NOTE TO REVIEWERS: This outline is intended to describe an approach to monitoring, management and adaptive management to facilitate discussion of the monitoring and management program framework. Text under the headings may be preliminary draft of what actually would appear in the section or may be just a description of what will appear in the section for the reviewer's information. THIS OUTLINE IS NOT INTENDED TO BE THE DRAFT CHAPTER. **THIS IS A CONSULTANT WORK PRODUCT AND HAS NOT BEEN REVIEWED BY THE REAT AGENCIES*

5.0 MONITORING AND MANAGEMENT PROGRAM

5.1 Purpose

The overall purpose of the Monitoring and Management Program (MMP) is to provide the programmatic framework for the long-term monitoring and management of the DRECP Reserve System. With successful implementation of the MMP, the DRECP will be able to meet its monitoring and management obligations in accordance with state and federal permits. The following subsections discuss the following:

- Regulatory framework for the MMP
- A conceptual summary of the key MMP components
- MMP Implementation Structure
- Management
- Monitoring.

5.2 State and Federal Guidelines and Policies Related to Monitoring and Management

TBD.

5.2.1 NCCP Conservation Guidelines

TBD.

5.2.2 HCP Five-point Policy

TBD.

5.2.3 Changed Circumstances

TBD.

5.2.3.1 Regulatory Definitions

TBD.

5.2.3.2 Changed Circumstances and Unforeseen Circumstances

TBD.

5.2.3.3 Procedures for Addressing Unforeseen Circumstances

TBD.

5.3 Role of Adaptive Management

TBD.

5.4 Conceptual Overview of the MMP

This section will summarize information and recommendations in the ISA report regarding monitoring and management, including:

- Developing a strong institutional structure with the authority to implement and enforce the MMP.
- Developing all available information that provides the foundation by which future conditions can be measured.
- Developing and implementing adaptive management hypotheses based on conceptual or quantitative models.
- Developing a feedback system that incorporates the results of previous studies into future management and monitoring actions.

