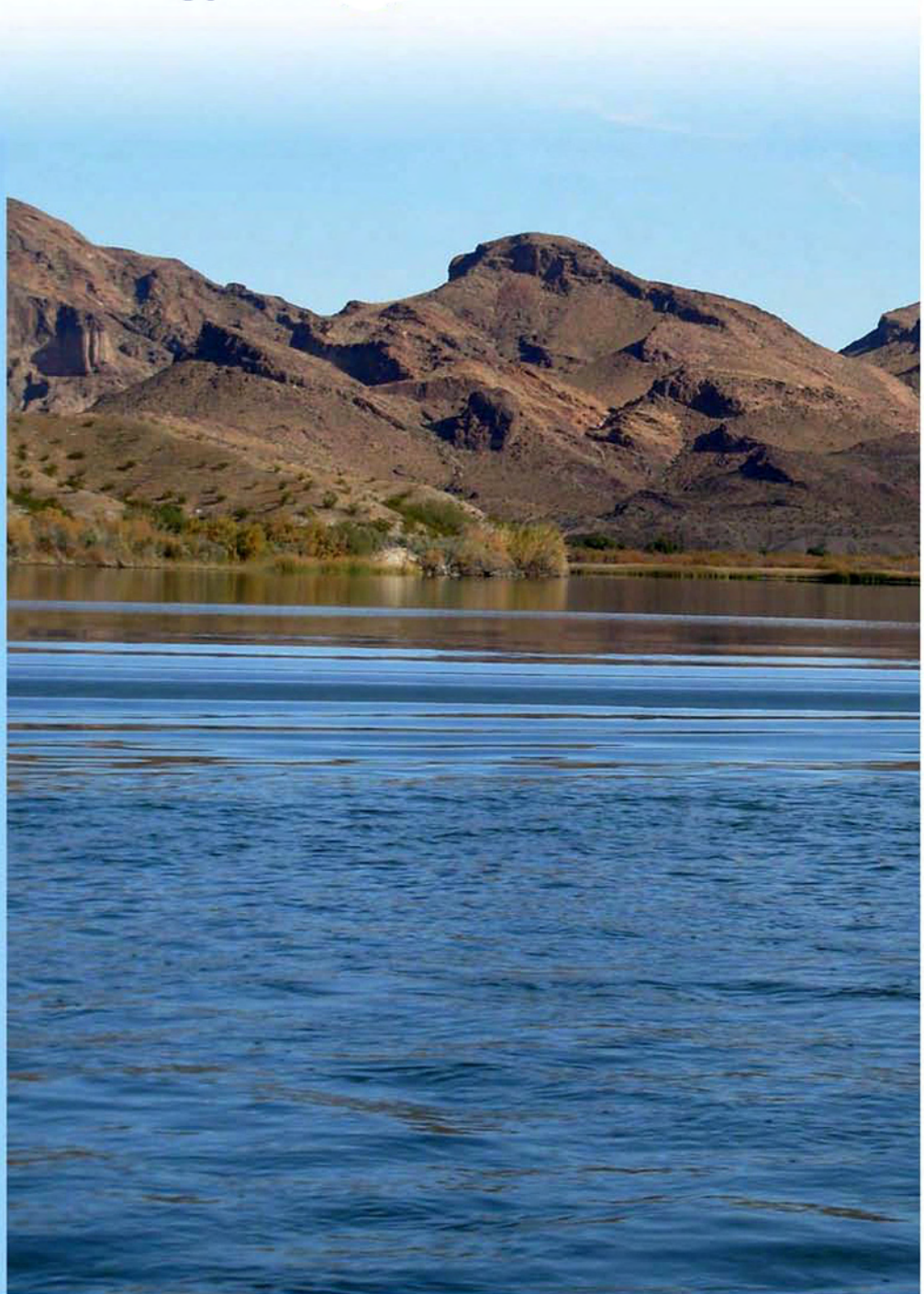
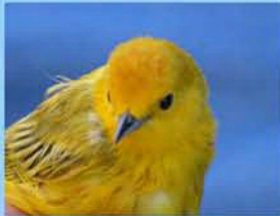




Lower Colorado River Multi-Species Conservation Program

Balancing Resource Needs

Final Science Strategy



November 2007

Lower Colorado River Multi-Species Conservation Program Implementation 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

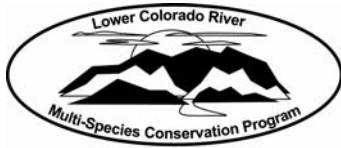
Colorado River Commission of Nevada
Nevada Department of Wildlife
Southern Nevada Water Authority
Colorado River Commission Power Users
Basic Water Company

Native American Participant Group

Hualapai Tribe
Colorado River Indian Tribes
The Cocopah Indian Tribe

Conservation Participant Group

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



Lower Colorado River Multi-Species Conservation Program

Final Science Strategy

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

November 2007

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Chapter 1. Introduction

Background

The Lower Colorado River Multi-Species Conservation Program (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) (LCR MSCP 2004). Most of the covered species are state and/or federally listed threatened and endangered species. The Bureau of Reclamation (Reclamation) is the entity responsible for implementing the LCR MSCP over the 50-year term of the program. A Steering Committee, currently consisting of 54 entities, has been formed as described in the *LCR MSCP Funding and Management Agreement* (FMA)¹, to provide input and oversight functions in support of LCR MSCP implementation.

The HCP² conservation measures are designed to meet the biological goals for the 26 covered species and potentially benefit the five evaluation species that were included in the LCR MSCP. The Science Strategy addresses 20 of the covered species for which Reclamation is responsible for implementing HCP conservation measures (see Appendix A).³ The biological goals and a summary of HCP conservation measures for these 20 covered and evaluation species are presented in Appendices B and C, respectively. The planning area for the LCR MSCP is shown in Figure 1.

The Science Strategy provides a process for identifying monitoring and research priorities using a 5-year planning cycle and a process for annually implementing these 5-year priorities during each planning cycle. The Science Strategy also provides for an adaptive management process for improving the effectiveness of

¹ Provided in Exhibit A of the LCR MSCP HCP (LCR MSCP 2004).

² Conservation measures are identified in LCR MSCP Chapter 5, Conservation Plan.

³ HCP conservation measures for the humpback chub, desert tortoise, flat-tailed horned lizard, relict leopard frog, sticky buckwheat, and three-corner milkvetch require Reclamation to provide funding to other specified conservation programs to implement measures to conserve these species. Consequently, conservation measures for these species are not addressed by the Science Strategy. Reclamation through the LCR MSCP annual work plan process, however, is responsible for ensuring that these funds are used to implement conservation actions that are consistent with the requirements of the HCP.

HCP implementation based on monitoring and research results. The monitoring element of the Science Strategy includes compliance monitoring. Compliance monitoring will be undertaken specifically to provide Reclamation with the information necessary to demonstrate regulatory compliance with the terms of the HCP and incidental take permits.

Purpose and Need

The purpose of this Science Strategy is to provide Reclamation with a science-based process for ensuring that relevant new information generated over the 50-year term of LCR MSCP is used to guide implementation of HCP conservation measures. New information regarding covered species, their habitat requirements, and methods for establishing and managing created habitats will be generated through monitoring and research conducted by Reclamation and others.

The HCP provides program-level guidance for ensuring that implementation of the conservation measures will be based on scientific information, methods, principles, and standards (see HCP Section 5.3.2). As new information on species and their habitats is developed, the HCP also provides for use of an adaptive management process to review and incorporate this new information as appropriate. In addition, implementation of the HCP is funded to levels specified in the FMA. Based on these funding levels, HCP implementation needs to be both biologically effective in meeting the biological goals and financially cost-efficient. Successful implementation of the HCP with scientific rigor, adaptive management, and cost efficiency requires development of a science strategy to provide a structural framework for incorporating these factors into Reclamation's planning, implementation, and decision making processes. Further, it is the intent of Reclamation that the Science Strategy provide a means to allow the implementation decision making process to be as transparent as possible.

The Science Strategy addresses two decision making functions:

- how the strategy will operate in Reclamation's implementation decision making process and
- the processes that can be used to identify uncertainties and knowledge gaps, develop monitoring and research priorities, and to incorporate new knowledge into the decision making process.

1 **Figure 1** Lower Colorado River MSCP Planning Area and River Reaches



Given the funding available for implementation, development and approval of specific actions in Reclamation's Annual Work Plans⁴ should be directed to those actions needed to ensure the achievement of the LCR MSCP biological goals.

Information Sharing

A key component of the science strategy is coordination with entities and groups within and external to the LCR MSCP Steering Committee (Steering Committee) whose knowledge and experience will provide significant benefits to HCP implementation. This coordination will facilitate the exchange of data and results of experiments or pilot projects among LCR MSCP Partners⁵ (Partners).

With such knowledge sharing, duplication of efforts that address similar research or habitat questions can be minimized with resultant time and cost savings. Coordinated monitoring programs can result in greater data-gathering power and resolution to enhance results. Potential cooperators include multi-agency conservation programs, state fish and wildlife agencies (Arizona Game and Fish Department, California Department of Fish and Game, and the Nevada Department of Wildlife), Native American Tribes, national and local conservation groups, and research institutions. Coordination with others may include sharing information collected through monitoring and research through a variety of venues, including:

- providing reports and other types of LCR MSCP related information on the LCR MSCP website;
- periodically publishing results of research either as LCR MSCP technical reports or as papers presented in scientific journals;
- presentation of monitoring and research results and other science-related LCR MSCP information at conferences hosted by Reclamation or others;
- periodic publication of informational materials describing LCR MSCP implementation progress; and
- providing others with data and information maintained in the LCR MSCP Database Management System.

The HCP identifies several categories of monitoring and research that will provide information needed to achieve the biological goals for the covered species (see LCR MSCP HCP Section 5.11). The categories (hereafter referred to as

⁴ Annual Work Plans are documents that are prepared by Reclamation in coordination with the Steering Committee and USFWS that identify actions that will be undertaken by Reclamation to implement conservation measures during each fiscal year (October 1-September 30).

⁵ LCR MSCP Partners are the member entities of the Steering Committee.

1 *implementation elements*) addressed by the Science Strategy include the
2 following:

- 3 • species research,
- 4 • habitat creation research,
- 5 • system monitoring, and
- 6 • post-development monitoring.

7 **Document Organization**

8 This document is organized into the following Chapters:

- 9 • Chapter 2: *Science Strategy Process* describes the overall Science Strategy
10 process for identifying and approving monitoring and research priorities
11 and providing for adaptive implementation of the HCP.
- 12 • Chapter 3: *Science Strategy Implementation Elements* describes the
13 implementation elements for which science-based processes are needed
14 and Reclamation's process for identifying monitoring and research needs
15 for each implementation element.
- 16 • Chapter 4: *Monitoring and Research Plans* describes Reclamation's
17 process for developing science-based monitoring and research plans based
18 on the best available information.

1 **Chapter 2. Science Strategy Process**

2 **Introduction**

3 This Chapter describes the Science Strategy process as part of Reclamation’s
4 implementation of the HCP. The Science Strategy is the procedure by which
5 Reclamation will incorporate science into their planning processes and coordinate
6 with the Steering Committee as described in the FMA.

7 **Role of Reclamation and the Steering Committee**

8 Section 7 of the FMA describes the management and implementation of the LCR
9 MSCP. The roles and responsibilities of Reclamation in the FMA are clear in
10 giving Reclamation the primary responsibility to administer and implement the
11 program through the HCP. Reclamation, through the LCR MSCP Program
12 Manager (Program Manager), cooperates and coordinates its management and
13 implementation activities with the Steering Committee in accordance with the
14 terms of the FMA. The role of the Steering Committee in decision making is
15 defined in the FMA.

16 As discussed in the FMA, Reclamation is responsible for developing an Annual
17 Work Plan that describes what conservation actions will be implemented for the
18 next year. This Annual Work Plan contains the individual work tasks identified
19 by Reclamation as needing to be implemented to provide for continued progress
20 to meet the biological goals in a biologically effective and cost efficient manner.

21 As part of the review process for the Annual Work Plans, budgets, and
22 implementation reporting developed since the LCR MSCP was signed in 2005,
23 Reclamation seeks input from ad hoc “Technical Work Groups” (TWG),
24 comprised of members of the Steering Committee and other parties expressing
25 interest. These TWGs review draft documents, provide information for
26 development of white papers, and serve other roles as determined by Reclamation
27 to contribute to the information base used by Reclamation in its decision making
28 process. The Science Strategy procedures described in this chapter are designed
29 to be incorporated into the existing roles and responsibilities of Reclamation and
30 the Steering Committee as described in the FMA.

