Lower Colorado River
Multi-Species Conservation Program

Balancing Resource Use and Conservation

Hart Mine Marsh Conservation Area Restoration Development and Monitoring Plan

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

July 2009

Lower Colorado River Multi-Species Conservation Program
Steering Committee Members

Federal Participant Group

Bureau of Reclamation
U.S. Fish and Wildlife Service
National Park Service
Bureau of Land Management
Bureau of Indian Affairs
Western Area Power Administration

Arizona Participant Group

Arizona Department of Water Resources
Arizona Electric Power Cooperative, Inc.
Arizona Game and Fish Department
Arizona Power Authority
Central Arizona Water Conservation District
Cibola Valley Irrigation and Drainage District
City of Bullhead City
City of Lake Havasu City
City of Mesa
City of Somerton
City of Yuma
Electrical District No. 3, Pinal County, Arizona
Golden Shores Water Conservation District
Mohave County Water Authority
Mohave Valley Irrigation and Drainage District
Mohave Water Conservation District
North Gila Valley Irrigation and Drainage District
Town of Fredonia
Town of Thatcher
Town of Wickenburg
Salt River Project Agricultural Improvement and Power District
Unit "B" Irrigation and Drainage District
Wellton-Mohawk Irrigation and Drainage District
Yuma County Water Users' Association
Yuma Irrigation District
Yuma Mesa Irrigation and Drainage District

Other Interested Parties Participant Group

QuadState County Government Coalition
Desert Wildlife Unlimited

California Participant Group

California Department of Fish and Game
City of Needles
Coachella Valley Water District
Colorado River Board of California
Bard Water District
Imperial Irrigation District
Los Angeles Department of Water and Power
Palo Verde Irrigation District
San Diego County Water Authority
Southern California Edison Company
Southern California Public Power Authority
The Metropolitan Water District of Southern California

Nevada Participant Group

Colorado River Commission of Nevada
Nevada Department of Wildlife
Southern Nevada Water Authority
Colorado River Commission Power Users
Basic Water Company

Native American Participant Group

Hualapai Tribe
Colorado River Indian Tribes
Cocopah Indian Tribe

Conservation Participant Group

Ducks Unlimited
Lower Colorado River RC&D Area, Inc.

Lower Colorado River
Multi-Species Conservation Program

Hart Mine Marsh Conservation Area Restoration Development and Monitoring Plan

Lower Colorado River
Multi-Species Conservation Program Office
Bureau of Reclamation
Lower Colorado Region
Boulder City, NV
http://www.lcrmscp.gov

July 2009

This page intentionally left blank

Table of Contents

Figures

Table

Acronyms and Abbreviations

AMM	Area Management Measures
BACI	Before-After Control-Impact
CCRP	USFWS Comprehensive Conceptual Restoration Plan
CNWR	Cibola National Wildlife Refuge
DO	Dissolved Oxygen
ECR	Existing Conditions Report
HCP	Habitat Conservation Plan
HMM	Hart Mine Marsh
HMMCA	Hart Mine Marsh Conservation Area
LCR	Lower Colorado River
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
LGP	Low Ground Pressure
MMRP	Mitigation Monitoring and Reporting Program
MRM	Monitoring and Research Management Measures
Reclamation	Bureau of Reclamation
RM	River Mile
USFWS	U.S. Fish and Wildlife Service

This page intentionally left blank.

Background

Cibola National Wildlife Refuge (CNWR) consists of about 16,600 acres of land located along approximately twelve miles of the lower Colorado River in Arizona and California (Figure 1). It was established in 1964 as a refuge and breeding ground for migratory birds and other wildlife. The Refuge is divided into six management units: Unit 1, Unit 2, Unit 3, Unit 4, Unit 5, and Unit 6. Hart Mine Marsh (HMM) is part of Unit 2 (Figure 2).

Hart Mine Marsh is located on the southern end of the CNWR in Arizona. The management unit encompasses approximately 646 acres, with approximately 523 acres that may have potential for development as wetlands. Proportionally, there is currently little existing marsh cover-type (open water and emergent vegetation) occupying this site, about 20 acres. The majority of the site (80%) is dominated by various classes of saltcedar associations. In general, HMM is a decadent wetland with poor water quality, marginal wetland/marsh habitat, and saline soils, with some areas completely devoid of vegetation. Likely reasons for the condition of this marsh include a drop in water table from river alterations, as well as past river and marsh water management practices.

Hart Mine Marsh had been identified as a site with potential for marsh habitat restoration by the Bureau of Reclamation before the implementation of the Lower Colorado River Multi-Species Conservation Program (LCR MSCP). Similarly, the U.S. Fish and Wildlife Service (USFWS) Lower Colorado River Refuges Comprehensive Management Plan and Ecological Assessment had also targeted Hart Mine Mash as a restoration priority in 1993. A portion of HMM has been selected for establishment as an LCR MSCP conservation area. This document further details the LCR MSCP portion of restoration efforts at HMM, and specifically defines this area as “Hart Mine Marsh Conservation Area” (HMMCA).

1.0 Introduction

The LCR MSCP is a multi-stakeholder Federal and non-Federal partnership responding to the need to balance the use of lower Colorado River (LCR) water resources and the conservation of native species and their habitats in compliance with the Endangered Species Act. This is a long-term (50-year) plan to conserve at least 26 species along the LCR from Lake Mead to the Southerly International Boundary with Mexico through the implementation of a Habitat Conservation Plan (HCP). Most covered species are State and/or Federally listed special status species. Reclamation is the entity responsible for implementing the LCR MSCP over the 50-year term of the program. A Steering Committee currently consisting of 56 entities has been formed, as described in the *LCR MSCP Funding and Management Agreement*, to provide input and oversight functions in support of LCR MSCP implementation.

Purpose

This document serves as the guide for the creation, monitoring, and maintenance/management of native land cover types which, through Adaptive Management, develop into habitat. This document, the *Hart Mine Marsh Conservation Area Restoration Development and Monitoring Plan*, provides an overall concept of the restoration plan for the site as well as the projected phased approach for construction and development of this conservation area.

The goal for the HMMCA is to maximize marsh land cover type and to develop an integrated mosaic of marsh habitats that will contribute to the habitat objectives for covered species outlined in the LCR MSCP HCP. The HMMCA will be approximately 174 acres of primarily permanent wetland targeted for Yuma clapper rail (*Rallus longirostris yumanensis*) and other marsh species. The creation of habitat includes both the establishment of native plants and the management of water levels to meet performance standards for integrating emergent vegetation and open water at varying depths into a mosaic of marsh habitats.

This plan also provides management options for habitats for covered species in Reach 4, which extends from Parker Dam (River Mile (RM) 192.3) to Reclamation's Cibola Gage (RM 87.3), and is described in more detail in the LCR MCSP HCP habitat objectives. The plan provides habitat restoration design and management methods, including construction (planning and design), monitoring, research and reporting incorporated within an adaptive management plan. Data from monitoring and research results will be integrated into the plan to provide for future successful habitat restoration and objectives.

