County of San Diego Multiple Species Conservation Program
Quino Checkerspot Butterfly Amendment
Proposed Adaptive Management and Monitoring Strategy

1.0 Introduction

This report provides the proposed adaptive management and monitoring strategy to be implemented as part of the County of San Diego's Quino Checkerspot Butterfly Amendment (Quino Amendment) to the Multiple Species Conservation Program (MSCP) Subarea Plan (County Subarea Plan). By providing a concise summary of the proposed adaptive management and monitoring strategy, this report will facilitate review by staff, analysts, consultants, property owners, and the Wildlife Agencies (California Department of Fish and Game and U.S. Fish and Wildlife Service). It is assumed that reviewers of this report have prior knowledge of the County Subarea Plan and Quino Amendment. Other aspects of the Quino Amendment (*i.e.*, conservation policies and financing) are addressed in separate review processes. Additionally, information in this report is additive to management actions in the Framework Management Plan (County of San Diego 2001).

Below, aspects of Quino checkerspot butterfly (Quino) habitat requirements, metapopulation dynamics, and existing threats relevant to the design and implementation of the adaptive management and monitoring program are summarized. Next, specific adaptive management and monitoring goals are described, along with proposed strategies for reaching those goals. Adaptive management and monitoring will be focused in preserves within the South County, Alpine-Jamul, and San Vicente Quino Management Units (QMU) (Figure 1). The adaptive management and monitoring program is intended to be flexible enough to allow for adjustments as new information is available and more is learned regarding appropriate strategies for maintaining Quino populations.

1.1 Quino Habitat Requirements

Quino occur in sparsely vegetated openings embedded in a variety of vegetation types where host plants occur, including coastal sage scrub, flat-topped buckwheat scrub, maritime succulent scrub, chaparral, coastal sage scrub/chaparral ecotone, grassland, vernal pool, juniper woodlands, and agricultural lands that are no longer in agricultural use and recovering habitat value (Stephenson and Calcarone 1999). Where the primary host plant, dwarf plantain, is present, optimum stand structure for Quino consists of patchy shrub or small tree landscapes with openings of several meters between large plants (Mattoni *et al.* 1997). Dwarf plantain and other native annuals are often associated with the presence of cryptobiotic crusts on the soil surface (Mattoni *et al.* 1997). These crusts appear to inhibit invasion of non-native grasses and forbs that may out compete native annual plants (Mattoni *et al.* 1997). As the species is frequently observed on hilltops, even in the absence of nearby larval host plants (Osborne 2001), hilltops and ridgelines, where adult males are often observed, are believed to be crucial elements of population survival (USFWS 2003).

1.2 Threats within Preserves

Based on observations of large-scale invasions by non-native species throughout the Quino's range (Freudenberger *et al.* 1987, Minnich and Dezzani 1998, Stylinski and Allen 1999), conversion from native vegetation to non-native annual grassland is one of the greatest threats to Quino within preserves. Corridors of human activity, such as unpaved roads, trails, and pipelines, through natural areas are conduits of non-native seed dispersal (Zink *et al.* 1995) and can introduce non-native species that lead to the decline of native habitats. Other causes of vegetation type conversion include frequent fires, grazing, off-road vehicle activity (USFWS 1997), and increased nitrogen deposition (Allen *et al.* 2000).

1.3 Metapopulation Dynamics

Metapopulation dynamics are important to the long-term survival and regional persistence of the Quino (USFWS 2003). A metapopulation is a group of separate populations that interact at some level. In discrete areas, populations of Quino may be temporarily extirpated, and subsequently re-colonized by nearby populations within the metapopulation. Therefore, reserves should be designed to provide a sufficient number of habitat patches to ensure that: 1) only a small number of habitat patches will likely be extirpated in a single year; and 2) patches are close enough so that natural re-colonization can occur at a rate sufficient to maintain a relatively constant number of patches to support larval development (USFWS 2003). As populations separated by more than two miles are thought to be demographically isolated (Mattoni *et al.* 1997), maintaining connections of less than two miles between satellite and source colonies is likely needed for population survival.

1.4 Quino Habitat Distribution within the South County Subarea

Although there have been many recent observations of Quino within the County Subarea, it has not been systematically surveyed for Quino. The County has developed a model to assist in determining distribution of potential Quino habitat in the County Subarea. This model is useful in estimating areas where Quino may or may not occur and helps in quantifying conservation and design monitoring plans.