Planning Processes

Reclamation uses planning processes that operate on 5-year and annual cycles for identifying HCP implementation priorities. The Science Strategy uses these planning cycles as the mechanism for identifying monitoring and research activities and for making changes to implementation through the LCR MSCP adaptive management process (see *Adaptive Management* below). The 5-year planning process (hereafter referred to as the *5-year cycle*) is used to identify monitoring and research priorities for the following 5 years of HCP implementation. The annual planning process culminates in the development of approved Annual Work Plans. Annual Work Plans identify work tasks that will be undertaken by Reclamation during each fiscal year to implement the HCP, including activities related to planning, monitoring and research, habitat creation and management, and fish augmentation. In the context of the Science Strategy, Annual Work Plans are the mechanism through which:

- specific monitoring and research activities that will be undertaken during each year of the 5-year cycle are identified to achieve the 5-year cycle monitoring and research priorities; and
- adaptive changes to HCP implementation are identified and approved.

Figure 2a illustrates the 5-year cycle. The starting point for the 5-year cycle is the consideration of the implementation elements, as this is the point at which knowledge and data gaps are identified by Reclamation staff. Figure 2b illustrates the Annual Work Plan process that would be accomplished annually for each year of the 5-year cycle. The annual cycle feeds out of the 5-year cycle at the point where the final 5-year monitoring and research priorities are determined, and feeds back into the 5-year cycle at the point where the next 5-year planning cycle is initiated.

The 5-year cycle and Annual Work Plan development processes are comprised of a series of sequential actions that provide an organized path for documenting how and where science-based processes are considered in Reclamation's decision-making process for implementing the HCP.

5-Year Cycle Process

The 5-year cycle process entails identifying monitoring and research priorities (hereafter referred to as *priorities*) based on review of the information needs for the implementation elements that are identified through the processes described in Chapter 3, *Implementation Elements*. Priorities are designed to answer general or specific questions that identify knowledge needs or data gaps that affect the ability of Reclamation to implement the HCP in a biologically effective and cost efficient manner. A 5-year cycle was selected because it is of sufficient duration to allow for new information for use in guiding implementation planning to be

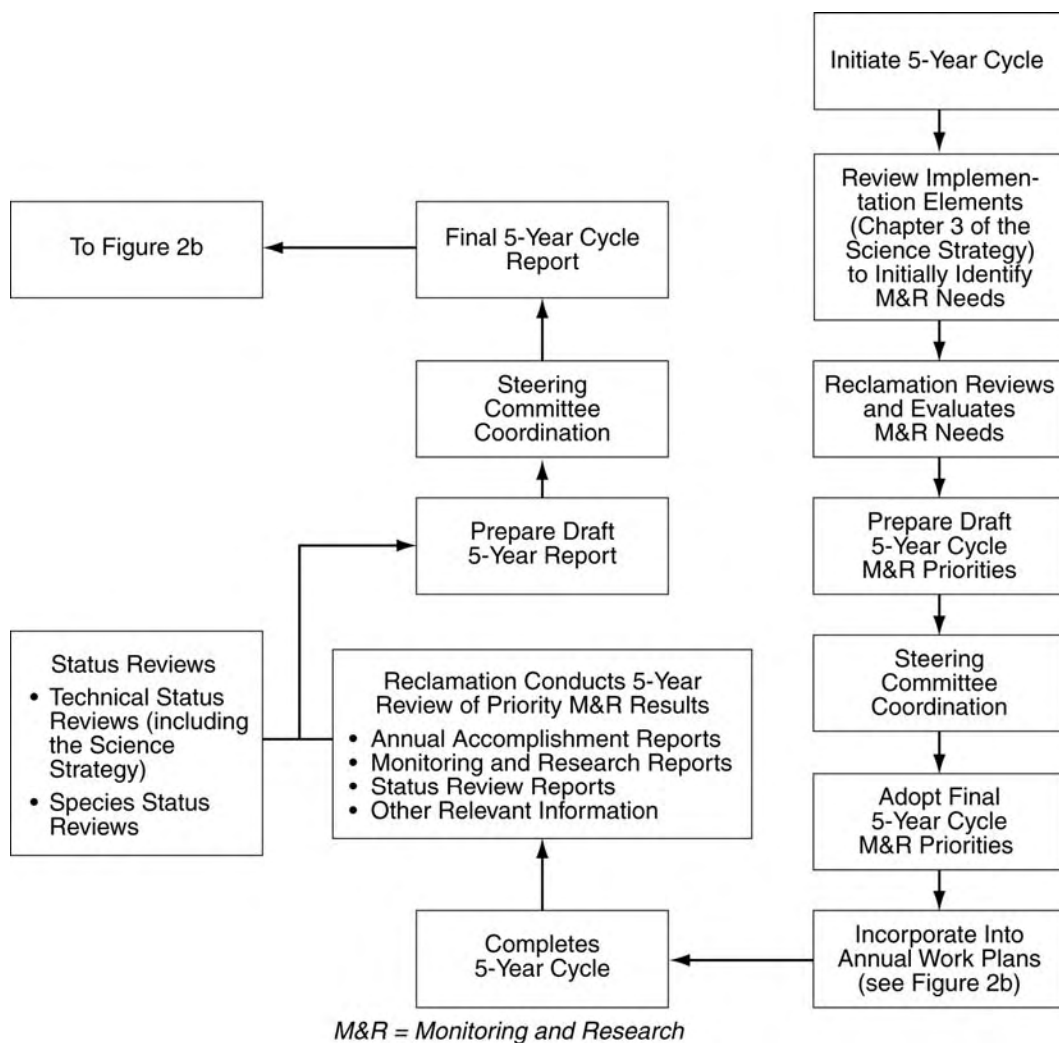
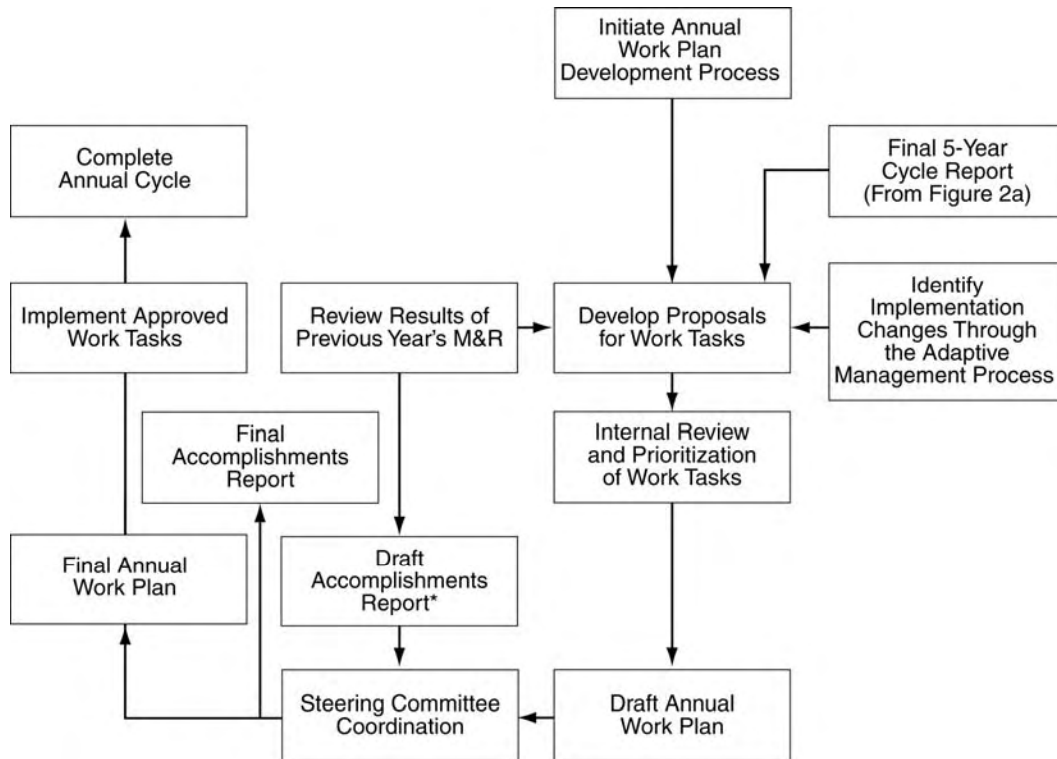


Figure 2a. 5-Year Process for Establishing Monitoring and Research Priorities



*Prepared for work tasks implemented in the previous fiscal year
M&R = Monitoring and Research

Figure 2b. Annual Work Plan Development Process

developed and is of short enough duration to provide for timely management responses to new information. For example, the 5-year planning cycle:

- provides sufficient time for the completion and analysis of multi-year research or monitoring actions;
- allows time for on-the-ground changes to occur in response to management actions (e.g., the establishment of created habitats) and be documented;
- allows time for specific monitoring and research proposals to be fully developed to include the best science; and
- is such that results of monitoring and research can be responded to quickly without a significant loss of time or funds resulting from proceeding in less desirable directions for implementation.

The 5-year cycle process entails Reclamation's process for identifying draft priorities and the Steering Committee coordination process for identifying the

final priorities that will be addressed through Annual Work Plans. Reclamation anticipates undertaking the following 4-step process to identify 5-year cycle priorities (see Figure 2a).

1. Identify knowledge needs and data gaps. Reclamation will initially review existing information, including results from monitoring and research conducted prior to adoption of the Science Strategy, to identify knowledge needs and data gaps for each of the implementation elements. Reclamation's process for developing priorities for each implementation element is described in Chapter 3. At the end of each 5-year cycle, Reclamation will evaluate, as appropriate, the results of priority-related monitoring and research implemented during the completed 5-year cycle. Results of this evaluation will be documented in a report and this information will be used, as appropriate, to develop draft priorities for the next 5-year planning cycle. In addition, Reclamation may periodically provide status reviews of the entire program that would also inform the process for establishing 5-year priorities. These reviews could include program-level status, 5-year cycle priorities, or focus on particular issues (see *Status Reviews* below). The format of these reviews is at the discretion of Reclamation, and would be determined after completion of Reclamation's internal review processes.

2. Initial ranking of data needs. Reclamation staff will review the knowledge needs and data gaps identified in Step 1 for each implementation element to initially rank them in order of importance for gathering the information necessary to ensure successful HCP implementation. Considerations for ranking knowledge needs and data gaps for each implementation element include, but are not limited to, the following.

Species Research: The information needs to be obtained during the 5-year cycle to establish effective created habitat design and management requirements to provide for the creation of habitat in accordance with the HCP implementation schedule.

Created Habitat Research: The information needs to be obtained to identify techniques that will effectively establish and maintain habitats to be created during the 5-year cycle.

System Monitoring: The subject of monitoring is needed to manage the direction of future HCP implementation and to effectively evaluate HCP implementation success.

Post-Development Monitoring: The monitoring needs to be conducted to determine if habitat creation and management methods are successful.

- 1 **3. Review initial data ranking and propose priorities.** Following initial
2 ranking of priorities, Reclamation will establish an internal review team
3 comprised of senior Reclamation staff with relevant expertise in biological
4 and physical sciences, scientific method, habitat restoration design and
5 engineering, and resource management. The internal review team will
6 review the initial priorities identified in Step 2 to identify the proposed
7 priorities that should be addressed in the 5-year cycle. Considerations for
8 identifying priorities may include:
- 9 • evaluating the monitoring and research projects to ensure they
10 focus on implementation of the HCP conservation measures;
 - 11 • evaluating the likelihood that the monitoring and research will:
 - 12 – provide information without which implementation efforts
 - 13 may be significantly hindered or rendered unsuccessful;
 - 14 – provide baseline information needed to initiate the
 - 15 implementation of other activities;
 - 16 – provide information necessary to develop or establish a part
 - 17 of the administration of the program by Reclamation;
 - 18 – provide the opportunity to obtain synergies with other
 - 19 conservation programs to obtain information needed by both
 - 20 programs at a savings of time or cost;
 - 21 • assessing the amount of funding available for each implementation
22 element over the 5-year period and the amount of funding needed
23 to meet habitat creation, habitat management, and fish
24 augmentation objectives during the 5-year cycle;
 - 25 • assessing whether or not the opportunity to implement the
26 monitoring and research is time-dependent or can be implemented
27 in subsequent 5-year cycles;
 - 28 • assessing the relationship of the proposed priorities to projects
29 currently under development or being planned; and
 - 30 • other considerations as identified by Reclamation.
- 31 **4. Determine final data need priorities.** At the beginning of each 5-year
32 cycle, Reclamation will provide the Steering Committee with a description
33 of the draft priorities and initiate coordination to identify the final 5-year
34 priorities. The description of each priority will document, as appropriate,
35 the basis used to develop the priorities, the rationale for each priority and
36 how addressing the priority is expected to inform HCP implementation,
37 and why each of the priorities need to be addressed during the current
38 5-year planning cycle. The Steering Committee coordination process may
39 include formation of a TWG, workshops, other reviews with Partners or

1 other cooperating entities, or other suitable means identified by
2 Reclamation. Information on how the final priorities are identified will be
3 documented as part of the transparency of the decision making process.