Site Description

The HMMCA consists of approximately 174 acres on CNWR located in Arizona between RM 90 and RM 93 (Figure 3). The initial partnership for the HMMCA includes Reclamation and the USFWS's CNWR.

The legal description of this area is Gila and Salt River Base and Meridian, La Paz County, Arizona; Township 1 South, Range 23 West, Section 31, Township 2 South, Range 23 West, Sections 6 and 5, and Township 2 South, Range 23 West Sections 7 and 8. The land and water resources will be provided by the USFWS.

Land Ownership

The property is owned by USFWS who will dedicate land and water to Reclamation to develop and maintain native land cover types for the LCR MSCP. The property will be owned and managed by USFWS.

Water

Cibola National Wildlife Refuge has second priority water rights. These include a diversionary entitlement of 27,000 acre-feet per year and a consumptive use entitlement (diversion minus return flow) of 16,793 acre-feet per year. In addition, the refuge has a circulatory (circulation water with minimum consumptive use) water right of 7,500 acre-feet per year. The 174-acre HMMCA will have an average of 1,258 acre-feet per year (7.23 acre-feet per acre, per year) available when the conservation area has been fully developed.

Agreements

A Land Use Agreement for general restoration activities on CNWR has been executed and is on file. Attachment 2 to Exhibit B of this Land Use Agreement, which specifies the activities at the HMMCA, was finalized, and secured the land and water resources at the HMMCA for the 50-year term of the LCR MSCP program.