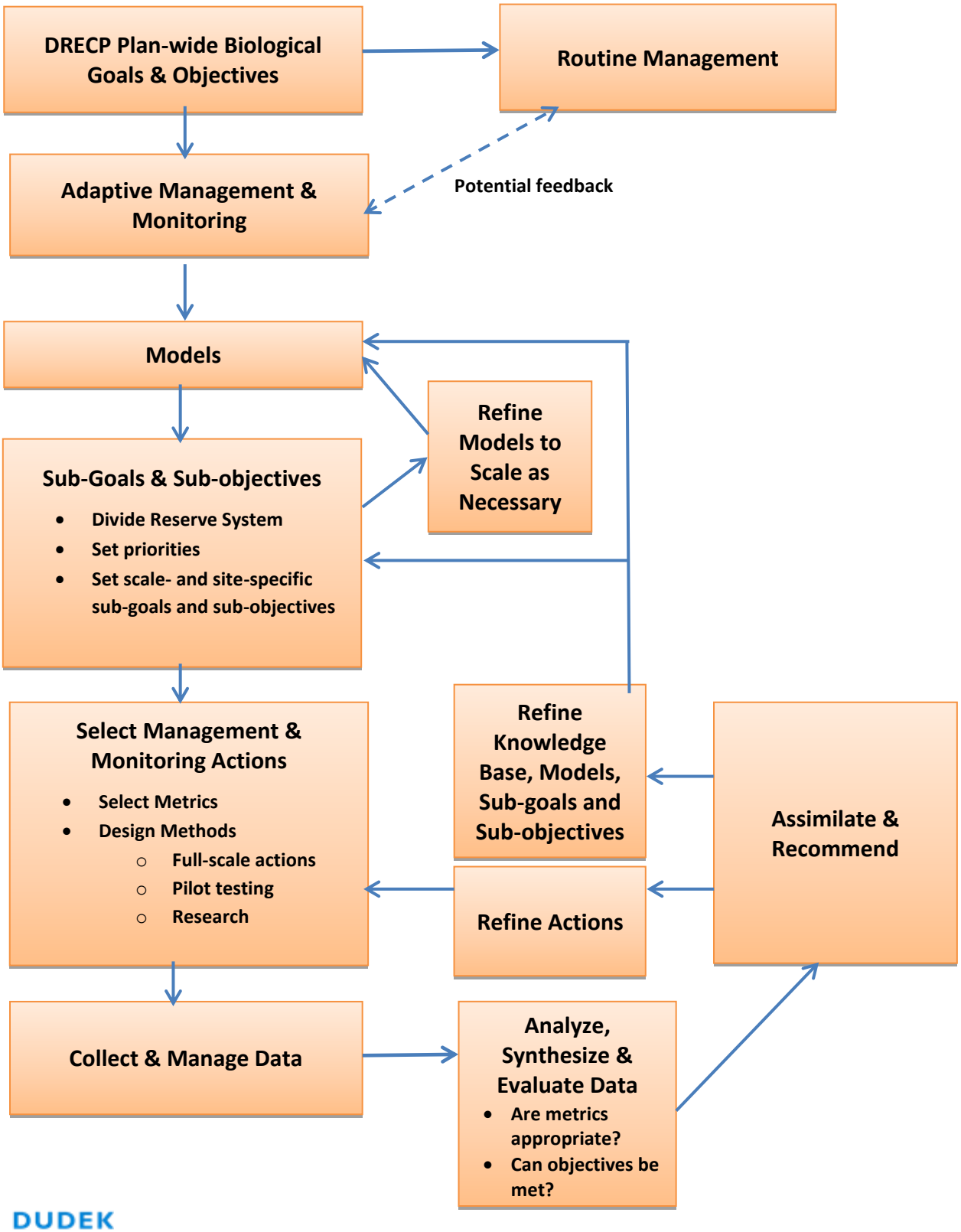
5.4.1 Adaptive Management

Adaptive management is a key element of the overall Conservation Strategy and is the foundation for long-term management of resources. By definition, adaptive management is an experimental and flexible approach to resource management that integrates ecological theory, modeling, hypotheses generation, field manipulations and interventions, and feedback that allows for refinement of the model(s) and hypotheses and, ultimately, improved management of the resource. Although not all management need be "adaptive" in the sense that the management actions are tested and verified using the scientific method (e.g., fencing to protect certain resources, collecting trash and garbage, security

patrols, and other "routine management actions), adaptive management is a powerful tool for managing biological resources where the objectives metrics are stated in terms of ecological indicators (e.g., positive population trends, reduction in non-native species, etc.).

Figure 5-1 illustrates the adaptive management framework, and the elements of the framework are discussed in more detail in the sections below.

Figure 5-1. DRECP Draft Adaptive Management Framework



5.4.2 Scope and Structure of MMP

The outline for the scope and structure of the monitoring and management program in the following subsections is largely based on the guidance (*i.e.,* non-regulatory) document *Designing Monitoring Programs in an Adaptive Management Context for Regional Multiple Species Conservation Plans* produced by the USGS, in partnership with the CDFG and USFWS (Atkinson *et al*. 2004).

5.4.2.1 Goals & Objectives and Relationship to MMP

The goals and objectives being developed for the DRECP are the foundation for the MMP. They dictate what needs to be monitored and managed, and in many cases where, and therefore provide the overarching framework for the MMP.

5.4.2.2 Compilation of Available Information

The first step in the MMP is to compile all relevant available information to support the MMP. This would include all of the data developed during preparation of the DRECP, including spatial (GIS) data, management plans, monitoring reports, focused research studies, etc. This information has been compiled and used in the preparation of the NCCP/HCP and to develop the DRECP biological goals and objectives, and will be used to inform monitoring and adaptive management to the extent that is applicable. For example, a review of the various conservation and management plans currently in place in the Plan Areas was conducted as part the baseline information assembly described in Chapter 3. A review of this information will also identify knowledge gaps and critical uncertainties that will need to be addressed in the development of monitoring and adaptive management models and actions, including the need to develop baseline information.