1.4.1 Potential Quino Habitat Model

To assess the suitability of different areas to support Quino, a Potential Quino Habitat Model (Figure 2) was developed. Only areas with habitat types generally considered capable of supporting Quino were considered in the model. Habitat types considered to have the potential to support Quino (*i.e.*, Potential Quino Habitat) are limited to the following:

- Coastal sage scrub (including flat-topped buckwheat scrub);
- Maritime succulent scrub;
- Chaparral;
- Coastal sage scrub/chaparral ecotone;
- Grassland;
- Vernal pool; and
- Agricultural lands that have been acquired for conservation and are no longer in agricultural use (*i.e.*, are recovering their habitat values).

Although dense-canopy chaparral is not generally considered to have potential to support Quino, all chaparral habitats have been included as Potential Quino Habitat since available mapping does not consider vegetation density or features such as fire breaks, dirt roads, or trails that could provide patches of suitable habitat. Many Quino observations have been in habitat largely mapped as chaparral, but which has been opened up by grazing, fire breaks, and dirt roads (*e.g.*, on Otay Mountain).

The assessment of potential habitat was based, overall, on vegetation mapping that was conducted to support development of the County Subarea Plan in 1995. This was, however, updated to some extent by 1) refining the vegetation data as more current survey data were available; and 2) reclassifying newly developed areas as “developed.”

Areas of Potential Quino Habitat have been assigned Classes A through C, with A representing the highest relative potential for Quino and C representing the lowest. This categorization takes into account survey results between 1999 and 2009. However, negative survey results from 2002 were not considered, as it was a relatively poor survey year for Quino. Proximity to known Quino locations was based on a one kilometer (0.6 mile) radius. This radius was selected because data from mark-recapture studies indicate that dispersal greater than this distance is not common in checkerspot butterflies (USFWS 2003).

Based on known Quino observations and negative survey data, the following classes were assigned to Potential Quino Habitat within the County Subarea:

- **Class A** includes Potential Quino Habitat within one kilometer (0.6 mile) of any known Quino location (1999 to 2009).
- **Class B** includes Potential Quino Habitat with no known 1999, 2000, 2001, 2003, 2004, 2005, 2006, 2007, 2008, or 2009 protocol survey, outside one kilometer (0.6 mile) of any known Quino location.
- **Class C** includes Potential Quino Habitat with a negative 1999, 2000, 2001, 2003, 2004, 2005, 2006, 2007, 2008, or 2009 protocol survey, outside one kilometer (0.6 mile) of any known Quino location.

1.4.2 Current Habitat Conditions

The total acreage of Potential Quino Habitat includes approximately 35,763 acres (23 percent) in Class A, 110,566 acres (71 percent) in Class B, and 9,936 acres (six percent) in Class C (Table 1 and Figure 2). Class A habitat is restricted to the South County, Alpine-Jamul, and San Vicente Quino Management Units (QMU) where Quino were observed since 1999 or later. Most of these observations were in the southern part of the County, although there have been a number of observations northwest of the San Vicente Reservoir and a smaller number of observations in Alpine.

Table 1. Potential Quino Habitat within Each QMU (in acres).

	Quino Management Unit						
Model Class	Alpine-Jamul	Lake Hodges	San Pasqual	San Vicente	South County	Total	Percent
A	2,097	0	0	2,740	30,927	35,763	23%
B	37,152	3,311	7,298	28,759	34,046	110,566	71%
C	1,072	2,792	409	4,031	1,632	9,936	6%
Total Potential Habitat:	40,321	6,102	7,707	35,529	66,605	156,265	

A large amount of the Potential Quino Habitat is within Class B, as a large portion of Potential Quino Habitat is not in close proximity to any known Quino observation and has not been subject to Quino surveys. This reflects the current uncertainty about the potential of many areas to support Quino.