Figure 1. Location of Cibola National Wildlife Refuge and Hart Mine Marsh

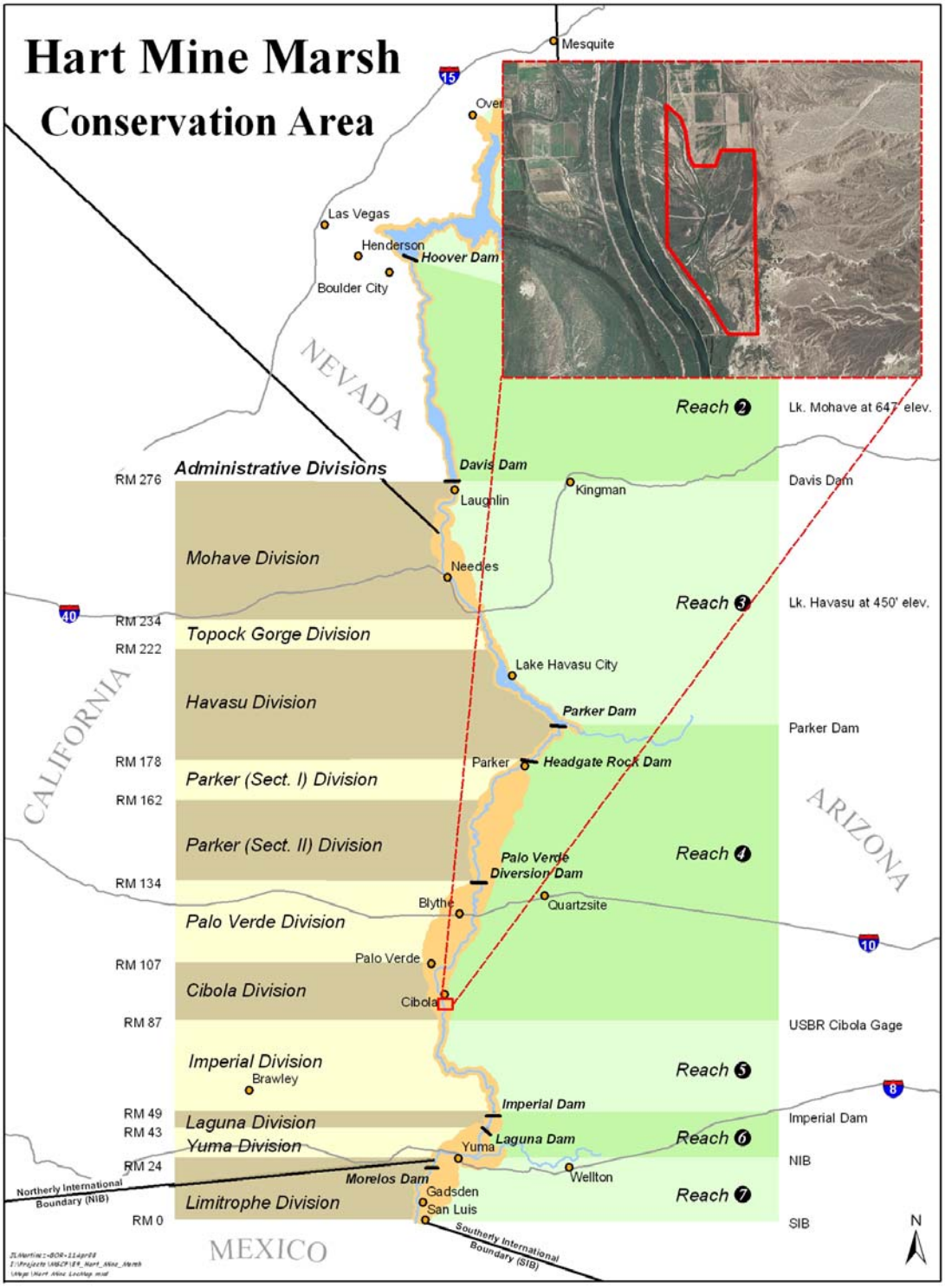


Figure 2. Six Management Units of Cibola National Wildlife Refuge

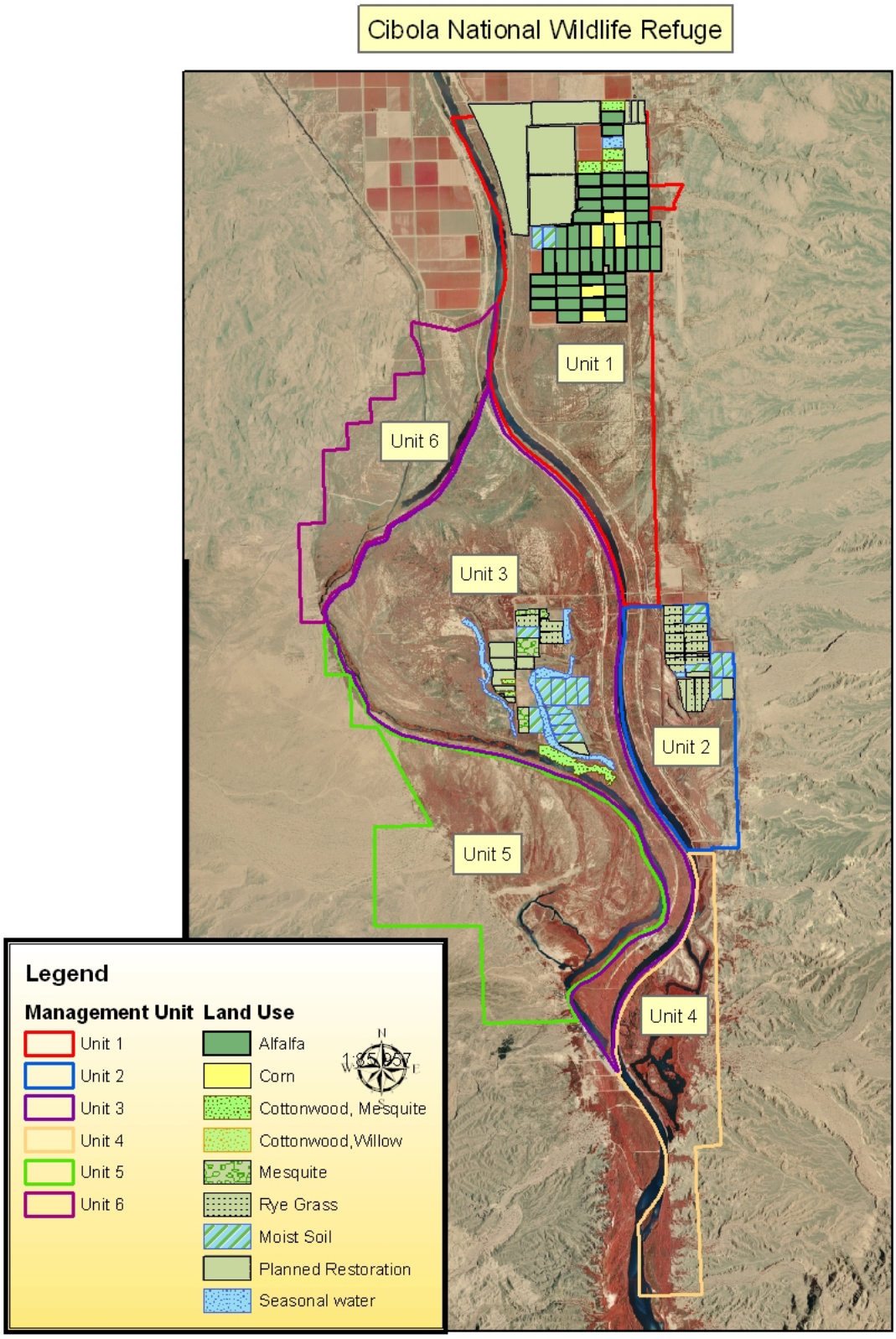
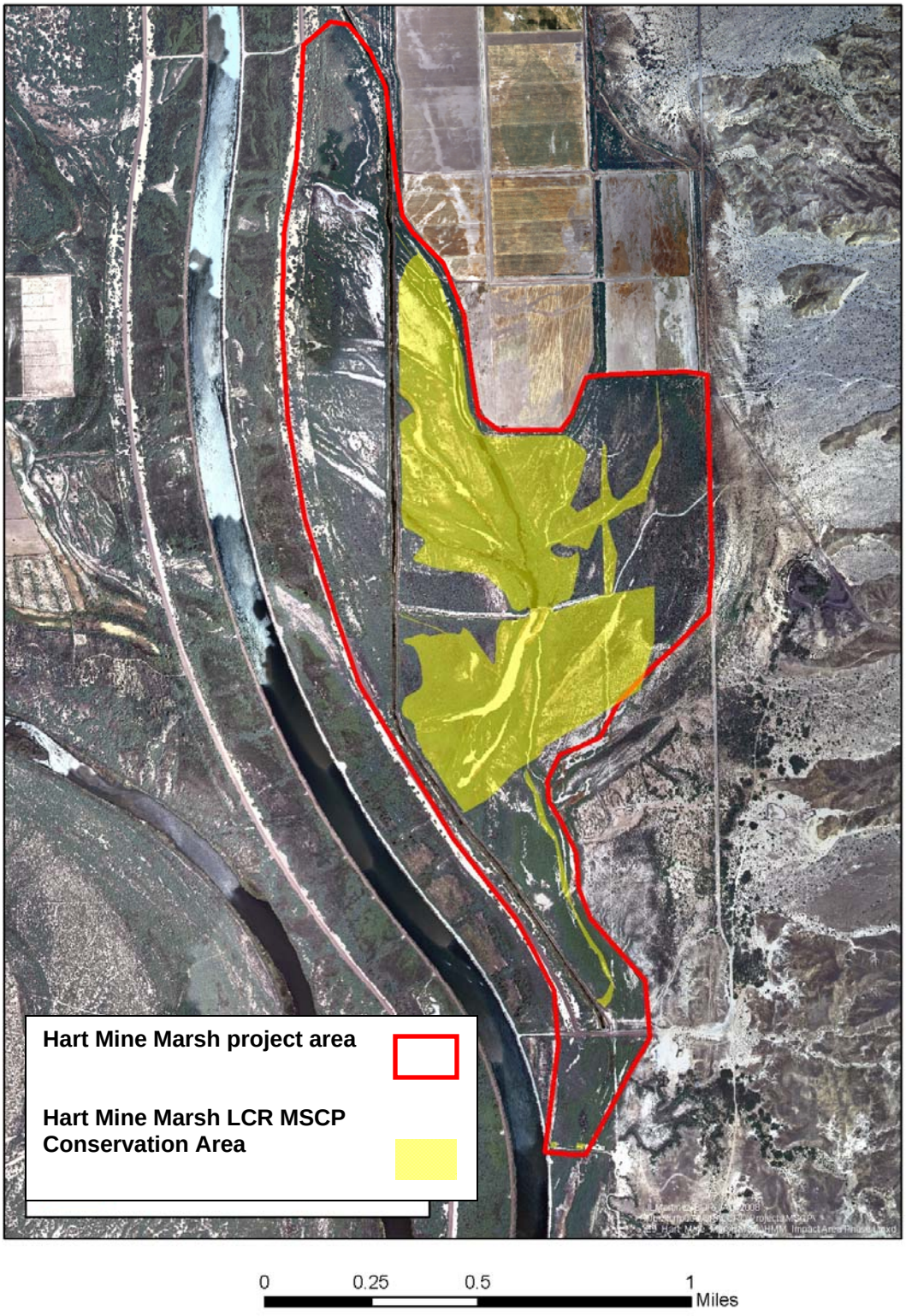


Figure 3. Hart Mine Marsh Conservation Area Detail



2.0 Restoration Development Plan

The goal of the LCR MSCP is to restore a minimum of 512 acres of marsh habitat along the LCR targeted specifically for Yuma clapper rail, California black rail (*Laterallus jamaicensis*), Western least bittern (*Ixobrychus exilis hesperis*), and other LCR MSCP covered species. The HMMCA is intended be a component of the LCR MSCP as partial fulfillment of the program's restoration goals. Restoration of HMM is also identified as one of the USFWS goals as indicated in the Lower Colorado River National Wildlife Refuges Comprehensive Management Plan and Environmental Assessment. Restoration of HMM is consistent with the goals for both agencies. As more specific information regarding habitat conditions for the covered species becomes known, that information will be incorporated into the design and management of the conservation area.

