MADREAN ARCHIPELAGO
RAPID ECOREGIONAL ASSESSMENT

ASSESSMENT WORK PLAN

REA Assessment Work Plan for:
Department of the Interior
Bureau of Land Management
Rapid Ecoregional Assessments

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This assessment work plan is provided to BLM as a Phase II, Task 1 deliverable.

Contents

Tables

Figures

1 Rapid Ecoregional Assessments: Purpose and Overview

Working with agency partners, in 2010 the Bureau of Land Management began conducting rapid ecoregional assessments[1] (REAs) covering approximately 450 million acres of public and non-public lands of the American West. The goal of the REAs is to characterize ecological resource status, their potential to change from a landscape perspective, and potential priority areas for conservation, restoration, and development. REAs are intended to serve BLM's developing "Ecoregional Direction" that links REAs and the BLM's Resource Management Plans and other on-the-ground decision-making processes. Ecoregional Direction establishes a regional roadmap for reviewing and potentially updating Resource Management Plans, developing multi-year work for identified priority conservation, restoration and development areas, establishing Best Management Practices for authorized use, designing regional adaptation and mitigation strategies, and developing conservation land acquisitions. While REAs produce information designed to be used in specific management processes, they are not decision documents and stop short of integrating the findings into management actions.

REAs are designed around ***management questions (MQs)*** that specify the key information needs of managers as expressed by the Assessment Management Team (AMT). REAs describe and map ***conservation elements (CEs)***, which are generally ecosystems, species, or other natural features of high ecological value or sensitivity. REAs look across all lands in an ecoregion to identify regionally important habitats for fish, wildlife, species of concern, and other features of management interest. REAs then evaluate the potential impacts on CEs from four overarching categories of environmental ***change agents (CAs):*** climate change, wildfires, invasive species, and development (such as land use, energy development, infrastructure, or hydrologic alterations).

REAs address all lands within the ecoregion of interest, regardless of ownership. Therefore, BLM engages with partners and stakeholders within the ecoregion to obtain input and to provide a set of products that can be used by any interested agency or organization. REAs are conducted by contractors, with guidance and input from BLM and partners within the ecoregion; BLM provides oversight for the project. The Assessment Management Team (AMT) and the Technical Team, which are composed of decision makers and technical experts from state and federal agencies, provide guidance, direction, and input throughout the REA process.

The REA process is organized as a series of tasks in two major phases: Phase I, the Pre-Assessment, and Phase II, the Assessment. Table 1-1 provides a simple summary of the two phases and the major tasks comprising an REA; an outline of the specific components of each task is included in the **Budget** section later in this work plan. The REA for the Madrean Archipelago ecoregion is scheduled to be completed within a two-year period; more information on schedule and timing is provided in the **Schedule** section of the work plan.

[1] Also see BLM's REA website at www.blm.gov/wo/st/en/prog/more/Landscape_Approach/reas.html.

Table 1-1. Simple overview of Phases and Tasks in the REA process.

Phase	Task #	Task
Phase I: Pre-Assessment	Task 1	Initiate REA Project: Engage Teams and Develop Pre-Assessment Work Plan
	Task 2	Implement Pre-Assessment Work Plan: Identify CEs, CAs, and MQs; Characterize the Ecoregion
Phase II: Assessment	Task 1	Create Assessment Work Plan
	Task 2	Inventory, Acquire, and Evaluate Data Develop Process Models
	Task 3	Develop Geoprocessing Models Conduct Analyses Generate Findings Assemble Data Packages
	Task 4	Final REA Report

2 Purpose and Overview of the Assessment Work Plan

As noted above, the assessment phase is the second of two phases for an REA. The goal of the assessment phase is to conduct the ecoregional assessment. Specific goals associated with the four tasks of the assessment include the following:

- Task 1
  - Develop a work plan that outlines the process and schedule for conducting the assessment
- Task 2:
  - Inventory and acquire data representing the CEs and CAs, and their indicators and attributes, as well as other data needed for the assessment; evaluate the data to confirm its quality and suitability for use in the assessments
  - Develop process models (diagrams) that visually illustrate the steps to be taken to conduct each of the assessments
- Task 3:
  - Use the process models to develop geoprocessing models to conduct the analyses for each of the assessments
  - Conduct the analyses (run the geoprocessing models)
  - Interpret the assessment results
  - Compile the assessment outputs into data packages, including relevant software tools and process documentation, and deliver them
- Task 4:
  - Draft the final report synthesizing the findings of the assessment, and including detailed appendices with additional information (e.g., CE conceptual models, process models and detailed methods for geoprocessing, other detailed methods, etc.)

Chapter 4 contains the primary content of the work plan, providing an overview of the assessment process and proposed or potential assessments, followed by the contractor's proposed approach for conducting Tasks 2, 3, and 4. This chapter includes examples of certain assessment products (e.g., process models, analysis outputs) so that REA participants can have a better understanding of what some of the products are expected to look like and provide preliminary input. As with the pre-assessment phase of the REA, the AMT and Technical Team will provide review and input via webinars and AMT workshops throughout the assessment process. Specifics of the AMT and Technical Team's participation are outlined within each task in chapter four of the work plan.

3 Project Administration

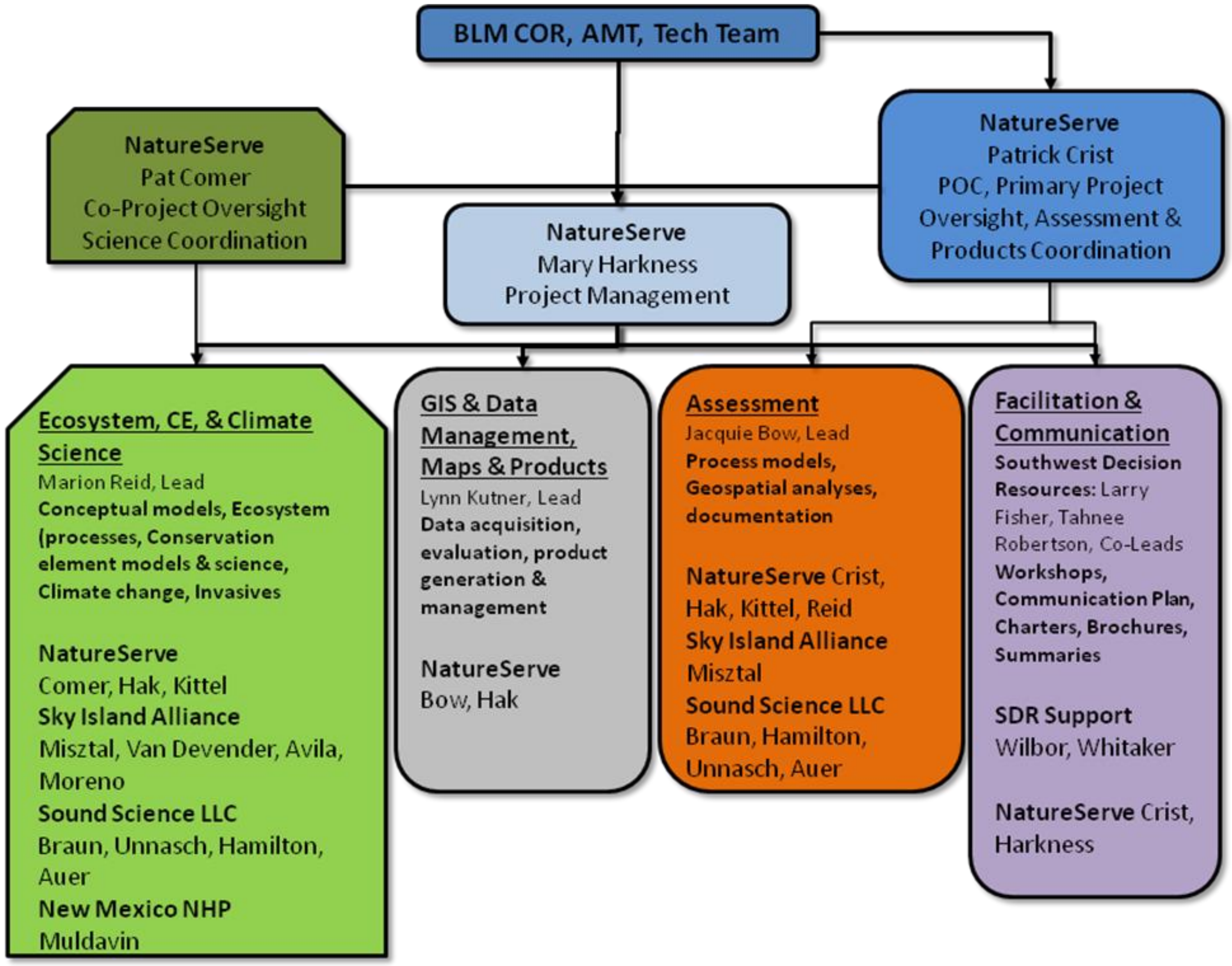
As noted in the Pre-Assessment Work Plan, the Madrean Archipelago REA will be conducted by the contractor team led by NatureServe under the guidance and direction of BLM, the Assessment Management Team (AMT), and the Technical Team, as described below.

3.1 Contractor Team

NatureServe and its partners, Sky Island Alliance (SIA), Southwest Decision Resources (SDR), Sound Science, and Natural Heritage New Mexico (NHNM), were selected as the contractor team to conduct the Madrean Archipelago REA. The NatureServe REA team is comprised of a core team of experienced REA practitioners and experienced scientists from organizations within the ecoregion. Southwest Decision Resources has strong relationships with partners and stakeholders throughout this ecoregion and provides facilitation and external communication. Sky Island Alliance contributes expertise in landscape species, invasives, and the ecoregion as a whole and is a critical link to in-ecoregion science expertise and data throughout the entire Madrean Archipelago ecoregion. Sound Science team members Dr. David Braun, Dr. Healy Hamilton, and Dr. Bob Unnasch provide expertise in hydrology, climate change assessment and modeling, and fire ecology, respectively. Dr. Braun also has extensive on-the-ground experience with hydrologic systems in this ecoregion. Natural Heritage New Mexico conducts research on the conservation and sustainable management of New Mexico's biodiversity, including inventory and monitoring of the state's biodiversity. NHNM provides in-ecoregion expertise and data on the ecology and species of the ecoregion.

NatureServe will manage the REA delivery and coordinate all team partners. Figure 3-1 illustrates the contractor team organization. The contractor team is organized into four broad thematic subteams – ecology/science, data management, assessment, and facilitation. Oversight of the entire REA is provided by Dr. Patrick Crist, Director of Conservation Planning and Ecosystem Management; overall science leadership is provided by Pat Comer, Chief Ecologist, while routine leadership of ecological work by the ecology/science team is led by Marion Reid, all located at NatureServe's Western Regional Office. Routine project management is conducted by Mary Harkness, Conservation Planner/Project Manager for NatureServe. Jacquie Bow manages geospatial analyses and Lynn Kutner manages database operations, metadata adherence, and QA/QC and product delivery to BLM. Other NatureServe staff members play key roles in geospatial modeling and analyses, decision support, database management, and map production. Facilitation is co-led by Tahnee Robertson and Larry Fisher of Southwest Decision Resources.

Figure 3-1. Organization of the NatureServe contractor team in relation to BLM, the AMT, and the Technical Team.



3.2 Project Management

The PI and Science Lead provide oversight and work closely with the project manager (Harkness) and thematic team leads (Reid, Bow, Robertson/Fisher, Kutner) to maintain daily project management and team coordination. In addition to the pre-assessment and assessment work plans that are part of the scope of work, the project manager is coordinating with the thematic team leads to maintain a detailed project work plan in Microsoft (MS) Project to track progress and anticipate problems among dependent activities and scheduled deliveries. All contractor team tasks are tracked within this file, as well as major BLM, AMT, and Technical Team tasks relating to reviewing various versions of deliverables. The project file also includes dates for AMT workshops, stakeholder update webinars, and similar events. The project file by design allows the project manager to specify which tasks or events (e.g., AMT workshops) are dependent on the completion of previous tasks and the amount of time planned (or specified by the SOW) to complete each task. This file is used on a day-to-day basis to monitor progress on specific tasks and to immediately identify any issues arising around timing of task completion or scheduling of events. (Where such issues arise, they will be immediately communicated with BLM’s COR to identify appropriate solutions.) It serves as the primary resource for timing, sequencing, and scheduling of tasks and events for this REA. The MS Project file will also be utilized to provide monthly status reports to BLM.

NatureServe has an established Microsoft SharePoint site for contractor team collaboration functions, such as shared workspaces, and for collaborating on documents and document and process management. The Pre-Assessment Report, Final Report, and other deliverables are being collaboratively developed using the SharePoint platform and coordinated by the project manager. Presentations for AMT workshops, update webinars, and other REA presentations will be developed in the same manner. Final deliverables (documents, presentations, data packages) will be posted on NatureServe's transfer site. The contractor team will also utilize the BLM REA portal or SharePoint site for coordination of product reviews with the AMT.

Contract oversight is provided by NatureServe's VP of Conservation Services and its Grants and Contracts department to ensure compliance with the terms and conditions of the REA contract.

3.3 Project Guidance and Collaboration

As a large landscape, cross-jurisdictional assessment, the REA process for the Madrean Archipelago will be guided and implemented by inter-agency teams led by the BLM and following collaboration guidance outlined in team charters and a communication and collaboration work plan.

3.3.1 Assessment Management Team

The Assessment Management Team (AMT) provides overall guidance and recommendations for the development of the REA, ensures that procedures and products are consistent with project objectives, ensures a collaborative, inter-agency approach, and provides policy and workload guidance to the Technical Team. The AMT is comprised of federal, tribal, state and local land management agencies. For more information, refer to the Team Charter provided in Appendix B of the Pre-Assessment Work Plan, which provides specific guidance to the AMT.

3.3.2 Technical Team

The Technical Team provides technical and ecological guidance, review, and recommendations for the development of the REA. The Technical Team is tasked with providing specific information and technical knowledge about the ecoregion to the Assessment Management Team in order to assist with developing management questions, evaluating conceptual models, reviewing process models, and interpreting results of the assessment. The Technical Team is comprised of technical experts from participating federal, tribal, state and local land management agencies. For more information, refer to the Team Charter provided in Appendix B of the Pre-Assessment Work Plan, which provides specific guidance to the Technical Team.

3.3.3 Communication and Collaboration

The Communication Work Plan outlines strategies and mechanisms for proactive interagency communication, collaboration, cooperation, and resource sharing between the BLM and partner agencies/entities. Most partner communication and collaboration is being fostered through the team workshops and meetings, webinars, brochures, and key documents. For more information, please see the Communication Work Plan, provided as a separate document.

3.4 *Project Sideboards*

The geographic and thematic scope of REAs provide an excellent opportunity to conduct a wide range of assessments that may be useful to natural resource managers throughout the ecoregion in question. It is important to keep in mind that while the REA team as a whole will focus on providing information and analyses that are most needed by and useful to managers through this assessment process, the REA will necessarily be conducted within the bounds of a number of sideboards on the project.

3.4.1 REA Purpose Limitations

As noted previously, the goal of the REAs is to characterize ecological resource status, potential to change from a landscape viewpoint, and potential priority areas for conservation, restoration, and development. The contract for this REA, as with all of BLM's REAs, clearly calls for the assessment to produce information designed to be used in specific decision-making and management processes. However, REA contracts also clearly stop short of including efforts to actually integrate the findings into management actions; **an REA is a toolbox, *not* a decision document**. REAs provide one of many sets of information that can be used to inform in decision-making processes; decision-making is informed by current conditions and impacts on multiple resources, as identified from an array of information sources such as REAs. The BLM has chosen to retain responsibility for all aspects of integrating the assessment into management actions and decisions.

