

PROJECT SUBMISSION FORM
For Consideration for *TransNet* Environmental Mitigation Program (EMP) Funding
for Land Management
(FY 2009 Funding Only)

General Information on the Property (Click on the fields below to begin typing). Please use as much space as is needed. Attach to front of Proposal).

Applicant Name: **Zoological Society of San Diego & City of San Diego Water Department**

Address: **15600 San Pasqual Valley Road, Escondido, CA 92027**

Name of Property: **San Diego Zoo's Wild Animal Park**

General Location: **San Pasqual Valley, Escondido, California**

Jurisdiction: **City of San Diego**

Total Acres: **900**

Acres Requiring Management: **45**

Owner(s) of Property: **City of San Diego Water Department, leased by the Zoological Society of San Diego**

Land Manager(s) of Property (include name(s), years of experience managing habitat lands, existing land management responsibilities, and references):

Bryan Endress, PhD. Associate Director CRES /Division Head, Applied Plant Ecology, Zoological Society of San Diego.

***Years experience managing habitat lands:* 5 years for Oregon State University and the Pacific Northwest Research Station (USDA Forest Service) on semi-arid shrubland/grassland restoration and management (multiple projects); 1.5 years of applied restoration research at the Zoological Society of San Diego on cactus scrub and coastal sage scrub ecosystems.**

***Existing land management responsibilities:* Post-fire restoration (invasive plant control and seeding/planting native species) and monitoring of cactus scrub and coastal sage scrub plots at the Wild Animal Park; provide input/management advice to The Nature Conservancy and USDA Forest Service regarding semi-arid bunchgrass restoration in NE Oregon.**

References:

Dr. Allison Alberts, Director of CRES, Zoological Society of San Diego.

Dr. Catherine Parks, Forestry and Range Sciences Lab, USDA Forest Service, La Grande, OR.

Nicole McGinnis, Senior Environmental Planner, Watershed and Resource Protection, City of San Diego Water Department.

***Years experience managing habitat lands:* 7 years managing over 10,000 acres of Water Department rural land holdings.**

***Existing land management responsibilities:* Provide management recommendations for Water Department to City officials; manage projects in support of habitat preservation, restoration and creation, watershed management and water quality.**

References:

John Martin, Refuge Biologist, United States Fish and Wildlife Service
Paul Schlitt, Environmental Scientist, California Department of Fish and Game
Michael Beck, San Diego Director, Endangered Habitats League
Jerre Stallcup, Conservation Biologist, Conservation Biology Institute

** If the applicant is not the landowner, please submit a letter or right-of-entry permit from the land owner granting permission to perform the land management duties as outlined in the application. Failure to provide the letter or right-of-entry permit will lead to disqualification of the application.

Funding Needs

1. How much money is being requested for this year? **\$341,153 over three years**
2. Are there matching funds available? ☒ **Yes** or ☐ **No**
If yes, please provide the source of funds and dollar amount: **\$359,137 over five years. This includes labor and supplies. Please refer to scope of work for details.**
3. What management activities will be done on the property? Please list each activity and its associated cost, and an implementation schedule including time frames for each activity (you may reference the project's scope of work): **Please refer to the attached Scope of Work for specifics. Primary activities include:**
 - **Habitat enhancement of 45 acres of cactus scrub.**
 - **Creation of a cacti propagation and salvage center at the Wild Animal Park to support restoration of cactus scrub in North County.**
 - **Propagation of enough prickly-pear cactus to support an additional 30 acres of habitat enhancement in San Pasqual Valley at partner sites managed by San Dieguito River Park and San Dieguito River Valley Conservancy.**
 - **Monitor cactus wren abundance and re-occupancy; relate to habitat quality and enhancement activities.**
4. Are there any federal or state permits required for these activities? ☐ **Yes** or ☒ **No**
If so, are there associated costs for these permits? ☐ **Yes** or ☒ **No**
If so, are the permit costs included in the request? ☐ **Yes** or ☒ **No**

Biological Significance

1. Does the property support or did it support natural vegetation in a core area? ☒ **Yes** or ☐ **No**
If yes, list the habitats contained on the property: **Coastal sage scrub, cactus scrub (*Opuntia* sp.), exotic-dominated grasslands.**
2. Does the property contribute to the Natural Communities Conservation Program regional preserve system? ☒ **Yes** or ☐ **No**
3. Is the property a linkage or regional wildlife corridor? ☒ **Yes** or ☐ **No** **Yes, this property is an important component of the San Dieguito River Valley corridor and helps maintain connectivity of habitat patches in the San Pasqual Valley/Lake Hodges area.**
4. Are there, or were there, significant populations of covered species or species proposed for coverage by a habitat conservation plan? ☒ **Yes** or ☐ **No**