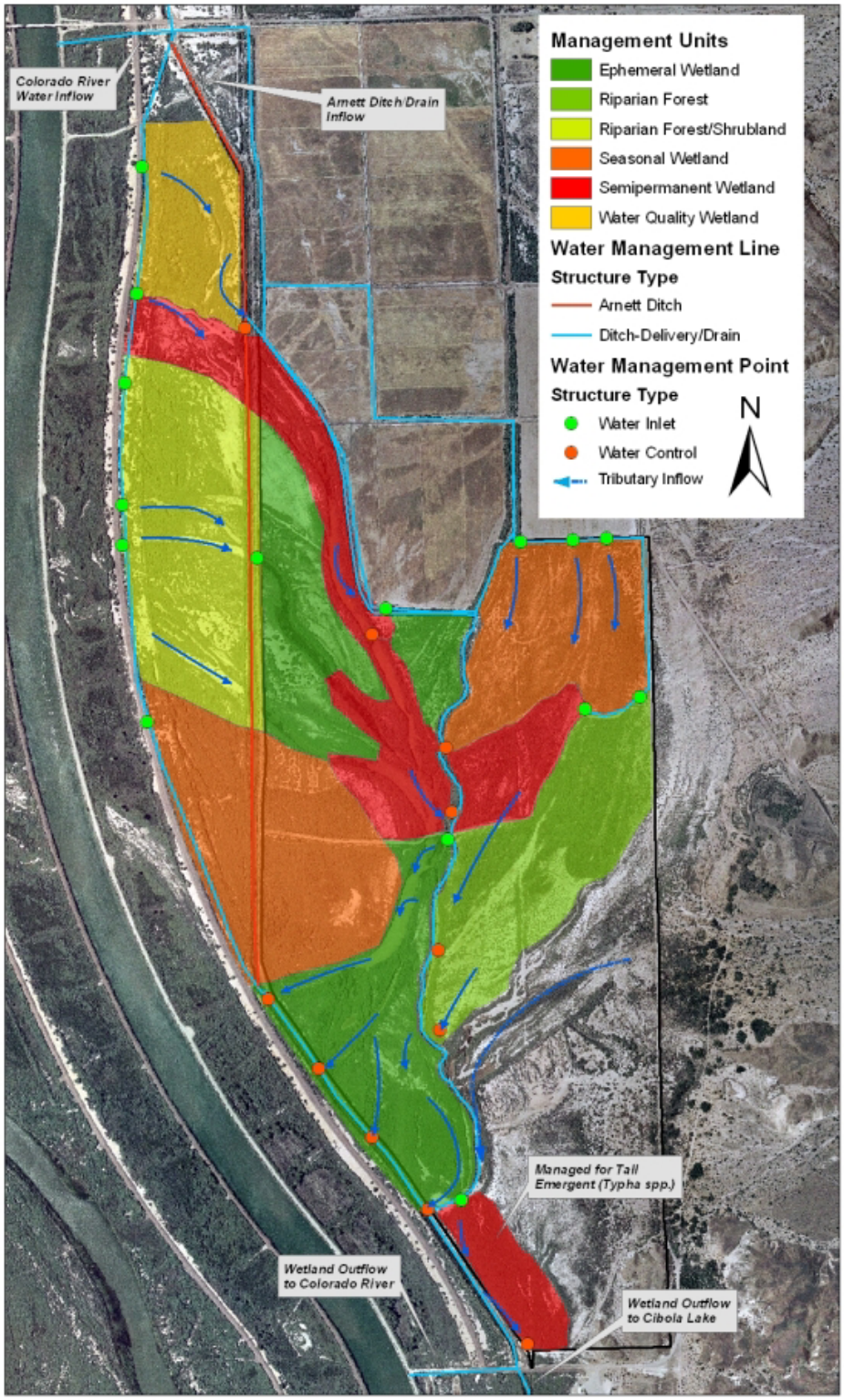
Conceptual Design

As part of the planning effort for restoration partnerships at HMM, the USFWS hosted a Wetland Review at the CNWR. It was comprised of an interdisciplinary gathering of approximately 20 scientists representing a range of federal, state, non-governmental organizations, and private agencies. The intent of the review was to generate the integral components of a restoration plan that functioned within the abiotic and physical process constraints of the HMM, as well as within the administrative and political discretions that exist for the LCR MSCP and for the CNWR.

Three core restoration components were identified at the Wetland Review. First, the marsh should be divided into separate subunits by following the dominant geomorphic breaklines. Second, restoration efforts should maximize infrastructure and water control at the marsh to the greatest extent possible, and provide the ability to manage the entire marsh as one unit or as individual subunits. Independent management of units would also include the management of drain water. The individual subunits could be filled and drained independently of Cibola Lake (downstream of HMM) and, ideally, independently of the other subunits. This would allow the CNWR to address the significant abiotic constraints including hyper-saline soils and high nitrate levels, as well as maximize the Refuge's ability to manage for a mosaic of habitat types. In addition, these independent subunits could be managed to simulate important historic physical processes that have been interrupted. For example, disturbance caused by historic spring flood peaks may be replaced with alternative sources of disturbance, such as mechanical treatment or prescribed fires.

The USFWS developed a Comprehensive Conceptual Restoration Plan (CCRP) based on the Wetland Review which included a conceptual design map (Figure 4). Reclamation determined that many of these approaches and practices could be incorporated into a restoration design and would ultimately improve habitat for the program's covered species. Guided in part by the CCRP, Reclamation developed an appropriate engineering design and approach (presented later in this document) for a portion of HMM that is intended to fulfill both the needs of the CNWR and those of the LCR MSCP.

Figure 4. Conceptual Design for Hart Mine Marsh (from the USFWS CCRP)



Engineering Design and Construction

To achieve the goals of the LCR MSCP with respect to marsh habitat creation at HMM, Reclamation identified the central portion of the marsh as most appropriate for Yuma clapper rail and other LCR MSCP covered species, and designated these regions as the HMMCA to be developed under the LCR MSCP (Figure 3). In general, habitat creation will target restoring permanent and semi-permanent wetland habitats for MSCP covered species; however, the creation of mosaics of habitat will likely benefit many additional wildlife species. The LCR MSCP goal for the HMMCA is the creation of 174 acres of habitat for covered species in Reach 4 (Yuma clapper rail, Western least bittern and Colorado River cotton rat) as described in the LCR MSCP HCP. The specific physical intent is to maximize marsh habitats that have emergent vegetation with water levels ranging from 1 to 12 inches.

The total footprint of the HMMCA will cover approximately 243 acres and will take approximately 3 years to develop. Of the 243-acre conservation area, 174 acres will be enhanced wetland habitats and 69 acres may be used for depositing native fill material, if necessary. This enhancement will be accomplished by: (1) installing control structures to manage water levels; (2) providing more water to the site and supplementing the marsh with sources of higher quality surface (Colorado River) water; (3) making physical changes to the site's topography; and (4) planting and supporting native wetland and marsh vegetation. Techniques used to reach these goals will include removing a substantial amount of existing saltcedar from the site, deepening areas of existing open water, contouring areas adjacent to these deeper areas to support marsh vegetation, and managing water on the site at higher elevations to promote and sustain marsh cover-type vegetation and wetland function.