3.4.2 REA Scope Limitations: Research and Data Collection

The BLM's Rapid Ecoregional Assessments are intended to be a relatively rapid assessment of the natural resources and major change agents of an ecoregion. Consistent with a broad scope, and with BLM requirements, only existing and available data will be used; the contractor team will not collect new data or conduct new research, inventories, or monitoring. Standard modeling approaches may be used to generate datasets from these existing data if useful for the REA. Limitations to answering management questions and assessing conservation elements or change agents resulting from a lack of data (data gaps) will be identified and tracked by the NatureServe team over the course of the REA and included in the final report. Data gaps identified during the REA may be addressed with follow-up sub-assessments, supplemental assessments, research, inventory, or monitoring outside of this contract.

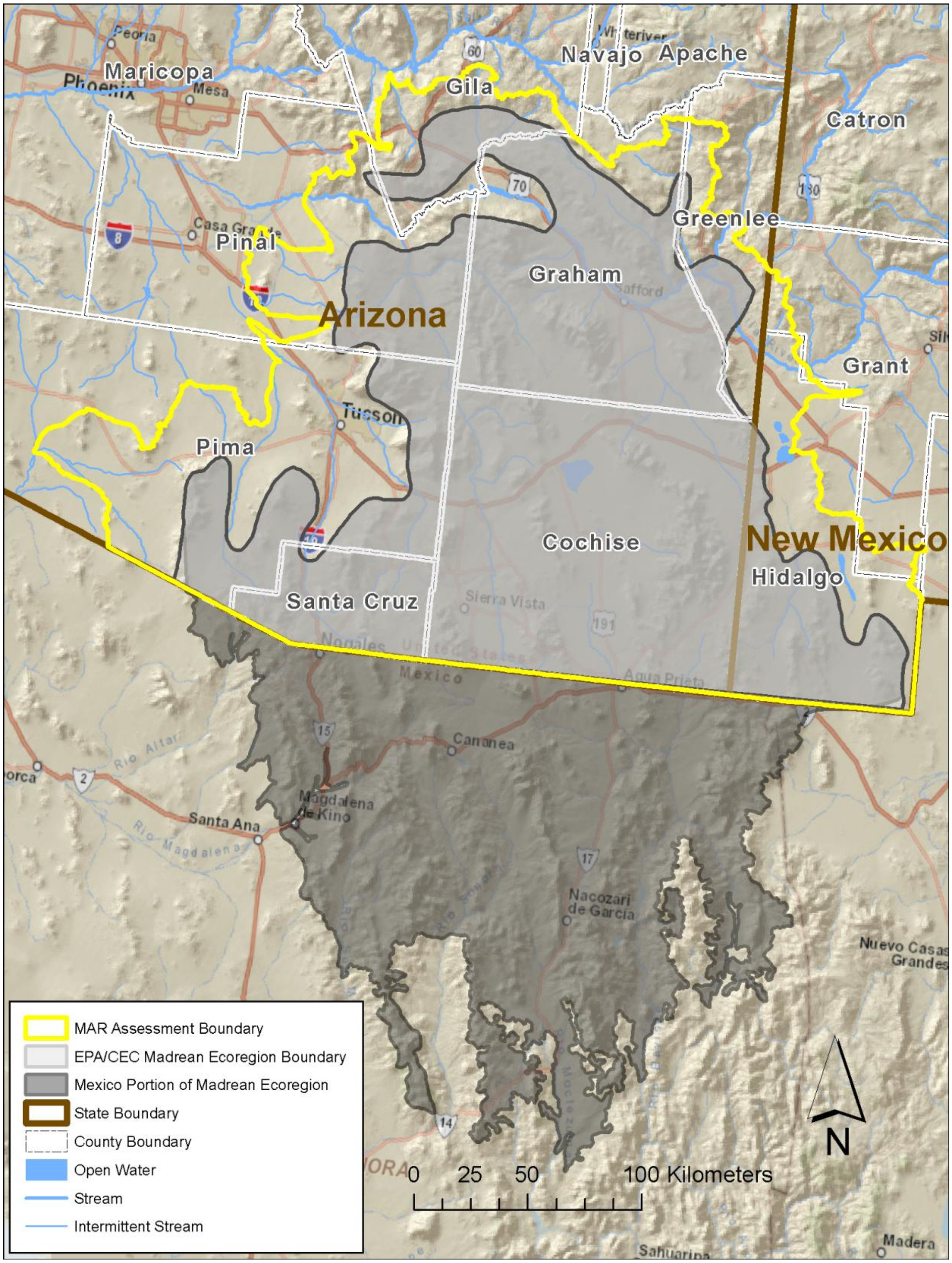
3.4.3 Spatial Extent

The Madrean Archipelago (MAR) ecoregion, as defined by the Commission for Environmental Cooperation (CEC, 1997) Level III Ecoregions, plus its intersecting 5th-level watersheds as defined by the Natural Resources Conservation Service (NRCS) Watershed Boundary Dataset (WBD), comprise the geographic extent of this ecoregional assessment. All land within this ecoregion and its buffer on the U.S. side will be assessed, not just BLM lands (if selected assessment features occur there). All 5th-level watersheds intersecting the Madrean Archipelago ecoregion, including those with minimal overlap and two watersheds almost touching the ecoregion (HUC 1505030502 in Pima County in AZ and HUC 1303020105 on the southern border of Grant County in NM), are included as part of the assessment area shown in Figure 3-2. (The rationale for being more inclusive was to ensure that entire mountain ranges were assessed, rather than being cut off at the ridgeline, and that other landforms were similarly included with associated features.) The assessment area for this ecoregion is 15.7 million acres or 24,600 square miles.

A substantial portion of the Madrean Archipelago ecoregion lies in Mexico, as shown in Figure 3-2. To date, the REAs have been conducted entirely within U.S. borders. From both an ecological and a management standpoint, it may be useful to understand the ecosystems and change agents throughout the entire ecoregion in order to address some management questions. Per decisions in the first AMT workshop, narrative text in the conceptual models for Conservation Elements will address the CEs' ecology for the entire Madrean Archipelago ecoregion (both U.S. and Mexico portions). Availability of key data sets for the Mexican part of the ecoregion will also be preliminarily evaluated and discussed with the AMT. At this stage, a decision has not been made to conduct spatial assessments beyond the U.S. border; data availability and project sideboards will inform that decision.

BLM has recently finalized and approved the Sonoran Desert REA (adjoining the west side of the Madrean Archipelago) and initiated the REA for the adjacent Chihuahuan Desert to the east. Given that REAs assess areas composed of ecoregions and their intersecting HUCs, there is built-in overlap in the geographies addressed in adjacent REAs. While BLM and the contractor team will coordinate accordingly with the Chihuahuan REA team on boundary concerns, overlap between the two assessment areas is ensured.

Figure 3-2. The MAR assessment area boundary (yellow line), composed of the U.S. Madrean Archipelago ecoregion (light gray area) combined with its intersecting 5th-level watersheds. Per decisions in the first AMT workshop, all intersecting watersheds are included in the assessment boundary, including those with minimal overlap and two watersheds that almost touch the ecoregional boundary. The Mexico portion (dark gray area) of the Madrean Archipelago ecoregion is shown for reference.



3.4.4 Schedule

The Madrean Archipelago REA will be conducted over the two-year period from September 30, 2012 through September 29, 2014. As noted previously, it is divided into two phases, the Rapid Ecoregional Pre-Assessment Phase (Phase I) and the Rapid Ecoregional Assessment Phase (Phase II), with specific tasks in each phase. Table 3-1 summarizes the two phases, their component tasks, and the timeframe for each task. In general, the timeframes are as specified in the SOW. However, given that the AMT membership was still being assembled for this REA three months into the project, the project initiation task (Phase I, Task 1) had a slightly longer time frame (3 months instead of 2), with the caveat that the additional month would be made up elsewhere to ensure completion according to the original schedule. Start dates for each task are approximate because in some instances, a small amount of work for the task in question may need to be initiated during the previous task; although not fully reflected here, there is some overlap between tasks.

Table 3-1. Summary of REA phases, tasks, and timeframes.

Phase	Task #	Task	Timeframe: # of months (adjusted)	Approximate Start Date	End Date	Timeframe Comments
Phase I	Task 1	Initiate Project	3 months	October 2012	End of December 2012	End date is currently extended beyond 13 weeks proposed, even with shortened turn-around time by both BLM and contractor on deliverables and their review, because AMT 1 workshop could not be scheduled earlier.
	Task 2	Implement Pre-Assessment Work Plan	6 months (5.6 months)	January 2013	End of June 2013	Planned for end of June; extended CE selection process has extended CE conceptual model development
Phase II	Task 1	Create Assessment Work Plan	2 months	July 2013	End of August 2013	Also slightly delayed in finalizing the work plan
	Task 2	Inventory, Acquire, and Evaluate Data Develop Process Models	6 months (5 months)	Late August 2013	Early January 2014	Due to the challenges frequently encountered in acquiring and evaluating data, data acquisition is expected to begin at the beginning of Phase II.
	Task 3	Develop Geoprocessing Models Conduct Analyses Generate Findings Assemble Data Packages	5 months	Early January 2014	End of June 2014	

Phase	Task #	Task	Timeframe: # of months (adjusted)	Approximate Start Date	End Date	Timeframe Comments
	Task 4	Final REA Report	3 months	July 2014	End of September 2014	The report contents will be compiled concurrent with other tasks as information becomes available.

AMT workshops are generally milestone events in each task where products or assessments or deliverables are reviewed by the AMT and Technical Team for needed revisions. In general, the contractor has committed to providing draft deliverables to the BLM, AMT, Technical Team, and others as specified or appropriate one week prior to AMT workshops, per contract requirements. In general, BLM has committed to providing comments or accepting or rejecting deliverables within two weeks after AMT workshops or after final deliverables have been submitted, also per contract requirements. The time needed to complete various components of REA tasks, the timing and sequencing requirements around AMT workshops and other events, and the broader timeframe constraints associated with each task collectively determine the details of the project schedule.

3.4.5 Budget

The budget is designed to cover the work proposed by BLM's Statement of Work for the Madrean Archipelago REA as defined by the contractor team's accepted proposal. The available budget was planned to address up to 20 conservation elements (CEs): 10-12 coarse-filter and 8-12 landscape species. Four primary categories of change agents, as specified by BLM, will be addressed: climate change, fire, invasives, and development. A limited number of special assessment MQs will be addressed, depending in part on their complexity. While these basic parameters for the REA are established, details about specific CAs and CEs, necessary input data generation, types of MQs, etc. will influence how many outputs are feasible within the time and budget constraints. The outline below summarizes the major components of each REA Phase and Task that will be conducted or provided by the contractor team for the budgeted amount.

The REA process is designed to allow for review and comment by the BLM and AMT to improve or enhance the REA products, and time is built into the project to accommodate this. Where suggested revisions or enhancements go beyond the original proposal, it will be up to the contractor team's discretion to determine whether such items can be addressed within the available budget. In general, work that goes beyond the original conceptual or geographic scope of the REA proposal, or would alter the timeline, cannot be part of a rapid assessment.

Phase I: Rapid Ecoregional Pre-Assessment

1) Task 1: Initiate Project
    a) Develop and Submit Draft and Final Deliverables:
        i) Pre-Assessment Work Plan
        ii) Assessment Management Team Charter
        iii) Technical Team Charter
        iv) Communication and Collaboration Work Plan
    b) Organize and Lead AMT Workshop 1
    c) Conduct Communication Updates
        i) Conduct Partner Update Webinar
        ii) Develop and Submit Brochure
2) Task 2: Implement Pre-Assessment Work Plan
    a) Organize and Lead Development Forums
    b) Develop and Submit Proposed, Draft, and/or Final Pre-Assessment Report
        i) Management Questions

ii) Conservation Elements
iii) Change Agents
iv) Draft Conceptual Models for 2 or 3 example Conservation Element (Key Ecological Attributes (KEAs), indicators, model diagram)
v) Final Conceptual Models for all Conservation Elements (final only)
vi) Conceptual Model for Ecological Integrity (draft and final only)
vii) Annotated Bibliography (final only)

c) Organize and Lead AMT Workshop 2

d) Develop and Submit Final Pre-Assessment Report

e) Conduct Communication Updates

i) Conduct Partner Update Webinar
ii) Develop and Submit Brochure

Phase II: Rapid Ecoregional Assessment

1. Task 1: Create Assessment Work Plan

    a. Develop and Submit Draft Assessment Work Plan

    b. Organize and Lead AMT Workshop 3

    c. Develop and Submit Final Assessment Work Plan

    d. Conduct Communication Updates

    i. Conduct Partner Update Webinar
    ii. Develop and Submit Brochure

2. Task 2: Inventory, Acquire, and Evaluate Data & Develop Process Models

    a. Develop and Submit Proposed, Draft, Final Data Inventory/Acquisition/Evaluation, Data Quality Assurance, and Process Models

    i. Data Inventory & Tracking Report
    ii. Data Quality Assurance Worksheet
    iii. Process Models for each CE/Conceptual Model

    b. Organize and Lead AMT Workshop 4

    c. Conduct Communication Updates

    i. Conduct Partner Update Webinar

    d. Updated Assessment Work Plan

3. Task 3: Develop Geoprocessing Models, Conduct Analyses, Generate Findings, and Assemble Data Packages

    a. Develop geoprocessing models based on the process models completed in Phase II Task 2, one for each conceptual model: Proposed (examples), Draft, Final

    b. Conduct analysis to deploy the geospatial models and document the processes involved: Proposed (examples), Draft, Final

    c. Conduct climate change assessment and document the processes involved: Proposed, Draft, Final *d.* Generate and interpret findings for each model with a focus on the status and potential for change for each CE: Proposed (examples), Draft, Final

   e. Assemble data packages for each geoprocessing model, containing all data and tools required to run each geoprocessing model: Proposed (examples), Draft, Final

   f. Organize and Lead AMT Workshop 5

   g. Conduct Communication Updates

      i. Conduct Partner Update Webinar

   h. Updated Assessment Work Plan

4. Task 4: Final REA Report

   a. Develop and Submit Report, Other Electronic Datasets, Working Documents, Background Documents and Index: Draft, Final

   b. Organize and Lead AMT Workshop 6

   c. Conduct Communication Updates

      i. Conduct Series of Results Webinars (BLM management, BLM offices, and partners)
      ii. Develop and Submit Three Final Brochures

4 Rapid Ecoregional Assessment

4.1 Overview of Assessment Process

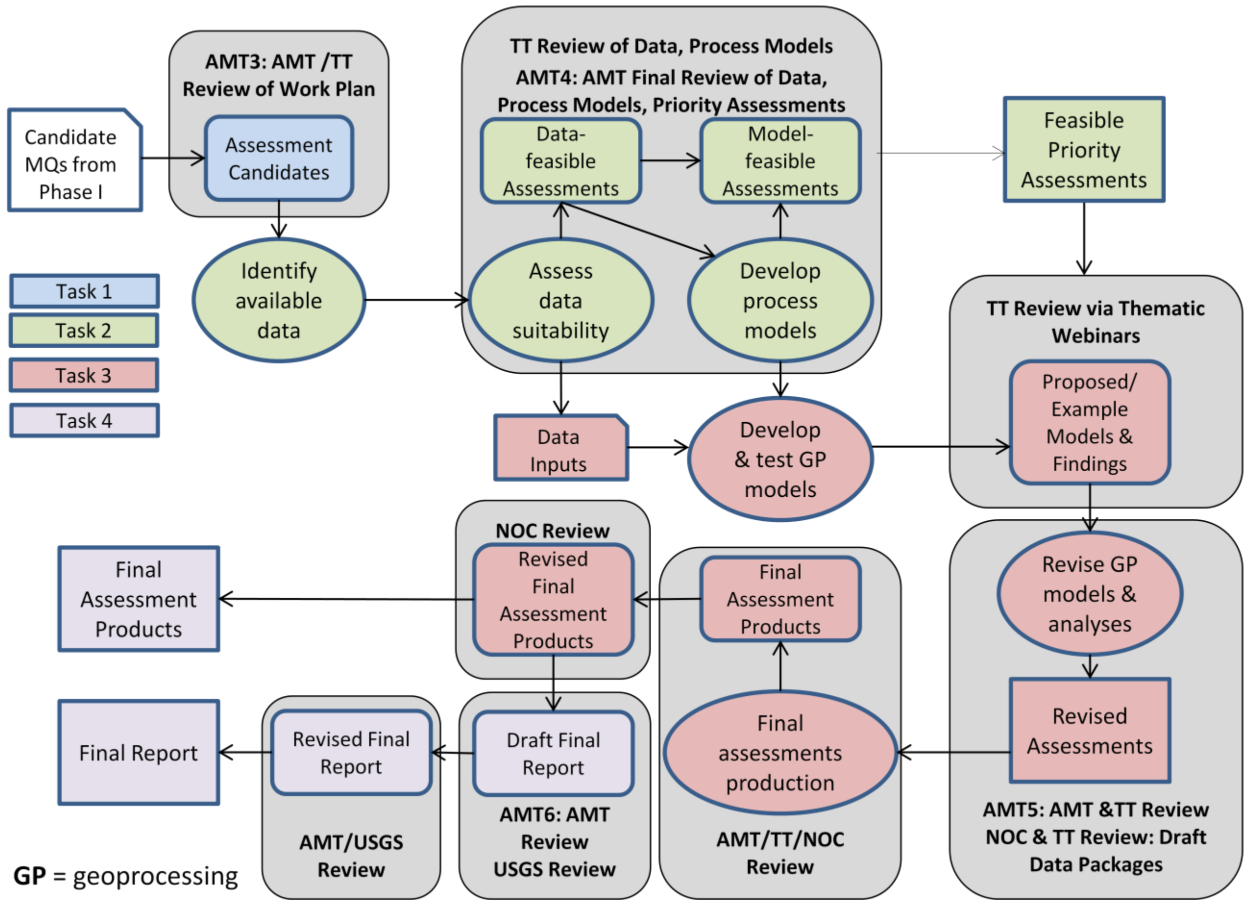
The Madrean Archipelago assessment is conducted in the second phase of the REA and is organized around four tasks. The initial task of the assessment phase (Phase 2, Task 1) is to develop the work plan for the assessment, reflected in this document, followed by the actual assessment work conducted in Tasks 2, 3, and 4. The work plan outlines both the standard assessments that will be conducted (e.g., ecological status, ecological integrity) and the array of potential special assessments that are under consideration for the REA, as well as the steps required to complete the REA, including the final report.