If yes, please list the species: **Cactus Wrens and California Gnatcatchers. 2008 surveys revealed this property has the greatest abundance of wrens and gnatcatchers in the region with 10 nesting pairs of cactus wrens and 10 nesting pairs of gnatcatchers identified. Other species covered by the MSCP occur within the areas proposed for enhancement including the San Diego horned lizard, orange-throated whiptail, and the spadefoot toad.**

Risk

1. Does the site suffer from natural, human, or domestic animal disturbance (e.g., off-road vehicle use, grazing, fire, flooding, and/or feral cats)? ☒ Yes or ☐ No

If yes, list the type(s) of disturbance: **Primary disturbance is frequent, repeated fire events followed by invasion of exotic plants. Some areas have burned 3 times in the last 12 years. Most recently, the Witch Fire burned 600 of the 900 acres of native habitat at the Wild Animal Park in October 2007. Since the area is fenced and access is severely restricted, off-road vehicle use/grazing or other disturbances are not an issue.**

2. Do exotic, invasive species threaten the preserve? ☒ Yes or ☐ No

If yes, list the species: ***Avena fatua*, *Brassica spp.*, *Erodium cicutarium*, *Bromus madritensis*, *Bromus diandrus*, *Centaurea melitensis*, and others to a lesser degree.**

3. Is there uncontrolled erosion? Uncontrolled access? ☐ Yes or ☒ No

If yes, identify the source if possible:

4. Is immediate action needed to address a problem, or else the site would degrade further? Would the further degradation potential affect covered species?

☒ Yes or ☐ No

If yes, explain: **Immediate action is warranted because (1) *Opuntia* recovery in some areas burned in 2007 has been very slow, (2) the risk type of conversion from cactus scrub to exotic grassland is a serious threat without habitat restoration and enhancement, and (3) areas only moderately burned contain the largest concentration of cactus wrens and gnatcatchers pairs in the region. Further degradation would not only jeopardize birds on-site, but would also endanger the species throughout the San Pasqual Valley/Lake Hodges region by increasing fragmentation and lengthening the distance between suitable habitat patches that are managed by various habitat managers, including the San Dieguito River Park, San Dieguito River Valley Conservancy, and the City of San Diego (e.g. Piedras Pintadas Habitat Restoration and Access Control near Lake Hodges). The San Pasqual Valley is a stronghold for coastal cactus wrens in the North County, and given limited dispersal abilities of juveniles (approximately 1.6 km), habitat enhancement near existing populations is the most effective and cost-efficient approach to ensure the species survival in the county for the long-term.**

Cost-Effectiveness

1. Does the proposal use efficient and proven methods and/or strategies to address the land management needs that would result in a high likelihood of success and reduce future land management costs? (e.g., control of small outbreak of aggressive exotic species, fencing to prevent damage to rare plant populations)

☒ Yes or ☐ No

If yes, explain: **The proposed techniques have been successfully employed in restoration projects in southern coastal San Diego County and are heavily informed by the Coastal Cactus Wren Working Group. The Coastal Cactus Wren Working Group consists of a number of public agencies and non-profit organizations (e.g., U.S. Fish and Wildlife Service, California Department of**

Fish and Game, San Diego Natural History Museum, The Nature Conservancy, Endangered Habitats League, Conservation Biology Institute, and Zoological Society of San Diego) collaboratively addressing cactus wren conservation. The techniques are also guided by our pilot cactus propagation studies and restoration activities that have been conducted in the past year.

2. Does the proposal implement a strategic approach which covers large geographic areas (e.g., watershed or subwatershed extent) involving multiple partners and providing multiple benefits (e.g., part of a larger coordinated effort) (i.e., High Economy-of-Scale)? ☒ **Yes** or ☐ **No**

If yes, explain:

This project implements a strategic approach in three ways:

- **The project is a part of the greater Coastal Cactus Wren Working Group conservation effort, which is focused on formulating and implementing a regional approach to address the precipitous decline of the coastal cactus wren populations across its range. Results of recent (2008) analyses indicate that the cactus scrub habitat at the Wild Animal Park is critical for coastal cactus wrens in San Pasqual Valley; the area provides habitat for one-third of all cactus wren pairs in the greater San Pasqual Valley/Lake Hodges area. Moreover, because of the limited dispersal distance of cactus wrens, restoration and enhancement activities adjacent to existing populations is more effective than restoration efforts not linked to existing occupied habitat patches. Therefore, restoration and enhancement of this area is a high-priority.**
 - **Other partners in the San Pasqual Valley, including the San Dieguito River Park, San Dieguito River Valley Conservancy, and the City of San Diego Water Department are also implementing habitat restoration and enhancement activities on MSCP lands in order to maintain and increase habitat connectivity for cactus wrens and gnatcatchers. This project will enhance those efforts by serving as a native plant material resource for restoration activities (see Scope of Work).**
 - **CRES (Conservation and Research for Endangered Species) is well situated to serve as an important contributor to conservation action in San Pasqual Valley because of our location at the Wild Animal Park, and our experience in species and habitat management globally. We view this project as the first step in building our capacity to fill a role as a regional conservation science resource. Increased involvement in regional habitat restoration activities by the Zoological Society of San Diego also increases opportunities for cost-sharing for local habitat restoration, enhancement, and conservation.**
3. How would the project result in measurable biological success to implement the Natural Communities Conservation Program regional preserve system? What measurable results would be used to determine success of the project? explain:

The project will enhance 45 acres of land that is currently marginal habitat for cactus wrens (due to the 2007 to wildfires) into habitat that is likely to support cactus wrens. It will also provide plant material to support 30 acres of restoration by partners in San Pasqual Valley. These areas are adjacent to existing high quality habitat. Approximately 5 years after project implementation, we expect these areas to support roughly 100 *Opuntia* plants > 1m tall/acre and have cactus wrens utilizing this habitat. We also expect to see an increase in cactus wrens within the larger MSCP boundaries (900 acres). Restoration efforts will be complemented with already-initiated Zoological Society of San Diego funded research that evaluates alternative approaches to restoration (direct planting vs. headstarting, cost-benefit analysis of alternate approaches, etc.). Results will be published in peer-reviewed restoration journals and technical reports directed for land managers.

These efforts will further guide and inform future restoration efforts. We also expect to propagate and grow at least 1250 *Opuntia* spp. plants per year that will be available for regional restoration efforts throughout North County. After 3 years, we expect to have an operating cacti-salvage nursery (see Scope of Work), which will be maintained to make material available to regional restoration efforts for many years to come.

4. Would the project involve the public outreach/public participation to identify the land management activities being funded and promote awareness of grant funded project? ☒ **Yes** or ☐ **No**

If yes, explain: Project reports and outreach efforts (such as a hosted workshop) for land managers engaged in restoration will be developed. **We will host up to two workshops for land managers involved in cactus scrub habitat restoration. Public outreach through the Zoological Society of San Diego websites and publications (ZOONOOZ, CRES Updates, PR releases) will promote awareness of the project as well as the TransNet Environmental Management Program. In addition, hundreds of students from San Diego County visit CRES each year and learn about on-going projects. Educational curricula relating to this project will be developed and integrated into the daily tours.**

PROJECT PROPOSAL

COASTAL CACTUS WREN HABITAT ENHANCEMENT IN SAN PASQUAL VALLEY

Executive Summary

The Wild Animal Park MSCP is one of the last remaining strongholds for coastal cactus wrens in the North County, and the cactus scrub supports the greatest abundance of cactus wrens in San Pasqual Valley. The 2007 Witch Creek fire damaged much of the cactus scrub at the Wild Animal Park and throughout the San Pasqual Valley. We propose to support and enhance the survival of coastal cactus wrens in the Valley using a strategic, multi-faceted approach. Specifically we propose to: (1) enhance 45 acres of damaged cactus scrub within the Wild Animal Park MSCP through cacti enrichment plantings, (2) construct a cactus propagation and salvage center that will serve as a long-term resource providing native cacti materials for restoration projects throughout the North County, (3) propagate over 1,200 prickly-pear cacti per year for restoration in the San Pasqual Valley (including the Wild Animal Park MSCP and partner-managed MSCP lands) and (4) monitor cactus wren abundance, distribution, and habitat use in relation to habitat enhancement to verify project success. We seek funding from TransNet for the first three years of this five year project. This project contains considerable matching and in-kind contributions. Publications and workshops will be held for land managers to disseminate information. The Zoological Society of San Diego views this project as a first step in a process to build our capacity to better serve and address local habitat restoration and conservation needs.

Background

In 2008, a group of concerned biologists from government and nongovernmental organizations throughout coastal southern California met to discuss the fate of coastal populations of Cactus Wrens in light of ongoing habitat loss, fragmentation, and degradation, frequent fires and exotic plant invasions. From this meeting, an ad hoc Cactus Wren Working Group was formed to coordinate and prioritize projects with the intent of leveraging funds from various sources to implement a regional approach to address the decline of cactus wren populations in San Diego and Orange Counties. This group identified two priority conservation areas for San Diego: San Pasqual Valley/Lake Hodges area and the Otay-Sweetwater area.