A preliminary engineering design is depicted in Figure 5. To accomplish restoration/habitat creation on the HMMCA, heavy equipment will be used extensively. Vegetation, consisting primarily of saltcedar, will be cleared on the 243 acres using Low Ground Pressure (LGP) dozers fitted with brush rakes. All woody debris will be roughly compacted and deposited on-site or burned in designated disposal areas. The engineering design follows the site's existing geomorphology and natural topography to dictate areas that are to be deepened and contoured. Land-based excavators will be used create channels and deepen areas in the marsh to provide greater water depths and areas of permanent open water for surface water connectivity throughout the marsh. In areas that can not be dewatered, or remain saturated through ground water seepage, amphibious excavators will be used. Bulldozers (LGP units) or other appropriate equipment will complete the contouring based on the design specifications. A substantial amount of the dredged material from the channels will be used to construct or complete the dikes that separate the three proposed management units (cells) of the HMMCA to allow for greater control of water on the site. The remainder of this cut, with the majority of these materials being side cast and used as fill during excavation and contouring, will be deposited in designated fill locations. Any remaining material may be used to bury woody debris from the vegetation removal activities.

Figure 5. Preliminary Engineering Design for Hart Mine Marsh Conservation Area

The development of HMMCA will be executed in a number of phases. The first phase began in October 2008, and was completed in March 2009 to avoid seasonal impacts to breeding native marsh species and the higher spring flows in the Colorado River which could cause subsurface invasion of groundwater into work areas.

Working from south to north, a series of water control structures were installed to create cells that can be independently managed. After water control was established, each cell was planted with native marsh vegetation. The ability to control water aided in the successful establishment of native vegetation, and helped restrict the occupation of nonnative species.

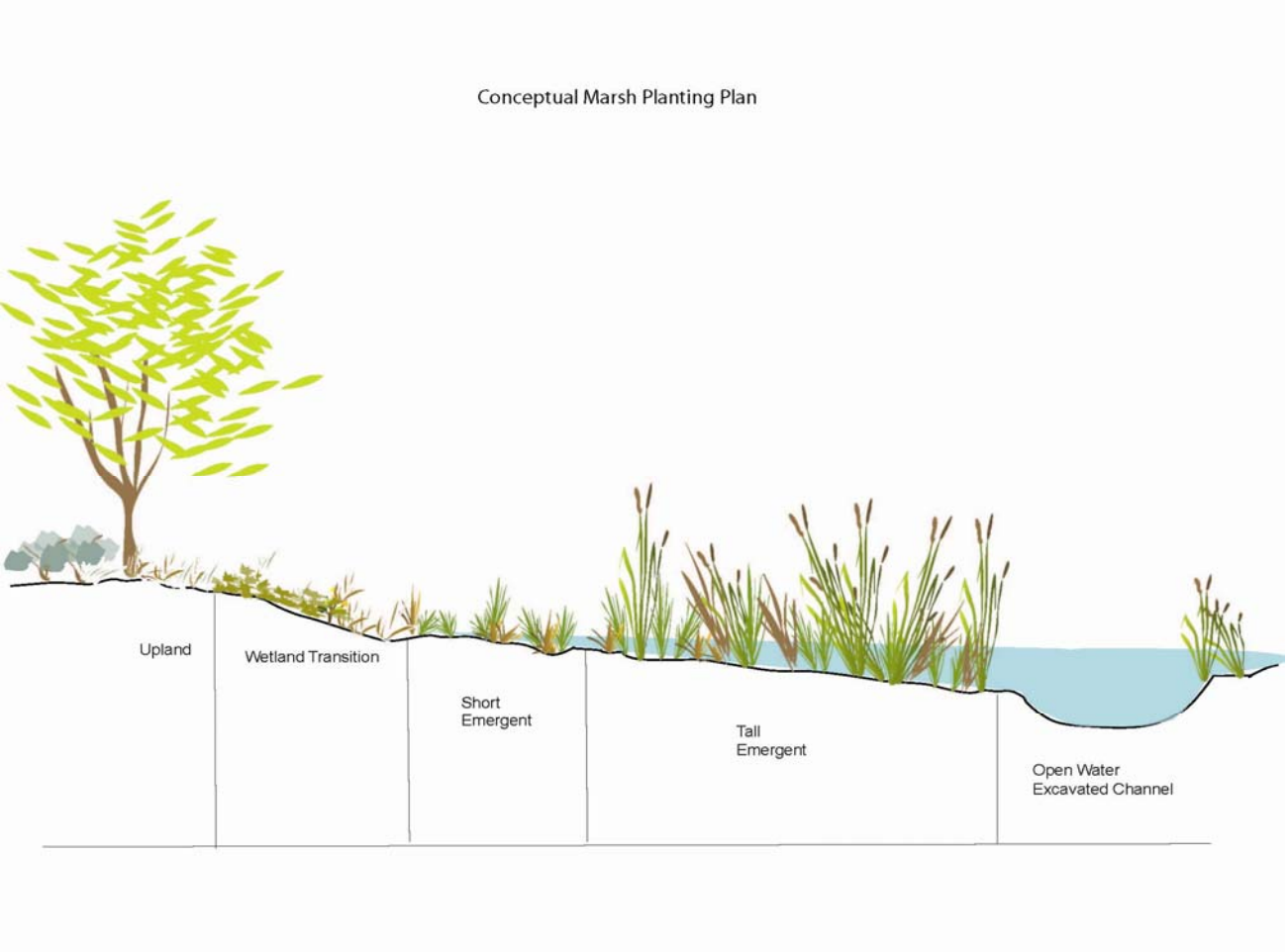
This phase's activities also included the establishment of new outfall structures below HMM to allow discharges for HMM to be directed to either Cibola Lake or back into the Colorado River. Simultaneously, vegetation covering Cell 2 was removed to prepare for excavation and contouring. After completion of the outfall structures, a channel in Cell 3 was re-established. Finally, all associated excavation, contouring and installation of control structures in Cells 2 and 3 was completed.

The second phase, which is expected to be complete on 2010, will involve the clearing, channel excavation, contouring, and installation of the remaining control structures on Cell 1. During the third phase, additional fresh water inlet points from the Unit 2 irrigation supply infrastructure to HMM will be constructed. This final phase of the HMMCA will also allow for any additional infrastructure completion or repair, and additional planting or remaining details.

Planting Design

The planting design incorporates native LCR wetland, wetland transition, and upland species into a mosaic of created habitats. Species have been stratified according to water demand and depth to develop an appropriate and functional mosaic of native marsh and marsh associated species (Figure 6). Areas of deeper water will be primarily planted with tall emergent vegetation or in some cases, left as open water areas. These tall emergent species will also be planted in areas of shallow water to meet the needs of the Yuma clapper rail. However, a diversity of shallow emergent vegetation will also be incorporated to support other LCR MSCP covered species. In areas where shallow water transitions to saturated soils and upland areas, species adapted to varying water depths, seasonal drought and higher salinities will be planted.