Wildland fire may have impacted Quino populations and habitat within the County Subarea in recent years. In 2003, the Otay Fire severely burned habitats where Quino had been observed previously in the Otay Mountain region. In 2005, the Border 50 Fire burned additional Quino habitat in the Marron Valley area. Post-fire monitoring surveys have not indicated that populations were completely extirpated by the 2003 and 2005 fires, but Quino densities and extent of occupied habitat appeared to be reduced. In addition, increased rates of invasion by non-native plant species has been detected, which poses an indirect threat to Quino host plants through competition. In 2007, the Harris Fire impacted the Otay Mountain region, including areas that had not been impacted by fires in 2003 and 2005. Habitat damage and impacts to Quino from the Harris Fire are still being assessed. (USFWS 2008)

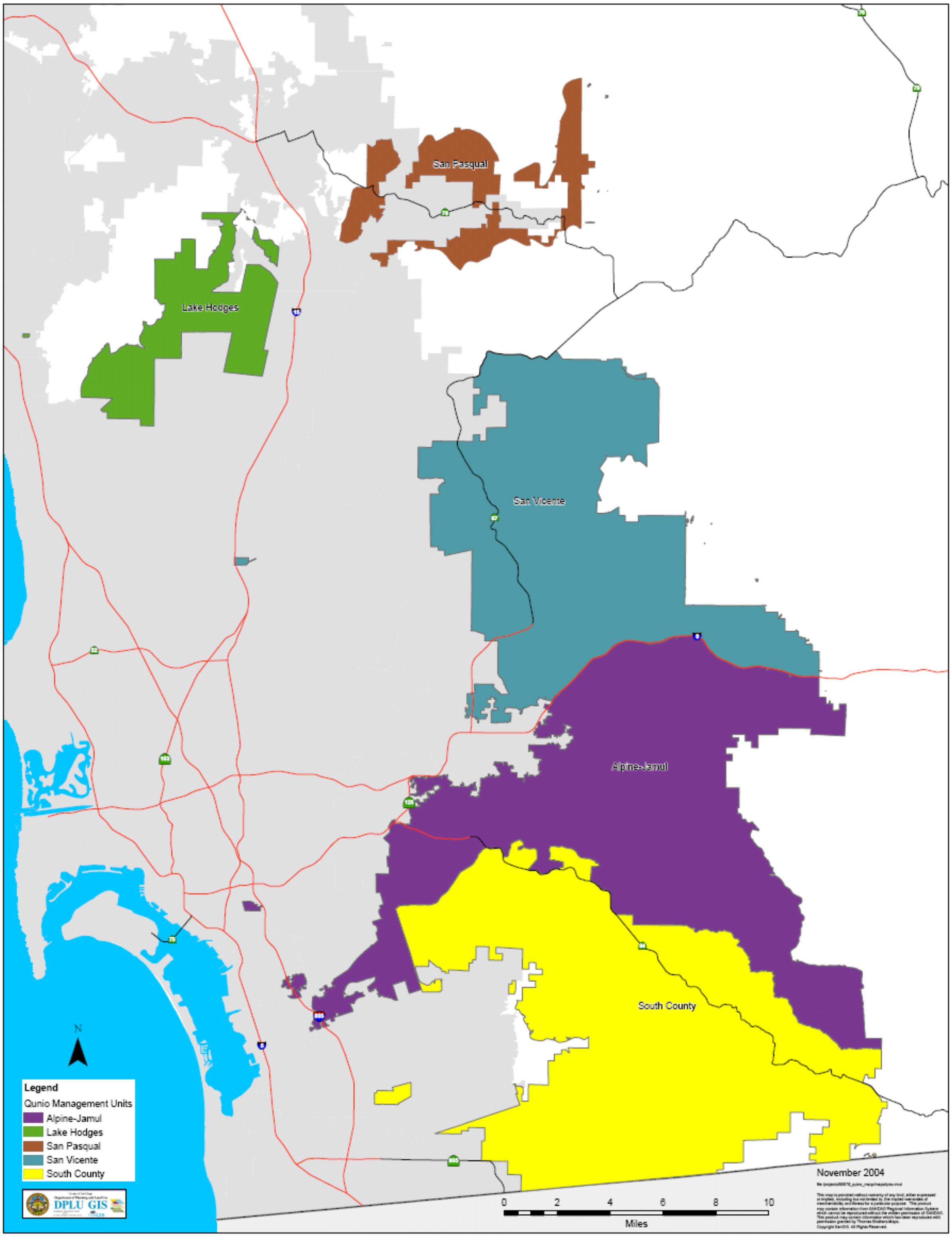

Figure 1. Quino Management Units (QMU). Adaptive Management and Monitoring will be focused in preserve areas in San Vicente (blue), Alpine-Jamul (purple), and South County (yellow) QMU.