The subset of special assessments that are technically feasible to conduct (from a data and methods availability perspective) will be determined in the course of the first two tasks of the assessment phase; their final prioritization for assessment will be a joint decision among the AMT, Technical Team, and contractor team. As part of the development of the work plan in Task 1, the special assessments under consideration received an initial review by the AMT and Technical Team to understand the relative priority of each and to confirm those identified as out-of-scope by the contractor team.

In Task 2, the team compiles and reviews available data and develops diagrams illustrating the process models for conducting both the standard and special assessments. Data review for special assessments will be informed by their relative priority as indicated through AMT review of the initial draft of the work plan. Where data are available and resources permitting, special assessments considered to be medium or high priority will receive process models. The contractor team will then review the suite of standard assessments (CE ecological status, ecoregion integrity), associated data preparation (e.g., if CE or CA distributions need to be improved or modeled), and potential special assessments to provide an initial indication of the subset of special assessments that may be feasible to conduct within the project resources. The contractor team will work with the AMT and Technical Team to further prioritize the special assessments to guide Task 3 geospatial analysis.

In Task 3, the process models are translated to geoprocessing models, geospatial analyses are conducted, and the results are reviewed; in the final Task 4, the findings are interpreted and summarized in a final report. The AMT and Technical Team are engaged to provide review at key points throughout each of the tasks in the assessment phase, as broadly illustrated in Figure 4-1 and detailed in the **AMT and Technical Team Review** sections later in the work plan for each of the three remaining assessment tasks, Tasks 2, 3, and 4.

Figure 4-1. Illustration of the specific tasks in the assessment phase of the REA (Phase II) and points of engagement with the AMT, Technical Team (TT) and National Operations Center (NOC). The diagram starts in the upper left and moves to the right and clockwise to finish in the lower left. The tasks are color-coded (green = Task 2, etc.) Review by AMT, TT, NOC, and other reviewers is shown in the gray rounded rectangles. Contractor tasks are shown in ovals, interim products are shown in rounded rectangles, and final products are shown in rectangles.



4.2 *Overview of Assessments to be Conducted*

The purpose of this section is to provide an overview of the specific assessments that may be conducted pending confirmation of data availability and model feasibility, as well as the special assessments that are under consideration for this REA. The fundamental goal of the REAs is to provide an understanding of the current ecological status of resources values (CEs) in the ecoregion, which CAs are impacting them and where, and the potential future status of CEs in relation to projections of CAs into the future. We separate the concept of Management Questions (MQs) from assessments because the intention is for the assessment outputs to be broadly applicable to many types of MQs but not necessarily provide the specific, detailed answers to any individual MQ.

These REA information needs can be further distilled into the following broad and inter-related categories of assessments:

- Where do CAs overlap with CEs? This is the most basic type of assessment that simply looks at coincidence between these features rather than an evaluation of CA effects on CEs. Such intersections are a precursor for conducting the next category of assessments: ecological status of CEs.
- What is the condition or ecological status of ecosystem and species CEs? (Ecological status is in part determined by the effects of CAs on CE extent and condition.)
- What is the ecological integrity of the ecoregion as a whole?
- Special assessments that do not easily fit into any of the above categories

Conservation Elements and Change Agents

The CE selection process described in the pre-assessment report (Harkness et al. 2013) for this REA, resulted in the selection of nineteen CEs for this REA: eleven ecological systems, six individual species, and two species assemblages. Selected ecological systems are listed in Table 4-1; the ecological systems are organized according to the major system components of the ecoregion conceptual model. Species are listed in Table 4-2.

Table 4-1. Ecological system CEs selected for the Madrean Archipelago REA.

Level in ecoregional conceptual model	Ecosystem Name	Percent of Ecoregion
Valley Dry Land Ecosystems		**56.0%**
Desert Scrub	Apacherian-Chihuahuan Mesquite Upland Scrub	19.5%
Desert Scrub	Chihuahuan Creosotebush Desert Scrub	13.2%
Semi-desert Shrub & Steppe	Apacherian-Chihuahuan Semi-Desert Grassland and Steppe	18.2%
Foothill Woodlands	Madrean Encinal	5.1%
Montane Dry Land Ecosystems		**13.4%**
Lower Montane Forests & Woodlands	Madrean Pinyon-Juniper Woodland	5.8%
Montane Shrublands	Mogollon Chaparral	4.8%
Subalpine/Montane Forests & Woodlands	Madrean Montane Conifer-Oak Forest and Woodland (includes ponderosa pine)	2.8%
Valley Wet Ecosystems		**4.3%**
Basin River & Riparian	North American Warm Desert Riparian Woodland and Shrubland, Mesquite Bosque and Stream	3.3%
Marshes/Cienegas	North American Arid West Emergent Marsh/Cienega and Pond	1.0%
Playa Lakes (ephemeral wetlands)	North American Warm Desert Playa & Ephemeral Lake	<1%
Montane Wet Ecosystems		**<1%**

Level in ecoregional conceptual model	Ecosystem Name	Percent of Ecoregion
Montane Streams & Riparian	North American Warm Desert Lower Montane Riparian Woodland and Shrubland and Stream	<1%

Table 4-2. Species CEs selected for the Madrean Archipelago REA.

Category	Species Name
Mammal	Desert bighorn sheep, all subspecies
Mammal	Pronghorn
Mammal	Coues deer
Mammal	Black-tailed prairie dog
Mammal	Nectar-feeding bats
Bird	Grassland bird assemblage
Reptile	Ornate box turtle
Amphibian	Chiricahua leopard frog

The change agents to be assessed in this REA represent four broad categories of stressors in the ecoregion and are listed below. “Development” in particular covers a range of infrastructure and direct human uses of land.

1. Development
    - Urban/suburban, commercial, industrial development
    - Roads
    - Utilities
    - Mining
    - Energy development
    - Agriculture
    - Livestock grazing
    - Border-related infrastructure, including barriers, roads, lighting, and related features
    - Other human infrastructure or direct uses of land not captured above
2. Fire
3. Invasives
    - Non-native, invasive species
    - Native woody increasers
4. Climate Change

The starting point for the REAs is documenting the location or spatial extent of CEs and CAs, to the extent permitted by available data or modeling tools. The questions of “Where are the CEs” or “Where are the CAs” are generally not considered to be a separate category of assessment in the REA; they are intentionally not listed as explicit MQs in the list of MQs that informed the scope of this REA. However, the CE and CA distributions are a building block of the REA that will be addressed through the provision of data on those spatial extents. These data sets will form the foundation for analyses conducted for the REA.

4.2.1 Scenario Approach for REA Assessments

To evaluate the current status of CEs (in relation to current CAs), understand how CAs might change in the future, and understand how that may affect future status of CEs, a scenario approach will be used for this REA. In other words, CEs and CAs are evaluated for both current conditions and anticipated future conditions, data permitting. The current distribution of CAs will be aggregated to provide a spatial representation of the current situation (2013 conditions, based on data available as of the initiation of the assessment process.) A near-term (2025) scenario and a mid-century (2060) scenario will also be developed, data permitting, to characterize potential future distributions of CAs and their projected impact on CEs in the future. The approximate time frames of 2025 and 2060 are proposed to be consistent with other REAs, but may be adjusted to reflect the time frames associated with data available for such analysis; climate change analyses in particular will reflect 30-year "time slices" around the near-time and mid-century time frames. Scenarios are cumulative, meaning that the current scenario represents all CAs currently existing in the MAR and that these features will be represented in the future scenarios as well, as long as they are anticipated to continue into those future time frames. Likewise, anticipated expansions of CA extents in the 2025 scenario will be represented in the 2060 scenario as appropriate. In technical terms, a scenario is comprised of a virtual stack of GIS layers that represent CA distributions and their attributes for that point in time (and for future scenarios, the CA distributions from previous scenarios as well) that are needed for modeling their effects on CEs.

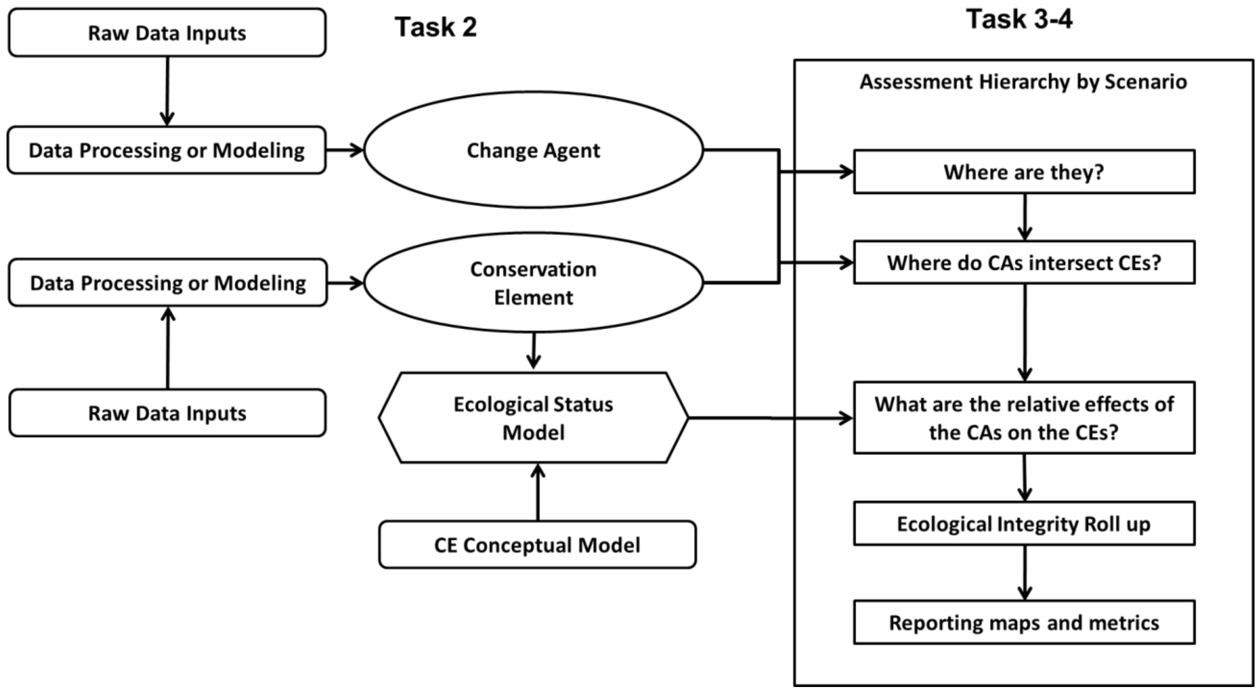
Previous REAs have typically used a near-term scenario for the year 2025 and a mid-century scenario around 2040-2060, depending on available data and assessment needs. The team proposes to use 2025 and 2060 as the two time frames for future scenarios for this REA, but these may be adjusted if needed based on data availability and information needs of the BLM and REA participants.

4.2.2 Ecological Status of CEs: Current and Future

Assessing the ecological status or condition of CEs is one of the major required components of an REA; status will be evaluated for all of the CEs selected for this REA for current conditions, and data permitting, future conditions as well. At its most basic, assessment of status will include the direct intersection of change agent distributions with distributions for each CE, to understand the patterns of spatial overlap between CAs and CEs. While a simple data intersection does not model CA effects on CEs, it allows quick visual and quantitative evaluation of the potential for CA impacts on CEs. Statistics on the area and proportion of the CE overlapped by each CA and total area and proportion of the CE overlapping with all specified CAs can be calculated and summarized.

At its most complex, assessing ecological status requires an estimation of the relative effects of CAs on CEs, initially documented in the conceptual model for each CE, and thence including a spatial representation of those effects. The general model for assessing ecological status is depicted in Figure 4-2; it illustrates how data are obtained or modeled to develop distributions for CEs and CAs, and how those data are intersected and otherwise assessed to estimate ecological status.

Figure 4-2. General conceptual model of ecoregional assessments depicting the steps from developing CE and CA distributions through the process of assessing ecological status.



The specific approach for assessing the ecological status of CEs will be drawn from the characterization of each CE as documented in its conceptual model. The CE conceptual models characterize the CE's reference conditions (including natural composition, structure, and dynamic processes, per Parrish et al. 2003, Unnasch et al. 2008), common stressors or change agents, and their observed ecological effects on the CE (Faber-Langendoen et al. 2012). Based on these characterizations, the conceptual models identify the key ecological attributes (KEAs) that together determine the health or ecological status of the CE; an example of KEAs is shown in Table 4-3. Using the KEAs, a series of specific, measurable indicators will be identified that may be used to gauge ecological status of the CE. The indicators may be stressor-based, reflecting the impacts of stressors or change agents on the CE (e.g., water quality indicators), or they may be direct indicators of the natural characteristics of the CE (e.g., native species composition).

Table 4-3. Examples of Key Ecological Attributes (KEA) for the North American Warm Desert Riparian Woodland and Shrubland, Mesquite Bosque, and Stream ecosystem. KEAs are the foundation for identifying specific, measurable indicators to assess ecological status.