San Pasqual Valley is one of the last remaining areas in the county that has relatively robust coastal cactus wren populations. Cactus wren surveys conducted by the Conservation Biology Institute in 2008 revealed 33 pairs in the area. The cactus scrub (dominated by *Opuntia spp.*) within the 900 acre MSCP habitat preserve at the Wild Animal Park contains the most cactus wrens in San Pasqual Valley (10 nesting pairs). In fact, this area and the adjacent San Pasqual Battlefield contain over 45% of all cactus wrens in the entire San Pasqual Valley/Lake Hodges area. Surveys also revealed 10 nesting pairs of California gnatcatchers at the Wild Animal Park preserve. Thus, this is a critical location for cactus wrens and other at-risk wildlife.

With a relatively large number of cactus wrens in the area it is unfortunate that much of San Pasqual Valley, including cactus scrub at the Wild Animal Park, was severely affected by the 2007 firestorms. The fires resulted in considerable damage and mortality of large cacti in some areas. Areas of cactus scrub that were heavily burned are now at risk for type conversion to exotic dominated annual grassland, while areas that were moderately burned are at risk to further degradation. Other remaining cactus wren habitat patches in San Pasqual Valley (managed by the City of San Diego Water Department, San Dieguito River Valley Conservancy and the San Diego River Park) face the same threat. Because of the relatively high number of cactus wrens on the Wild Animal Park MSCP property and surrounding habitat, it is critical to focus on post-fire habitat enhancement and restoration to not only stabilize current cactus wren population numbers, but also to enhance and expand habitat in the area to ensure the long-term success of cactus wrens in North County.

Project Goals and Objectives

To address these concerns, the City of San Diego Water Department and the Zoological Society of San Diego will collaborate on a project to:

1. Restore 45 acres of degraded cactus scrub within the Wild Animal Park MSCP through cacti enrichment plantings.
2. Create a cactus propagation and salvage repository center at the Wild Animal Park to:
(1) provide cacti for habitat restoration projects at the Wild Animal Park MSCP and throughout the San Pasqual Valley, and (2) serve as a repository to support the County's developing program to require salvage of cacti impacted by development, as part of mitigation for such projects (lead: Endangered Habitats League).
3. Provide cacti materials via propagation to enhance an additional 30 acres of critical cactus wren habitat on MSCP lands in the San Pasqual Valley managed by other partners (San Dieguito River Valley Conservancy, San Dieguito River Park, and the City of San Diego). Materials propagated here will be used by the City of San Diego as part of their 4.75 acre Piedras Pintadas Land Management project.
4. Conduct applied research on restoration projects in effort to improve cactus scrub restoration techniques.
5. Monitor cactus wren abundance, distribution, use and re-occupancy of enhanced cactus scrub habitat.

We are requesting TransNet funds to support costs for the first three years of this five year project. This proposal contains significant matching funds (greater than a 1:1 match) from the Zoological Society of San Diego (see Budget below), and we view this as the first step of a long term Zoological Society of San Diego-supported cactus scrub restoration program.

Scope of Work

Proposed Tasks

1. *Cacti collecting.* Beginning in late 2009 (see timeline) 2,000 cacti pads/year for three years (6,000 pads total) will be collected from existing *Opuntia littoralis* stands of cacti at the Wild Animal Park MSCP for subsequent propagation and out-planting. No more than 2 pads will be collected from the same cacti each year so as not to jeopardize extant individuals. On-going research at CRES indicates that larger pads propagate, root, and add new pads more quickly than smaller ones, so collectors will target pads greater than 8 inches in length (Endress, unpublished data). Standard cacti propagation techniques will be followed (e.g. pads will be allowed to callus prior to planting, etc.).
2. *Cacti Propagation and Salvage Center.* In order to support cactus scrub restoration efforts across the North County, the Division of Applied Plant Ecology at CRES will modify existing infrastructure at the Wild Animal Park's Botanical Conservation Center to support propagation and production of several cacti species. We expect to propagate least 1250 cacti individuals per year at the center, which will be available for restoration efforts in San Pasqual Valley and beyond. Initial propagation will focus on *O. littoralis* for restoration in San Pasqual Valley, but will expand to include other species (e.g. *O. oricola*, *Cylindropuntia* spp.) in the future. Cacti collected in Task 1 (above), will be propagated here.