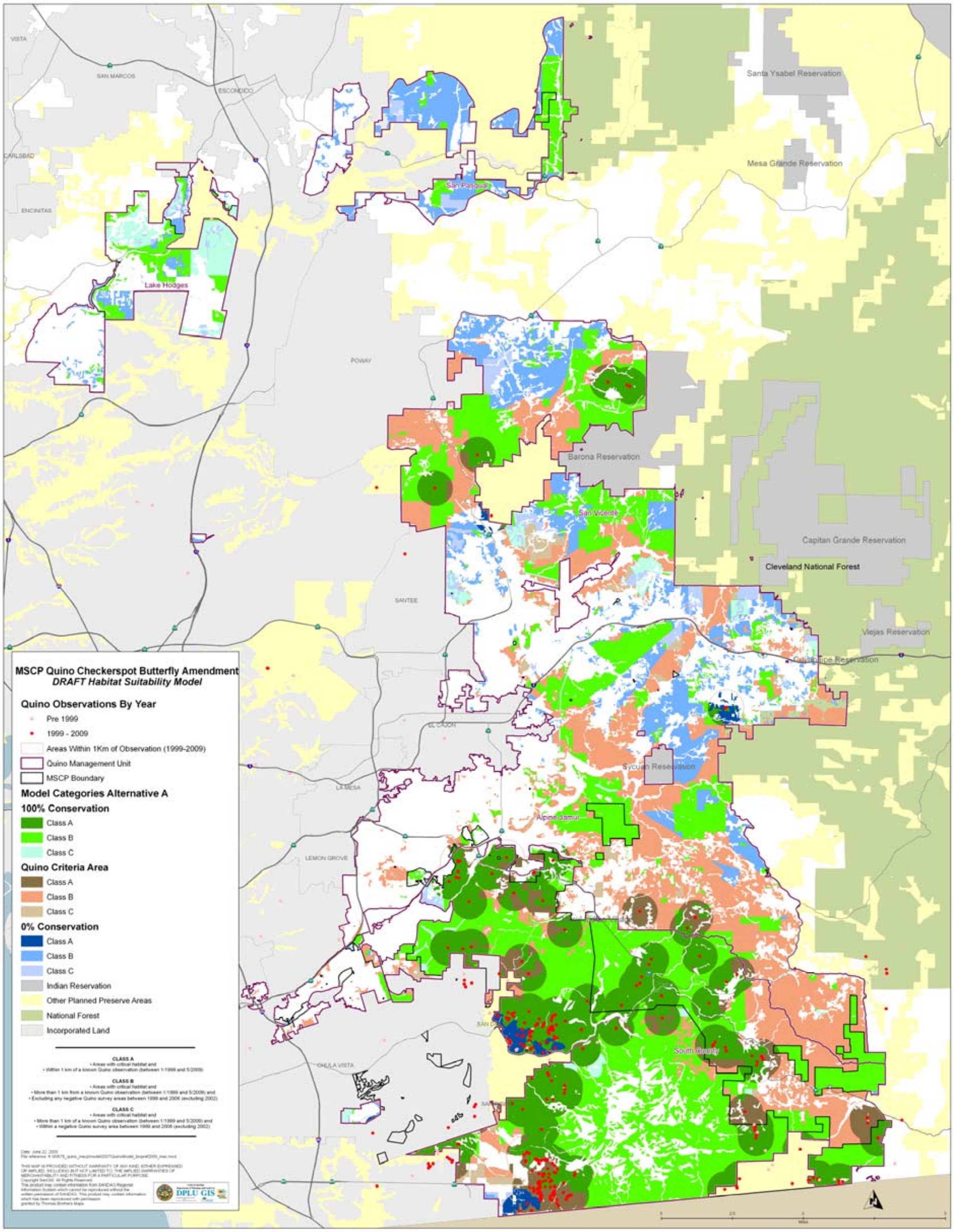

Figure 2. Potential Quino Habitat Based on Results of Potential Quino Habitat Model; Grouped by Conservation Policy Categories / Classes (see Summary of Proposed Conservation Policies).