KEA Class: **Name**	**Definition**	**Rationale**	**Stressors**
Landscape Context: **Landscape Cover**	The extent of natural ground cover for the watershed containing the riparian/stream ecosystem occurrence, versus the extent of different kinds of modifications to the watershed surface for human use.	Surrounding watershed cover in unaltered landscapes helps determine the rates of precipitation runoff versus infiltration, evapotranspiration, soil erosion (both "sheet" and "channel" erosion), and transport of sediment, dissolved and suspended nutrients to the riparian/stream location from the watershed as a whole and from its immediate "near-stream" buffer zone. Surrounding watershed cover also shapes the connectivity between the riparian/stream corridor and the surrounding landscape for fauna that move between the two settings; and the longitudinal connectivity of the buffer zone alongside the corridor within which additional wildlife movement takes place. (Comer and Hak 2009)	Stressors to landscape cover include watershed development and/or excessive grazing, which can alter the rates of runoff versus infiltration from precipitation, evapotranspiration, soil erosion (both "sheet" and "channel" erosion), and transport of sediment, dissolved and suspended nutrients to the riparian/stream location from the watershed as a whole and from its immediate "near-stream" buffer zone. Development and excessive grazing also can introduce pollutants and cause fragmentation (reduces connectivity) between the riparian/stream corridor and the surrounding landscape and along the buffer zone surrounding the corridor. Climate change also has the potential to cause additional change in landscape cover.
Size/Extent: **Vegetation Corridor Extent**	The longitudinal extent of uninterrupted (unfragmented) native vegetation patches along the riparian corridor.	Unfragmented riparian corridors support individual animal movement, gene flow, and natural flooding and sediment deposition and scour processes upon which aquatic and wetland species depend. More extensive and highly connected riparian corridors are ecologically more resistant and resilient, for example by providing refugia and movement routes that support recovery following disturbance or incursions by non-native species (Faber-Langendoen et al. 2012b).	Stressors to vegetation corridor extent include development on/in the riparian corridor itself, including: conversion to agriculture, excessive grazing, commercial/industrial/residential use; construction of transportation infrastructure; and dams/impoundments. These changes can alter the movement of water, nutrients, animals, and sediment. Lateral constrictions can lead to increased velocity of flows, contributing to increased erosion and down-cutting. Climate change also has the potential to cause additional change in vegetation corridor extent, through its impacts on hydrology (see Hydrologic Regime).

KEA Class: Name	Definition	Rationale	Stressors
***Size/Extent:* Aquatic Corridor Extent**	The longitudinal extent of the stream channel network, uninterrupted by barriers or reaches without even naturally seasonal or intermittent flow.	Unfragmented aquatic corridors support up- and downstream movement and gene flow for aquatic animal species, natural downstream transport of larvae and seeds, and natural downstream transport of sediment and both dissolved and suspended nutrient matter -- all processes crucial to sustaining the aquatic food web, aquatic and riparian species populations, and succession and recovery from disturbances. More extensive and highly connected aquatic corridors are ecologically more resistant and resilient, for example by providing refugia and movement routes that support recovery following disturbance.	Stressors affecting aquatic corridor extent include dams and diversions, riparian corridor development (see Vegetation Corridor Extent), surface- and groundwater use (see Hydrologic Regime), channelization (see Geomorphology), and concentrated contamination such as from mine waste (see Water Chemistry). Climate change also has the potential to cause additional change in aquatic corridor extent, through its impacts on hydrology (see Hydrologic Regime).
***Biotic Condition:* Riparian & Aquatic Flora**	The taxonomic composition of the native floral assemblage of the riparian corridor including woody and non-woody vegetation - terrestrial, wetland, and aquatic - and the pattern(s) of natural variation in this composition over time (seasonal, annual, longer-term).	The taxonomic composition of the riparian & aquatic floral assemblage is an important aspect of the ecological integrity of a riparian/aquatic ecosystem. Numerous native species of woody and non-woody plants occur preferentially or exclusively in riparian habitats, from floodplain terraces to stream banks and perennial pools; and occur in different successional settings following disturbance. These species vary in their sensitivity to different stresses such as alterations to riparian corridor hydrology (e.g., water table and flood dynamics), aquatic and riparian corridor connectivity (affecting availability of seed for recolonization following disturbance), and altered water quality. Alterations in the taxonomic composition of the riparian floral assemblage beyond its natural range of variation therefore strongly indicates the types and severities of stresses imposed on the riparian ecosystem.	Stressors to the taxonomic composition of the riparian native floral assemblage experiences include the cumulative impacts of all stressors affecting the landscape context, size/extent, and abiotic condition of the riparian/stream ecosystem, including altered wildfire and excessive grazing; and incursions of non-native species that alter the habitat (e.g., alter soils) or directly compete with the native flora.

KEA Class: Name	Definition	Rationale	Stressors
Biotic Condition: **Aquatic Fauna**	The taxonomic and functional (e.g., guild) composition of the native faunal assemblage of the stream, including fishes, reptiles and amphibians, and invertebrates; and the pattern(s) of natural variation in this composition over time (seasonal, annual, longer-term).	The taxonomic and functional composition of the aquatic faunal assemblage are important aspects of the ecological integrity of a stream ecosystem. Aquatic species - as especially well studied for fishes and macroinvertebrates - vary in their roles in the aquatic food web and in their sensitivity to different stresses such as alterations to stream hydrology, habitat quality, water quality, and nutrient inputs. Alterations in the taxonomic and functional composition of the aquatic faunal assemblage beyond their natural ranges of variation therefore strongly indicate the types and severities of stresses imposed on the aquatic ecosystem.	Stressors affecting the taxonomic and functional composition of the aquatic faunal assemblage include the cumulative impacts of all stressors affecting the landscape context, size/extent, and abiotic condition of the riparian/stream ecosystem; and incursions of non-native species that alter the food web or directly compete with or prey on the native fauna.
Abiotic Condition: **Hydrologic Regime**	The pattern of surface flow in the stream channel and surface-groundwater interaction along the riparian corridor - as characterized by, for example, the frequency, magnitude, timing, and duration of extreme flow conditions and extreme water table elevations; the magnitude and timing of seasonal and annual baseflow and total discharge; and the magnitude of seasonal and annual water table mean elevation.	The surface flow regime determines which aquatic species can persist in a stream system through their requirements for or tolerances of different flow conditions at different times of the year; shapes sediment transport and geomorphology and therefore aquatic habitat distributions and quality; and determines the pattern of flood disturbance. In turn, interactions between the surface flow regime and underlying aquifer conditions shape the pattern of baseflow in the former and the pattern of water table variation along the riparian corridor. The surface flow regime and surface-groundwater interactions thereby together strongly influences both aquatic and riparian habitat and biological diversity (e.g., Poff et al. 1997; Collins et al. 2006; Poff et al. 2007).	Stressors affecting the hydrologic regime include watershed development that alters runoff, infiltration (recharge), and evapotranspiration rates; surface water diversions, transfers, and use; groundwater withdrawals from basin-fill and alluvial aquifers; return flows of municipal and agricultural wastewater; dams, dam operations, and impoundment evaporation; riparian corridor development; and alterations to the riparian floral assemblage including invasions of non-native flora with high water consumption. Climate change also has the potential to cause additional change in the hydrologic regime, through its effects on precipitation form (snow vs. rain), spatial distribution, magnitude, and timing; and through its effects of evapotranspiration rates both within the riparian zone and across the surrounding watershed. Climate change may also cause changes in human water use.

KEA Class: Name	Definition	Rationale	Stressors
Abiotic Condition: **Geomorphology**	The geomorphology of the stream channel, banks, and floodplain, including channel steepness, cross-sectional form, sediment size distributions, and geomorphic stability/turnover.	Channel and floodplain geomorphology, shaped by watershed runoff (sediment and water) and surface flows in the stream, create the habitat template for both riparian and stream flora and fauna. Altered channel substrate and geomorphology strongly affect aquatic faunal assemblage composition and complexity and both stream-floodplain and surface-groundwater interactions along riparian corridors.	Stressors affecting the geomorphology of the stream channel, banks, and floodplain include the cumulative effects of alterations to watershed cover, riparian and aquatic corridor connectivity, riparian flora, and hydrology; the effects of bank and channel trampling from excessive use by livestock; and the effects of direct channel and floodplain modifications such as channelization and gravel mining. Climate change also has the potential to cause additional change in stream channel morphology through its impacts on watershed cover (see Landscape Cover) and hydrology (see Hydrologic Regime).
Abiotic Condition: **Water Chemistry**	The chemical composition of the water moving into the riparian corridor water table and along the stream channel, including the pattern(s) of natural variation in this composition over time (seasonal, annual, longer-term).	The chemistry of the water flowing into and through riparian and stream habitat strongly determine which plant and animal species can persist in these habitats through their requirements for or tolerances of different soil and stream water chemistries. Stream fauna, for example, vary in their requirements for or tolerances of variation in salinity, dissolved oxygen, temperature, turbidity, and the presence/absence of different dissolved and suspended matter including anthropogenic pollutants.	Stressors affecting water quality include the cumulative effects of non-point source pollution from watershed development, point-source pollution (e.g., municipal, industrial, mining wastewater), atmospheric deposition, excessive use of riparian zones as pasturing areas for livestock, and altered groundwater discharge (see Hydrologic Regime). Climate change has the potential to exacerbate these impacts through changes in watershed runoff and water use.

Ecological status will be assessed by reviewing the KEAs and possible relevant indicators identified in the conceptual model for each CE. Many direct measures of ecological condition (such as native species composition) require field-based observation and measurement, while many indicators of ecosystem or species habitat stress can be addressed using remotely sensed data (e.g., land cover), other data compiled in a GIS (e.g., certain water quality indicators), or modeling using such spatial data sets. Given the rapid and regional nature of an REA, and the rarity of comprehensive, consistent, field-based observation data on direct indicators of condition, stressor-based indicators will generally be used.

Appendix C of the pre-assessment report (Harkness et al. 2013) describes the approach for assessing ecological status in more detail. It also discusses how indicators for measuring status might be selected, depending upon the available data and the purpose of the assessment being conducted. In addition, it provides an overview of the levels of assessments of status and the kinds of data used for those, which are summarized here in Table 4-4. While an REA is generally a “remote” assessment, if field-based data are available across the entire ecoregion in a useable format, they can be utilized to represent one or more indicators. An example would be data on field-mapped occurrences of invasive plant species which can be used to build a predictive distribution model for those invasives.

Table 4-4. Summary of three-level approach to conducting ecological integrity assessments (adapted from Brooks et al. 2004, USEPA 2006).

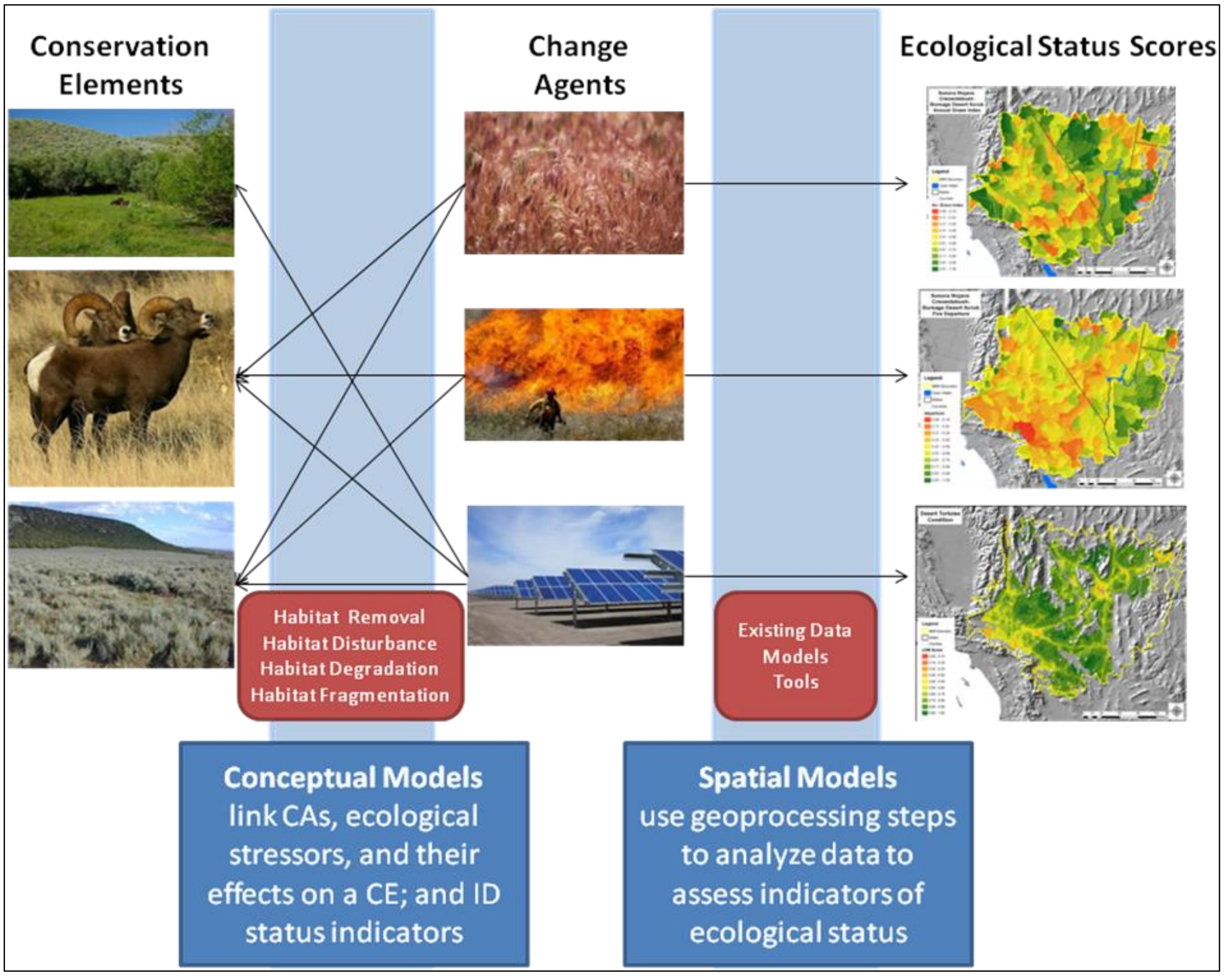
Level 1: Remote Assessment	Level 2: Rapid Assessment	Level 3: Intensive Assessment
General description: Remote assessment	**General description:** Rapid field-based assessment	**General description:** Detailed field-based assessment
Evaluates: Condition of individual areas / occurrences **Using:** • metrics within the occurrence that are visible with remote sensing data, and • Landscape / watershed condition around the occurrence	**Evaluates:** Condition of individual areas / occurrences **Using:** • relatively simple field metrics • coupled with remote sensing metrics for landscape context, • limited ground truthing / resolution	**Evaluates:** Condition of individual areas / occurrences **Using:** • relatively detailed quantitative field metrics • coupled with remote sensing metrics for landscape context • expanded ground truthing / resolution

Based on:
• GIS and remote sensing data
• Layers typically include:
  ○ Land cover
  ○ Land use
  ○ Other ecological maps
• Stressor metrics (e.g. land use, roads, predicted invasives)
	Based on:
	• Condition metrics (e.g., hydrologic regime, species composition); and
	• Stressor metrics (e.g., ditching, road crossings, and pollutant inputs)
		Based on:
		• metrics that have been calibrated to measure responses of the ecological system to disturbances (e.g., indices of biotic or ecological integrity)

Potential mitigation uses: • Identifies priority sites • Identifies status and trends of acreages across the landscape • Identifies integrity of ecological types across the landscape • Informs targeted restoration and monitoring	**Potential mitigation uses:** • Informs monitoring of many attributes for implementation of restoration or mitigation projects • Supports landscape / watershed planning • Supports rapid assessment of mitigation of reference sites against mitigation sites	**Potential mitigation uses:** • Informs monitoring of a select set of attributes • Identifies status and trends of specific occurrences or indicators • Supports and informs monitoring for restoration, mitigation, and management projects
Example metrics: • Landscape Development Index (integrated a series of land use categories) • Land Use Map • Road Density • Impervious Surface • Predicted abundance of invasive grasses	**Example metrics:** • Landscape Connectivity • Vegetation Structure • Invasive Exotic Plant Species • Forest Floor Condition	**Example metrics:** • Landscape Connectivity • Structural Stage Index • Invasive Exotic Plant Species • Floristic Quality Assessment (mean C) • Veg Index of Biotic Integrity • Soil Calcium:Aluminum Ratio

The team will identify data sets reflecting those indicators for each CE and develop process models illustrating the analytical steps that will be proposed to assess those indicators using those data sets. The process models will be translated into a series of specific geoprocessing steps that will be used to calculate a set of values indicating the relative status of the CE in relation to the particular indicator across the entire distribution of the CE. The relationship between the CE conceptual models, their characterization of the CE and its relationships to CAs, and the calculation of scores for indicators of ecological status is illustrated in Figure 4-3.