4 **Annual Planning Cycle**

5 Once the priorities for a 5-year cycle have been identified, the Annual Work Plans
6 developed for that cycle will use the priorities as one factor in developing specific
7 work tasks for that Annual Work Plan. Reclamation will annually evaluate the
8 5-year priorities to determine if they should be implemented, in whole or in part,
9 under each Annual Work Plan. This evaluation is necessary to ensure that work
10 tasks can be accomplished within the annual implementation budget and all
11 components of HCP implementation should be considered in determining which
12 specific monitoring and research proposals to address. The 5-year priorities will
13 be funded. New priorities not related to the 5-year cycle priorities would
14 generally not be funded unless some significant new information was developed
15 that prompts a review by Reclamation to determine the need for a change in
16 priorities. If new monitoring and research priorities are identified within a 5-year
17 cycle, the need for the new priority would be documented through the Annual
18 Work Plan process described below and would be incorporated as an identified
19 priority in the next 5-year cycle planning process.

20 This annual review of 5-year cycle priorities is accomplished and documented, in
21 part, through annual monitoring and research project reports and Reclamation's
22 preparation of its annual Accomplishments Report at the end of each fiscal year.
23 The Accomplishments Report summarizes the HCP implementation progress for
24 that year and is provided for Steering Committee review through the Steering
25 Committee coordination process. Accomplishments Reports include information
26 obtained through the priority monitoring and research conducted during that year.
27 The reported information for each priority could include:

- 28 • a description of the purpose of the monitoring and research priority (e.g.,
29 what new information is to be obtained and why is it needed to inform
30 implementation);
- 31 • summary of the funded monitoring and research results;
- 32 • any minor modifications to HCP implementation of funded tasks that
33 resulted from findings of the monitoring and research during the fiscal
34 year;
- 35 • any major modifications to HCP implementation of funded tasks that
36 resulted from findings of the monitoring and research during the fiscal
37 year; and
- 38 • a recommendation, based on the sufficiency of new information gathered
39 through the monitoring and research, of whether or not the monitoring and
40 research should be continued as originally described or in a modified form
41 or discontinued.

1 Reclamation anticipates a 5-step process to develop and implement Annual Work
2 Plan work tasks for priority monitoring and research.

3 1. Reclamation will review results of monitoring and research conducted in
4 the previous year to determine if their purpose has been achieved and if
5 previously approved monitoring and research should be continued,
6 modified, or discontinued (this review is documented in the
7 Accomplishments Report described above).

8 2. Reclamation will review 5-year priorities that were not addressed in
9 previous years within the 5-year cycle to identify monitoring and research
10 that should be identified for implementation in the current Annual Work
11 Plan. Considerations for identifying research and monitoring include:

- 12 • an assessment of costs to implement the research and monitoring
13 relative to the available annual budget and other implementation
14 priorities;
- 15 • the need to implement the research and monitoring to answer
16 questions necessary to implement other elements of the HCP; and
- 17 • whether or not the results of previous monitoring and research
18 indicate that the priority is still valid or should be discontinued.

19 3. Each research and monitoring work task proposed in the draft Annual
20 Work Plan should include a description of:

- 21 • the purpose of the monitoring and research, including questions
22 that will be answered, the rationale for why the question needs to
23 be answered (i.e., how it is expected to guide HCP
24 implementation), and why it needs to be answered during the
25 annual work plan cycle;
- 26 • estimated budget;
- 27 • anticipated duration of the monitoring and research;
- 28 • a general description of the methods used to implement the
29 monitoring and research; and
- 30 • if applicable, a description of coordination that may be undertaken
31 with other monitoring and research projects implemented by other
32 programs within and outside of Reclamation.

33 4. Following completion of the draft Annual Work Plan, the draft will
34 undergo coordination with the Steering Committee. Reclamation will
35 prepare the final Annual Work Plan based on results of coordination with
36 the Steering Committee as appropriate.

5. Following approval of the final Annual Work Plan, Reclamation will prepare detailed monitoring and research plans for implementing the approved monitoring and research tasks as described in Chapter 4.

Adaptive Management

The state of current knowledge surrounding covered species requirements and the ability to create their habitats is such that uncertainty regarding outcomes of implementing the HCP relative to achieving biological goals is unavoidable. To address these uncertainties, the HCP provides for monitoring and research to address knowledge gaps and uncertainties and provides for adaptively managing implementation based on new information. The LCR MSCP adaptive management process allows for adjusting HCP implementation based on new information that may be developed through monitoring and research over the term of the LCR MSCP. The adaptive management process is consistent with the USFWS's Five-Point Policy for HCPs (65 FR 106, June 1, 2000), which broadly defines adaptive management:

as a method for examining alternative strategies for meeting measurable biological goals and objectives, and then if necessary, adjusting future conservation management actions according to what is learned.

Adaptive Management Structure and Process

The Science Strategy provides for effecting adaptive implementation of the HCP through the 5-year cycle and Annual Work Plan development process described above under *Planning Processes*. The adaptive management process addresses adaptive implementation of the HCP at the project-level and program-level. Program-level adaptive management addresses adjustments to HCP implementation that would require concurrence by the Steering Committee and USFWS to effect. Examples of program-level adaptive management decisions would be changes to HCP conservation elements or the overall direction of the HCP. Project-level adaptive management addresses adjustments to HCP implementation that can be effected by the Program Manager without requiring participation by the Steering Committee or USFWS. Reclamation, however, will provide opportunities, as appropriate, for participation by the Steering Committee, USFWS, and other entities to contribute to information used to make implementation-level decisions.

Both levels of adaptive management rely on the initial receipt of new information, the analysis of that information, and the incorporation of the new information into the design or direction of future work tasks. This process will occur in some degree of detail for each Annual Work Plan task that relies on the Science Strategy at the end of each implementation year through preparation of annual Accomplishments Reports, the beginning of each 5-year planning cycle and

Annual Work Plan cycle, and at other appropriate times as determined by Reclamation.

Project Adaptive Management

Project adaptive management relies on the 5-year cycle and Annual Work Plan development processes. The project adaptive management process begins for each project with the review of completed or interim reports presenting results of monitoring and research from funded proposals developed to meet 5-year cycle priorities. This is a Reclamation staff-level review. The information in the reports is assessed to determine if the new information indicates that a change in HCP implementation is warranted. If indicated through this assessment, the Reclamation staff leads for the affected work tasks will draft recommended changes, including supporting information, to HCP implementation. The draft recommendations are then reviewed by Reclamation's technical adaptive management team for their approval.

If the technical adaptive management team determines that proposed changes to HCP implementation would have more than a minor effect on existing 5-year cycle priorities or result in potentially significant changes to projects being implemented, the Steering Committee, USFWS, and other entities, as appropriate, will be provided an opportunity to review and discuss Reclamation's analysis and recommendations. Reclamation may provide for such reviews in a number of ways, including a technical work group, peer review by recognized experts, workshops, or other forms of information review. The result of this expanded review is a recommendation to Reclamation for changes to 5-year cycle priorities or projects for the next year. Reclamation will make the final decision on the implementation of recommendations.

Proposed changes to HCP implementation that are recommended by Reclamation through this adaptive decision making process are proposed and documented, as appropriate, through the 5-year cycle and Annual Work Plan Steering Committee coordination processes (see Figures 2a and 2b.).

Program Adaptive Management

Program-level adaptive management provides for adjustments to HCP implementation that, to effect, would require adjustments to LCR MSCP funding levels, revisions to HCP conservation measures, adoption of alternate conservation measures, or other significant changes that affect what the HCP includes as part of the conservation direction. Reclamation will, during the program adaptive management process, determine if recommended changes to HCP implementation are significant enough to warrant program modification. If Reclamation makes that decision, the Steering Committee must be involved in the review of the recommendations. Reclamation has several options as to how this could be done, including a technical work group, peer review by recognized experts, workshops, other forms of information review, or through use of

procedures described in the FMA regarding coordination between Reclamation and the Steering Committee.

Program-level adaptive management is not anticipated to occur often over the 50-year term of the LCR MSCP because the HCP conservation direction was developed using the best available information and accepted principles of conservation planning. Consequently, with the exception of possibly providing coverage for evaluation species under the HCP, the likelihood that new information would be developed of a magnitude that would necessitate a change in the conservation direction sufficiently to trigger this process makes its use likely to be rare. This process would not be used in the event of changed circumstances or unforeseen circumstances. Regulations for section 10(a)(1)(B) permits, and for changes to biological opinions under section 7 have specified pathways for consideration and resolution that would be used if these situations occur.

Process for Covering Evaluation Species

In addition to the covered species, the HCP addresses five evaluation species: the California leaf-nosed bat, pale Townsend's big-eared bat, desert pocket mouse, Colorado River toad, and lowland leopard frog. These species could become covered under the HCP during the term of the LCR MSCP through the process described under *Program Adaptive Management* above.

These evaluation species could become listed in future years, but were not covered under the HCP because sufficient information was not available at the time the HCP was prepared to determine their status in the LCR MSCP planning area, to assess the potential effects of covered activities, or to develop specific conservation measures. The HCP, however, does include monitoring and research measures for these species that provide for gathering information necessary to better define their status, distribution, and habitat requirements in the LCR MSCP planning area (see Appendix C). Implementation of these research and monitoring measures will be implemented as described for the covered species in Chapters 2 through 4. The evaluation species could be proposed for coverage through the program adaptive management process if sufficient information is gathered through monitoring and research to identify conservation measures that would, at a minimum, meet the HCP conservation goal of avoiding, minimizing, and fully mitigating adverse effects of the covered activities and HCP implementation for each of the species (see HCP Section 5.2.1).

Status Reviews

In addition to evaluations of HCP implementation that are conducted to inform adaptive decision making in the 5-year cycle and Annual Work Plan development processes, Reclamation may conduct periodic program-wide status reviews of

HCP implementation. The purpose of these status reviews is to provide Reclamation with a methodical process to periodically evaluate its HCP implementation procedures and the conservation needs of covered species. Results of status reviews would be used to adjust implementation procedures and approaches to species conservation if needed. Two types of status reviews, technical status reviews and species status reviews, may be conducted. Unlike evaluations of monitoring and research results conducted for the 5-year cycle and Annual Work Plan processes, status reviews would also include evaluations to determine if implementation procedures (e.g., monitoring protocols) require updating based on the best available information and regional assessments of the status of covered species to determine if their status has changed sufficiently to affect their conservation needs. These reviews will be conducted at the discretion of Reclamation as needed.

Technical Status Reviews

Reclamation may undertake technical status reviews of HCP implementation processes to ensure that they incorporate current information and reflect current Reclamation practice. Elements subject to technical status reviews include:

- system and post-development monitoring plans,
- research plans (if applicable),
- habitat management prescriptions,
- approaches to created habitat designs,
- guidelines for screening and evaluating potential conservation areas,
- the Science Strategy, and
- Geographic Information Science (GIS) and database structure, software, documentation, user manuals and other elements of Reclamation's data management system.

Reclamation will prepare a document summarizing review results and recommending corrective actions and schedules for their implementation. Recommended corrective actions, depending on Reclamation's assessment of their level of effect on HCP implementation, will undergo Steering Committee coordination, as appropriate, as described above under *Project Adaptive Management*.

Species Status Review

Reclamation may undertake periodic reviews of the status of covered species for which habitat is created under the HCP to identify:

- LCR and regional population trends;
- occupancy of created habitats;

- 1 • new information related to the creation and management of habitats
2 established by others;
- 3 • new information regarding the habitat requirements and behavior of
4 species;
- 5 • new information regarding factors that may be limiting species
6 populations; and
- 7 • new techniques for species management.

8 This information will be evaluated to determine if changes in HCP conservation
9 measures or implementation techniques may be warranted to improve
10 conservation of covered species. Recommendations developed through this
11 process, depending on Reclamation's assessment of their level of effect on HCP
12 implementation, will undergo Steering Committee coordination, as appropriate, as
13 described under *Adaptive Management*.