Another 1 acre site (already secured) at the Wild Animal Park will be developed to serve as a container nursery for both cacti propagated on-site and for salvaged cacti collected as part of new, upcoming regulations established by the County of San Diego and the City of San Diego that would require salvage of cacti as part of mitigation for development projects. Salvaged cactus will have all possible joints broken from them, then the main stem and roots dug up with a ball of soil for translocation. Because of the uncertainty regarding availability of salvaged cactus and when the new policies will come into effect, the exact restoration plan for these plants has not yet been developed. This site will serve as the North County salvage repository just as the Rancho Jamul Ecological Reserve is creating a facility to support the South County cacti salvage program (funded by a TransNet grant in FY 2008).

3. *Restoration and Enrichment Planting.* The goal of the enrichment planting is to plant cacti on 45 acres of suitable habitat adjacent to existing cacti patches at the Wild Animal Park at a density of at least 100 cacti individuals per acre. Accounting for mortality rates of 25-30% (typical in restoration efforts), we will plant at least 150 cacti per acre (total of 6,745 plants). Within each acre, 50 of the plants will come from propagated stock (Tasks 1 & 2) and another 100 plants will be directly planted in the field. 15 acres will be planted each year for three years. Pads will be collected and allowed to callus for at least 1 week prior to planting. Planting will occur in late fall, just before the onset of winter rains. If weed cover appears to be affecting growth and survival spot spraying of the herbicide glyphosate around the transplants will occur as needed.

Since the Cacti Propagation Center will be able to propagate 1,250 plants per year, and habitat enhancement activities at the Wild Animal Park need only 750 propagated cacti per year, the remaining 500 cacti each year will be available for other ongoing cactus restoration efforts in San Pasqual Valley directed by the San Dieguito River Park and the San Dieguito River Valley Conservancy. Both organizations have indicated that they will be able to use these plants for upcoming restoration efforts. This is enough material to enhance an additional 30 acres of cactus scrub habitat following the same methods.

4. *Monitoring and Applied Research*

Monitoring will consist of two components: 1) monitoring of survival and growth of cacti in the 45 acres of habitat enhancement; and 2) monitoring of colonization, abundance, and habitat use by cactus wrens within the enhanced areas as well as in existing adjacent patches of cactus scrub within the Wild Animal Park MSCP. To monitor survival and growth of cacti, we will randomly select 10% of planted cacti for annual measurements (total=450 individuals). Cacti will be tagged with a unique ID and their location recorded with a GPS. Cacti will be visited and assessed quarterly to determine survival and growth (height, number of pads, and widest distance across the canopy). To monitor colonization, abundance, and habitat use of cactus wrens at the site, the protocol developed by the Cactus Wren Working Group will be implemented by our staff (directed by Dr. Lisa Nordstrom).

Additionally, we will conduct applied research on cacti restoration. Organizations are currently expending considerable effort in planting cacti across the county, but the most cost-effective methods of cactus propagation and restoration are unclear. Two general approaches are promoted: (1) direct planting of pads at the site and (2) propagating pads in a shadehouse, followed by planting in the field. These two approaches differ in the amount of time and effort expended and little is known about the relative success of the two methods in terms of establishment, growth, and survival. To address this we began a field experiment in December 2008 with 600 pads to test (1) if direct planting or propagation is the most cost-effective methods of restoration and (2) which direct planting methods (laying flat vs. burying) increases cacti survival, establishment and growth. A split-plot design across 6 sites was used and the fate of the 600 individual cacti will be tracked over 5 years. Labor costs associated with the experiment will be covered by the Division of Applied Plant Ecology at CRES.

Deliverables

1. Habitat enhancement of 45 acres of cactus scrub at Wild Animal Park through cacti enrichment planting.
2. Propagation of cacti plant material to enable an additional 30 acres of cactus scrub habitat enhancement at critical MSCP sites in San Pasqual Valley.
3. Construction of Cacti Propagation and Salvage Center to serve the North County of San Diego.
4. Publications (professional and technical) evaluating best methods for cacti restoration and the importance of habitat enhancement on cactus wren abundance.
5. Report, based on annual monitoring, that evaluates success of project and its impact on cactus wren populations.
6. Outreach and educational activities to highlight the program, including (a) land manager workshops, (b) articles and press in Zoological Society of San Diego's publications and, and (c) cactus wren habitat enhancement information will be incorporated into CRES Conservation Lab curriculum for visiting students.

Timeline

Project start date: December 2009

Project end date: December 2014

TransNet funds are requested to cover costs for first three years of this five year effort (through December 2012).