2.0 Biological Monitoring

The monitoring program will involve baseline habitat surveys and Quino occupancy and habitat monitoring. Baseline habitat surveys will delineate Quino habitat within existing and future preserves. This information will be used to develop a sampling scheme for Quino occupancy and habitat monitoring. Quino occupancy monitoring will track Quino population trends over time. Quino habitat monitoring will track changes in habitat quality and quantity.

2.1 Baseline Habitat Surveys

Since information regarding the actual distribution of Quino and Quino habitat within preserves is limited, the long-term monitoring protocols for Quino occupancy and habitat monitoring will be refined as information is gained from field observations. Baseline habitat surveys will begin to fill this information gap.

2.1.1 Objective

Develop baseline data regarding the distribution of Quino habitat in order to develop protocols for Quino occupancy and habitat monitoring.

2.1.2 Methods

Existing preserves without current Quino survey results in the South County, Alpine-Jamul, and San Vicente QMUs (Figure 1) will be surveyed within three years of adoption of the Quino Amendment, as funding is available. Future preserves within these QMUs will be surveyed for Quino within three years after land is dedicated to the preserve system. Quino surveys will be conducted on preserves prior to development of recreational facilities or infrastructure. Surveys will not be conducted in the Lake Hodges or San Pasqual QMUs where, based on a lack of recent observations, Quino are not expected to occur.

Using existing Quino location data, vegetation data, and aerial photos, areas within preserves that have a high likelihood of Quino occupancy will be identified. Survey routes will be delineated within these areas, which will be surveyed by biologists permitted to survey for Quino by the USFWS, using the USFWS' survey protocol for Quino. Surveyors will map habitat that has the potential to support Quino (see Section 1.1 for general description of Quino habitat).

2.2 Quino Occupancy and Habitat Monitoring

The location of monitoring points will be randomly selected from potential Quino habitat in the County Subarea. Presence/absence surveys for Quino will be done at these locations. The sampling framework will involve both sentinel sites (*i.e.*, sites to be surveyed every year) and panel sites (*i.e.*, sites that will be surveyed less frequently). During some years, Quino do not exhibit an adult phase and cannot be adequately detected. In such a case, the survey schedule will be delayed until the next year when Quino can be adequately surveyed. By conducting Quino occupancy and habitat monitoring at the same locations, information regarding Quino habitat requirements will be generated.

Upon general acceptance of the strategy proposed in this summary report, the County will work with statisticians to design the occupancy monitoring framework (*i.e.*, survey recurrence and number of survey sites) and associated costs for Quino occupancy and habitat monitoring.

2.2.1 Quino Occupancy Monitoring

Objective

Track the status of Quino populations, allowing for long-term population trends to be identified.

Survey Methods

As described above, the occupancy monitoring method will be used to monitor population trends for Quino. Occupancy monitoring requires the presence or absence of the species to be determined at each sampling location. Five surveys for Quino should detect, with a probability of 0.95, populations with more than 10 observable individuals (Zonneveld *et al.* 2003). Observable individuals account for search efficiency; if search efficiency is 10 percent, a population of 100 Quino will have 10 observable individuals. Such survey protocol is used by the USFWS and will be applied to sentinel and panel sites. Walking surveys that cover the sample site will be conducted. When Quino is found, a point count system can be established. Zonneveld *et al.* (2003) suggest that the five presence surveys for Quino should be completed on the last day of February, March 16, March 30, April 14, and May 1, which may be amended to reflect weather circumstances. To avoid a situation in which an individual adult Quino that has immigrated to a site is counted as species presence there, more than one individual must be observed to be considered indicative of presence for quantitative analysis. Additionally, sites where adults have been observed for the first time should be surveyed to locate pre-diapausal larvae to confirm recruitment and presence for quantitative analysis.

2.2.2 Quino Habitat Monitoring

Objectives

1) Track the quality and quantity of Quino habitat, allowing for major changes (*i.e.*, relative to non-native invasive species, wildfire, etc.) in habitat quality or quantity to be identified and appropriate adaptive management responses initiated and consider areas where new potential Quino habitat may have been created due to changes (*i.e.* resulting from wildfire, fire breaks, dirt roads, trails, etc.).

2) Further the understanding of habitat characteristics most beneficial to the long-term persistence of Quino.