Chapter 3. Science Strategy

Implementation Elements

Introduction

This Chapter provides guidance for developing and identifying monitoring and research activities that will be undertaken by Reclamation for each of the four Science Strategy implementation elements.

Species Research. The species research element implements research to address information gaps in the knowledge of the life history and habitat requirements of covered and evaluation species that is necessary for directing the successful establishment and management of created habitats.

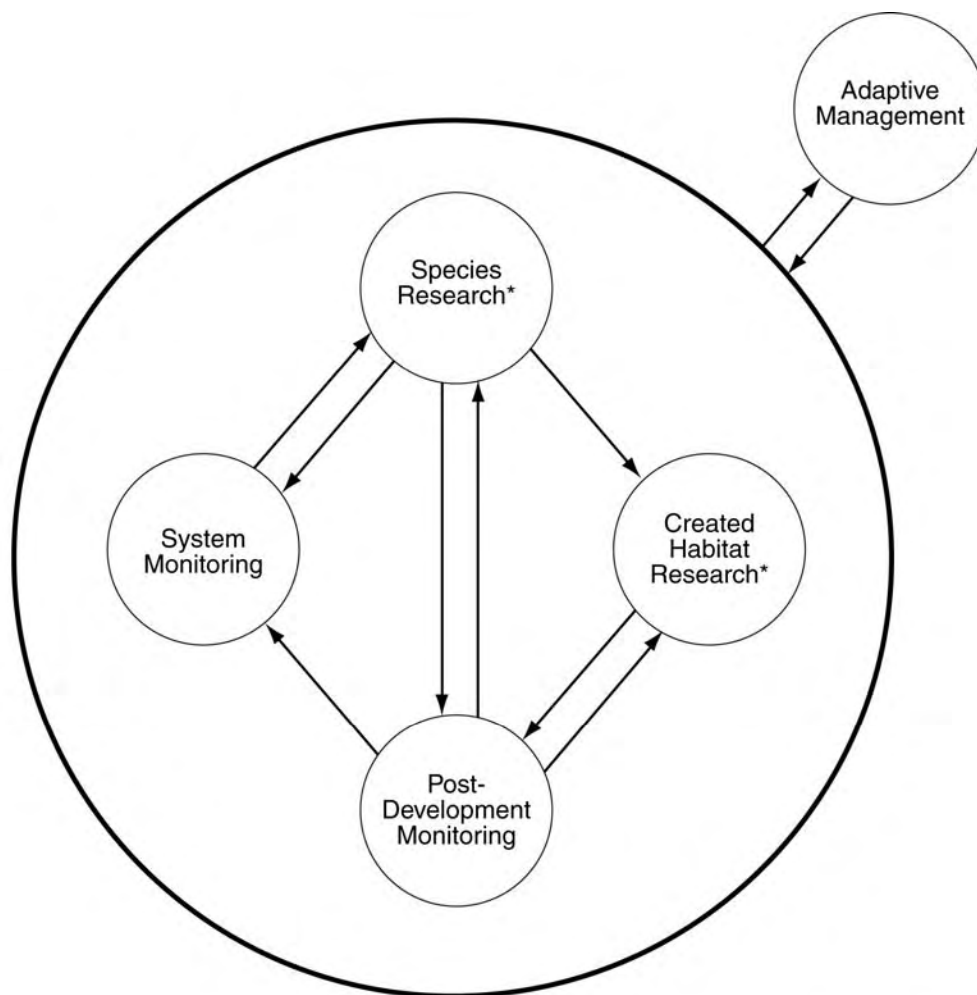
Created Habitat Research. The created habitat research element implements research to address uncertainties related to the techniques for creating habitat and managing covered species habitats to maintain habitat values over the term of the LCR MSCP.

System Monitoring. The system monitoring element implements monitoring to determine the ongoing status of covered species and their habitats in the LCR MSCP planning area.

Post-Development Monitoring. The post-development monitoring element implements monitoring to determine the progress of implementation towards achieving HCP biological goals and to collect information necessary to assess the efficacy of habitat creation designs and habitat management prescriptions.

Monitoring and research data collected under each of these implementation elements are expected to inform implementation of one or more of the other elements. The information and adaptive management linkages among the elements are illustrated in Figure 3.

The HCP specifies monitoring and research that will be undertaken to address knowledge needs and data gaps to help ensure successful HCP implementation. These monitoring and research conservation measures are listed in Table 1. As described for each of the implementation elements below, Reclamation may identify and undertake additional monitoring and research if needed to better manage implementation of the HCP.



** Species and created habitat research are not expected to be implemented over the term of the LCR MSCP as data gaps are addressed by research conducted early in implementation.*

Figure 3 Information and Adaptive Management Linkages Among Science Strategy Implementation Elements

Table 1. LCR MSCP Monitoring and Research Conservation Measures

<i>LCR MSCP Code</i>	<i>Summary Description Conservation Measure^a</i>
General Monitoring and Research Conservation Measures	
MRM1	Conduct surveys and research to better identify covered and evaluation species habitat requirements.
MRM2	Monitor and adaptively manage created covered and evaluation species habitats.
MRM3	Conduct research to determine and address the effects of nest site competition with European starlings on reproduction of covered species.
MRM4	Conduct research to determine and address the effects of brown-headed cowbird nest parasitism on reproduction of covered species.
MRM5	Monitor selenium levels in created backwater and marsh land cover types, and study the effect of selenium released as a result of dredging activities.
Species-Specific Monitoring and Research Conservation Measures	
BONY3	Bonytail augmentation program
BONY5	Conduct monitoring and research, and adaptively manage bonytail augmentations and created habitat
RASU3	Razorback sucker augmentation program
RASU6	Conduct monitoring and research, and adaptively manage razorback sucker augmentations and created habitat
RASU7	Provide funding and support for continuation of the Reclamation/SNWA ongoing Lake Mead razorback sucker studies.
WRBA1	Conduct surveys to determine the distribution of the western red bat.
WYBA1	Conduct surveys to determine the distribution of the western yellow bat.
CRCR1	Conduct research to better define Colorado River cotton rat habitat requirements.
YHCR1	Conduct research to better define Yuma hispid cotton rat habitat requirements.
FLSU3	Assess flannelmouth sucker management needs and develop management strategies.
MNSW1	Conduct surveys and research to locate MacNeill's sootywing skipper habitat and to better define its habitat requirements.
CLNB1	Conduct surveys to locate California leaf-nosed bat roost sites.

Table 1. LCR MSCP Monitoring and Research Conservation Measures
(continued)

<i>LCR MSCP Code</i>	<i>Summary Description Conservation Measure^a</i>
PTBB1	Conduct surveys to locate pale Townsend's big-eared bat roost sites.
CRT01	Conduct research to better define the distribution, habitat requirements, and factors that are limiting the distribution of the Colorado River toad.
CRT03	Conduct research to determine feasibility of establishing the Colorado River toad in unoccupied habitat.
LLFR1	Conduct research to better define the distribution, habitat requirements, and factors that are limiting the distribution of the lowland leopard frog.
LLFR3	Conduct research to determine feasibility of establishing the lowland leopard frog in unoccupied habitat.
^a Full descriptions of conservation measures are provided in the LCR MSCP HCP. A summary of all species conservation measures is provided in Appendix C.	

Species Research Element

The goal of the Science Strategy's species research element is to undertake research necessary to fill information gaps in the understanding of the life history and habitat requirements of covered and evaluation species as they relate to informing the successful creation and management of habitat. The HCP specifies research to be undertaken to fill existing information gaps for some of the covered species (Table 1). Reclamation may identify and undertake additional species research if needed to better manage implementation of the HCP. Research plans would be prepared as described in Chapter 4, *Monitoring and Research Plans* for each species research study approved through the Annual Work Plan development process.

Reclamation anticipates that most species research will be implemented early in HCP implementation and that, as the species-related information needed to implement the HCP is gathered, the need for species research will eventually diminish and may be discontinued in later years of implementation.

Identifying Species Research Needs

As indicated by the conservation measures in Table 1, research for covered species will be directed primarily towards gathering the information needed to understand species habitat requirements and current distribution in the LCR MSCP planning area sufficiently to create and manage functioning habitats. This information will be used, as appropriate, to guide the design and management of

1 habitats to be created for these species. A guiding principle of the HCP is that
2 habitat created for the yellow-billed cuckoo and southwestern willow flycatcher
3 will also provide habitat for the other cottonwood-willow associated covered
4 species. Consequently, species research is anticipated to initially focus primarily
5 on identifying the physical and biological components of yellow-billed cuckoo
6 and southwestern willow flycatcher habitat to provide the information necessary
7 to effectively design, establish, and manage cottonwood-willow habitats for these
8 species.

9 Reclamation anticipates identifying future research needs using the following
10 6-step process.

- 11 1. **Prepare species accounts.** Reclamation will initially prepare detailed
12 species accounts describing the current knowledge about each covered
13 species' life history and habitat requirements, behavior, and management
14 as it relates to the creation and management of their habitats. Reclamation
15 will use these species accounts to identify information gaps for each
16 species that, if addressed, would better inform the creation and
17 management of covered species habitats. Species accounts will be
18 periodically updated, as appropriate, as new information is collected
19 through monitoring and research conducted by Reclamation and others
20 during the status review process (see Chapter 2).
- 21 2. **Identify research conducted by others.** Reclamation will contact state
22 and federal resource agencies, Partners, universities, and other appropriate
23 entities to identify ongoing research being conducted by others that is
24 relevant to implementation of the HCP.
- 25 3. **Review results of LCR monitoring and research.** Reclamation will
26 initially evaluate results of relevant monitoring and research previously
27 conducted along the LCR, as appropriate, to determine if additional
28 species research is required or if ongoing research should be modified.
29 Evaluation of results of ongoing and future LCR MSCP monitoring and
30 research will be evaluated by Reclamation as described under Step 6
31 below.
- 32 4. **Identify LCR MSCP research priorities.** Reclamation anticipates
33 initially identifying species research needs and priorities based on an
34 assessment of information developed for the species accounts and on
35 research being conducted by Reclamation and others. As HCP monitoring
36 and research is implemented, results of monitoring and research will also
37 be used to identify future research priorities. The highest priorities for
38 research are anticipated to be those that address uncertainties that are the
39 most important for ensuring the successful creation and management of
40 habitats. Final research priorities will be determined through
41 Reclamation's process for establishing 5-year priorities and developing
42 Annual Work Plans (see Chapter 2).

- 1 **5. Develop and implement species research plans.** Reclamation will
2 develop and implement research plans⁶, as appropriate, for each species
3 research project approved through the Annual Work Plan development
4 process. The process for development and science review of research
5 plans is described in Chapter 4.
- 6 **6. Adjust LCR MSCP species research priorities.** As information is
7 collected and analyzed through monitoring and research, species research
8 priorities are expected to change over the term of the LCR MSCP.
9 Reclamation will review, as appropriate, results of monitoring and
10 research and re-evaluate species research priorities during the Annual
11 Work Plan and 5-year cycle plan processes (see Chapter 2). If indicated
12 through this re-evaluation, species research priorities may be adjusted
13 through the adaptive management process described in Chapter 2.

14 **Research Associated with Fish Augmentations**

15 The HCP includes conservation measures to provide for the stocking of up to
16 620,000 bonytail and 660,000 razorback sucker. Based on an assessment of the
17 current body of knowledge surrounding the behaviors, habitat requirements, and
18 conservation of razorback sucker and bonytail, Reclamation anticipates initially
19 focusing research and monitoring of these stocked fish to determine:

- 20 • important environmental correlates affecting growth and survival during
21 rearing;
- 22 • mechanisms affecting fish survival and health during fish transporting and
23 stocking processes and methods to improve survival and health; and
- 24 • post-stocking distribution and survival and factors affecting distribution
25 and survival.

26 Reclamation will, as appropriate, develop and implement research plans as
27 described in Chapter 4 to address these knowledge gaps. Information from these
28 research studies will be used to guide implementation of fish augmentations and
29 created razorback sucker and bonytail habitat design and management in future
30 years. Consequently, the focus of research may change in future years if
31 indicated by results of this initial research and monitoring through the adaptive
32 management process (see Chapter 2). Reclamation has initiated several fish-
33 augmentation monitoring research studies, which are described in the LCR MSCP
34 Fish Augmentation Plan.

35 **Approaches to Research**

36 Species research is expected to be primarily directed towards addressing
37 knowledge gaps related to the habitat, ecology, and behaviors of covered species

⁶ Research plans prepared by Reclamation are termed “study plans.”

that need to be filled to effectively implement the conservation measures and achieve the biological goals. Most research is anticipated to be directed towards providing information related to the following three areas of uncertainty.