Figure 6. Typical Planting Plan



Planting Material and Planting Techniques

Table 1 lists the potential plant species that may be used in the development of habitat at the HMMCA. All species to be included in the planting design will be native to the LCR. Stock will either be collected locally or procured from sources that can provide these species. Due to varying topography throughout the site and the presence of saturated soil conditions, most or all the plant materials will be hand-planted according to this planting design. Native vegetation will be planted as plugs in clumps (several plugs/plants per location) on five to ten foot centers in their appropriate elevation zone to aid in establishment. This equates to approximately 4,000 to 8,000 plants per acre.

Table 1. Potential Native Plant Species List

Scientific Name	Common Name
Schoenoplectus tabernaemontani	great bulrush[1]
Scirpus americanus	Olney threesquare
Schoenoplectus californicus	California bulrush
Eleocharis palustris	common spikerush
Distichlis stricta	inland saltgrass
Allenrolfea occidentalis	iodine bush, pickleweed
Atriplex lentiformis	quailbush, big saltbush
Prosopis glandulosa var. *torreyana*	honey mesquite
Sporobolus airoides	alkali sacaton

[1]Cattail/bulrush is currently present on the site and will typically require little encouragement for its expansion. Due to its invasive nature, this species will likely not be planted, or only be planted in small quantities. It is a component of Yuma clapper rail habitat so it is included in this table, and will be present within in the species habitat mosaic for the Hart Mine Marsh Conservation Area.

Herbicide/Fertilizer/Pesticide Application

To maintain healthy stands of native plant species, the application of herbicides, fertilizer, and pesticides may be required. All herbicide, fertilizer, or pesticide will be applied by persons possessing valid applicators' licenses for the chemicals being applied and in compliance with the rules, regulations, and laws set by the State of Arizona, La Paz County, and CNWR.

All records and associated chemical application documents will be stored by the land manager and will include:

- Training records of all employees handling pesticides and herbicides
- Material Safety Data Sheets for all pesticides, herbicides, and fertilizers
- Location map of herbicide and pesticide storage site
- Use of Arizona State, La Paz County, and CNWR approved herbicide, pesticide, and fertilizers
- Records of herbicide, pesticide, or fertilizer use

3.0 Management Overview

Land Management

The property will be owned and managed by USFWS. Reclamation will be responsible for ensuring the long-term operation and maintenance of the HMMCA throughout the 50-year term of the LCR MSCP. The details of operations and maintenance of the HMMCA have been agreed upon between Reclamation and USFWS, and will include monitoring wildlife species, water quality, water use, vegetation composition and structure. Other operational tasks will include law enforcement, public use, wildfire management, and research. Each specific area will be addressed in the adaptive management portion of Section 4 in this plan.

To document the development of habitat on the conservation area, as-builts will be included in the first HMMCA annual report that will be published the fiscal year following completion of construction. This and subsequent annual reports will also include any additional specific planning, design, planting, and monitoring activities that occurred in that particular fiscal year or across the conservation area in general, whichever is more appropriate. The annual report will include summaries of restoration and monitoring activities conducted during the previous year. Specific information on the contents of the annual report can be found in Section 5 of this document.

Adaptive Management

Adjustments in development, operation, management, and monitoring of this conservation area will be made through the adaptive management process. Lessons learned through site operation, vegetation development, and habitat responses will be identified through monitoring. The monitoring results will be used to suggest alterations in site management to maximize the effectiveness of the created habitats based on the parameters measured (as described in Section 4 of this document).

Vegetation Management

As described previously, the timing and types of vegetation planting are directly related to construction activities and design elevation contours. Additional management of native vegetation will take place during seasonal managed flooding events (alteration of high water elevation). These events – which may be periods of inundation or drought – will be planned seasonally to either encourage the establishment and expansion of native vegetation, or to restrict or inhibit occupation and encroachment of non-native species.

Measures will be taken to physically manage vegetation on the site. This includes the use of herbicides and/or mowing and other means of extraction to control non-native or invasive species. Intensive weed management/nonnative suppression is expected for the first three years

following the completion of construction. Native marsh habitats may also require occasional vegetation management to insure healthy and productive vegetation composition. This may include the mechanical (mowing/dredging) or non-mechanical (controlled burns) setback of overabundant or decadent marsh and transitional vegetation. All physical management of vegetation on the site will be coordinated with the land owner/agency and will be based on feedback from on-site monitoring data as per the adaptive management approach.

Water Management

When completed, the HMMCA will have three distinct manageable surface water inputs: the Arnett Ditch, and two new inlet structures from the Unit 1 irrigation supply channel at the northwest and northeast points of cell 1. Water from the Arnett Ditch primarily consists of drain water from the agricultural units (Unit 1 and Unit 2) on CNWR; however, a turnout from the Unit 1 irrigation supply canal can be used to deliver pumped Colorado River water into the Arnett Ditch just north of the HMM. This turnout can be used if greater flows and/or improved water quality are required in the Arnett Ditch for either HMM or Cibola Lake. These three inputs will be evaluated to determine the best balance of Arnett Ditch drain water and pumped Colorado River water sources that will provide flows to maintain seasonal water elevations, appropriate levels of water quality, and the ability to flush salts at HMM while working within the Refuge's water entitlement for usage on this site.

A general seasonal water management scenario would include relatively static elevations during the Yuma clapper rail breeding season (early spring through summer) with water elevations adjusted and held to maximize depths of 1 to 12 inches. Transitional periods on either side of this season could be used to flush salts within the marsh (flooding and draining of the cells), or for other management practices (vegetation management, etc.). During the winter months, the marsh could be managed at higher water elevations for greater inundation of surrounding vegetation, salt mitigation, and greater areas of open water for migrating waterfowl.

Law Enforcement

Specific law enforcement arrangements will be developed as is described in the LCR MSCP Law and Fire Strategy, and the LCR Conservation Area Law and Fire Strategy.

Public Use

Public use and other activities will be coordinated with USFWS and other stakeholders to ensure they are consistent with and do not adversely affect restoration activities at HMMCA.

Wildfire Management

As guided by commitments in the HCP, wildfire management practices at HMMCA will:

- Reduce the risk of created habitat loss to wildfire by providing resources to suppress wildfires, such as contributing to and integrating with local, State, and Federal agency fire management plans; and
- Implement land management and habitat creation measures to support the reestablishment of native vegetation that is lost to wildfire.

Specific wildfire management may include a rapid response of flooding HMM and adjacent fields in Unit 2 if a wildfire breaks out or if there is an impending threat from a nearby fire. Specific fire management will be developed as is described in the LCR MSCP Law and Fire Strategy, and the LCR Conservation Area Law and Fire Strategy.

4.0 Monitoring

This section contains the overall strategy for monitoring the HMMCA restoration project. Subsequent documents (Restoration Phase Plans) will provide the specific monitoring requirements for each phase, and will typically be created on an annual basis.

Monitoring is critical to the Adaptive Management Program. This process allows the LCR MSCP to analyze implementation activities, address the uncertainty inherent in a 50-year program, and respond appropriately. Scientifically designed monitoring studies will be conducted to evaluate whether: (1) the restoration parameters established for each covered species habitat are being achieved; (2) the restoration area develops as covered species habitat; and (3) the habitat is being utilized by the covered species. Results on how the created habitat develops, relative to the restoration and management techniques employed, will be used to refine techniques and develop the most cost-effective and efficient approaches for future phases at HMMCA and other restoration sites.