Survey Methods

The Quino habitat monitoring program is intended to improve the current understanding of the habitat and environmental correlations to Quino population size and stability and provide the basis for adaptive management strategies. The rarity of Quino makes estimating these relationships difficult, since it is presumed that many suitable sites are likely to be unoccupied. Metapopulations dynamics also complicate temporal patterns of occupation (Hanski 1996). Variables measured at each patch will include structure and composition of the plant community; presence and density of larval host plants, nectar plants, and other plants that co-occur with Quino; amount of bare ground; and other correlates of Quino occupancy, such as the presence of cryptobiotic soil crusts.

The habitat monitoring plan for the County Subarea has been revised by researchers at San Diego State University, which will allow for more efficient monitoring of habitat quality and quantity. To the extent possible, monitoring of Quino habitat variables should occur in conjunction with the broader County Subarea habitat monitoring program.

3.0 Adaptive Management

Conversion from native vegetation to non-native annual grassland is likely the greatest threat to Quino within preserves (Freudenberger *et al.* 1987, Minnich and Dezzani 1998, Stylinski and Allen 1999). Therefore, a primary focus (at least initially) of adaptive management will be maintaining native vegetation communities suitable for Quino occupancy. The Framework Management Plan (County of San Diego 2001) provides the basis for general preserve management and will continue to be used. The monitoring described above will be used to identify appropriate adaptive management actions specifically related to Quino conservation.

Due to the metapopulation dynamics of Quino, it will be important to maintain the quality and quantity of both occupied and unoccupied Quino habitat. Maintenance of unoccupied habitat is needed to allow Quino to colonize or re-colonize these areas in the future. The following discussion describes specific findings that will trigger specific adaptive management actions for Quino.

3.1 Objectives

1) Maintain net quality and quantity of occupied and unoccupied Quino habitats.

2) Maintain viable and interconnected Quino populations.

3.2 Adaptive Management Triggers

3.2.1 Trigger 1: Reduced Number of Occupied Sites

Trigger 1 will be considered to have occurred if a 20 percent reduction in occupancy has occurred after three monitoring periods. If declines are attributable to low rainfall, then no action is required. Otherwise, the County and Wildlife Agencies, in consultation with qualified scientists, will attempt to determine whether dispersal, habitat quality, or weather conditions explain the reduction in number of occupied sites. If habitat quality is found to be the likely cause, the County will initiate enhancement action of sites where Quino is extirpated over an appropriate area, while maintaining habitat values for other species.

3.2.2 Trigger 2: Extirpation at Specific Sites

Trigger 2 will be considered to have occurred if a 40 percent reduction in occupancy occurs between two sampling periods. If vegetation and other site variables show that vegetation has declined, then the County would initiate habitat enhancement actions. If habitat quality does not appear to be the cause of extirpation, then the County would consider other actions, such as performing additional research studies or reintroducing the species through translocation of wild or captive stock, in coordination with the Wildlife Agencies.

3.2.3 Trigger 3: Populations are Stable

Trigger 3 will be considered when occupancy remains constant through time (*i.e.,* three sampling periods or longer), showing that populations are stable. In this situation, the County would initiate restoration of unoccupied sites, as funding is available. In this manner, available resources would be directed to creation of new habitat only when declines in existing habitat have already been addressed.

3.3 Methods

The success of this adaptive management program will depend on the development of techniques that can efficiently reestablish native forbs and grasses on large scales. Habitat restoration and enhancement should follow an experimental framework that identifies the most efficient and effective methods that can be adopted for long-term implementation. The specific design of this program will be coordinated with the Wildlife Agencies and leading experts in the field of Quino ecology and habitat restoration.

The focus of restoration and enhancement research to date has been almost exclusively related to shrub establishment (Cione *et al.* 2002; Eliason and Allen 1997), with few studies on the native herbaceous understory critical to Quino occupancy (Allen *et al.* 2000; Bowler 1993). Even less focus has been placed on reestablishment of cryptobiotic crusts (Bowler and Belnap 2000). However, some techniques have been proposed for restoration of native forbs in a coastal sage scrub mosaic, such as dethatching and extensive hand weeding (Dodero and Hanson 2002). It is evident that most coastal sage scrub restoration does not reestablish a diverse understory of native forbs and grasses and efforts to do so are expensive and of limited size.