The available information will be assessed for its utility in establishing "baseline" conditions (e.g., is there sufficient available data for a particular species to establish a baseline level of occupancy condition?). It is important to understand that in most cases adequate baseline data would be not a single "snapshot" of resources over time (e.g., species presence/absence, habitat condition, etc.). Several years of comparable data that capture variability over both space and time in a relevant time frame (e.g., a wet/dry weather cycle) are often needed to establish the baseline condition for a species or an ecosystem. Establishing such variance over time and space in a normally operating system is essential for detecting change related to other extrinsic factors (e.g., Covered Activities, climate change, or other disturbances) with any statistical precision. As described in the Data Characterization sections of the Covered Species profiles, there are few Covered

Species (or locations) for which existing baseline information would likely be considered adequate for detecting biologically significant changes due to DRECP Covered Activities.

5.4.2.3 Strategic Division of Reserve System and Setting Priorities

This step is critical in the allocation of MMP activities and resources. Initially this step involves identifying the most important elements of the Reserve System, such as by land features (e.g., critical habitat linkages, unique landscape features), natural communities, and species. Strategic division of the Reserve System allows for identifying the most important components of the system to monitor and manage and for setting priorities, especially given the likely limited resources for monitoring and management in the early years of the program.

This step also includes identifying and evaluating all the ongoing management and monitoring activities already underway in the Reserve System by the various land managers. This concept is similar to the Reserve Management Units (RMUs) developed for the Coachella Valley Multiple Species Habitat Conservation Plan that are based on habitat/natural community patterns, land ownership, and similar management needs. Once this information has been developed, it will be possible to identify and prioritize areas of the Reserve System for coordinated management and monitoring (e.g., a critical habitat linkage or core area for a Covered Species) and identify the appropriate land manager(s) for a particular resource (e.g., can one land manager bear the primary responsibility for coordinating activities for a particular Covered Species?).

Setting of monitoring and management priorities should be based on biological factors, such as the level of species endangerment or vulnerability of habitat to stressors, but also may consider several other factors identified by Dahm et al. (2009), including:

- Ease of implementation
- Interdependence of measures
- Feasibility of near-term implementation
- Availability of funding
- Uncertainty of measure implementation and outcomes
- The potential for synergies among measures.

5.4.2.4 Management-oriented Models

Developing management-oriented models (conceptual or quantitative, both ecosystem- and species-based) will be based on the goals and objectives identified at the landscape, natural community, and species levels. Models formalize the relationship between the goals and objectives, the existing knowledge about the system, and the expected outcome of the Conservation Measures. The management-oriented models will also clarify the interactive relationships among the multiple scales of the system (e.g., landscape, natural community, and species) and the different scales of the Conservation Measures. By developing management-oriented models at the different scales, potential conflicts among goals and objectives can be identified. For example, tamarisk is identified as a threat to desert riparian systems for a variety of reasons, including direct displacement of native riparian species that provide valuable wildlife habitat for native species, superior competition for ground water resources, and increased fire risk. At a natural community level, and at the species-level for several Covered Species, a management-oriented model would identify tamarisk as a significant threat requiring management. However, for at least one Covered Species – southwestern willow flycatcher – tamarisk is currently an important nesting habitat and its temporal loss resulting from eradication efforts could have a substantial adverse effect on the breeding success of this species (Paxton et al. 2011b; Sogge, pers. comm. 2012).

The models are used to generate specific adaptive management hypotheses, provide the framework for designing adaptive management experiments, and allow for testing predictions of management action outcomes (e.g., raven controls will increase desert tortoise hatchling survival and recruitment rates). To the extent feasible, the models should also provide performance metrics (e.g., percent reduction of a non-native species) by which the management outcomes are evaluated. Based on the information generated by the management experiments, the models are refined or revised to reflect the management outcomes, and ideally become more precise and accurate over time. For example, qualitative predictions based on initial conceptual models may become more quantitative, with relationships described by equations rather than coarse directional predictions. In this way, they provide the critical link between the goals and objectives and the outcome of the management action. As the models are refined, management actions should also become more focused and efficient because erroneous management hypotheses will be discarded and extraneous variables in the models will be eliminated. Also, as models become more refined and management experiments become more focused, it is expected that causal mechanisms will emerge, also allowing for more directed management of the most important causal factors.

