmsworth Associates & Goodman 2002, 2003). The success of this project was likely due to the location of the created pond (relatively isolated from human access), suitable aquatic habitat (both deep and shallow areas with appropriate pond turtle refugia), suitable upland habitat (south facing slope with native vegetation), and the absence of non-native species.

The success of a head starting and captive breeding programs or other species recovery programs cannot be determined without research on the behavior and survival of both captive reared and wild turtles (Heppell et al. 1996). A successful strategy for increasing turtle populations through head starting and captive rearing must ensure that the entire population is self-perpetuating (Haskell 1998). In other words, the program will only be effective if causes of older juvenile and adult mortality are reduced and the head started turtles eventually reproduce successfully (Congdon et al. 1993; Heltzel 2000).

A possible source population for similar programs within the MSCP is the Sycuan Peak Ecological Reserve, Sweetwater River population. Other possible source populations to consider outside of the MSCP include those on U. S. Forest Service Land in Pine Valley Creek and Cedar Creek. Possible reintroduction/introduction sites include Jamul Creek (also suggested by Brattstrom and Messer 1988) and several of cattle ponds found within Rancho Jamul Ecological Reserve; Hollenbeck Creek in Hollenbeck Canyon Wildlife Area; and San Diego River and Alvarado Creek in Mission Trails Regional Park. Los Peñasquitos Canyon Preserve, 4S Ranch, Lake Murray/Alvarado Creek in Mission Trails Regional Park, and Sycuan Peak Ecological Reserve should all be considered for population enhancement, as all populations are below what is considered viable (Holland et al., unpublished report).