4.0 References

Allen, E.B., S.A. Eliason, V.J. Marquez, G.P. Schultz, N.K. Storms, C.D. Stylinski, T.A. Zink, and M.F. Allen. 2000. What are the Limits to Restoration of Coastal Sage Scrub in Southern California? In J. E. Keeley, M. B. Keeley and C. J. Fotheringham (eds.) 2nd Interface Between Ecology and Land Development in California. USGS Open-File Report 00-62, Sacramento, CA.

Bowler PA. Species richness and coastal sage scrub restoration. In: Bowler PA, Read E, editors. Special Publication No. 1. 1993. Irvine, CA. Society for Ecological Restoration-California Chapter. p 2–14.

Bowler PJ, Belnap J. Cryptobiotic soil surfaces in coastal sage scrub and other southern California habitats. 2000. Fullerton, CA. Southern California Botanists.

Cione NK, Padgett PE, Allen EB. 2002. Restoration of a native shrubland impacted by exotic grasses, frequent fire, and nitrogen deposition in southern California. Restoration Ecology. 10(2):376–384.

County of San Diego. 1997. Multiple Species Conservation Program; County of San Diego Subarea Plan.

County of San Diego. 2001. County of San Diego Multiple Species Conservation Program: Framework Management Plan.

Dodero MW, Hanson BM. 2002. Improving habitat for insect pollinators at rare plant restoration and translocation sites. Tucson, AZ. p 115.

Eliason SA, Allen EB. 1997. Exotic grass competition in suppressing native shrubland re-establishment. Restoration Ecology 5(3):245–255.

Freudenberger DO, Fish BE, Keeley JE. 1987. Distribution and stability of grasslands in the Los Angeles [California, USA] basin. Bulletin Southern California Academy of Sciences 86(1):13–26.

Longcore, T., D.D. Murphy, D. Deutschman, R. Redak, and R. Fisher. 2003. A Management and Monitoring Plan for Quino Checkerspot Butterfly (Euphydryas editha quino) and Its Habitats in San Diego County. Advisory Report to the County of San Diego.

MacKenzie, D.I. and Nichols, J.D. 2004. Occupancy as a surrogate for abundance estimation. *Animal Biodiversity and Conservation*, 27.1: 461–467.

Mattoni, R., G. Pratt, T. Longcore, J. Emmel, and J. George. 1997. The endangered Quino checkerspot butterfly, Euphydryas editha quino (Lepidoptera: Nymphalidae). J. Res. Lep. 34:99-118.

Minnich RA, Dezzani RJ. 1998. Historical decline of coastal sage scrub in the Riverside-Perris Plain, California. Western Birds 29(4):366–391.

Osborne, K. 2001. Observations of Euphydryas editha quino made on April 16, 2001 in the vicinity of Lake Skinner. Submitted to U.S. Fish and Wildlife Service, Carlsbad Fish and Wildlife Office. 24 Hour Survey Report # 8.

Stephenson, J. R., and G. M. Calcarone. 1999. Southern California mountains and foothills assessment: habitat and species conservation issues. General Technical Report PSW-GTR-172. Albany, CA: Pacific Southwest Research Station, USDA Forest Service.

Stylinski CD, Allen EB. 1999. Lack of native species recovery following severe exotic disturbance in southern Californian shrublands. Journal of Applied Ecology 36(4):544–554.

United States Fish and Wildlife Service. 1997. Endangered and Threatened Wildlife and Plants: Determination of Endangered Status for Laguna Mountain Skipper and Quino Checkerspot Butterfly. Federal Register 62:2313-2322. January 6.

United States Fish and Wildlife Service. 2003. Recovery Plan for the Quino Checkerspot Butterfly (Euphydryas editha quino). Portland, Oregon. 179 pp.

Unites States Fish and Wildlife Service. January 17, 2008. Revised Designation of Critical Habitat for the Quino Checkerspot Butterfly (*Euphydryas editha quino*); Proposed Rule.

Unites States Fish and Wildlife Service. June 17, 2009. Revised Designation of Critical Habitat for the Quino Checkerspot Butterfly (*Euphydryas editha quino*); Final Rule.

Weiss, S. B., D.D. Murphy, and R. R. White. 1988. Sun, slope, and butterflies: topographic determinants of habitat quality for Euphydryas editha. Ecology 69:1486:1496.

Zink, T.A., M.F. Allen, B.I. Heindl-Tenhunen, and E.B. Allen. 1995. The effect of a disturbance corridor on an ecological reserve. Restoration Ecology 3: 304-311.