One the main reserve system-wide landscape goals is to have a reserve system that will accommodate species range contractions and expansions in response to climate change. Climate change as it relates to adaptive management is discussed in the Memorandum, *Approach for Integration of Climate Change Analysis into Reserve Design and Adaptive Management and Monitoring*, dated June 8, 2012. The management-oriented models will need to include management and monitoring components for species identified as vulnerable to climate change effects in the Technical Appendix on Climate Change (see Figure 8, Vulnerability Matrix). Monitoring and adaptive management will be particularly important for these species because of the current uncertainty about specific climate change effects. Such monitoring and management will need to occur at the landscape level (e.g., landscape linkages, broad ecosystem processes), natural community level, and species level.

Section 7 of the Baseline Biology Report provides a summary of information for the 77 proposed Covered Species presented in the context of key landscape issues, key ecological process issues, and potential environmental stressors and threats (see Tables 7-1 and 7-2).This information is the foundation for developing the biological goals and objectives, including those relating to adaptive management. However, management-oriented models for most resources in the DRECP area have not yet been developed Developing these models will require input from various entities, including federal and state agency scientific staff and independent scientists. It is anticipated that development of the initial set of management-oriented models will occur in the first xx months (e.g., 18-24 months) of implementation of the DRECP.

5.4.2.5 Knowledge Gaps, Critical Uncertainties and Monitoring Priorities

Based on the management-oriented models, knowledge gaps and critical uncertainties will be identified, and these will be used to set monitoring priorities in the early years of the program. It is expected that an implementing entity will work with other entities (e.g., agency, NGO, academic, and other independent scientists and experts, land managers, etc.)(see Section 5.5) to review the critical uncertainties identified in the models. This will require an evaluation of the entire set of DRECP goals and objectives in the context of monitoring and management actions already in place. That is, are there existing monitoring and management actions that are adequate for establishing baselines conditions and for meeting certain goals and objectives and/or are there additional monitoring and management actions needed to meet other goals and objectives? Identification of knowledge gaps and critical uncertainties will also identify the need for pilot testing and additional research needs (see Section 5.7).

5.4.2.6 Data Management

Having a centralized system for data management will be critically important for the success of the MMP. Ideally, monitoring and management data and other relevant information (e.g., independent research studies within the Reserve system, scientific literature, etc.) would be compiled and managed by a single entity to ensure that all relevant data and information are integrated, synthesized, and evaluated. This entity would be responsible for data storage and management. Data storage and management should be standardized to maintain a high level of quality assurance and should include specific protocols for naming directories, subdirectories and files. All data files should be accompanied by metadata that describe in detail the dataset in terms of the who, how, what, and where information in the dataset. While data management should be the responsibility of single entity, this management should also be coordinated with the other relevant parties to allow them access to and feedback about the data.

5.4.2.7 Iterative Feedback/Refinement, and Decision-making Process

Iterative feedback is the key step of adaptive management. It is essential for informing future monitoring and management; i.e., what is, and what is not working? Because feedback is so important for the success of the MMP, a formal process for soliciting and incorporating feedback from the entities directly involved in monitoring and management (e.g., land managers) and the scientific community is critical. Primary feedback mechanisms should include long-term monitoring and management plans and annual reports.

One approach for formalizing the feedback and decision-making processes is for the implementing entity to initially, and on a periodic basis (e.g., every 5 years), develop long-term action plans that set forth the monitoring and management actions for a specified upcoming period. The long-term action plans would provide the framework for the annual work plans and should include all of the general monitoring and management activities contemplated for the upcoming years, including natural community plans, species-specific plans, etc. The annual work plans should reflect continuity with the long-term action plan, but also retain flexibility in response to prior monitoring and adaptive management; i.e., incorporation of feedback. Especially in the early years of the monitoring and management program, the "learning curve" will be steep and it is likely that portions of the successive long-term actions plans could be substantially modified to reflect what did and did not work in the previous period. However, the annual work plans based on a particular long-term action plan should reflect adjustments and fine-tuning rather than radical departures from what was outlined in the long-term plan. In this way, refinement of the monitoring and

management program over time can occur in a more orderly and systematic way and can provide adequate time to thoroughly test various monitoring and management approaches. The long-term actions plans would provide the opportunity to make significant changes to the monitoring and management program, if necessary.