Task	Date
• Modify infrastructure at Botanical Conservation Center (Wild Animal Park) to support cacti propagation	Winter 2009 – Summer 2010
• Site development for cacti salvage and container plant nursery (Cacti Propagation and Salvage Center).	Summer 2010-Spring 2011
• First round of pad collection, propagation, and subsequent care	Winter 2009
• Planting on first set of 15 acres at Wild Animal Park MSCP	Winter 2009
• Second round of cacti pad collection, propagation, and subsequent care	Winter 2010
• Planting on second set of 15 acres at Wild Animal Park MSCP	Winter 2010
• Delivery of 500 propagated cacti to local restoration partners	Winter 2010
• Third round of cacti pad collection, propagation, and subsequent care	Winter 2011
• Planting on third set of 15 acres at Wild Animal Park MSCP	Winter 2011
• Delivery of 500 propagated cacti to local restoration partners	Winter 2011
• Delivery of 500 propagated cacti to local restoration partners	Winter 2012
• Quarterly monitoring of cactus wren distribution, abundance, and habitat use (annually March, June, September, December).	2010-2014
• Quarterly monitoring of habitat enhancement activities (annually each March, June, September, December)	2010-2014
• Prepare annual reports (each December 2010-2014)	2009-2014

Exhibit A

SCOPE OF WORK

Project Introduction

The Wild Animal Park MSCP is one of the last remaining strongholds for coastal cactus wrens in the North County, and the cactus scrub supports the greatest abundance of cactus wrens in San Pasqual Valley. The 2007 Witch Creek fire damaged much of the cactus scrub at the Wild Animal Park and throughout the San Pasqual Valley. We propose to support and enhance the survival of coastal cactus wrens in the Valley using a strategic, multi-faceted approach. Specifically we propose to: (1) construct a cactus propagation and salvage center that will serve as a long-term resource providing native cacti materials for restoration projects throughout the North County, (2) propagate over 1,200 prickly-pear cacti per year for restoration in the San Pasqual Valley (including the Wild Animal Park MSCP and partner-managed MSCP lands), (3) enhance 45 acres of damaged cactus scrub within the Wild Animal Park MSCP through cacti enrichment plantings, (4) monitor establishment and growth of planted cacti, and (5) monitor cactus wren abundance, distribution, and habitat use in relation to habitat enhancement to verify project success.

Task #: 1. Creating a Cacti Propagation and Salvage Center

Description Existing infrastructure at the Wild Animal Park's Botanical Conservation Center will be modified and expanded to support propagation and production of several cacti species. This will also provide space for a container plant nursery for both cacti propagated on-site and for salvaged cacti collected as part of new, upcoming regulations established by the County of San Diego and the City of San Diego that would require salvage of cacti as part of mitigation for development projects. This site will serve as the North County salvage repository just as the Rancho Jamul Ecological Reserve is creating a facility to support the South County cacti salvage program (funded by a TransNet grant in FY 2008).

Deliverables

- Functioning facility able to propagate 2,000 cacti/year.
- Functioning facility that is able to store and maintain salvaged cacti and succulents as part of the new emerging regulations.

Task #: 2. Cacti Propagation

Description Initial propagation will focus on *Opuntia littoralis* for restoration in San Pasqual Valley, but can expand to include other species (e.g. *O. oricola*, *Cylindropuntia* spp.) in the future in response to conservation and restoration needs. At least 2,000 cacti pads/year for three years (6,000 pads total) will be collected from existing *Opuntia littoralis* stands of cacti at the Wild Animal Park MSCP for subsequent propagation and out-planting. No more than 2 pads will be collected from the same cacti each year so as not to jeopardize extant individuals. On-going research at the Institute indicates that larger pads propagate, root, and add new pads more quickly than smaller ones, so collectors will target pads greater than 8 inches in length (Endress, unpublished data). Standard cacti propagation techniques will be followed (e.g. pads will be allowed to callus prior to planting, etc.).

Deliverables

- 2,000 cacti plants per year available for restoration projects in San Pasqual Valley (and beyond if requested); of these 500 per year will be available for local restoration partners.

Task #: 3. Restoration and Enhancement Planting

Description The goal of the enrichment planting is to plant cacti on 45 acres of suitable habitat adjacent to existing cacti patches at the Wild Animal Park at a density of at least 100 cacti individuals per acre. Accounting for mortality rates of 25-30% (typical in restoration efforts), we will plant at least 150 cacti per acre (total of 6,745 plants). Within each acre, 50 of the plants will come from propagated stock (Task 2) and another 100 plants will be directly planted in the field. 15 acres will be planted each year for three years. Pads will be collected and allowed to callus for at least 1 week prior to planting. Planting will occur in late summer/fall, just before the onset of winter rains. South facing slopes adjacent to existing cacti scrub patches will be targeted for enhancement.