1. **Determining key habitat parameters to support the design and management of created habitats.** This type of research is directed towards identifying the physical and biological conditions that must be present to create functioning habitat for species whose habitat requirements along the LCR are not well known. An example of this type of research would include studies undertaken to determine the timing, duration, and extent of moist soil conditions that must be present to support food production (i.e., flying insects) in southwestern willow flycatcher breeding habitat.
2. **Determining species distribution along the LCR.** This type of research is directed towards determining the distribution of covered species for which this information is required to ensure created habitats are established in locations that are used by the species. This research would apply primarily to species that are not well distributed along the LCR and whose movements along the LCR are limited. For example, conducting research to locate western red bat and western yellow bat roost sites will enable foraging habitats to be created in locations that are within their flight ranges from roost sites.
3. **Determining the effects of and responses to nest parasitism and competition.** This type of research is directed towards determining the adverse effects of brown-headed cowbird nest parasitism and nest site competition with European starlings on covered bird species. This research would focus on determining the level of effect cowbirds and starlings are having on the reproductive success of affected covered species, the level of adverse effect on reproduction that would be necessary to trigger management actions to reduce their effects, and effective methods for reducing nest parasitism and nest site competition.

Created Habitat Research Element

The goal of the Science Strategy's created habitat research element is to undertake applied research necessary to address uncertainties related to habitat creation and management techniques for maintaining habitat values over the term of the LCR MSCP. Reclamation anticipates that most created habitat research will be implemented early in HCP implementation and that, as habitats are created and habitat creation-related information needed to establish habitats is gathered, the need for created habitat research will diminish and likely be discontinued before the full extent of HCP habitat has been created.

Identifying Created Habitat Research Needs

Reclamation anticipates identifying created habitat research needs using the following 6-step process.

1. **Review of existing information.** Reclamation will initially review habitat creation-related literature and identify the current body of information related to the techniques and considerations for the establishment and management of covered species habitats. Reclamation will also review, as appropriate, previous and ongoing habitat restoration projects implemented in the LCR MSCP planning area and relevant projects implemented elsewhere to identify areas of uncertainty regarding methods used to establish and manage habitats.
2. **Identify other research.** Reclamation will contact state and federal resource agencies, Partners, universities, and other appropriate entities, as appropriate, to identify ongoing habitat creation-related research being conducted by others that is relevant to HCP implementation.
3. **Review results of LCR monitoring and research.** Reclamation will initially evaluate results of relevant monitoring and research previously conducted along the LCR, as appropriate, to determine if additional created habitat research is required or if ongoing research should be modified. Evaluation of results of ongoing and future LCR MSCP monitoring and research will be evaluated by Reclamation as described under Step 6 below.
4. **Identify LCR MSCP created habitat research priorities.** Reclamation anticipates initially identifying created habitat research needs and priorities based on an assessment of information provided through the review of existing information and research identified under items 1 and 2 above. As HCP monitoring and research is implemented, results of monitoring and research will also be used to identify future research priorities. Currently, the highest priorities for research are anticipated to be those that address uncertainties that are the most important for the initial and successful creation of habitat. As habitat is created, research emphasis is expected to shift towards developing and refining management techniques for maintaining habitat values for covered species. Final research priorities will be determined through Reclamation's process for establishing 5-year priorities and developing annual work plans (see Chapter 2).
5. **Develop and implement created habitat research plans.** Reclamation will develop and implement research plans, as appropriate, for each created habitat research project approved through the Annual Work Plan development process. The process for development and science review of created habitat research plans is described in Chapter 4.

1 6. **Adjust LCR MSCP created habitat research priorities.** As information
2 is collected and analyzed through monitoring and research, created habitat
3 research priorities are expected to change over the term of the LCR
4 MSCP. Reclamation will review, as appropriate, results of monitoring and
5 research conducted by Reclamation and others and re-evaluate created
6 habitat research priorities during the Annual Work Plan and 5-year cycle
7 processes (see Chapter 2). If indicated through this re-evaluation, created
8 habitat research priorities may be adjusted through the adaptive
9 management process described in Chapter 2.

10 **Approaches to Research**

11 Reclamation anticipates that created habitat research may be undertaken as pilot
12 projects, as research studies conducted in created habitats, and as directed
13 research. Created habitat research will generally be directed towards answering
14 specific questions regarding techniques to ensure the effective establishment and
15 management of created habitats.

16 ***Pilot Projects***

17 Reclamation may implement specific pilot projects or demonstration projects
18 designed to test different habitat creation and management methods. Pilot
19 projects are defined as small habitat creation projects that will test one or more
20 implementation techniques to determine the most effective and cost efficient
21 methods for establishing components of habitat. Pilot projects will generally be
22 designed such that the lands on which they are located will have the potential to
23 develop as created habitat. Examples of pilot projects that may be undertaken
24 include testing:

- 25 • techniques for propagating key plant species that support covered species
26 habitat;
- 27 • methods for establishing cottonwood-willow vegetation with the structure
28 necessary to achieve habitat objectives for cottonwood-willow associated
29 species;
- 30 • techniques for establishing key plant species; and
- 31 • irrigation methods.

32 Reclamation anticipates that pilot projects would be implemented before the large
33 scale commitment of resources are made for creating certain habitats using
34 specific techniques. Research plans would be prepared for each pilot project and
35 undergo science review as described Chapter 4.

36 ***Conservation Area Research Studies***

37 As habitats are created on conservation areas, Reclamation anticipates that small
38 scale research studies will be undertaken to address uncertainties specifically

related to management of created habitats. These studies could involve testing the effectiveness of different habitat management prescriptions on portions of created habitat set aside for this purpose. Examples of these types of research studies include testing:

- methods for setting back vegetative succession;
- methods for controlling invasive plant species;
- methods for controlling non-native fish in created backwaters;
- different irrigation schedules (i.e., timing, frequency, and quantity of irrigation) to identify the most efficacious schedules for establishing and maintaining key plant species and to provide moist surface soil conditions for the southwestern willow flycatcher and other species;
- other physical parameters for creating habitat; and
- quantifying water use needs for specific habitat types.

Research plans would be prepared for each conservation area research study as described in Chapter 4.

Directed Research

Reclamation may conduct research directed to answering specific questions related to techniques for creating habitats. Examples of directed research may include, but not be limited to, determining:

- the best methods for collection of plant propagules from native plants;
- specific ecological factors important to the establishment and survival of key plant species in different riparian and marsh systems; and
- the best methods for controlling and reducing soil salinity in managed habitats.

Research plans would be prepared for each directed research project and undergo science review as described in Chapter 4.

Management Observations

Reclamation will maintain, as appropriate, records of management activities undertaken to maintain created habitats at each conservation area (e.g., timing and frequency of irrigation). Review of these records will allow Reclamation to identify potential linkages between specific management actions and the observed outcomes of those actions as determined through post-development monitoring. These cause and effect observations will contribute to the body of information that would be used by Reclamation to adaptively manage created habitats as described in Chapter 2.

System Monitoring Element

The goal of the Science Strategy’s system monitoring element is to undertake monitoring necessary to determine the ongoing status of covered species and their habitats in the LCR MSCP planning area. System monitoring will provide information necessary to identify the status and trends of covered species on a regional scale and determine the contributions of created habitats to species conservation. To facilitate regional monitoring of species status and trends, Reclamation will coordinate, as appropriate, with other regional monitoring efforts (e.g., state Partners in Flight monitoring programs) to ensure that Reclamation’s monitoring protocols and analytical methods are compatible with these monitoring efforts. A component of system monitoring may also include ongoing review of monitoring and research results from elsewhere in the range of covered species to determine if factors that cannot be addressed by the LCR MSCP may be adversely affecting the status of covered species in the LCR MSCP planning area (e.g., changes in wintering habitat conditions of neotropical migrants, such as southwestern willow flycatcher and Arizona Bell’s vireo) and if trends occurring along the LCR are different from trends elsewhere in a species range.

System monitoring is intended to provide a “big picture” view of the status of covered species and their habitats that will provide Reclamation with information necessary to help determine HCP implementation priorities and to inform the adaptive management process. For example, if the status of a species appears to be substantially improving, creation of additional habitat for the species may be deferred to provide earlier funding to create additional habitat for covered species not faring as well.

System monitoring information may be collected and analyzed from the following sources:

- monitoring undertaken by Reclamation specifically for the purpose of system monitoring;
- results of post-development monitoring (see Post-Development Monitoring Element below) and species research (see Species Research Element above)⁷;
- results of Reclamation’s water use accounting monitoring; and
- results of monitoring and research conducted by others.

⁷ Includes ongoing monitoring conducted by Reclamation under conditions of the 2001 ISC/SIA biological opinion (USFWS 2001).

Determine Changes from Baseline Conditions

System monitoring will provide the information necessary to determine changes from the baseline status and condition of covered species and their habitats in the LCR MSCP planning area over time. The approach for determining changes from baseline conditions in the LCR MSCP planning area may include the following activities.

Determining the extent and distribution of land cover types that provide habitat for covered species. Reclamation anticipates this will be accomplished through interpretation of aerial imagery (e.g., aerial photographs or other remote imagery of appropriate resolution) using a land cover type classification system that is compatible with the classification system used to prepare the HCP. Land cover types would be delineated and maintained in Reclamation's GIS database. Reclamation anticipates that changes in the extent of covered species habitats within the LCR MSCP planning area from baseline conditions would be determined through application of the HCP habitat models developed for the following species⁸.

- Western red bat
- Western yellow bat
- Yuma hispid cotton rat
- Yellow-billed cuckoo
- Elf owl
- Gilded flicker
- Gila woodpecker
- Vermilion flycatcher
- Arizona Bell's vireo
- Sonoran yellow warbler
- Summer tanager

Identifying the distribution and abundance of covered species and the extent and distribution of their habitats. Reclamation anticipates this will be accomplished through review of existing species and habitat distribution information and results of monitoring and research conducted by Reclamation and others. Species occurrence and distribution data will be digitized into Reclamation's GIS database. Habitat for the southwestern willow flycatcher will be delineated through field surveys conducted for this purpose. Reclamation may also delineate habitat for the Yuma clapper rail, California black rail, western least bittern, and Colorado River cotton rat through interpretation of aerial imagery if the known vegetative and other characteristics of their habitats can be effectively identified on the imagery.

⁸ Habitat models for these species are described in LCR MSCP HCP Table 3-9.

1 It is anticipated that current conditions for covered species and their habitats will
2 be determined concurrently with preparation of the species accounts described
3 above under *Species Research Element*. Reclamation will update this
4 information, as appropriate, if environmental conditions present along the LCR
5 were to substantially change in the future.

6 **Identifying System Monitoring Needs**

7 Reclamation anticipates that system monitoring will initially focus on conducting
8 species-specific and multi-species monitoring to collect data needed to assess the
9 status and trends of covered species in the LCR MSCP planning area. As the body
10 of information acquired through system monitoring increases, the frequency with
11 which system monitoring would need to be conducted is expected to decrease
12 over time (e.g., as the understanding of the habitat requirements, habitat use areas,
13 and abundance of a species in the LCR MSCP planning area increases, the
14 frequency with which that species would need to be monitored would lessen
15 unless the species' habitat conditions along the LCR were to change
16 substantially). Reclamation may identify additional system monitoring efforts
17 using the following 5-step process.

- 18 1. **Identify existing monitoring efforts.** In 2006, Reclamation initiated
19 identification monitoring and research relevant to system monitoring being
20 conducted by Reclamation and others in the LCR MSCP planning area.
21 Reclamation will evaluate the types of data being collected under each
22 monitoring and research effort for which data can be made available to
23 Reclamation to determine its relevancy for use in system monitoring.
- 24 2. **Review results of monitoring and research.** As described in Chapter 2,
25 Reclamation will evaluate results of LCR MSCP monitoring and research
26 during the Annual Work Plan development and during 5-year cycle
27 processes. Results of monitoring and research will be evaluated, as
28 appropriate, to determine if additional system monitoring is required or if
29 ongoing monitoring should be modified. Reclamation may also identify
30 the need to modify system monitoring to ensure ongoing compatibility of
31 data with other regional monitoring programs should those monitoring
32 programs change in the future.
- 33 3. **Identify system monitoring priorities.** Reclamation will initially
34 identify system monitoring needs and priorities based on the evaluation of
35 existing monitoring and research efforts identified under items 1 and 2
36 above.
- 37 4. **Develop and implement system monitoring plans.** Reclamation will
38 develop and implement monitoring plans, as appropriate, for each system
39 monitoring effort approved through the Annual Work Plan development
40 process. The process for development and science review of monitoring
41 plans is described in Chapter 4.