The long-term actions plans may include, but not be limited to, the following elements:

- A description of the existing information for the Reserve System (e.g., vegetation database, species occurrences, etc.)
- A set of working management-oriented models
- A description of management units within the Reserve System
- An explicit set of the Conservation Measures, including monitoring and management actions linked to the DRECP goals and objectives via the management-oriented models and setting of change or performance criteria
- A description of monitoring and management priorities (e.g., landscape features such as certain habitat linkages, natural communities, Covered Species, areas of the Reserve System, etc.)
- A description of monitoring and management approaches, including, as applicable:
    - Routine or ongoing management
    - Active or passive adaptive management (see Section 5.7)
    - Design of the monitoring program (e.g., sample plot selection methods, BACI studies, pilot testing, etc.).
    - Field methods (e.g., point counts, transects, inventories, etc.)
    - Analytic methods (e.g., occupancy metrics, statistical methods, etc.)
- Data management
- Schedules
- Staffing and costs

The annual reports, at minimum, should include the following information:

- Results of monitoring and management activities from the previous year, and synthesis with previous information.
- Comments on, and recommended refinement revisions to, the management-oriented models.

- An evaluation of the previous work in relation to achieving the DRECP goals and objectives.
- Identification of significant problems or successes in the MMP that may alter future monitoring and management, such as:
    - Whether the monitoring and management field or analytic methods are satisfactorily addressing DRECP goals and objectives (e.g., are the measurement methods sensitive or precise enough?) and whether the methods (e.g., sampling protocols, metrics, etc.) need refinement or major revision.
    - Whether the data for a particular monitoring state variable suggest that a species or habitat is being adversely affected to the extent (including monitoring activities) that some immediate action is required.
    - Whether the data indicate an earlier or more substantial than expected response of a species or a habitat to adaptive management such that continued testing is unnecessary or becomes a lower priority.
- Suggested revisions to the monitoring and management program.
- Suggested monitoring and management activities for the upcoming year and near future (e.g. 3 to 5 years out).

The annual report, which would be prepared by the implementing entity, should be submitted to all of the relevant plan participants for review and comment. At least one annual formal meeting and additional informal coordination (e.g., email, conference calls) should be conducted to discuss the results in the annual report and to act on the recommendations in the annual report for the upcoming year and the near future.

5.5 Implementation Structure for MMP

A strong and well-defined implementation structure with the authority to implement and enforce the MMP is essential for the success of the program because of the large size of the Reserve System and the likely diversity of the plan participants. Although the actual implementation structure is yet to be defined, there should be an overarching implementing entity that administers the plan and provides the nexus for coordination among other plan participants, including permittees signatory to the plan, land managers, and other participants that may serve in an advisory capacity. Generally, the implementation structure should be designed in a way that ensures that the MMP is implemented in accordance with the permit requirements and provides the feedback mechanism to inform decisions about the effectiveness of the Conservation Measures.

5.5.1 Implementing Entity

TBD – The implementation structure will be described in detail in Section 8.1, Implementation Structure in Chapter 8, Plan Implementation.

5.5.2 Advisory Participants

In addition to the implementing entity, it is expected that the MMP will include a variety of participants that function in an advisory capacity to the implementing entity or agents of the implementing entity on issues related to monitoring and management of the Reserve System, including biological, technical, and operations expertise. Advisory participants may include state and federal agency staff, NGOs, and academic and other scientists and experts (including a designated panel of independent scientists and experts, described in Section 5.6).

5.5.3 Program Management

TBD - Program management will be described in Chapter 8, Plan Implementation.

5.5.4 Federal, State and Local Participation

Review, tracking, implementation and/or oversight of the MMP likely will include participation by various federal, state and local agencies, including:

- U.S. Fish and Wildlife Service
- Bureau of Land Management
- National Parks Service
- Department of Interior
- Department of Defense
- U.S. Geological Survey
- California Department of Fish and Game
- State Lands Commission
- California State Parks
- Imperial County
- Inyo County
- Kern County

- Los Angeles County
- Riverside County
- San Bernardino County
- Other Local Governments
- Others?