Deliverables

45 acres of enhanced habitat (verified by task #4, below).

Task # 4: Monitoring and Applied Research

Description

Monitoring will consist of two components: 1) monitoring of survival and growth of cacti in the 45 acres of habitat enhancement; and 2) monitoring of colonization, abundance, and habitat use by cactus wrens within the enhanced areas as well as in existing adjacent patches of cactus scrub within the Wild Animal Park MSCP. To monitor survival and growth of cacti, we will randomly select 10% of planted cacti for annual measurements (total=450 individuals). Cacti will be tagged with a unique ID and their location recorded with a GPS. Cacti will be visited and assessed quarterly to determine survival and growth (height, number of pads, and widest distance across the canopy). To monitor colonization, abundance, and habitat use of cactus wrens at the site, the protocol developed by the Cactus Wren Working Group and US Fish & Wildlife Service will be implemented by our staff. Additionally, we will conduct applied research on cacti restoration. Organizations are currently expending considerable effort in planting cacti across the county, but the most cost-effective methods of cactus propagation and restoration are unclear. Two general approaches are promoted: (1) direct planting of pads at the site and (2) propagating pads in a shadehouse, followed by planting in the field. These two approaches differ in the amount of time and effort expended and little is known about the relative success of the two methods in terms of establishment, growth, and survival. To address this we began a field experiment in December 2008 with 600 pads to test (1) if direct planting or propagation is the most cost-effective methods of restoration and (2) which direct planting methods (laying flat vs. burying) increases cacti survival, establishment and growth. A split-plot design across 6 sites was used and the fate of the 600 individual cacti will be tracked over 5 years. Additional studies may be developed if warranted.

Deliverables

- Quantitative report evaluating the efficacy of restoration activities in terms of cacti establishment and growth
- Evaluation and estimates of cactus wren abundance and use within cactus habitat and restored areas
- Publications (professional and technical) evaluating best methods for cacti restoration and the importance of habitat enhancement on cactus wren abundance.
- Outreach and educational activities to highlight the program, including (a) land manager workshops, (b) articles and press in Zoological Society of San Diego's publications and, and (c) cactus wren habitat enhancement information will be incorporated into the Institute's Conservation Lab curriculum for visiting students

Exhibit B

APPROVED PROJECT BUDGET

Invoices will be provided to SANDAG on a quarterly basis covering the costs of the work done by Task during that time period.

Maximum SANDAG Contribution: \$ 325,290

Maximum Percentage(s) of SANDAG Participation (if applicable): 68.1%

Project's 3 year budget (2009-2012)*

Item	TransNet Request	In-kind contribution	Total
Labor	\$209,035	\$121,017	\$330,052
Materials and Supplies	\$50,200	\$31,120	\$81,320
Total Direct Costs	\$259,235	\$152,137	\$411,372
Indirect Costs / Administration (31.6%)**	\$66,055		
Total	\$325,290	\$152,137	\$477,427

*Please note that this project will continue an additional two years beyond the three-year TransNet request. All costs in those two final years (labor, materials, supplies, etc.) will be covered by the San Diego Zoo through internal and external funding sources (grants, donations, etc. estimated as an additional \$207,000 in project support).

** Indirect costs are only applied to labor and not materials and supplies.

Labor. This includes labor for senior personnel, a biological technician to be hired in support of the project and three undergraduate summer interns (one each year). Senior staff, the biological technician, and the interns will be involved with all of the tasks, many of which will occur simultaneously (see Exhibit C for Project Schedule). This includes labor associated with development and operation of the propagation and salvage center (Task 1); collecting, propagating, care for, and planting cacti (Task 2 & 3); collecting and analyzing data; cactus wren surveys, monitoring restoration efforts; generating reports; coordinating efforts with local conservation partners (Task 4).