Figure 4-3. Illustration of how the CE conceptual model characterizes the relationship between CEs and CAs , and how those relationships are translated into the spatial models that are used to calculate scores for the various indicators that determine a CE's ecological status.



Examples of tables and maps that could be used to summarize and illustrate CE status indicator scores are provided below (Table 4-5 and Table 4-6, and Figure 4-4 and Figure 4-5).

Table 4-5. Examples of ecological status scores for several species (from the Mojave Basin and Range REA), displayed as counts of 4-km pixels where the CE habitat occurs falling within each scoring interval. Status scores range from 0 to 1, with 1 being the highest status score and 0 the lowest. Graphical illustration of the results for Mojave ground squirrel are shown in the accompanying figure.

KEA: Stressors on Biotic Condition											
Indicator: Presence of Invasive Plant Species	**Count of 4 km pixels by status score interval**										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Mojave Ground Squirrel	2,368	**267**	**374**	205	182	141	149	150	153	181	**566**
Brewer's Sparrow - Breeding Habitat	2,103		6	75	151	97	76	70	76	131	**1421**
Brewer's Sparrow - Migrating Habitat	4,186		2	51	78	86	100	97	126	214	**3432**
Sage Sparrow	386							1	3	20	**362**
Sage Thrasher	1,162		4	53	**115**	97	55	64	77	80	**617**

Figure 4-4. Graphical display of ecological status results for Mojave ground squirrel. Ecological status is scored from high (1.0, dark green) to low (0.0, red) values for the distribution of the CE within each 4-km pixel.

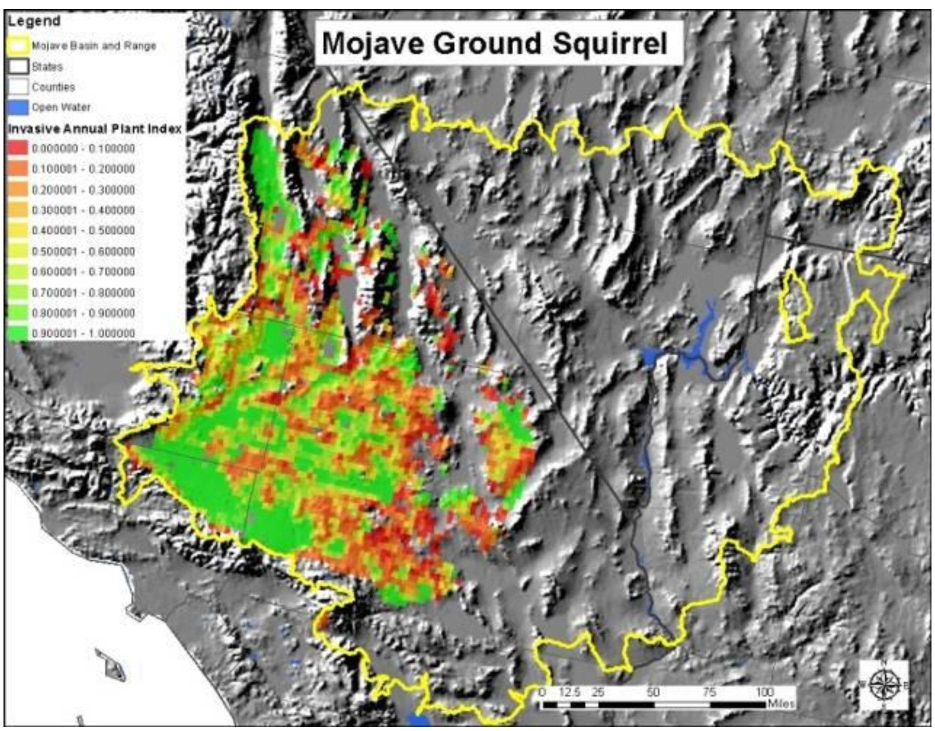
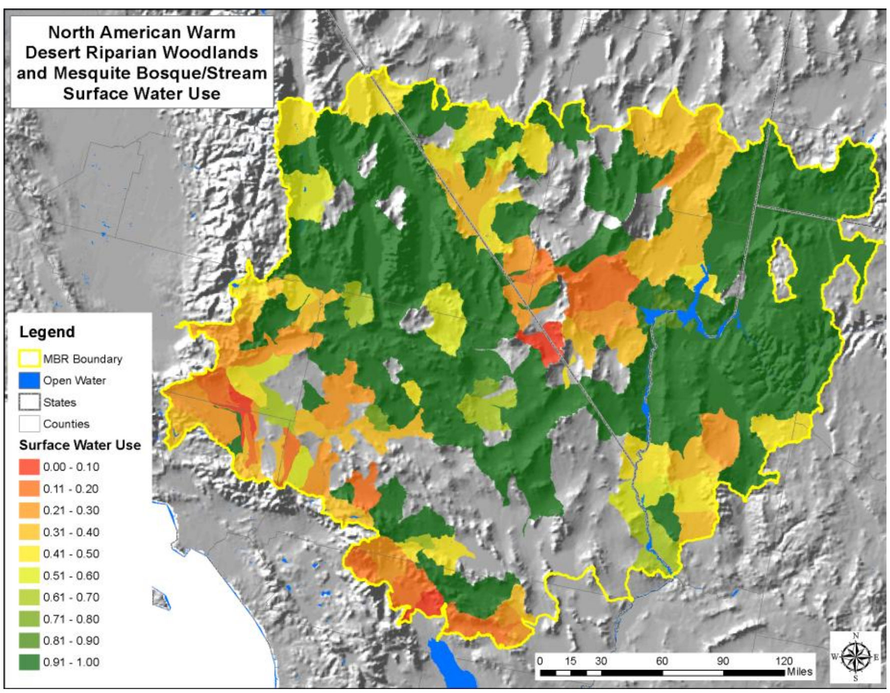


Table 4-6. Examples of ecological status scores for two aquatic/wetland CEs, displayed as counts of 5th-level watersheds where the CE occurs for each scoring interval (from the Mojave Basin and Range REA). Status scores range from 0 to 1, with 1 being the highest status score and 0 the lowest. Graphical illustration of the results for the first of these two CEs is shown in the accompanying figure.

KEA: Stressors on Hydrology Condition											
Indicator: Surface Water Use	**Count of watersheds by status score interval**										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
North American Warm Desert Riparian Woodland and Mesquite Bosque / Stream	246	3	15	20	31	19	8	5	2	1	142
North American Warm Desert Lower Montane Riparian Woodland and Shrubland / Stream	87		6	5	10	8	5				53

Figure 4-5. Graphical display of ecological status results for a riparian/stream (aquatic) CE. Ecological status is scored from high (1.0, dark green) to low (0.0, red) values for the distribution of the CE within each 5th-level watershed.



4.2.3 Ecological Status of CEs: Specific Approaches or Questions

The previous section of the work plan provides a general overview of how ecological status assessments will be approached. In some areas, the contractor team has already developed more detail on potential approaches for assessing certain aspects of ecological status. In addition, a number of management questions were identified by REA participants that did not directly ask "What is the ecological status of conservation element X?" but the questions nonetheless are directly related to the assessment of ecological status for particular ecological system types or species (e.g., aquatic/wetland systems) or in relation to particular change agents (e.g., climate change, grazing, fire, etc.) for all relevant CEs. Although these questions fit broadly under the overall category of ecological status assessments, they highlight particular information needs on CE ecological status that will inform specific approaches and data that should be used in the CE status assessments. Assuming relevant data are readily available, such questions are intended to be addressed as part of the ecological status assessments and interpretation of those assessments will inform questions about the relative role of individual CAs in affecting CE status. These questions were broadly summarized in the pre-assessment report (Harkness et al. 2013) for the REA.

This section of the work plan outlines two types of content relating to ecological status assessments:

1) where it has been developed, the additional detail on potential approaches for assessing certain aspects of ecological status (e.g., the content in the **Hydrology and Aquatic/Wetland CEs** section); or
2) questions that relate back to ecological status assessments, but highlight particular information needs relevant to the CEs or CAs of this ecoregion; to the extent possible at this stage of the REA, specifics on how these might be addressed are included here.

This additional information on specific **approaches** for assessing particular aspects of ecological status or specific **questions** relating to ecological status assessments is organized thematically (consistent with the pre-assessment report) and summarized below. Whether highlighting a specific question or a specific approach, the question is shown in bold and a short-hand name for the question is listed in brackets following the question – for example, [*Ecological Status: Aquatic and Wetland CEs*].

Hydrology and Aquatic/Wetland CEs

Additional information is included here regarding specific **approaches** for assessing ecological status of aquatic/wetland CEs:

1. **What is the ecological status of aquatic and wetland ecological systems?** [*Ecological Status: Aquatic and Wetland CEs*]

   The REA will address questions concerning the current status of each aquatic CE, assessed using "Level 1" indicators (indicators that are based on remotely sensed data; see Table 4-4) for all key ecological attributes (KEAs) for which data are available. The current status of the riparian corridor can be assessed using existing remote-sensing-based data on adjacent development. Given the likely lack of geospatial data on actual flow conditions throughout the ecoregion, we propose to address questions concerning riparian/stream hydrologic condition indirectly using geospatial data on key stressors that affect this condition, such as surface water and groundwater use, and land development within mountain and mountain-front zones of recharge to basin fill aquifers. Such analyses will require data with sufficient spatial resolution to distinguish rates of water use and the extent of development of recharge zones in different portions of each 5th-level watershed.

2. **What are the effects of CAs on aquatic and wetland ecological systems?** [*Ecological Status: Current CA Effects on Aquatic and Wetland CEs*]

   The REA will address questions concerning the current intensity and spatial distribution of each CA affecting each aquatic/wetland CE. The CAs that affect the condition of aquatic/wetland CEs include development (municipal, industrial, agricultural), grazing, climate change, and invasive species. The effects of a CA on an aquatic/wetland CE depend on both the intensity of the CA and its hydrogeologic proximity to the CE. Therefore, the REA must assess development in terms of both its direct removal of aquatic/wetland habitat and its alteration of watershed conditions that affect runoff/recharge and evapotranspiration. We propose to assess removal of aquatic/wetland habitat and alteration of watershed hydrologic functions (e.g., the abundance and distribution of impervious surfaces and runoff-concentrating features) using existing remote-sensing-based data on watershed-scale and near-stream land development. Similarly, it is important to assess consumptive water use – a consequence of development – in terms of the relative magnitudes of surface flow diversions both near and far upstream of a CE type within a watershed, and the relative magnitudes of groundwater withdrawals from both hydrogeologically close (especially alluvial) and more distant (e.g., basin fill) aquifers. Pending confirmation of data availability, therefore, we propose to assess the intensity and spatial distribution of surface water diversions and groundwater withdrawals not only with spatial data on water use (per above) but also with data on, for example, the spatial distribution of surface water diversions and the proportion of each stream's surface flow allocated to human use within the surface drainage network. We will also attempt to assess (pending confirmation of available data) the spatial distribution (point locations) of groundwater pumping, the affected aquifers, and whether aquifer levels (potentiometric surface elevations) are stable, rising, or falling.

3. **How will CAs affect aquatic and wetland ecological systems in the future?** [*Ecological Status: Future CA Effects on Aquatic and Wetland CEs*]

   The REA will address questions concerning the future intensity and spatial distribution of the activity of each CA affecting each aquatic/wetland CE, using geospatial forecasts developed by previous studies, if such data are available for the REA assessment area. For example, such forecasts might address possible scenarios for the future distribution and density of municipal development or for future consumptive water use. However, independent forecasts will not be developed for these CAs within this REA due to the level of intensive modeling that would be required, as well as the likelihood of obtaining results that are too speculative to be useful.

Grazing

A number of questions asked about specific effects of grazing on the ecological status of CEs; those **specific questions** are listed here, along with general information on how the question might be assessed. All of these questions tie back to overall ecological status of CEs, but reflect a need to understand particular aspects of grazing's potential impact on status of relevant CEs.

1. **What are the past, current, and potential future effects of livestock grazing on the ecological status** (extent, condition (including structure and composition), and function) **of ecological systems, particularly semi-desert grassland and riparian/stream systems?** [*Ecological Status: Grazing Effects on System CEs*, and *Ecological Status: Grazing Effects on Soils/Productivity*]

   This group of questions includes understanding impacts to the soils that support these ecosystems. Characterizing the impact of grazing on ecological status could be feasible if appropriate and adequate spatial data on grazing are readily available.

2. **Where has grazing (either historical or present-day) degraded ecosystems to a point where it is not practical to restore them?** [*Ecological Status: Grazing Effects on System CEs*]

   The results of the ecological status assessments for ecological system CEs will provide an indication of where the ecological systems are in poor condition, as well as an indication of which stressors were the primary causes of the poor condition. This will provide an initial indication of where ecological systems may be beyond the point of restoration.

Municipalities, Utilities, Transportation, Industry, Agriculture, and International Border

Additional information on general **approaches** for assessing the effects of development-related infrastructure and land uses on the ecological status of CEs is outlined briefly here.

1. **Where are these features and activities in relation to ecosystems and species?** [*Development CA Distribution*]

   This only requires a simple intersection of these CAs with CEs.

2. **What are the effects of these features and activities on the status of ecosystems and species?** [*Ecological Status: Development Effects on CEs*]

   The relative effects of the development CAs on status will be interpreted from the CE status assessments.

3. **Where are these features and activities expected to be constructed or taking place in the future, and what will their effects on the status of ecosystems and species be in the future?** [*Ecological Status: Future Development Effects on CEs*]

   The REA will not attempt to model the change in distribution of CAs but will utilize existing spatial models or data layers of such changes to assess future (e.g., 2025) CE status.

4. **How will synergies between these features and activities and other CAs (climate change, invasive species, fire) affect the status of ecosystems and species?** [*Ecological Status: Synergistic Effects of Development and Other CAs on CEs*]

   The ecological status assessments provide an additive, cumulative assessment of the effects of all relevant CAs combined together. Synergies may imply a change in the distribution or intensity of one CA based on another CA (e.g., a change in the distribution of an invasive species as a result of infrastructure development) and will generally not be modeled.

5. **Where are ecosystems and species most vulnerable to these impacts, both now and in the future?** [*Ecological Status: Synergistic Effects of Development and Other CAs on CEs*]

   The results of the status assessments (current and future) will identify which CEs are affected, where, and to what degree by the CAs.

Fire

A number of **specific questions** sought to understand fire regimes in relation to the status of ecological systems having fire as a driving ecological process; they were synthesized into the question below. Information on the specific **approach** for assessing this issue is also summarized.

1. **How has the distribution of successional classes in each terrestrial community CE departed from historical conditions?** [*Ecological Status: Ecological Departure of System CEs*]

   Ecological departure is a measure developed by the LANDFIRE program that assesses landscape mosaic structure, by ecological system (also termed "biophysical setting" or BPS). Under a natural fire regime, the number and spatial extent of successional classes remains stable over time as fires "reset" older patches back to early successional stages. Ecological departure, then, is a measure of how this mosaic structure (the relative proportion of each of these successional classes on the landscape) has transitioned as a result of changes in the fire regime. Departure can be reported by both ecological system or stratified by watershed to provide a finer-resolution perspective of where the terrestrial systems are most departed from historical conditions. We anticipate using data from LANDFIRE and the ILAP project to document ecological departure for systems and watersheds. We will use data on recent fire extent and severity to validate (as much as possible) these departure measures. This evaluation is expected to be a component of the ecological status assessment for relevant CEs.

Invasive Non-Native Species and Native Woody Increasers

A specific **approach** is briefly noted for understanding the distribution of this CA. A **specific question** relating to ecological status, and the general approach for addressing it, is also listed.