These agencies may function in various capacities, including as regulators, as permittees, as land managers, or as others directly and indirectly affected by Covered Activities authorized under the plan (e.g., local agencies). The common theme is that they would all have some interest in implementation of the MMP.

5.5.5 Other Participating Groups

It is likely that other groups will be direct and indirect participants in the MMP, either as landowners (including private), land managers, conservation organizations, and public advisors. Non-public members of the DRECP stakeholders may be participants.

5.5.6 Coordination Among the Implementing Entity and Participating Groups

Close coordination among the implementing entity and groups participating in the plan will be critical for the success of the MMP. It is expected that some participants who are also land managers (e.g., USFWS, BLM, NPS, CDFG, etc.) will have their own monitoring and management obligations, but as participants in the DRECP, they would be expected to coordinate their activities with the MMP. This may include revisions to their programs based on specific requirements of the DRECP MMP to ensure that the MMP is implemented in a coordinated fashion. In order to have a strong implementation structure, the implementing entity should be responsible for ensuring this coordination. Such activities would be expected to include, but not be limited to, the coordination of:

- DRECP long-range monitoring and management plans for defined subunits within the Reserve System with adjacent plans of the participating entities.
- Annual work plans for consistency of monitoring and management activities between DRECP reserves and adjacent lands of participating entities.
- Budgets, schedules, and opportunities for cost sharing.
- Defined responsibilities for coordinated monitoring and management actions.
- Dissemination of information from independent scientists to participating groups.

- Dissemination of information from the permitting agencies regarding the status of the DRECP.

5.6 Outside Input

Independent scientists and experts, along with the other groups participating in the MMP, probably will play an important role in structuring the monitoring and management program, and these scientists and experts can be a primary source of information and data for generating and refining the management-oriented models that are the foundation of the adaptive management. The primary purpose and role of the independent scientists and experts would be to provide assistance in obtaining the best scientific information available so that "effectiveness monitoring" and adaptive management of the Reserve System is carried out in accordance with the DRECP biological goals and objectives. It is expected that independent scientists and experts will provide objective information that is neutral with respect to the Permittees of the Plan and the permitting agencies, and their input would be advisory.

Scientists and other experts most likely would be drawn from academia or other sources (e.g., NGOs, research institutes) with recognized expertise in desert ecology, species, and conservation science, but may also be affiliated with the private sector (e.g., consulting firms) where very specific expertise is needed. However, individuals from the private sector would need to be "independent" and able to demonstrate no conflicts of interest. Although independent science panels may vary in size, it would be desirable to have a manageable size (e.g., 4-6 members), but with enough members to provide representative expertise in plant and animal ecology, quantitative methods, and statistical analysis.

The independent scientists and experts would be expected to fulfill several functions:

- Assist in the development of a scientifically credible monitoring and management program that will provide reliable information needed to manage the Reserve System in accordance with the DRECP biological goals and objectives, including, but not limited to:
  - Setting monitoring and management priorities;
  - Identifying adaptive management studies; and
  - Establishing change thresholds or performance criteria for management triggers.
- Review the quality and relevance of the scientific and technical information gathered as part of the DRECP monitoring and implementation requirements.

- Contribute to the analysis and interpretation of the monitoring data in light of the regulatory requirements of the DRECP.
- Advise the implementing entity and other plan participants on scientific matters that reflect on the design, interpretation, or implementation of the monitoring and management program.
- At least once a year, provide an independent written assessment of the monitoring and management data collected to date and make recommendations for adjustments to the monitoring and management program based on review and analysis of the data.
- Review, comment on, and synthesize technical studies or reports generated by supplemental research activities conducted by outside third parties that may be permitted within the Reserve System and submit comments on such research to the implementing entity, where applicable.
- Review and prepare evaluations of proposals for carrying out management, monitoring and research activities in the Reserve System.
- Meet periodically with the implementing entity and other plan participants.