1 5. **Adjust system monitoring priorities.** As information is collected
2 through monitoring and research, system monitoring priorities may change
3 over the term of the LCR MSCP. Reclamation will review results of
4 monitoring and research conducted by Reclamation and others, as
5 appropriate, and re-evaluate system monitoring priorities during the
6 Annual Work Plan development and 5-year cycle processes. If indicated
7 through this reevaluation, Reclamation will adjust system monitoring
8 priorities through the adaptive management process described in Chapter
9 2.

10 **Post-Development Monitoring**

11 The goal of the Science Strategy's post-development monitoring element is to
12 undertake monitoring necessary to determine progress of HCP implementation
13 towards achieving HCP biological goals and to collect information necessary to
14 assess the effectiveness of habitat creation designs and habitat management
15 prescriptions. Post-development monitoring includes compliance monitoring,
16 implementation monitoring, and response monitoring. Compliance monitoring
17 will be conducted, as appropriate, to ensure that implementation is proceeding in
18 compliance with the HCP and incidental take permits. Implementation and
19 response monitoring will provide Reclamation with the information necessary to
20 improve implementation over the term of the LCR MSCP through the adaptive
21 management process.

22 Monitoring plans will be developed for each type of post-development monitoring
23 undertaken by Reclamation as described in Chapter 4. This section describes the
24 broad objectives of compliance, implementation, and response monitoring. The
25 specific monitoring objectives, sampling designs, protocols, schedules, and
26 analytical methods for each habitat creation project and fish monitoring activity
27 will be identified in project-specific monitoring plans.

28 **Compliance Monitoring**

29 Reclamation will conduct compliance monitoring to demonstrate that LCR MSCP
30 implementation is proceeding in accordance with the terms of the HCP, incidental
31 take permits, and the Implementing Agreement. In the context of the Science
32 Strategy, compliance monitoring includes monitoring to document progress
33 towards achieving the biological goals and minimum habitat requirements
34 described in Appendix B, Tables B-1 and B-2, respectively. The types of
35 information that may be collected through compliance monitoring includes:

- 36 • documenting fish releases, including time, numbers and size, and location;
- 37 • documenting when habitat creation activities are initially undertaken and
- 38 completed;

- 1 • documenting when created habitat objectives have been achieved for each
 - 2 habitat creation site; and
 - 3 • documenting the total extent of habitat that has been created for each
 - 4 covered species and annually maintained over the term of the LCR MSCP.
- 5 Results of compliance monitoring will be summarized in annual Accomplishment
- 6 Reports.

7 **Implementation Monitoring**

8 Implementation monitoring will be conducted to monitor the success of habitat

9 creation techniques in achieving specific habitat design goals and the success of

10 fish augmentation techniques in augmenting razorback sucker and bonytail

11 populations. Information about the relative success of the various implementation

12 techniques that may be employed by Reclamation will provide the basis for

13 improving the effectiveness of implementation methods through the adaptive

14 management process.

15 Implementation monitoring is anticipated to collect information necessary to:

- 16 • document that habitats are established in accordance with created habitat
- 17 design plans and specifications;
- 18 • estimate the survival rate, composition, and distribution of planted
- 19 vegetation;
- 20 • document that razorback sucker and bonytail are released in accordance
- 21 with annual fish stocking plans; and
- 22 • determine the effectiveness of habitat creation techniques for initially
- 23 establishing cottonwood-willow, honey mesquite, and marsh vegetation.

24 Reclamation may also conduct other types of implementation monitoring as

25 needed to collect information necessary to assess the success of implementation

26 techniques. Data collected through implementation monitoring will also serve as

27 an early indicator of the need for management interventions if habitats are not

28 developing as intended. Results of implementation monitoring will be

29 summarized in annual Accomplishment Reports.

30 **Response Monitoring**

31 Response monitoring will be conducted to determine the response of individuals

32 and populations of covered species to the establishment and management of

33 created habitats and species-specific conservation measures. Monitoring to

34 determine the response of razorback sucker and bonytail to fish augmentations

35 will be conducted as part of fish augmentation research studies described above

36 under *Research Associated with Fish Augmentations*.

37 Response monitoring is a key instrument for providing the information necessary

38 for adaptively managing HCP implementation to better ensure species are

conserved (see Chapter 2). This information will be used to identify the habitat management activities that created the conditions used by the species, evaluate if similar conditions are present in other habitat areas created for the species and, if not, adjust habitat management prescriptions, if appropriate, to create the observed conditions used by the species.

Habitat Response

Reclamation anticipates monitoring indicators of species habitat at creation sites to determine if habitat conditions have developed and are maintained. Monitoring plans for created habitats will identify, as appropriate, specific indicators that will be monitored and indicator thresholds that, when achieved, will indicate that created habitat objectives have been attained. Indicators selected for monitoring are anticipated to be primary components of species habitats that can be easily and repeatedly measured.

Response monitoring will include, as appropriate, monitoring to assess the progression of habitat development over the term of the LCR MSCP. This type of monitoring is anticipated to be conducted on an ongoing basis and is intended to provide the information necessary to improve habitat creation techniques and habitat management prescriptions and to facilitate adaptive management decision making. Examples of this type of monitoring would include measuring:

- the annual growth of plants;
- establishment patterns and rates of invasive non-native plants;
- development of invertebrate communities in support of the foodweb;
- volunteer establishment patterns and rates of native plants; and
- development of understory and midstory canopy layers.

Comparisons of these types of monitoring data with the habitat creation techniques and habitat management prescriptions will provide Reclamation with information necessary to determine if the habitat creation and management methods are effective or can be improved. This type of monitoring information will also provide Reclamation with an early warning to execute management interventions to preclude potential site failure based on an observed lack of habitat development or regression of habitat conditions.

Species Response

Species response monitoring will focus on determining if habitats are used by covered species and to document the timing, type (e.g., nesting, migration stopover), and degree of use by covered species. Similarly, Reclamation will also monitor use of nest boxes and artificial snags by gilded flickers, Gila woodpeckers, and elf owls and survival of razorback sucker and bonytail stocked to augment existing populations, as appropriate. Species distribution and abundance information collected through response monitoring will also provide a

source of information for use in assessing the overall status of the species in the LCR MSCP planning area as part of system monitoring.

The initial step for monitoring species response will be to establish baseline conditions before habitat is created. Reclamation will also use this information to design created habitats to avoid and minimize potential effects on covered species. Baseline conditions form the basis from which future use of created habitats by covered species will be measured. In areas that do not support existing covered species habitats and that are planned for habitat creation, baseline conditions are assumed not to support covered species. In habitat creation areas that support existing habitat, baseline conditions will be determined by conducting surveys, as appropriate, to determine if covered species are present and the timing and degree of habitat use by the species.⁹

Science Review of Monitoring and Research Reports

Information developed through the monitoring and research implementation elements described above is an important element for adaptively managing HCP implementation and measuring progress. Monitoring and research reports will be reviewed by senior Reclamation scientists and resource managers to ensure that the reports are complete and that reported results, findings, and recommendations are valid and supported by the data and analytical methods. Reviewers will consult with other experts, as appropriate, to conduct reviews. If results or findings are not supported, reviewers will identify the causes and recommend corrective actions as appropriate (e.g., correcting mathematical errors, revising protocols and analytical methods).

During this review process, Reclamation will also evaluate reported results to determine if changes in monitoring and research protocols or priorities, LCR MSCP implementation priorities, or HCP conservation measures may be warranted. If so, reviewers will be responsible for drafting appropriate recommendations for adopting changes in implementation, as appropriate, through the 5-year cycle, Annual Work Plan development, and adaptive management processes described in Chapter 2.

⁹ The period over which surveys should be conducted to determine if covered species are present will vary depending on the species for which habitat is present and will be identified for each species in monitoring plans.

Chapter 4. Monitoring and Research Plans

Introduction

This Chapter describes processes for incorporating science and review into development of monitoring and research plans that will guide Reclamation's implementation of the HCP. These processes are important foundational elements for successful implementation of the HCP. Because results of monitoring and research provide the basis for adaptive implementation of the HCP, failure to incorporate valid scientific approaches into monitoring and research plans could jeopardize attainment of LCR MSCP biological goals (see Table B-1).

Development of Monitoring and Research Plans

Reclamation will develop monitoring and research plans for each monitoring and research activity that is approved through the Annual Work Plan process. Plans for system monitoring and research are anticipated to be stand alone documents. Reclamation anticipates that post-development monitoring plans will be included as part of conservation area management plans and fish augmentation plans.

These monitoring plans will address all monitoring activities that may be undertaken on each conservation area or for each fish augmentation plan. Protocols for each type of post-development monitoring (e.g., survey protocols for detecting nesting southwestern willow flycatchers, survey protocols for measuring the growth of cottonwood trees) and methods used to analyze monitoring data (e.g., statistical tools), however, are expected to be consistent among conservation area management plans and fish augmentation plans.

The monitoring and research development process provides for review of draft plans to ensure they are based on scientific principles and the best available information.

Monitoring Plans

Monitoring plans will be developed, as appropriate, for each system monitoring and pre- and post-development monitoring activity undertaken by Reclamation. Standardized monitoring protocols and analytical methods may be provided in separate documents that may be incorporated by reference in conservation area and fish augmentation plans.

Monitoring plans should include, as appropriate, the following types of information:

- description of monitoring purpose and objectives;
- description of monitoring protocols (may be incorporated by reference) and sampling design, including citations supporting the validity of the methods and sampling design;
- procedures that will be used to analyze monitoring data (may be incorporated by reference), including citations supporting the validity of the methods;
- procedures for validating monitoring data and methods;
- monitoring schedule and duration, including citations supporting the validity of the monitoring schedule;
- schedule for submitting monitoring report;
- monitoring report content requirements;
- monitoring data storage procedures;
- references, including printed references and personal communications;
- date the monitoring plan was prepared and dates of subsequent revisions; and
- other types of information as appropriate to specific monitoring plans.

All monitoring plans, including elements such as survey protocols that may be standardized, will undergo the review process described under *Monitoring and Research Plan Review Process* below. Reclamation maintains a library of monitoring protocols. Reclamation anticipates that these protocols will be incorporated by reference into monitoring plans developed for each conservation area and fish augmentation plan.

Key elements of monitoring plans are survey protocols, monitoring variables or indicators, sampling design, and methods used to analyze monitoring data (e.g., statistical tools). Reclamation may develop standardized survey protocols, monitoring variables, sampling design, and methods used to analyze monitoring data for each monitoring subject (e.g., southwestern willow flycatcher breeding surveys, surveys to assess establishment of vegetation in created habitats). Standardization of these monitoring procedures will allow for comparison of monitoring data among different monitoring locations, different individuals conducting the monitoring, and among monitoring years over the term of the LCR MSCP. As described above, these standardized procedures will be incorporated into monitoring plans for conservation areas and fish augmentations.

Reclamation will review, as appropriate, relevant existing science-reviewed monitoring procedures. These existing monitoring procedures may be adopted by Reclamation without further review (e.g., USFWS monitoring protocols for

southwestern willow flycatcher and other listed species). Reclamation will develop procedures for monitoring for which science-reviewed procedures have not previously been developed. An important consideration for development of monitoring plans includes providing for comparability of Reclamation monitoring with results of monitoring conducted by others. To develop monitoring procedures not already science reviewed, Reclamation will solicit information from the Partners and resource agency experts, independent scientists, and other experts as appropriate. Draft procedures may be field tested and revised as needed based on test results to ensure that they can be effectively implemented and yield the desired monitoring information.

Reclamation will conduct reviews of its monitoring plans to ensure that the monitoring procedures are valid for achieving the stated monitoring objectives and that they provide all the information described above that are required for monitoring plans. Reclamation will revise or replace monitoring plans, as appropriate, if indicated through the review. Reclamation also anticipates preparing monitoring plans for any ongoing efforts for which monitoring protocols are not well documented.

Research Plans

As described in Chapter 3, Reclamation will undertake research to collect information necessary to fill knowledge gaps and resolve uncertainties primarily related to:

- life history and habitat requirements of covered species,
- techniques for the creation of habitat,
- techniques for the management of created habitats, and
- the stocking of razorback sucker and bonytail.

The extent of uncertainties related to the above topics is large. Research will be directed only towards applied research that is likely to yield tangible results for resolving the knowledge gaps and uncertainties that are critical for ensuring successful implementation of the HCP. Information collected through research will be used in the adaptive management decision making process to improve HCP implementation success over the term of the LCR MSCP (see Chapter 2). Research will be conducted under the species research and created habitat research Science Strategy implementation elements.