1. **What is the current distribution of invasive non-native species and other species that are undesirable from a biodiversity management perspective?** [*Invasive Non-native and Native Woody Increasers CA Distribution*]

   Assuming that data are available, providing the mapped extent of change agents such as invasive species is a foundational part of the REA. If adequate data are not available, it may be possible to develop predictive models of potential distribution (e.g., for invasive grasses) as a special assessment. For native woody increasers, the contractor team has a current mapped distribution for mesquite (*Prosopis* spp.), showing its extent in uplands where it has invaded and altered the semi-desert grasslands and encinal. The current distribution of upland mesquite shrublands can be overlaid with the historical distributions of the other ecological system CEs to determine where mesquite has expanded its extent at the expense of other ecosystems. Similar analysis can be done with the creosotebush (*Larrea tridentata*).

2. **Which invasive non-native species are of greatest concern in relation to managing native ecosystems and species and maintaining their ecological status?** [*Ecological Status: Invasive Non-natives and Native Woody Increaser Effects on CEs*]

   This is addressed in part through the conceptual models for the CEs, as well as preliminarily summarized in the pre-assessment report (Harkness et al. 2013).

Climate Change: Climate Space Trends

In the case of climate change, the contractor team has already identified a highly detailed **approach** for assessing climate change in this REA, which is described here. [*Climate Space Trends: Future, 4-km*]

Following careful review of the many climate change-related MQs, the team proposes a revised analysis of climate change impacts for the Madrean REA. Analysis of spatial climate trends using a variety of climate datasets describing historical, current, and modeled future climates will provide basic, spatially explicit, visually intuitive metrics of observed and projected changes. While these metrics may not be converted to a climate change-related indicator for use in ecological status assessment of CEs, this method offers metrics for managers to understand the rate, magnitude, spatial and temporal nature of current and forecast climate trends and view these trends in relation to the spatial distribution of the CEs. The proposed climate space trend analysis will generate baseline values of a range of climate variables, quantify their natural climatic variability, and map the degree of observed change between baseline values and projected changes in future decades.

For understanding projected future changes, the team proposes to use Climate Western North America (Wang et al. 2012), a gridded, time-series, spatial climate dataset of directly calculated and derived variables. The dataset is built on the PRISM 4-kilometer grid, and is therefore consistent with the grid used in the spatial climate and bioclimatic envelope analyses for the CBR and MBR REAs. The dataset includes observations from 1900-2010 and 20 projected futures from a range of GCM x emissions scenario combinations for three 30-year time slices: 2010-2039 (near-term), 2040-2069 (mid-century), 2070-2099 (end century). To be most consistent with previous REAs, all analyses of future change will be based on the **mid-century** time slice.

The team proposes to examine climate space trends for five variables:

1. *Average annual temperature*
2. *Summer maximum temperature*
3. *Winter minimum temperature*
4. *Total annual precipitation*
5. *Summer precipitation*

The final selection of variables is subject to further discussion with the AMT. We will conduct a series of per pixel analyses of trends in these basic variables between a twentieth-century baseline and projected mid-century future conditions from an ensemble of future projections. We will create a baseline value for every 4-kilometer pixel in the REA assessment area for each of the five climate variables by averaging the years 1901-1980. In addition, we will quantify the per-pixel standard deviation across the 80-year baseline, as a metric of natural climatic variability for each variable. We will then create a per-pixel value for the same variables for the mid-21st century future (2040-2069). These values will be derived from averaging the six available future projections from the Climate Western North America dataset that have been run under the A2 emissions scenario as listed in Table 4-7. The A2 emissions scenario is used for consistency with other REAs; that was the only scenario considered in the USGS Hostetler data set that BLM required for use in previous REAs. In addition, this scenario most closely correlates to IPCC's new RCP6.0 scenario and is closest to the trajectory that we are currently on. Only one emissions scenario is addressed due to project scope limitations.

Table 4-7. Future projections available for the A2 emissions scenario from the Climate Western North America dataset.

Model	Run #	Emission Scenario	Time Slice
mri_cgcm232a	1	A2	2040-2069
miroc32_medres	2	A2	2040-2069
gfdl_cm21	1	A2	2040-2069
cccma_cgcm3	5	A2	2040-2069
cccma_cgcm3	4	A2	2040-2069
bccr_bcm20	1	A2	2040-2069

Finally, we will calculate the changes (deltas) and the climate anomalies between the future and the baseline. The deltas represent the per pixel difference in the value of each variable between the mid-21st century future and the 20th century baseline. This analysis will identify the location of the pixels that are changing the most and those that are changing the least for each variable. The climate anomaly analysis compares the future value of each variable per pixel to the standard deviation of the baseline, to identify where future value are forecasted to exceed levels of natural climatic variability. For each variable, we will identify pixels where the future value exceeds plus or minus one or two standard deviations beyond the 20th century baseline. This analysis is intended to identify the nature, spatial distribution, and magnitude of projected climate changes that are exceeding the range of natural climatic variability to which native biodiversity is adapted. Equally important, areas identified as not significantly changing could be considered as resisting change in that variable. When the same area consistently does not experience significant climate change for multiple variables, that region may act as a climate refuge in the future. These results will be intersected with each individual CE, so that significant changes in the climate variables can be viewed against the CE's distribution and summarized.

Our simple, intuitive method uses long-term, 20th century climate records to establish baseline values during 1901-1980, a time representative of the climate to which our cultures and economies are adapted. We calculate the standard deviation (SD) across this 80-year baseline as a metric of natural climatic variability, and use this metric to assess directional, significant changes in the future values of climate variables. When SD values for a given variable are low, the range of values observed over the 80-year baseline is narrow. Conservation elements are adapted to this narrow range of values, and only a little amount of climate change could push CEs beyond their climate tolerance. For example, summer minimum temperatures throughout the range of the coast redwood vary only slightly, since redwood forests occur only along a cool, summer fog-laden sliver of coastal California. Standard deviations across the 80-yr baseline for summer minimum temperature in the area of redwood distribution are low, and redwood-associated species are adapted to this narrow range of summer minimum temperature values. A small increase in summer minimum temperature could expose redwood forest-associated species to the edges of climate tolerance. Alternatively, if there is a very wide range of values observed over the 80-year baseline period for a given climate variable, standard deviations will be relatively high. This is often the case with precipitation in the west, which is highly variable. A substantial change in the amount and distribution of precipitation may be required to exceed the wide range of values to which the regional biota are adapted.

To summarize, this method will produce the following datasets for the five climate variables listed earlier (average annual temperature, summer maximum temperature, winter minimum temperature, average annual precipitation, and summer precipitation):

1) The average value per 4-kilometer pixel per variable for the 20th century baseline (1901-1980)
2) The value of the standard deviation per pixel for that variable across the 80-year baseline
3) The per-pixel changes (deltas) between the baseline and one future mid-century time slice (2040-2069, 6 projections averaged) for each variable
4) The identification of per-pixel climate anomalies for one future mid-century time slice (2040-2069, 6 projections averaged) for each variable

Below is an example of climate space trend analysis for the last 30 years compared to a 20th century baseline, using June minimum temperature as a demonstration variable for this sample analysis in the Madrean REA. This example uses the PRISM 800-meter spatial climate dataset and therefore provides a finer spatial scale than the CWNA 4-kilometer data will be able to provide (see supplement).

Figure 4-6. The delta, or per pixel change in value, for June minimum temperature for the period 1981-2010 compared to the period 1901-1980, in the Madrean Archipelago ecoregion and surroundings.

Darker red values indicate larger magnitudes of recent increase in June minimum temperatures, cream to light red indicates slight warming, and blue values indicate slight cooling in the last 30 years relative to the preceding eighty. While June minimums have increased through most of the assessment area, there is much spatial variability to the magnitude of the increase, and some of the mountain ranges have not experienced this trend.

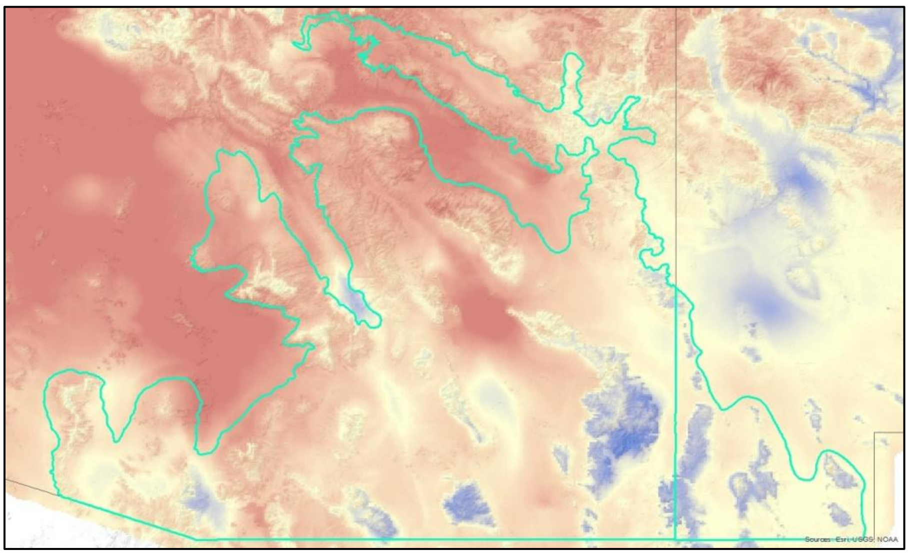
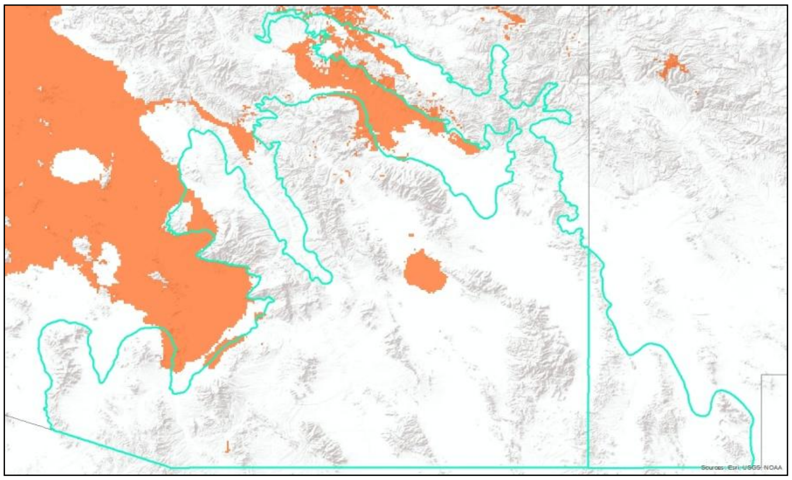


Figure 4-7. Analysis of "climate anomalies." This map shows the location of anomalous values for June minimum temperature in the last 30 years compared to the baseline. Orange pixels have values that exceed 1 SD beyond the value of the 20th century baseline. (Up to 2 SDs can be calculated with the existing modeling tool for this assessment.) These analyses can help to identify trends in the distribution of significant climate change over time. In this particular example, for this particular variable, the increase in June minimums appears to be insignificant for most of the Madrean ecoregion proper (green outline). However, orange areas just outside the ecoregional boundary have experienced significant change in their June minimums. Note that if all 5 climate variables are assessed, there could be significant changes in their values.



4.2.4 Ecological Integrity of the Ecoregion

A simple, overall index of ecological integrity is desired to summarize conditions in the ecoregion as a whole. At the scale of the entire ecoregion, ecological integrity is a function of the interactions among the numerous ecosystem processes that shape the ecoregion and the stressors acting upon it, and the expression of these interactions in the biotic and abiotic condition of the ecoregion. Tests of the various options for building an index of ecological integrity in past REAs suggest that several distinct, but complimentary, indices would provide the best summary information on ecological integrity across the ecoregion. As indicators of ecological status are finalized for individual CEs, they will be used to inform the identification of ecoregion-scale indicators of integrity. The team will consider overarching natural drivers and stressors that affect multiple CEs, and identify data to assess those as indicators of integrity for the ecoregion independently of the CE status assessments.

Some indicators of ecoregional integrity (e.g., fire regime changes, sky island connectivity, extent of native woody increaser shrub species) will be relevant and measurable for upland systems and the species utilizing them, while others (e.g., change to hydrologic regimes) will be more relevant to the wetlands and aquatic features of the ecoregion, and those species CEs closely tied to wetland or aquatic habitats. For example, a model of the potential abundance of invasive grasses could be developed and used as one of the indicators for scoring "biotic condition" as represented by invasive grasses in each 4-km grid cell, for the entire ecoregion. Such an invasive grass indicator of integrity might look like what is shown in Figure 4-8 for the Mojave Basin and Range ecoregion. Fire regime departure could be summarized for all the montane ecological systems and separately for all the lower elevation/valley ecological systems (since current fire regime alterations are likely to be different between the montane and valley systems). Other indicators would be chosen that are relevant to the aquatic CEs, such as a summary of hydrologic condition by 5th level watershed, based on combined groundwater and surface water use (Figure 4-9).

Alternative approaches to assessing ecological integrity for the ecoregion as a whole will be explored, and of necessity will be closely linked to the data identified for assessing ecological status of individual CEs. While the contractor team is not recommending this approach, another option that should be noted includes utilizing status assessment scores for individual CEs and combining those into measures of ecological integrity across the ecoregion (e.g., combining hydrologic condition scores for all aquatic CEs within 5th level watersheds, using an area-weighted averaging method). On-going concerns around the methodological and scientific validity of this approach would require discussion and resolution if it is identified as the desired approach.

Figure 4-8. Summary indicator of potential abundance of invasive annual grass within 4km grid cells for the Mojave Basin & Range ecoregion, scaled from 0.0 (= low integrity, red) to 1.0 (= high integrity, green).

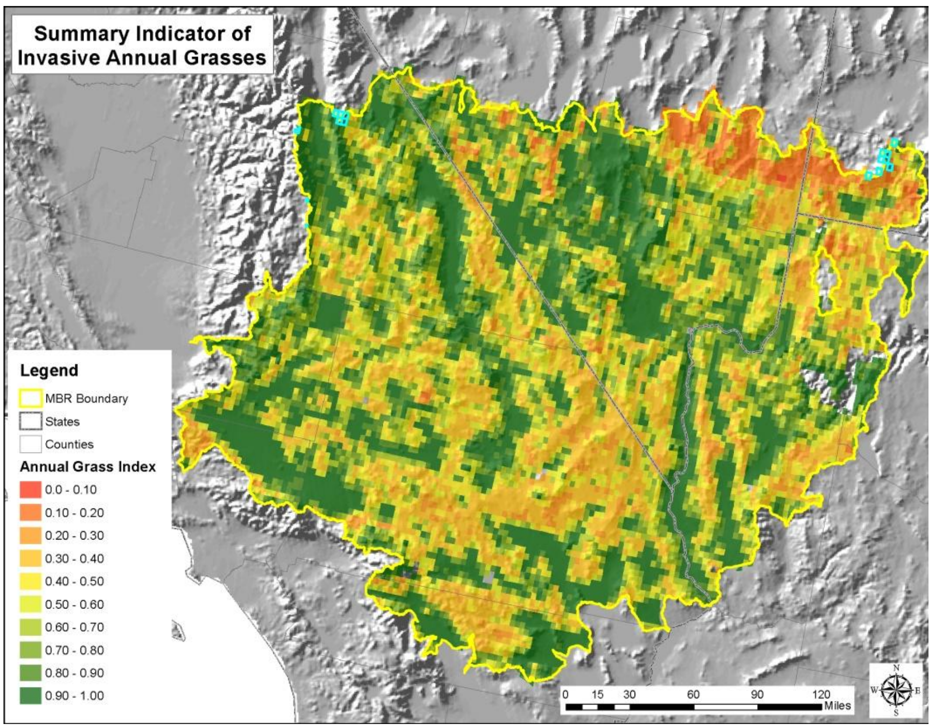
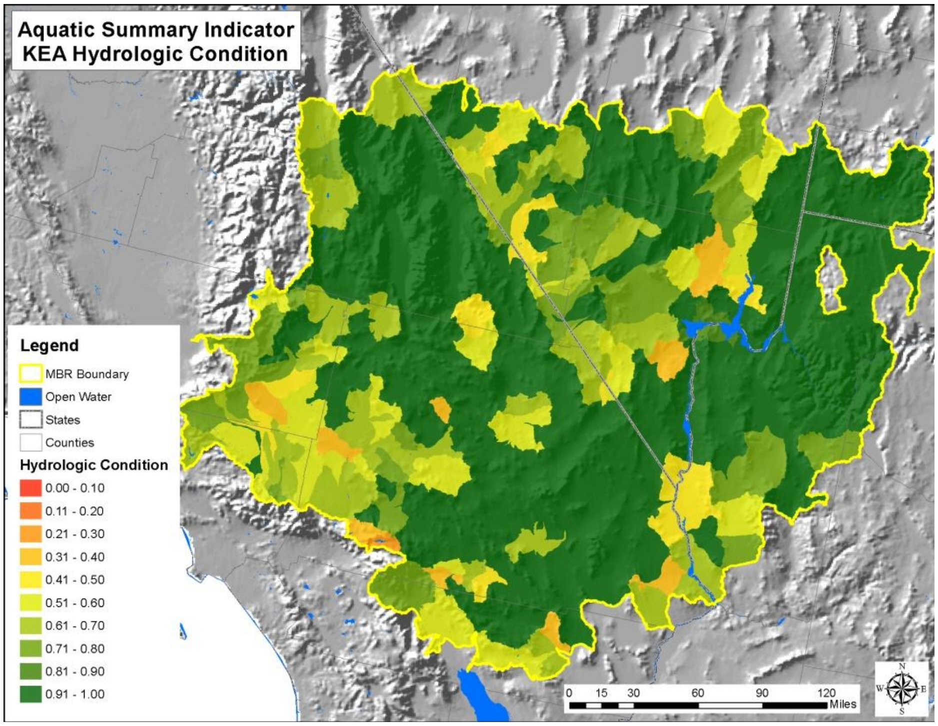


Figure 4-9. Map depicting the degree of stress on hydrologic condition by 5th-level watershed in the Mojave Basin and Range ecoregion based on surface water use, ground water use, number of diversions, and flow modification by dams; scaled from 0.0 (= low integrity, red) to 1.0 (= high integrity, green).