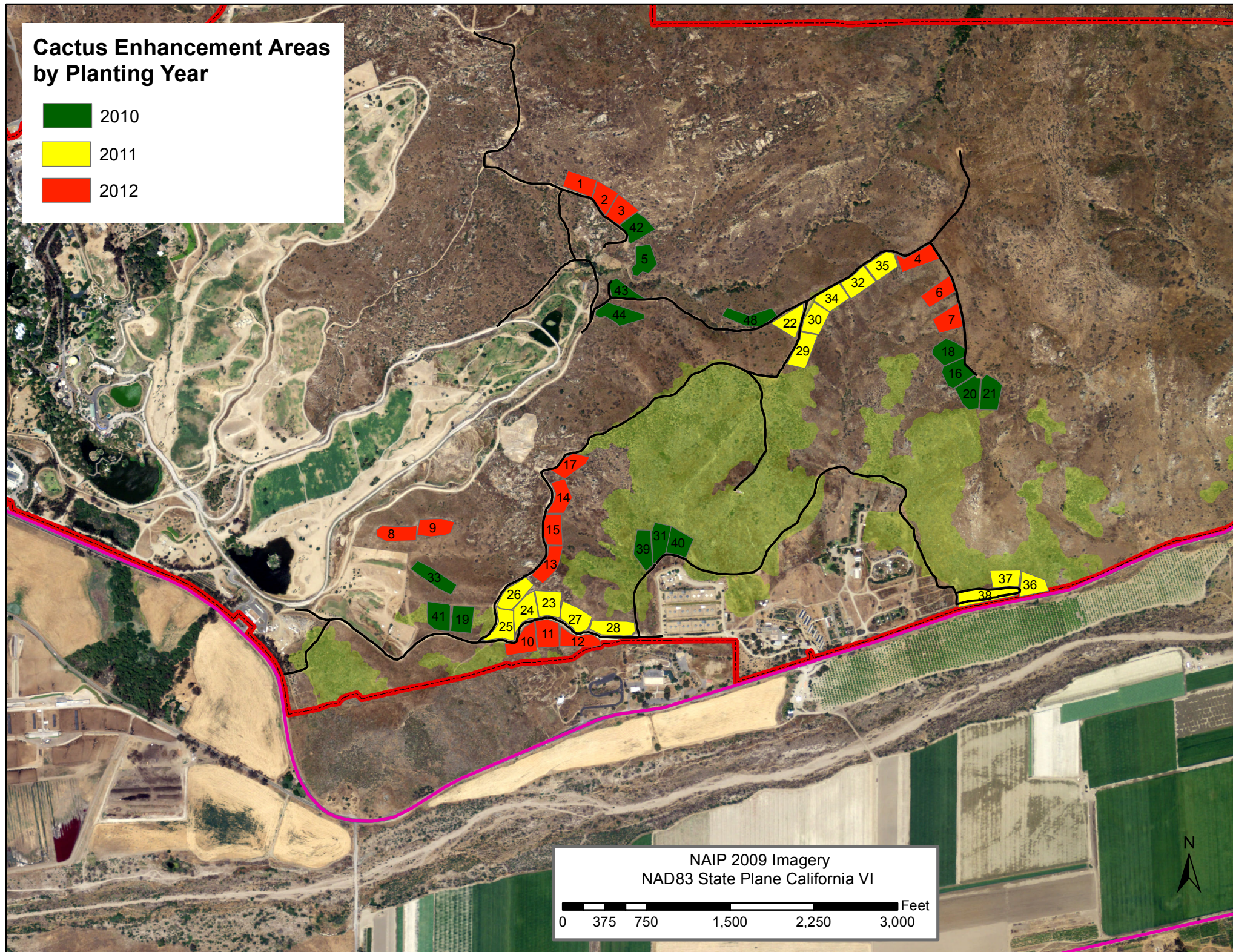
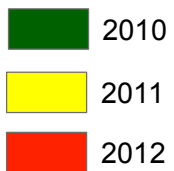
Materials and Supplies. This includes materials and supplies needed to develop the cacti salvage and propagation center (e.g. benches, shade cloth, irrigation, fencing, minor electrical and grading, etc.; Task

1); propagation supplies (e.g. pots, soil, tools, fertilizer, hoses etc.; Task 2); miscellaneous field supplies for cacti restoration and cactus wren monitoring (e.g. gloves, plastic buckets, trowels, shovels, binoculars, tape recorders, etc. Task 3 & 4); and costs associated with disseminating information (workshops, publications, presentations; Task 4).

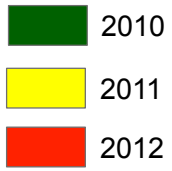
PROJECT SCHEDULE*

TASK	NAME	START	END
1	Cacti Propagation and Salvage Center	9/15/2009	10/15/2010
2	Cacti Propagation	9/15/2009	12/1/2011
3	Restoration & Enhancement Planting	11/1/2009	12/30/2011
4	Monitoring & Applied Research	9/15/2009	9/15/2012

Cactus Enhancement Areas by Planting Year



Cactus Enhancement Areas by Planting Year



Caging/Watering Experiment Cacti:

- Watered every 4 weeks, caged
- Watered every 6 weeks, caged
- Watered every 8 weeks, caged
- Not watered, not caged
- Not watered, caged