Research plans should include, as appropriate, the following information:

- description of research purpose and objectives;
- hypotheses and supporting information;
- description of research methods and design, including citations supporting the validity of the methods;

- 1 • procedures that will be used to analyze and interpret research data (e.g.,
- 2 statistical tools), including citations supporting the validity of the methods;
- 3 • procedures for validating research data and methods
- 4 • research schedule and duration;
- 5 • research reporting schedule and content requirements;
- 6 • research data storage procedures;
- 7 • references, including printed references and personal communications; and
- 8 • other types of information as appropriate to specific research projects.

9 All research plans will undergo the review process described under *Monitoring*
10 *and Research Plan Review Process* below.

11 **Monitoring and Research Plan Review Process**

12 Because outcomes of the activities addressed in the monitoring and research plans
13 are critical to the success of HCP implementation, it is important that they are
14 based on the best available information and sound scientific principles. Flawed
15 monitoring and research plans could result in decision making that results in
16 inefficient or unsuccessful implementation. Draft monitoring and research plans,
17 including standardized plan elements (e.g., species survey protocols), will
18 undergo the review process described below. This process is intended to provide
19 for timely and efficient science review of monitoring and research plans.
20 Accordingly, the level of review will differ among plans, depending on the level
21 of uncertainty associated with the guidance and its role in guiding
22 implementation. For example, a monitoring plan that implements protocols that
23 are generally accepted by the resource management community will require less
24 extensive review than for a monitoring effort for which survey protocols do not
25 exist.

26 Draft monitoring and research plans will be reviewed by internal review teams
27 comprised of Reclamation staff with relevant expertise in biological and physical
28 sciences, scientific method, habitat restoration design and engineering, and
29 resource management, as appropriate to the topic of monitoring or research.
30 These teams will review draft monitoring and research plans to ensure that
31 methods and approaches are valid and well documented and that they will achieve
32 their intended objectives. Draft monitoring and research plans would be revised
33 through an iterative process (if necessary) and either approved by the Program
34 Manager as final documents or submitted for additional review by Partners,
35 resource agency experts, and others. This additional review may be provided if
36 the internal review team determines that the review will better ensure that a plan
37 is based on the best available information. Reclamation may provide for these
38 reviews through informal communications (e.g., conference calls, email) with

- 1 experts and other knowledgeable individuals, the establishment of TWGs,
- 2 workshops, or other venues that may be identified by Reclamation.

1 Citations

- 2 Lower Colorado River Multi-Species Conservation Program. 2004. *Lower*
3 *Colorado River Multi-Species Conservation Program, Volume II: Habitat*
4 *Conservation Plan*. Final. December 17. Available at:
5 <http://www.usbr.gov/lc/lcrmscp/publications/VolumeII.pdf>
- 6 U.S. Fish and Wildlife Service. 2001. *Biological opinion for interim surplus*
7 *criteria, secretarial implementation agreements, and conservation*
8 *measures on the lower Colorado River, Lake Mead to the southerly*
9 *international boundary; Arizona, California and Nevada*. Phoenix, AZ.

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1 **Appendix A. Covered and Evaluation**
2 **Species Addressed by the**
3 **Science Strategy**

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**Table A. Covered and Evaluation Species
Addressed by the Science Strategy**

<i>Common and Scientific Name</i>	<i>Common and Scientific Name</i>
Covered Species	Covered Species (cont.)
Yuma clapper rail <i>Rallus longirostris yumanensis</i>	Gila woodpecker <i>Melanerpes uropygialis</i>
Southwestern willow flycatcher <i>Empidonax trailii extimus</i>	Vermilion flycatcher <i>Pyrocephalus rubinus</i>
Bonytail <i>Gila elegans</i>	Arizona Bell's vireo <i>Vireo bellii arizonae</i>
Razorback sucker <i>Xyrauchen texanus</i>	Sonoran yellow warbler <i>Dendroica petechia sonorana</i>
Western red bat <i>Lasiurus blossewillii</i>	Summer tanager <i>Piranga rubra</i>
Western yellow bat <i>Lasiurus xanthinus</i>	Flannelmouth sucker <i>Catostomus latipinnis</i>
Colorado River cotton rat <i>Sigmodon arizonae plenus</i>	MacNeill's sootywing skipper <i>Pholisora graciellae</i>
Yuma hispid cotton rat <i>Sigmodon hispidus eremicus</i>	Evaluation Species
Western least bittern <i>Ixobrychus exilis hesperis</i>	Desert pocket mouse <i>Chaetodipus penicillatus sobrinus</i>
California black rail <i>Laterallus jamaicensis coturniculus</i>	California leaf-nosed bat <i>Macrotus californicus</i>
Yellow-billed cuckoo <i>Coccyzus americanus occidentalis</i>	Pale Townsend's big-eared bat <i>Corynorhinus townsendii pallescens</i>
Elf owl <i>Micrathene whitneyi</i>	Colorado River toad <i>Bufo alvarius</i>
Gilded flicker <i>Colaptes chrysoides</i>	Lowland leopard frog <i>Rana yavapaiensis</i>

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1 **Appendix B. Covered Species**
2 **Biological Goals and Habitat**
3 **Creation Requirements**

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**Table B-1. LCR MSCP Biological Goals for Covered Species
Addressed in the Science Strategy**

<i>Covered Species</i>	<i>Biological Goal</i>
Threatened and Endangered Species	
Yuma clapper rail	Create and maintain 512 acres of species habitat.
Southwestern willow flycatcher	Create and maintain 4,050 acres of species habitat.
Bonytail	Create and maintain 360 acres of species habitat and rear and release up to 620,000 subadult bonytail along the LCR over the term of the LCR MSCP.
Razorback sucker	Create and maintain 360 acres of species habitat and rear and release up to 660,000 subadult razorback sucker along the LCR over the term of the LCR MSCP.
Other Covered Species	
Western red bat	Create and maintain 765 acres of species roosting habitat.
Western yellow bat	Create and maintain 765 acres of species roosting habitat.
Colorado River cotton rat	Create and maintain 125 acres of species habitat in Reaches 3 and 4.
Yuma hispid cotton rat	Create and maintain 76 acres of species habitat in Reaches 6 and 7.
Western least bittern	Create and maintain 512 acres of species habitat.
California black rail	Create and maintain 130 acres of species habitat.
Yellow-billed cuckoo	Create and maintain 4,050 acres of species habitat.
Elf owl	Create and maintain 1,784 acres of species habitat in Reaches 3–5.
Gilded flicker	Create and maintain 4,050 acres of species habitat in Reaches 3–7.
Gila woodpecker	Create and maintain 1,702 acres of species habitat in Reaches 3–6.
Vermilion flycatcher	Create and maintain 5,208 acres of species habitat.
Arizona Bell's vireo	Create and maintain 2,983 acres of species habitat.
Sonoran yellow warbler	Create and maintain 4,050 acres of species habitat.
Summer tanager	Create and maintain 602 acres of species habitat.

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**Table B-1. LCR MSCP Biological Goals for Covered Species
Addressed in the Science Strategy (continued)**

<i>Covered Species</i>	<i>Biological Goal</i>
Flannelmouth sucker	Create and maintain 85 acres of species habitat in Reach 3 and provide \$400,000 in funding to support existing species conservation programs.
MacNeill’s sootywing skipper	Create and maintain 222 acres of species habitat in Reaches 1–4.

1 **Table B-2. Minimum Requirements for Achieving Covered Species Habitat Creation**
2 **Goals**

<i>Species</i>	<i>Habitat Creation Goal (acres)</i>	<i>Created Land Cover Type that will Provide Species Habitat</i>	<i>Minimum Patch Size of Created Land Cover that will Provide Habitat (acres)</i>
Threatened and Endangered Species			
Yuma clapper rail	512	Marsh with water depths no greater than 12 inches	5
Southwestern willow flycatcher	4,050	Cottonwood-willow types I–IV with moist surface soil conditions during the breeding season	10
Desert tortoise	0	Not applicable	Not applicable
Bonytail	360	Backwaters that contain the physical, chemical, and biological conditions required to support native LCR fishes in a healthy condition	Not applicable
Razorback sucker	360	Backwaters that contain the physical, chemical, and biological conditions required to support native LCR fishes in a healthy condition	Not applicable
Other Covered Species			
Western red bat (roosting habitat)	765	Combination of cottonwood-willow types I and II and honey mesquite type III	No minimum requirement
Western yellow bat (roosting habitat)	765	Combination of cottonwood-willow types I and II and honey mesquite type III	No minimum requirement ^d
Colorado River cotton rat	125	Marsh	No minimum requirement
Yuma hispid cotton rat	76	Cottonwood-willow with a moist herbaceous understory	No minimum requirement
Western least bittern	512	Marsh with water depths no greater than 12 inches	No minimum requirement
California black rail	130	Marsh with water depths no greater than 1 inch	5
Yellow-billed cuckoo	4,050	Cottonwood-willow types I–III	25

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Table B-2. Minimum Requirements for Achieving Covered Species Habitat Creation Goals (continued)

<i>Species</i>	<i>Habitat Creation Goal (acres)</i>	<i>Created Land Cover Type that will Provide Species Habitat</i>	<i>Minimum Patch Size of Created Land Cover that will Provide Habitat (acres)</i>
Elf owl	1,784	Combination of cottonwood-willow types I and II and honey mesquite type III	No minimum requirement
Gilded flicker	4,050	Cottonwood-willow types I–III	No minimum requirement
Gila woodpecker	1,702	Cottonwood-willow types I–IV	50
Vermilion flycatcher	5,208	Combination of cottonwood-willow types I–IV and honey mesquite type III	No minimum requirement
Arizona Bell’s vireo	2,983	Combination of cottonwood-willow types III and IV and honey mesquite type III	No minimum requirement
Sonoran yellow warbler	4,050	Cottonwood-willow types I–IV	2.5
Summer tanager	602	Cottonwood-willow types I and II	No minimum requirement
Flannelmouth sucker	85	Backwaters that contain the physical, chemical, and biological conditions required to support native LCR fishes in a healthy condition	Not applicable
MacNeill’s sootywing skipper	222	Honey mesquite type III created with quail bush to create honey mesquite–quail bush	No minimum requirement

1 **Appendix C. Summary of Conservation**
2 **Measures for Covered and**
3 **Evaluation Species**

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1 **Table C. Summary of LCR MSCP HCP Conservation Measures for Covered**
2 **and Evaluation Species Addressed in the Science Strategy**

<i>Species</i>	<i>Conservation Measures^a</i>
Covered Species	
Yuma clapper rail	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM2—Avoid impacts of flow-related covered activities on covered species habitats at Topock Marsh AMM3—To the extent practicable, avoid and minimize disturbance of covered bird species during the breeding season AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM1—Conduct surveys and research to better identify covered and evaluation species habitat requirements MRM2—Monitor and adaptively manage created covered and evaluation species habitats MRM5—Monitor selenium levels in created backwater and marsh land cover types, and study the effect of selenium released as a result of dredging activities CLRA1—Create 512 acres of Yuma clapper rail habitat CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire CLRA2—Maintain existing important Yuma clapper rail habitat areas
Southwestern willow flycatcher	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM2—Avoid impacts of flow-related covered activities on covered species habitats at Topock Marsh AMM3—To the extent practicable, avoid and minimize disturbance of covered bird species during the breeding season AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM1—Conduct surveys and research to better identify covered and evaluation species habitat requirements

1 **Table C. Summary of LCR MSCP HCP Conservation Measures for Covered**
2 **and Evaluation Species Addressed in the Science Strategy (continued)**

<i>Species</i>	<i>Conservation Measures^a</i>
Southwestern willow flycatcher (cont.)	MRM2—Monitor and adaptively manage created covered and evaluation species habitats MRM4—Conduct research to determine and address the effects of brown-headed cowbird nest parasitism on reproduction of covered species WIFL1—Create 4,050 acres of southwestern willow flycatcher habitat CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire WIFL2—Maintain existing important habitat areas
Bonytail	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM4—Minimize contaminant loads in runoff and return irrigation flows from LCR MSCP created habitats to the LCR AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM5—Monitor selenium levels in created backwater and marsh land cover types, and study the effect of selenium released as a result of dredging activities BONY1—Coordinate bonytail conservation efforts with the USFWS and recovery programs for endangered fish species in the Lower Basin BONY2—Create 360 acres of bonytail habitat BONY3—Augment bonytail populations BONY4—Evaluate and develop, if necessary, additional bonytail rearing capacity BONY5—Conduct monitoring and research, and adaptively manage bonytail augmentations and created habitat