Initial conservation area monitoring plans are based on elements described in the HCP (LCR MSCP 2004). A document describing the science and adaptive management plan strategies for the LCR MSCP is found in the LCR MSCP Draft Final Science Strategy (Bureau of Reclamation 2006). The monitoring plan elements for HMMCA may be revised after those strategies have been adopted.

Monitoring at HMMCA will be structured into four categories:

- Predevelopment Monitoring
- Implementation Monitoring
- Habitat/Species Monitoring
- Monitoring Analysis and Evaluation

The goals for monitoring may be revised depending on the Adaptive Management Program results, covered species requirements, or other management decisions in the future. All monitoring will be designed specifically for each phase and habitat type within that phase. Covered species monitoring will be organized in the following guilds: marsh birds, and small mammals. The MacNeill's sootywing skipper may be monitored using species-specific protocols. The HMMCA is being created primarily for covered marsh bird species (Yuma clapper rail and least bittern); however, the possibility exists that suitable habitat for the Colorado River cotton rat and MacNeill's sootywing skipper may also be created; thus monitoring of these species may also occur.

Purpose

The purpose of the HMMCA monitoring plan is to determine whether restoration parameters established for each covered species habitat are being achieved, when each phase of HMMCA develops as covered species habitat, and if the habitat is being utilized by the covered species. The Avoidance and Minimization Measures, Conservation Area Management Measures (AMM), Monitoring and Research Measures (MRM), and General- and Species-Specific Conservation Measures from the LCR MSCP HCP document dictate the range of data collected, analyzed, and incorporated into the adaptive management plan.

Monitoring Design

Sampling design is based on quasi-experimental design using the Before-After Control-Impact (BACI) design (Stewart-Oaten and Osenberg 1992, Bernstein and Zalenski 1983, Green 1979). The BACI approach prescribes the collection of data prior to an activity and comparison to data collected after the activity (Smith 2002). The quasi-experimental design will use pre-restoration phases as controls. The designs will utilize randomization where possible. Subsamples of each phase will be taken at the same or similar randomized points both pre- and post-restoration. Pre-restoration marsh bird monitoring was conducted for 3 years prior to the start of construction.

Resources

Population and habitat resources are determined based on the appropriate AMM, MRM, and General- and Species-Specific Conservation Measures, and monitoring will be conducted both pre- and post-restoration. Select resources will only be monitored post-restoration if no potential exists prior to development for the existing marsh to support populations of targeted covered species. In most cases, the resources monitoring will focus on guilds of species for efficiency. The pre- and post-restoration resources that will be monitored are summarized below in each appropriate monitoring category.

Predevelopment Monitoring

Predevelopment monitoring is designed to establish the types of restoration activities that may be conducted, establish baseline data for evaluating post-development, and identify whether covered species currently inhabit HMMCA. To establish baseline conditions, an understanding of the current and historical conditions at HMMCA is necessary.

Predevelopment monitoring is divided into abiotic (soil features) and biotic (vegetation and covered species) factors:

- Abiotic Monitoring
  - Soils
    - Soils were monitored as part of the pre-development Hart Mine Marsh Existing Conditions Report (ECR) (USFWS - http://www.lcrmscp.gov/worktasks/conservationareas/E9/HartMineconditions.pdf) and wetland delineation (BIO-WEST 2008).
    - Water quality including dissolved oxygen (DO), pH, specific conductivity, temperature, turbidity, and selenium was recorded by Reclamation prior to development. Additional pre-development water quality measurements were recorded by the USFWS and are reported in the ECR.
- Biotic Monitoring
  - Vegetation Monitoring
    - As part of the pre-development Existing Conditions Report (USFWS - http://www.lcrmscp.gov/worktasks/conservationareas/E9/HartMineconditions.pdf) and wetland delineation, vegetation transects were conducted (BIO-WEST 2008). Originally, HMMCA consisted of a highly degraded wetland with small patches of marsh vegetation surrounded by tamarisk.
  - Avian Monitoring:
    - Marsh birds were monitored using a standardized multi-species marsh bird protocol (Conway 2005).
  - Small mammal surveys were not conducted because no cotton rat habitat occurs at HMMCA.
  - MacNeill's sootywing skipper presence/absence surveys were not conducted because no *Atriplex* spp. occurs at HMMCA.

Implementation Monitoring

Implementation monitoring will be conducted to assess whether land cover type creation and management actions have been implemented as designed for each phase. This type of monitoring quantifies changes immediately after treatments and evaluates whether actions were implemented as prescribed (Block et al. 2001). For example, this type of monitoring would be used to determine that the planting techniques employed were effective and vegetation was planted according to the phase design specifications. This monitoring is focused on the habitat (biotic) and conditions therein (abiotic):

- Abiotic Monitoring
  - Water
    - Deliveries will be recorded and water levels will be monitored.
- Biotic Monitoring
  - Vegetation
    - Aerial photos will be taken annually and the wetland will be classified and/or delineated and compared to original planting designs.

Habitat/Species Monitoring

Habitat/species monitoring is designed to determine whether each phase is providing the habitat requirements needed for the targeted covered species; if any covered species is utilizing the habitat; and if there are differences in wildlife use of the habitat depending on planting design, composition, and watering regimes. The monitoring is divided into habitat and covered species, and will be analyzed incorporating both categories:

- Habitat Monitoring
  - Abiotic Conditions
    - Water Quality
      - Water quality will be measured at least once in spring and once in summer on an annual basis. Measurements likely to be included will be: temperature, salinity (as specific conductivity), DO, pH, turbidity, and selenium.
    - Water Levels
      - Water levels will be monitored in connection with marsh bird surveys.
  - Biotic Conditions
    - Vegetation
      - Vegetation will be monitored once per year at each marsh bird survey point using the wetland habitat measurements included in the Standardized North American Marsh Bird Monitoring Protocols (Conway 2008).
      - Vegetation monitoring will include a 164-ft (50-m) radius plot around each survey point which would include percent coverage of each habitat cover type (e.g. 50% open water, 40% marsh, 10% upland) and percent coverage of each wetland plant species as well as dead vegetation within the marsh habitat cover type (e.g. 50% cattail, 40% dead marsh vegetation, 10% bulrush).
      - If cotton rats are found utilizing the site (primarily in the marsh/upland transition area), herbaceous ground cover surveys will be implemented.

- Covered Species Monitoring
    - Marsh birds
        - Monitoring will be conducted using the multi-species survey from the Standardized North American Marsh Bird Monitoring Protocols after all construction is complete and marsh vegetation has been planted.
        - This incorporates playing calls of all target species with a CD player and speakers at each survey point to elicit a response which will determine presence of the target species.
    - Small mammals
        - If the seeding and planting of the transition zone between the marsh and upland is successful and potential cotton rat habitat (dense grassy/weedy vegetation) occurs in large enough patches, then standardized presence/absence surveys will be conducted at least once annually during fall and/or spring.
        - Trapping will be conducted overnight using Sherman live traps. Traps will be placed in linear transects within the transition zone.
    - MacNeill's sootywing skipper
        - If the planting of quailbush is successful, surveys will be conducted when quailbush crown coverage is approximately 10 ft x 10 ft (3 m x 3 m).
        - Pollard Walks (Pollard 1977) visual surveys will be conducted in the quailbush habitat when the skipper flies between April and October to determine presence/absence. A minimum of three surveys will be conducted.