All of these duties should be carried out in a transparent manner to ensure that all participants in the plan have the information necessary to evaluate the status of the monitoring and management program; e.g., on what basis were recommendations made?

5.7 Management

Management will include both routine management that is already commonly implemented throughout the DRECP area (e.g., controlling public access to sensitive areas, fencing, signage, etc.) and adaptive management. Adaptive management is scientifically-based management where results of management experiments and activities are used to inform future management. Adaptive management may be *active* or *passive* (Dahm et al. 2009). Active adaptive management is experimental and may involve active manipulations to assess outcomes of management alternatives (e.g., comparing burning and mowing to reduce invasive species). Passive management is not experimental, but is still based on the scientific principle of systematic observation (e.g., monitoring data related to a management action) and inferring relationships (e.g., through statistical methods such as regression). The choice of active or passive adaptive management will be dictated by the type of system and conservation measure being evaluated. For example, one would not typically apply a non-reversible active adaptive management experiment to a very rare resource such that if the experiment had an adverse effect, the resource could not recover.

Where appropriate (e.g., where management actions are reversible), active adaptive management is preferred because experiments generally are more efficient and have more power to detect effects.

Potential adaptive management actions will be evaluated for application at the appropriate level. Dahm et al. (2009) identified three levels of adaptive management actions:

1. Full-scale actions
    - Designed to address large-scale problems
    - Action is considered highly likely to achieve goals and objectives
    - Benefits outweigh potential adverse effects
    - Additional pilot testing or research studies would add little value.
2. Pilot actions
    - Action is expected to have positive effect, but still uncertain and requires manipulation of system.
3. Research
    - Action is directed toward a specific issue that is key to Plan implementation. Research would be required where there is a high degree of uncertainty in the outcome of the action.

As discussed in Section 5.4.2.3, Strategic Division of Reserve System and Setting Priorities, the Reserve System should be divided into subareas or units for the purpose of management based on features such landscape, natural communities, and species, as well as land ownership and existing management. Such a division of the Reserve System will reflect the diversity of the system and allow for focused management activities that are most important in particular areas, as well as consolidate management under fewer entities within a defined unit. Any existing management plans that are already in place in the unit can then be evaluated and refined or revised, if necessary, to be consistent with the DRECP MMP and the overall DRECP goals and objectives. The representatives of each management unit would work with the implementing entity and other relevant participating groups to develop separate management plans for each of management units. The management plans should describe ongoing management and new management needed to help meet the DRECP goals and objectives. The plans should describe specific management actions, schedules, and responsibilities. The plans should include sub-objectives, if necessary, that step down the DRECP goals and objectives to the particular unit.

5.7.1 Reserve Management Units

This section describes the identified Reserve Management Units (as a suggested approach) and the various landowners and managers.

5.7.1.1 Reserve Management Unit 1

This section would describe the existing management activities in this unit.

5.7.1.2 Reserve Management Unit 2

5.7.1.3 Etc.

5.8 Monitoring

The monitoring requirements of the MMP include *compliance monitoring* and *effectiveness monitoring* (sometimes referred to as "performance monitoring").

Compliance monitoring tracks the status of DRECPNCCP/HCP implementation and refers primarily to administrative duties related to verifying that the permittees are carrying out the terms of the DRECP NCCP/HCP, the permit, and the Implementing Agreement. Compliance monitoring information includes a summary of dates of completion, revisions, and implementation progress of the NCCP/HCP components.

Effectiveness monitoring assesses the status of ecological, natural communities, and Covered Species conditions in the Reserve System over time and space relating to implementation of the NCCP/HCP.

5.8.1 Compliance Monitoring

The implementing entity would be responsible for the compliance monitoring component of the DRECP. Compliance monitoring should, at minimum, include:

- All Conservation Measures initiated, continued, or completed in the previous year.
- All Conservation Measures initiated, continued, or completed to date since commencement of the DRECP (e.g., the effective date).
- Conservation Measures to be initiated, continued, or completed the next 3 (5?) years.
- A running tabulation of habitat created, restored, or enhanced under the plan.
- Description of all findings, conclusions, and results of monitoring, research, or Conservation measure previously undertaken.