4.2.5 Special Assessments and Out-of-Scope Assessments

During the pre-assessment phase of the REA, numerous management questions (MQs) were identified by REA participants, and by the contractor team through its synthesis of the character and current functioning of the natural systems of the ecoregion. As described in the pre-assessment report (Harkness et al. 2013), the contractor team compiled the MQs and synthesized them into a small set of narratives capturing the primary questions and issues reflected in the numerous individual MQs that were originally identified.

As noted previously, “standard” REA assessments include basic characterization of CE and CA distribution, the overlap between CEs and CAs, the current and future ecological status of CEs, and overall ecological integrity of the ecoregion. Many MQs identified for this REA would require assessments that go beyond the standard REA assessments; these questions are categorized as “special assessments.” With available REA resources, a subset of these special assessments can be conducted. The contractor team’s initial recommendations for which assessments should be considered in the “pool” of special assessments and how they might be conducted are outlined in this section. The recommendations are based on the team’s expertise in these subject areas, our knowledge of which assessments are likely most feasible within the project scope and with available data and modeling tools, and our understanding of what appear to be the most critical information needs of REA participants. Assessments considered by the contractor team to be out of scope are identified separately. Note that in a number of cases, components of the out-of-scope assessments are at least partially addressed in the qualitative descriptions of CA impacts on CEs in the CE conceptual models. The special and out-of-scope assessments are first organized thematically (e.g., hydrology, climate change, etc.), and then by whether they are potentially within the scope or outside the scope.

The special assessments and out-of-scope assessments are described below. They are framed as questions; a short-hand name for each assessment is listed in brackets following the question – for example, [*Water Resources Availability*]. See the following section, **Special and Out-of-Scope Assessments: Additional Review and Prioritization**, for the summary of how these special assessments will be further reviewed and prioritized for geospatial analysis (or other assessment) in Task 3.

Hydrology and Aquatic/Wetland CEs: Special Assessments

The MAR REA potentially could address additional questions concerning the current and future status of aquatic/wetland Conservation Elements (CEs) and Change Agents (CAs). However, these would require special assessments not presently included in the REA Scope of Work:

1. **What is the availability of water resources in this ecoregion?** [*Water Resources Availability*]

   The REA potentially could include a special assessment of water resource availability for the ecoregion as a whole, rather than for individual CEs, guided by a conceptual model of the entire ecoregion. The geospatial data layers of water resource condition that we propose to try to assemble for the individual aquatic/wetland CEs – data on surface diversions and groundwater withdrawals, declining aquifer levels, and development of recharge zones – will be ecoregional data layers. Their completeness will depend on whether we can assemble comparable data from both AZ and NM.

2. **How does the historical distribution of ciénegas and riparian reaches compare to the current distribution of these systems?** [*Historical Distribution of Aquatic Systems*]

   The REA potentially could include a special assessment to compare the historical distributions of ciénegas and perennially wetted riparian reaches to their current distributions, to place the current conditions and management needs for these CEs in historical context. The standard scope of an REA typically does not include such questions, unless prior investigations have already assembled the relevant information digital geospatial datasets or unless the REA is provided supplemental resources to assemble such datasets. Hendrickson and Minckley (1984) produced hand-drawn maps of the distribution of ciénegas and perennially wetted riparian reaches during the Spanish colonial period across most of the Madrean Archipelago ecoregion. The present REA could include a special assessment to identify and analyze an already-existing geospatial dataset (properly geo-referenced) based on these hand-drawn maps, or to produce and analyze our own digital version if no existing version is available.

3. **How will climate change affect watershed hydrology?** [*Climate Change and Watershed Hydrology*]

   The REA potentially could include a special assessment concerning the ways in which climate change will affect watershed hydrology within individual watersheds. Such a special assessment would require the analysis of climate projections at a much finer spatial resolution as described in the revised approach for the climate analysis (see climate section under **Ecological Status of CEs: Specific Approaches or Questions**) as a starting point. These results could support analyses of variation in variables such as temperature and precipitation at different elevations. This variation has profound effects on the hydrology of individual watersheds – their rates of runoff and recharge, and the proportion of winter mountain precipitation that falls as snow versus rain.

Hydrology and Aquatic/Wetland CEs: Out-of-Scope Assessments

Several questions relating to aquatic/wetland CEs lie outside the scope of an REA. Answering such questions through analyses of geospatial data may be crucial for management of the resources of the

MAR ecoregion, but an REA is not the platform for conducting such analyses. However, the conceptual models for all aquatic/wetland CEs do recognize such questions in their narrative descriptions and diagrams of causal relationships, including the effects of specific stressors on CEs. Examples of such questions include:

1. **How have past human activities affected aquatic/wetland conservation elements?** [*Out-of-Scope: Impacts of Past Human Activities*]

   For example, How has past grazing affected the distribution and condition of perennial streams? Such questions require not only geospatial data on historical conditions but also detailed literature reviews, conceptual causal models, and geospatial analytical models concerning how individual CAs have affected a given conservation element in the past. Further, the ways in which past human activities have affected aquatic/wetland CEs in the ecoregion are matters of debate; e.g., concerning the relative roles of climate change and grazing in triggering the down-cutting of streams in the ecoregion following the late 1800s (Hendrickson and Minckley 1984). REAs typically do not include such questions within their scope because of the difficulties of developing appropriate causal models – which typically must express multiple alternative causal hypotheses – and assembling geospatial data with which to address questions based on such models.

2. **What is the legal status of water resources in general, and how may this affect water availability?** [*Out-of-Scope: Legal Status of Water Resources*]

   REAs typically do not include such questions because they require a review of matters relating to water law and water resources regulation rather than analyses of geospatial data. Almost all of the water resources within the ecoregion are subject to the ongoing General Adjudication of All Rights to Use Water in the Gila River System and Source, to which the federal government – and therefore the Department of the Interior – is a party. A review of the status of this adjudication and the underlying state and federal statutes and court precedents on which it rests, is beyond the scope of an REA. However, if an existing review of this matter has identified geospatial questions for possible attention, the REA could then consider such questions for possible inclusion in the scope of an REA as a special assessment.

3. **What are the likely human responses to climate change and how may these responses further affect aquatic/wetland conservation elements?** [*Out-of-Scope: Human Response to Climate Change*]

   For example, how will human water uses – and their own associated impacts on conservation elements – change in response to climate change? Such questions require development of conceptual, causal models of the ways in which climate change might affect human water uses, presumably with multiple scenarios that take into account possible ranges of variation in water consumption rates, transfers of water rights from agricultural to municipal use, and development of alternative water sources (e.g., desalinization). Developing such feedback models and associated scenarios – let alone developing geospatial models – is beyond the scope of an REA.

4. **How should water resources and aquatic ecosystems be managed to sustain them?** [*Out-of-Scope: Sustainable Management of Water Resources*]

   For example, how might watershed health, development, and groundwater resources be managed to protect aquatic habitat? Developing management recommendations is outside of the purview of an REA, but characterizing the status of CEs and CAs (that will be conducted) provides a crucial foundation to help resource managers assign priorities and identify strategies to maintain these critical resources.

Fire: Special Assessments

Special assessments for fire go beyond direct application of the LANDFIRE or ILAP data by further manipulating and combining it with other data to address more complex assessments. The MAR REA proposes to use existing data on fire frequency and extent in combination with other data to address additional broad questions that tie back to specific fire-related MQs that have been identified for this REA.

1. **How does the departure in fire frequency and intensity interact with other CAs to potentially affect both terrestrial and aquatic CEs?** [*Ecological Status: Fire Regime Departure With Other CAs and Effect on CEs*]

   Throughout much of the arid west, fire suppression has resulted in the accumulation of fuels which, in turn, changes the severity and intensity of the wildfires that do occur. Terrestrial CEs having a high degree of departure from historical or natural fire regimes and that occur on highly erodible soils, for example, will more likely result in post-fire erosion and associated sediment loading within the watershed. We anticipate using the departure maps created as described above and combining those maps on STATSGO or SURGO soils maps to identify those areas within the Madrean ecoregion likely to have these interactive effects.

2. **How is fire interacting with exotic invasive grasses, and how has that impacted the distribution of terrestrial CEs not adapted to periodic fire?** [*Fire and Invasive Grasses Impacts on CE Distribution*]

   The introduction of pyrogenic grasses into the ecoregion has already resulted in significant changes to the distribution of many terrestrial CEs. Several of the terrestrial CEs have no history of fire because they never produced fuels sufficient to carry fire. These systems are susceptible to invasion by exotic pyrogenic grasses that leave a homogeneous layer of fine fuels. The resulting fires convert these communities into a monoculture of exotic grasses. We anticipate using data on the distribution of these invasive grasses and susceptibility models to identify those areas within the ecoregion that are very susceptible to invasion and conversion and those areas that may be resilient to these effects.

Fire: Out-of-Scope Assessments

Many of the management questions proposed by the AMT and others bear on anticipated future conditions and associated CE status.

1. **What is the ecological status of CEs in the future as a result of altered fire regimes?** [*Out-of-Scope: Ecological Status: Future Fire Regime Effects on CEs*]

   The MAR REA could theoretically address additional questions concerning the future status of terrestrial CEs and their interaction with changing fire regimes. However, these efforts would require a degree of modeling on the fire dynamics of these CEs that is beyond the resources of the REA.

2. **How will an altered climate change fire regimes, and how will that shift the patterns of vegetation on the landscape?** [*Out-of-Scope: Ecological Status: Ecological Departure of Upland CEs Under Future Climate and Fire*]

There is also a desire to understand how climate change will affect fire regimes and, in turn, the landscape mosaic. In order to address these questions, the team would need to use quantitative state and transition models for the CEs of interest. The development and use of these models is outside of the current SOW for the REA. However, it would be possible to examine this using existing models (e.g., from LANDFIRE or ILAP) developed for the ecoregion to address these future-looking questions. The NatureServe team has the experience and expertise to modify and run these models, if desired.

Climate Change: Special Assessments

Based on the pervasive and potentially extreme impacts of climate change, and the number of MQs identified that involve this issue, this CA is a major issue for resource managers throughout this ecoregion. Special assessments could lay the foundation for addressing three major areas of concern that were reflected in the MQs:

1. **What is the projected influence of climate change on the ecological status of CEs?** For example, how will climate change affect the structure and function of ecological communities?
2. **What are the projected impacts of climate change on resource availability**, such as aquatic or grazing resources? This question is somewhat related to the first question; both ask how climate change will affect CEs or other resources.
3. **What is the projected influence of climate change on distributions of species and ecological systems?** More specific questions in this category related to *What is the relative degree of potential risk for loss of particular communities, such as semi-desert grassland, or particular species, such as bats or sky island endemics?*

Within the scope of the REA (or an assessment with a much larger scope), it is not possible to quantify and project the myriad of potential changes to habitat selection, daily or seasonal animal movements, feeding behavior and success, reproductive behavior and success, and countless other traits for species CEs that may result from climate change. Similarly, it is not possible to quantify and project changes in comparable traits – plant species composition and structure, dispersal and recruitment, and others – that may result from climate change.

What can be done within the REA is to characterize climate trends by looking at specific climate variables, and characterize whether the trends show a significant difference from historical climatic norms. A fine-scale spatial analysis of past, current, and projected future trends in climate would offer a spatially explicit understanding of which climate variables are changing the most (and least) dramatically in which geographic areas. This lays the groundwork for understanding where CEs may be most at risk from climate change impacts and can provide a basis for prioritizing species, community, or other resource-specific climate change impacts analyses.

For this REA, the BLM provided some specifications for climate change analysis; based on those needs and available resources, a relatively small, discrete climate analysis was proposed within the scope of this REA. The proposed revision to that in-scope analysis was summarized earlier in the work plan.

In contrast to all of the other, non-climate change special assessments outlined elsewhere in this section, the special assessments outlined here for climate change have already been agreed on by the BLM and will be conducted.

Current trends in climate space at fine spatial resolution [*Climate Space Trends: Recent, 800-meter*]

A number of the management questions posed for the Madrean REA can begin to be addressed by understanding how changes in climate are *already* occurring throughout the region. An analysis of current trends in climate space, using the same basic analysis methods described for the in-scope climate change assessment earlier in the work plan, can identify the rate, magnitude, spatial and temporal nature of trends in climate change across the Madrean REA region at much finer spatial resolution than are available from downscaled future projections. In addition, because these are changes that are already observed, there is much greater certainty regarding the results, which can support decision-making processes.

We propose to conduct an analysis of current trends in climate space using the PRISM 800-meter spatial climate dataset, which is the official climatology of the USDA. Similar to the future climate space trend analysis proposed for the in-scope work, we will create a value representing the 20th century baseline and its standard deviation for each 800-meter pixel for each variable using the years 1901-1980. We will then create values for each variable based on 3 time slices representing recent trends: 1981-2011, 1991-2011, and 2001-2011. We will then calculate the deltas (changes) and identify climate anomalies for each pixel, similar to the in-scope work. The deltas are a per-pixel value for each variable representing the difference between the recent and the baseline for each of these 30 yr, 20 yr, and 10 yr recent time slices. Additionally, for each of these 30 yr, 20yr, and 10 yr recent time slices, we will identify the anomalies, defined here as the pixels are already experiencing values that exceed plus or minus one or two standard deviations of the baseline for a given variable. These comparisons between time slices representing current trends in values versus the 20th century baseline can help identify the rate, magnitude, nature, and spatial distribution of change that is already occurring. In addition, the fine spatial scale available for this analysis offers managers a greatly improved understanding of the interactions between climate and topography across the Madrean Archipelago ecoregion.

The variables that will be analyzed are dependent upon available resources for funding supplemental work. The basic climate variables the PRISM dataset offers are monthly minimum temperature, monthly maximum temperature, and monthly total precipitation. We can provide current trends in climate space for all 36 of these variables if sufficient funds were available. However, assuming funding is limited, we can summarize climate space trends seasonally, and provide tmin, tmax, and precip analysis for spring, summer, fall and winter, thereby cutting the number of data layers from 36 to 12 for each time slice.