1 **Table C. Summary of LCR MSCP HCP Conservation Measures for Covered**
2 **and Evaluation Species Addressed in the Science Strategy (continued)**

<i>Species</i>	<i>Conservation Measures^a</i>
Razorback sucker	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM4—Minimize contaminant loads in runoff and return irrigation flows from LCR MSCP created habitats to the LCR AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM5—Monitor selenium levels in created backwater and marsh land cover types, and study the effect of selenium released as a result of dredging activities RASU1—Coordinate razorback sucker conservation efforts with USFWS and recovery programs for endangered fish species in the Lower Basin Implementation Program RASU2—Create 360 acres of razorback sucker habitat RASU3—Augment razorback populations RASU4—Develop additional razorback sucker rearing capacity RASU5—Support ongoing razorback conservation efforts at Lake Mohave RASU6—Conduct monitoring and research, and adaptively manage razorback sucker augmentations and created habitat RASU7—Provide funding and support for continuation of the Reclamation/SNWA ongoing Lake Mead razorback sucker studies RASU8—Continue razorback conservation measures identified in the ISC/SIA BO
Western red bat (roosting habitat)	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM1—Conduct surveys and research to better identify covered and evaluation species habitat requirements MRM2—Monitor and adaptively manage created covered and evaluation species habitats WRBA1—Conduct surveys to determine species distribution of the western red bat WRBA2— Create 765 acres of western red bat roosting habitat CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire

1 **Table C. Summary of LCR MSCP HCP Conservation Measures for Covered**
2 **and Evaluation Species Addressed in the Science Strategy (continued)**

<i>Species</i>	<i>Conservation Measures^a</i>
Western yellow bat (roosting habitat)	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM1—Conduct surveys and research to better identify covered and evaluation species habitat requirements MRM2—Monitor and adaptively manage created covered and evaluation species habitats WYBA1—Conduct surveys to determine species distribution of the western yellow bat WYBA2—Avoid removal of western yellow bat roosts trees WYBA3— Create 765 acres of western yellow bat roosting habitat CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire
Desert pocket mouse	AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area DPMO1—Conduct surveys to locate desert pocket mouse habitat
Colorado River cotton rat	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM2—Avoid impacts of flow-related covered activities on covered species habitats at Topock Marsh AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM2—Monitor and adaptively manage created covered and evaluation species habitats MRM5—Monitor selenium levels in created backwater and marsh land cover types, and study the effect of selenium released as a result of dredging activities CRCR1—Conduct research to better define Colorado River cotton rat habitat requirements CRCR2—Create 125 acres of Colorado River cotton rat habitat CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire

1 **Table C. Summary of LCR MSCP HCP Conservation Measures for Covered**
2 **and Evaluation Species Addressed in the Science Strategy (continued)**

<i>Species</i>	<i>Conservation Measures^a</i>
Yuma hispid cotton rat	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM2—Monitor and adaptively manage created covered and evaluation species habitats YHCR1—Conduct research to better define Yuma hispid cotton rat habitat requirements YHCR2—Create 76 acres of Yuma hispid cotton rat habitat CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire
Western least bittern	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM2—Avoid impacts of flow-related covered activities on covered species habitats at Topock Marsh AMM3—To the extent practicable, avoid and minimize disturbance of covered bird species during the breeding season AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM1—Conduct surveys and research to better identify covered and evaluation species habitat requirements MRM2—Monitor and adaptively manage created covered and evaluation species habitats MRM5—Monitor selenium levels in created backwater and marsh land cover types, and study the effect of selenium released as a result of dredging activities LEBI1—Create 512 acres of western least bittern habitat CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire

1 **Table C. Summary of LCR MSCP HCP Conservation Measures for Covered**
2 **and Evaluation Species Addressed in the Science Strategy (continued)**

<i>Species</i>	<i>Conservation Measures^a</i>
California black rail	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM2—Avoid impacts of flow-related covered activities on covered species habitats at Topock Marsh AMM3—To the extent practicable, avoid and minimize disturbance of covered bird species during the breeding season AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM1—Conduct surveys and research to better identify covered and evaluation species habitat requirements MRM2—Monitor and adaptively manage created covered and evaluation species habitats MRM5—Monitor selenium levels in created backwater and marsh land cover types, and study the effect of selenium released as a result of dredging activities BLRA1—Create 130 acres of California black rail habitat CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire BLRA2—Maintain existing important California black rail habitat areas
Yellow-billed cuckoo	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM2—Avoid impacts of flow-related covered activities on covered species habitats at Topock Marsh AMM3—To the extent practicable, avoid and minimize disturbance of covered bird species during the breeding season AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM1—Conduct surveys and research to better identify covered and evaluation species habitat requirements MRM2—Monitor and adaptively manage created covered and evaluation species habitats YBCU1—Create 4,050 acres of yellow-billed cuckoo habitat CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire YBCU2—Maintain existing important yellow-billed cuckoo habitat areas

1 **Table C. Summary of LCR MSCP HCP Conservation Measures for Covered**
2 **and Evaluation Species Addressed in the Science Strategy (continued)**

<i>Species</i>	<i>Conservation Measures^a</i>
Elf owl	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM3—To the extent practicable, avoid and minimize disturbance of covered bird species during the breeding season AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM1—Conduct surveys and research to better identify covered and evaluation species habitat requirements MRM2—Monitor and adaptively manage created covered and evaluation species habitats MRM3—Conduct research to determine and address the effects of nest site competition with European starlings on reproduction of covered species ELOW1—Create 1,784 acres of elf owl habitat ELOW2—Install elf owl nest boxes CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire
Gilded flicker	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM2—Avoid impacts of flow-related covered activities on covered species habitats at Topock Marsh AMM3—To the extent practicable, avoid and minimize disturbance of covered bird species during the breeding season AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM1—Conduct surveys and research to better identify covered and evaluation species habitat requirements MRM2—Monitor and adaptively manage created covered and evaluation species habitats MRM3—Conduct research to determine and address the effects of nest site competition with European starlings on reproduction of covered species GIFL1—Create 4,050 acres of gilded flicker habitat GIFL2—Install artificial snags to provide gilded flicker nest sites CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire

1 **Table C. Summary of LCR MSCP HCP Conservation Measures for Covered**
2 **and Evaluation Species Addressed in the Science Strategy (continued)**

<i>Species</i>	<i>Conservation Measures^a</i>
Gila woodpecker	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM3—To the extent practicable, avoid and minimize disturbance of covered bird species during the breeding season AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM1—Conduct surveys and research to better identify covered and evaluation species habitat requirements MRM2—Monitor and adaptively manage created covered and evaluation species habitats MRM3—Conduct research to determine and address the effects of nest site competition with European starlings on reproduction of covered species GIWO1—Create 1,702 acres of Gila woodpecker habitat GIWO2—Install artificial snags to provide Gila woodpecker nest sites CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire
Vermilion flycatcher	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM2—Avoid impacts of flow-related covered activities on covered species habitats at Topock Marsh AMM3—To the extent practicable, avoid and minimize disturbance of covered bird species during the breeding season AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM1—Conduct surveys and research to better identify covered and evaluation species habitat requirements MRM2—Monitor and adaptively manage created covered and evaluation species habitats MRM4—Conduct research to determine and address the effects of brown-headed cowbird nest parasitism on reproduction of covered species VEFL1—Create 5,208 acres of vermilion flycatcher habitat CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire

1 **Table C. Summary of LCR MSCP HCP Conservation Measures for Covered**
2 **and Evaluation Species Addressed in the Science Strategy (continued)**

<i>Species</i>	<i>Conservation Measures^a</i>
Arizona Bell's vireo	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM2—Avoid impacts of flow-related covered activities on covered species habitats at Topock Marsh AMM3—To the extent practicable, avoid and minimize disturbance of covered bird species during the breeding season AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM1—Conduct surveys and research to better identify covered and evaluation species habitat requirements MRM2—Monitor and adaptively manage created covered and evaluation species habitats MRM4—Conduct research to determine and address the effects of brown-headed cowbird nest parasitism on reproduction of covered species BEVI1—Create 2,983 acres of Arizona Bell's vireo habitat CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire
Sonoran yellow warbler	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM2—Avoid impacts of flow-related covered activities on covered species habitats at Topock Marsh AMM3—To the extent practicable, avoid and minimize disturbance of covered bird species during the breeding season AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM1—Conduct surveys and research to better identify covered and evaluation species habitat requirements MRM2—Monitor and adaptively manage created covered and evaluation species habitats MRM4—Conduct research to determine and address the effects of brown-headed cowbird nest parasitism on reproduction of covered species YWAR1—Create 4,050 acres of Sonoran yellow warbler habitat CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire

1 **Table C. Summary of LCR MSCP HCP Conservation Measures for Covered**
2 **and Evaluation Species Addressed in the Science Strategy (continued)**

<i>Species</i>	<i>Conservation Measures^a</i>
Summer tanager	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM3—To the extent practicable, avoid and minimize disturbance of covered bird species during the breeding season AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM1—Conduct surveys and research to better identify covered and evaluation species habitat requirements MRM2—Monitor and adaptively manage created covered and evaluation species habitats MRM4—Conduct research to determine and address the effects of brown-headed cowbird nest parasitism on reproduction of covered species SUTA1—Create 602 acres of summer tanager habitat CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire
Relict leopard frog	RLFR1—Provide funding to support existing relict leopard frog conservation programs
Flannelmouth sucker	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM4—Minimize contaminant loads in runoff and return irrigation flows from LCR MSCP created habitats to the LCR AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area AMM6—Avoid or minimize impacts on covered species habitats during dredging, bank stabilization activities, and other river management activities MRM2—Monitor and adaptively manage created covered and evaluation species habitats MRM5—Monitor selenium levels in created backwater and marsh land cover types, and study the effect of selenium released as a result of dredging activities

1 **Table C. Summary of LCR MSCP HCP Conservation Measures for Covered**
2 **and Evaluation Species (continued)**

<i>Species</i>	<i>Conservation Measures^a</i>
Flannemouth sucker (continued)	FLSU1—Create 85 acres of flannemouth sucker habitat FLSU2—Provide funding to support existing flannemouth sucker conservation programs FLSU3—Assess flannemouth sucker management needs and develop management strategies
MacNeill’s sootywing skipper	AMM 1—To the extent practicable, avoid and minimize impacts of implementing the LCR MSCP on existing covered species habitats AMM5—Avoid impacts of operation, maintenance, and replacement of hydroelectric generation and transmission facilities on covered species in the LCR MSCP planning area MRM2—Monitor and adaptively manage created covered and evaluation species habitats MNSW1—Conduct surveys and research to locate MacNeill’s sootywing skipper habitat and to better define its habitat requirements MNSW2—Create at least 222 acres of MacNeill’s sootywing skipper habitat CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire
Evaluation Species	
California leaf-nosed bat (roosting habitat)	MRM1—Conduct surveys and research to better identify covered and evaluation species habitat requirements MRM2—Monitor and adaptively manage created covered and evaluation species habitats CLNB1—Conduct surveys to locate California leaf-nosed bat roost sites CLNB2—Create covered species habitat near California leaf-nosed bat roost sites CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire
Pale Townsend’s big-eared bat (roosting habitat)	MRM1—Conduct surveys and research to better identify covered and evaluation species habitat requirements MRM2—Monitor and adaptively manage created covered and evaluation species habitats PTBB1—Conduct surveys to locate pale Townsend’s big-eared bat roost sites PTBB2—Create covered species habitat near pale Townsend’s big-eared bat roost sites CMM1—Reduce risk of loss of created habitat to wildfire CMM2—Replace created habitat affected by wildfire

1 **Table C. Summary of LCR MSCP HCP Conservation Measures for Covered**
2 **and Evaluation Species (continued)**

<i>Species</i>	<i>Conservation Measures^a</i>
Colorado River toad	CRT01—Conduct research to better define the distribution, habitat requirements, and factors that are limiting the distribution of the Colorado River toad CRT02—Protect existing unprotected occupied Colorado River toad habitat CRT03—Conduct research to determine feasibility of establishing the Colorado River toad in unoccupied habitat
Lowland leopard frog	LLFR1— Conduct research to better define the distribution, habitat requirements, and factors that are limiting the distribution of the lowland leopard frog LLFR2—Protect existing unprotected occupied lowland leopard frog habitat LLFR3— Conduct research to determine feasibility of establishing the lowland leopard frog in unoccupied habitat
^a Full descriptions of the conservation measures are provided in Chapter 5 of the LCR MSCP.	

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