Monitoring Analysis and Evaluation

After the data collected during implementation, habitat/species monitoring, and vegetation classification are analyzed, the results will be evaluated based on thresholds and trigger points identified by the reference conditions.

Reference Conditions

The HMMCA reference conditions will be modeled on conditions found during Yuma clapper rail studies along the LCR. These variables may change depending on the analysis of future studies. The reference conditions are taken from Conway (1993) which includes having a mosaic of variable-aged stands of cattail/bulrush-dominated marsh vegetation interspersed with open-water pools to ensure habitat suitability year round. Having variable water depths within the marsh ensure habitat is available for both nesting and wintering rails. It is anticipated that HMMCA will include all habitat recommendations as stated above. It has been suggested that periodic burning and flooding of small tracts of marsh vegetation on a 4- to 5-year cycle within the larger marsh system will provide the necessary habitat requirements (e.g. variable aged marsh vegetation) for the Yuma clapper rail (Conway et al. 1993).

Thresholds

Thresholds signal that conditions are appropriate to continue current management practices. The thresholds are as follows:

- Yuma clapper rail reference habitat conditions are achieved.
- One or more covered species are utilizing HMMCA during non-breeding season.
- One or more covered species are utilizing HMMCA during breeding season.

In addition, if any monitoring activities documented that covered species were occupying the site before reference conditions were achieved, management and maintenance activities would be adjusted, as appropriate.

Trigger Point

Trigger points signal the need to alter current management activities to achieve HMMCA goals for the restoration site or change the goals for HMMCA. The trigger point is:

- Yuma clapper rail reference habitat conditions have not been achieved.

Adaptive Management

Data will be evaluated annually to determine if the thresholds and/or trigger point were reached. If results indicate that the restoration activities meet or exceed thresholds, recommendations will be made in the annual report for future management activities at HMMCA as well as other restoration activities. If results indicate that restoration activities were deleterious to covered species or habitats, recommendations on prescriptions and modifications will be identified, and other methods tested.

Plant community and structural type are a component necessary for obtaining performance criteria for marsh cover types. Criteria used to define marsh cover types are determined by the Younker and Andersen Marsh Vegetation Classification System (1986). Annual reports will summarize the performance criteria of newly created habitat acreage and the specific habitat type acreage that will be credited as restored habitat. Through the adaptive management process, any structural management determined from vegetation classification will be defined in the annual report.

5.0 Reports

Annual Report

An annual report will be prepared by Reclamation and made available each calendar year summarizing the following:

- General description of the project status and the effects on the covered species
- A table from the Mitigation Monitoring and Reporting Program (MMRP) indicating current implementation status of each mitigation measure
- A description of all restoration activities and monitoring actions conducted over the past year
- A summary of monitoring and research activities over the past year
- Results and analyses of monitoring and research data
- An assessment of the effectiveness of each mitigation measure in minimizing and compensating for project impacts
- The total number of acres planted
- The total number of acreage that meets or exceeds the performance standards
- Any other applicable information

Through the adaptive management process, an annual report will be prepared. This plan will incorporate the monitoring results from the previous year. The plan will include the planting design, planting techniques grading plan, and demonstration or research plan for the acreage that will be converted. The monitoring results will indicate the amount of structural management that will be accomplished in the next year and any modifications to previously restored habitats. Once the site has become established, the annual reporting period may be lengthened as appropriate.

Final Report

A final report will be prepared by Reclamation and submitted no later than 180 days after the completion of all mitigation measures. The final report is anticipated in 2055 and will include the following information:

- A copy of the table in the MMRP with notes showing when each mitigation measure was implemented
- Recommendations on how mitigation measures might be changed to more effectively minimize and mitigate the impacts of future projects on the species
- Any other pertinent information

Literature Cited

Bernstein, B.B. and J. Zalenski. 1983. An optimum sampling design and power tests for environmental biologists. Journal of Environmental Management 30:129-133.

BIO-WEST, Inc. 2008. Hart Mine Marsh Wetland Investigation. Report submitted to U.S. Bureau of Reclamation. BIO-WEST Inc. Logan, UT.

Block, W.M., A.B. Franklin, J.P. Ward, Jr., J.L. Ganey, and G.C. White. 2001. Design and implementation of monitoring studies to evaluate the success of ecological restoration on wildlife. Restoration Ecology 9(3):293-303.

Bureau of Reclamation. 2006. Lower Colorado River Multi-Species Conservation Program Draft Final Scientific Strategy. Lower Colorado Region, Boulder City, NV 66pp.

Conway, C. J. 2008. Standardized North American Marsh Bird Monitoring Protocols. Wildlife Research Report #2008-01. U.S. Geological Survey, Arizona Cooperative Fish and Wildlife Research Unit, Tucson, AZ.

Conway, C. J. 2005. Standardized North American Marsh Bird Monitoring Protocols. Wildlife Research Report #2005-04. U.S. Geological Survey, Arizona Cooperative Fish and Wildlife Research Unit, Tucson, AZ.

Conway, C. J., W. R. Eddleman, S. H. Anderson, and L. R. Hanebury. 1993. Seasonal changes in Yuma clapper rail vocalization rate and habitat use. Journal of Wildlife Management 57: 282-290).

Green, R.H. 1979. Sampling Design and Statistical Methods for Environmental Biologists. John Wiley and Sons, New York.

Halterman, M. and M.J. Johnson. 2005 Draft Western Yellow-billed Cuckoo Natural History Summary and Survey Methodology. Southern Sierra Research Station, Weldon, CA.

Lower Colorado River Multi-Species Conservation Program. 2004. Lower Colorado River Multi-Species Conservation Program, Volume II: Habitat Conservation Plan. Final. December 17. (J&S 00450.00) Sacramento, CA.

Pollard, E. 1977. A method for assessing changes in the abundance of butterflies. Biological Conservation. 12:115-134.

Smith, E.P. 2002. *BACI design.* Volume 1, p141-148 in Encyclopedia of Environmetrics. Abdel H. El-Shaarawi and Walter W. Piegorsch, eds. John Wiley & Sons, Ltd. Chichester.

Stewart-Oaten, A., J.R. Bence, and C.W. Osenberg. 1992. Assessing effects of unreplicated perturbations: no simple solutions. Ecology 73:1396-1404.

U.S. Fish and Wildlife Service. 2007. Existing Conditions Report (USFWS - http://www.lcrmscp.gov/worktasks/conservationareas/E9/HartMineconditions.pdf)

Younker, G. L., and C. W. Andersen. 1986. Mapping methods and vegetation changes along the lower Colorado River between Davis Dam and the border with Mexico. Report submitted to Bureau of Reclamation in fullfillment of Contract No. 6-CS-30-03800. AAA Engineering & Drafting Inc. Salt Lake City, UT.