5.8.2 Effectiveness Monitoring

Effectiveness monitoring assesses whether the Conservation Measures are achieving the DRECP goals and objectives. Effectiveness monitoring would be conducted at three scales – landscape, community, and species and would be focused on addressing threats posed by the Covered Activities and other threats, as identified in the management-oriented models, including climate change. The effectiveness monitoring would be directly linked to the DRECP goals and objectives.

Landscape-level monitoring is intended to monitor large, coarse-scale changes over time. For example, altered fire and climate regimes can have broad-scale interactive effects that may cause substantial habitat changes over time, including large-scale invasions of non-native grasses and forbs (e.g., Sahara mustard). There are emerging remote sensing technologies that may allow for efficient and cost-effective landscape-level monitoring such as satellite or aerial imagery combined with LIDAR (Light Detection and Ranging) that can provide information about changes in vegetation height, cover, density, and which allow for the development of change detection algorithms (e.g., are areas being invade by invasive herbaceous species and displacing native shrubs?).

Natural community level monitoring will require a standardized baseline vegetation map for the DRECP area, likely using the methods applied to the western Mojave by Keeler-Wolf. Once a Reserve System-wide vegetation database is created, the remote sensing methods discussed above may be applied at the community level to detect large-scale changes. However, fine-grained monitoring at the natural community level may also be needed to detect changes at the association level that may be biologically significant and necessary to monitor to meet the goals and objectives for the community (e.g., in certain targeted areas). This may include establishing monitoring sites in the Reserve System on a stratified basis using probability-based plot selection methods (that allow inference across a large area), and field methods such as the rapid assessment Relevé method, point-intercept transects, and/or quadrat methods. However, due to the large expanse of the Reserve System, because such ground-based monitoring is typically labor intensive, it should be focused on communities or areas that require a fine-grained level of monitoring. Otherwise the monitoring burden could become enormous and infeasible.

Species-level monitoring can be conducted using a variety of methods, depending on the species and the objective of the monitoring (e.g., ranging from determining presence/absence to monitoring population trends).

Suitable monitoring methods for all three scales will come out the management-oriented models, the knowledge gaps, critical uncertainties, and monitoring priorities. A key step in

developing the monitoring approaches will be to explicitly link the monitoring to the DRECP goals and objectives so that the monitoring results directly inform plan implementation and provide objective measures of plan success. The DRECP objectives in particular establish the monitoring state variables (e.g., species occupancy rates, vegetation community nativeness, etc.), which then dictate the appropriate monitoring methods and metrics.For example, the DRECP objective of maintaining adequate marsh hydrology and increasing the cover of native marsh plant species that provide nesting, cover and/or foraging habitat for native birds (including several Covered Species) will likely require a monitoring protocol that samples both hydrological characteristics such daily and/or seasonal water fluctuations and vegetation characteristics such as density, percent cover, and native species diversity. Ideally, monitoring these abiotic and biotic state variables would be accompanied by monitoring native birds (e.g., occupancy rates) so that relationships between habitat features and native birds can be statistically analyzed (e.g., through regression analyses).Such a monitoring program could be implemented as part of a Before/After, Control/Impact (BACI) study if there is an expectation that a particular Covered Activity could affect marsh habitats (e.g., by altering the natural hydrologic regime). The BACI method provides a more powerful tool for assessing impacts and for establishing causal relationships than simply concurrently monitoring several variables and teasing out statistically significant relationships using regression analyses (i.e., observational studies).Another key requirement of developing monitoring methods is to establish the criteria by which effectiveness is measured, which would be generated in the management-oriented models.This requires setting an a priori change threshold (e.g., a 20% decline in occupancy rate) or performance threshold (e.g. reduce non-native species cover to less than 10%).

Depending on the monitoring approaches and methods ultimately selected, some pilot study testing may be necessary to evaluate factors such as sample site selection procedures, number of samples, and frequency of sampling needed to provide adequate statistical power for detecting differences or trends in relation to pre-established change thresholds or performance standards. The need for pilot study testing will be identified as the monitoring approaches and methods are developed.