Future trends in climate space using additional variables from the Climate Western North America (CWNA) dataset [*Climate Space Trends: Future, Added Variables, 4-km*]

The resources available for the current scope of work can deliver a future climate space trend analysis for five variables from the CWNA dataset. However, there are two reasons it may be desirable to conduct supplemental work with the CWNA dataset. First, this dataset offers a number of derived variables that are highly biologically relevant, such as growing or chilling degree-days, precipitation as snow, extreme minimum and maximum temperatures, and climatic moisture deficit. An analysis of future trends in climate space for these ecologically important variables could provide significant additional insight into processes that directly relate to many of the management questions than have been posed in the Madrean REA process.

In addition, it is possible between the PRISM 800-meter data and the CWNA data to create a continuous analysis of trends in climate space for the same suite of variables, from the 20th century baseline, to recent trends, to projected future changes. If, for example, we conduct the first proposed supplemental analysis described above (***Current trends in climate space at fine spatial resolution***) on the seasonal values of tmin, tmax, and precip with the 800-meter PRISM dataset, we could compare the future projections from the CWNA dataset to the actual current trends for those same variables. This would allow REA users to see where current trends in climate are consistent with future projections, where current changes in climate are exceeding the pace forecasted from future projections, and where future climate changes are projected, but are not yet being observed.

Below are three tables summarizing the available annual (Table 4-8), seasonal and monthly (Table 4-9), and derived (Table 4-10) variables for the Climate Western North America data set (Wang et al. 2012).

Table 4-8. Annual variables available for the Climate Western North America data set.

Variable abbreviation	Variable definition
MAT	mean annual temperature (°C)
MWMT	mean warmest month temperature (°C)
MCMT	mean coldest month temperature (°C)
TD	temp. difference between MWMT and MCMT, or continentality (°C)
MAP	mean annual precipitation (mm)
MSP	mean summer (May to Sept.) precipitation (mm)
AH:M	annual heat:moisture index (MAT+10)/(MAP/1000))
SH:M	summer heat:moisture index ((MWMT)/(MSP/1000))

Table 4-9. Seasonal and monthly variables available for the Climate Western North America data set.

Variable abbreviation	Variable definition
Tave_wt	winter (Dec. - Feb.) mean temperature (°C)
Tave_sp	spring (Mar. - May) mean temperature (°C)
Tave_sm	summer (Jun. - Aug.) mean temperature (°C)
Tave_at	autumn (Sep. - Nov.) mean temperature (°C)
Tmax_wt	winter mean maximum temperature (°C)
Tmax_sp	spring mean maximum temperature (°C)
Tmax_sm	summer mean maximum temperature (°C)
Tmax_at	autumn mean maximum temperature (°C)
Tmin_wt	winter mean minimum temperature (°C)
Tmin_sp	spring mean minimum temperature (°C)
Tmin_sm	summer mean minimum temperature (°C)
Tmin_at	autumn mean minimum temperature (°C)
PPT_wt	winter precipitation (mm)
PPT_sp	spring precipitation (mm)
PPT_sm	summer precipitation (mm)
PPT_at	autumn precipitation (mm)

Table 4-10. Derived variables provided in the Climate Western North America data set.

Variable abbreviation	Variable definition
DD<0 (DD_0)	degree-days below 0°C, chilling degree-days
DD>5 (DD5)	degree-days above 5°C, growing degree-days
DD<18 (DD_18)	degree-days below 18°C, heating degree-days
DD>18 (DD18)	degree-days above 18°C, cooling degree-days
NFFD	the number of frost-free days
FFP	frost-free period
PAS	precipitation as snow (mm)
EMT	extreme minimum temperature over 30 years.
EXT	extreme maximum temperature over 30 years.
Eref	Hargreaves reference evaporation
CMD	Hargreaves climatic moisture deficit

Bioclimatic envelope modeling for select conservation elements of the Madrean ecoregion *[Bioclimate Envelope Modeling]*

A substantial number of management questions indicated the need to understand the potential impacts of climate change on the geographic distribution of a species or a vegetation assemblage. While it is not possible to forecast the exact location of the future distribution of a given species, it is possible to model the future distribution of the *climatic conditions* that occur across the current known range of the CE of interest. Using digital distribution data for the CE of interest, spatial climate data from the current and from downscaled GCMs, and species distribution modeling algorithms, we can create a current bioclimatic envelope for a given CE, and project the geographic location of that same bioclimatic envelope under future conditions. Bioclimatic envelope modeling can help identify the spatial distribution of the regions of stability, contraction, and expansion in the climate envelope defined by the current distribution of a given CE.

Working with the AMT, we propose to do the following:

1) Identify a set of CEs for which bioclimatic envelope modeling will be of greatest use to BLM in relation to the Madrean Archipelago and the greater desert southwest
2) Assess the quality of the locality data for these CEs across their range, and assess the degree to which climate is a factor influencing their ecology
3) For a select, appropriate group of species (i.e., species having good quality locality data range-wide), we will create a current bioclimatic envelope model using the species distribution modeling algorithm Maxent. All spatial climate data inputs will be from the CWNA dataset. At a minimum, the variables used will be the five climate variables identified in the current in-scope climate space trend effort. Additional variables can be applied and should be chosen based on the final list of conservation elements selected for bioclimatic modeling. Importantly, we will assess the locality data used to define the current distribution and create an appropriate temporal baseline of spatial climate data for input into the modeling effort. That is, if we model desert bighorn sheep and the locality data used to define the species current distribution was

collected from 1995-2008, it would be inappropriate to use a 1901-1980 baseline for climate values for bioclimatic modeling. To the extent feasible, we will match the temporal range of locality data and climate data in creating the current modeled distribution for each CE.

4) We will model the mid-century future distribution (2040-2069) of the current bioclimatic envelope for each CE based on EACH of the 6 available future projections in the CWNA dataset run under the A2 emission scenario. Thus each CE will have a current and 6 future bioclimatic envelope models
5) We will compiled the results across the 6 future bioclimatic envelope models per pixel, to identify which pixels have the highest and lowest degree of model agreement in the future distribution of suitable bioclimatic for that CE
6) We will create summary results representing the areas of stability, contraction, and expansion for each CE's bioclimatic envelope based on a threshold of model agreement (such as 2/6 model projections per pixel).

This analysis is similar in methods to those conducted during the CBR and MBR REAs, but represents improvements in the spatial climate data used for future projections.

Climate Change: Out-of-Scope Assessments

1. **What are the interactive effects of climate change together with other stressors, such as invasive species?** [*Out-of-Scope: Quantification of CA Interactive Effects on Ecological Status of CEs*]

   Available resources will allow for a simple assessment of the overlap of multiple CAs on CEs and narrative interpretation of likely synergistic impacts on the CEs, as indicated for various assessment components earlier in the work plan. In addition, the interactions of multiple CAs and their impacts on CEs is described qualitatively, as relevant, in the CE conceptual models. However, the level of complex and intensive modeling (sometimes using a series of high-level modeling tools) that would be needed to quantify these interactive effects or provide spatially explicit results showing ecological impacts of such interactions is not possible with available REA resources.

2. **What is the impact of climate change on restoration activities?** [*Out-of-Scope: Climate Change and Restoration*]

   These questions seek to understand how current management activities might be modified in light of future projected changes, as well as which activities are likely to be most effective. REAs do not make recommendations on management activities or decisions; instead, other components of the REA, particularly the ecological status of CEs, will provide some of the information managers need to inform such decisions.

Grazing: Special Assessments

Given the extent of livestock grazing in this ecoregion, resource managers identified a number of specific information needs relating to grazing that would require special assessments.

1. **Where are areas that are not currently grazed but have potential to be grazed, particularly as a factor of proximity to existing water development?** [*Future Distribution of Grazing*]

   When questions are posed about potential future distribution of land use CAs, they typically require development of a suitability model. This question specifically addresses suitability relative to existing water developments. If data showing currently grazed areas and water development are readily available, that layer could be compared with the distribution of relevant CE types to indicate areas with potential for grazing. If other factors of grazing suitability need to be accommodated, then a more complex model would be required.

2. **Where might climate change impacts on grassland ecosystems affect the ability to continue grazing?** [*Ecological Status: Climate Change Impacts on Grasslands and Grazing*]

   The special assessments for climate will identify current trends in seasonal temperature and monthly precipitation regimes at fine spatial resolution throughout the Madrean region, including areas currently used for grazing. The results of this analysis could be overlaid with grazing allotments or other relevant data to provide an understanding of where climate is already changing beyond levels of historical variability in relation to the allotments, as well as grazing areas which are not experiencing rapid climate change today. In general, we can identify where climate is already changing and where it is projected to change substantially in relation to ecological systems and/or areas that are grazed. However, assessing whether those changes will affect the ability to continue grazing in a particular area would likely require substantial modeling and detailed data on local conditions; addressing this question in its entirety is likely beyond the scope of the REA.

Grazing: Out-of-Scope

1. **What are the interacting effects of grazing in conjunction with other CAs?** [*Out-of-Scope: Quantification of CA Interactive Effects, Including Grazing, on Ecological Status of CEs*]

   There is a need to understand the interactions in particular between grazing and climate change, expansion of native woody species (mesquites), invasion and spread of invasive, non-native grasses, and altered fire regimes – both currently and in the future. Available resources will allow for a simple assessment of the overlap of multiple CAs on CEs and narrative interpretation of likely synergistic impacts on the CEs, as indicated for various assessment components earlier in the work plan. In addition, the interactions of multiple CAs and their impacts on CEs is described qualitatively, as relevant, in the CE conceptual models. However, addressing the interactions of grazing with other CAs beyond simple overlays and narrative discussions would require significantly more complex modeling, and would also depend on data availability.

2. **What are the effects of specific grazing-related management or restoration practices on ecosystems and habitats?** [*Out-of-Scope: Effects of Specific Grazing Management Practices*]

   There is a need to understand the effects of individual management practices, as well as combinations of treatments, and to identify which treatments are most effective under various conditions. Characterizing effects of restoration practices is beyond the scope of an REA; however, understanding where CEs are in better or more degraded condition can broadly inform where management or restoration should be continued and will be addressed through standard ecological status assessments.

3. **Where and how have the effects of grazing on ecosystems affected wildlife species?** [*Out-of-Scope: Indirect Grazing Effects on Species CE Ecological Status*]

   Grazing impacts on ecological system status could theoretically be assessed at the REA scale, but this is dependent on the availability of appropriate grazing data. Effects of grazing on habitat and ecosystems supporting the species CEs are documented in their conceptual models with numerous citations of recent literature and studies. However, extrapolating that to quantify or spatially model direct or indirect effects on wildlife species (populations, distribution, other variables) would generally be a substantial research and modeling effort beyond the scope of the available REA resources. One possible assessment might use grazing allotment boundaries or associated fenceline data to provide some indication of habitat permeability for pronghorn or Coues deer.

Municipalities, Utilities, Transportation, Industry, Agriculture, and International Border: Special and Out-of-Scope Assessments

A number of management issues that were explicitly identified in relation to these infrastructure features, land uses, or activities generally tied back to water usage and availability and impact on aquatic and riparian ecosystems.

Another set of questions around these features generally related to their impacts on the ecological status of ecosystems and species (aside from their effects on water availability.) One series of questions went beyond the direct impacts on ecological status to indirect impacts; these questions are special assessments (and potentially in scope) if considered only within the U.S. portion of the ecoregion and are out of scope to address across the U.S.-Mexico border:

1. **What are the effects of these features and activities on habitat fragmentation and connectivity?**

   [1. *Connectivity: U.S. Only*]

   [2. *Out-of-Scope: Connectivity Across the U.S.-Mexico Border*]

   This question can be assessed through landscape permeability or habitat connectivity modeling on the U.S. side using development features as inputs to a connectivity or permeability model, where those features represent barriers or areas of "resistance" to movement of organisms. Within the U.S. portion of the ecoregion, connectivity or permeability model(s) could be developed for individual CEs; or one could be developed to assess connections or barriers between the Sky Islands, as suggested in the ecoregional conceptual model. Modeling connectivity for an individual species is a time-intensive modeling effort and could only be done for one or two CEs. In addition, the results would have limitations if only the U.S. portion of the CE's range is modeled (for those CEs present in the Mexican portion of the Madrean as well). Assessing habitat connectivity across the U.S./Mexican border would require a series of key spatial data sets for the Mexican portion of the ecoregion, including vegetative and land cover, roads, and other infrastructure features, thus putting this component beyond the REA scope.

Invasive Non-Native Species and Native Woody Increasers: Special Assessments

Resource managers also identified a number of information needs relating to species that are undesirable from a biodiversity management perspective. In addition to understanding the current and potential distribution of these species, there is also a need to understand how other CAs (e.g., climate change, fire, etc.) may influence the spread and future distribution of these species. All of these questions are important questions and within the purview of the REA; however, most would require significant REA resources, so it will be necessary to prioritize which, if any of these, should be evaluated as special assessments.

1. **Where are invasive non-native species projected to expand their geographic distribution?** [*Future Distribution of Invasive Non-native Species*]

   Modeling potential spread of invasive species is possible; there are established methods for this. This modeling could only be done for a limited number of key, non-native invasives. Addressing this has the potential to require a significant proportion of REA resources. This is distinguished from the subsequent question in that it would simply model currently available habitat that has not yet been invaded (without considering the influences of climate change or other variables).

2. **How will climate change and anthropogenic activities influence the expansion of existing invasive non-native species and the introduction of invasive species not currently present in the ecoregion?** [*Future Distribution of Invasive Non-natives: Effects of Climate Change and Other CAs*]

   The intent behind this question on invasive non-native species is within the realm of an REA. The team assumes that addressing this question would entail obtaining existing distributions of key non-native invasives both established and likely to become established in the ecoregion, and then model their likely expansion under climate change, development, and associated hydrologic changes. However, the extent of modeling that would be required to spatially assess this question for even a small number of key species is substantial, and likely to consume an inordinate proportion of REA resources, to the exclusion of most other special assessments. If modeling were focused on expansion of existing non-native invasives in relation to a single variable (e.g., climate change), it could potentially be addressed as a special assessment for a small number of species, as a series of bioclimate envelope models.

3. **How will the geographic distribution and dominance of native woody increasers (mesquites, creosote bush) change in response to climate change?** [*Future Distribution of Native Woody Increasers: Effects of Climate Change*]

   The risk of shifts in geographic distribution as a result of climate change could potentially be assessed using climate envelope models as described in the earlier section on climate change special assessments. USGS REA participants (K. Thomas) noted that models of the potential geographic distribution of native woody increasers have been developed for different climate change scenarios.

4. **Which problematic non-native species not currently present in this ecoregion are likely to be introduced and become established?** [*Impending Non-Native Invasions*]

   This could potentially be addressed as a combination of expert and literature review to identify species meeting these criteria; this would be a non-spatial assessment. If this is assessed, the contractor would work with the AMT and TT to identify a subset of specific individual species that would be addressed.

4.2.6 Special and Out-of-Scope Assessments: Additional Review and Prioritization

In reviewing the first draft of the work plan during Task 1 of the assessment phase, AMT and Technical Team input was requested to provide initial prioritization (high, medium, low) of the special assessments and to confirm the contractor team's assumptions about special assessments identified as out-of-scope. This initial prioritization and review by the AMT and Technical Team will inform the subset of special assessments that will be carried forward into Task 2 of the assessment phase for evaluation of whether suitable spatial data and modeling approaches are readily available. The special assessments agreed to be out-of-scope will not be evaluated in Task 2.

Limited time and resources for conducting Task 2 require prioritization of data and process model evaluation for assessments. Therefore, the contractor team is evaluating data availability and model/approach feasibility in the following order during Task 2: standard assessments (ecological status, ecological integrity), special assessments identified as high or moderate priority by AMT members in the initial review of the work plan, and finally, special assessments noted as low priority by AMT members in their review. As we go through the Task 2 data and model evaluations, the contractor team may request additional guidance on the most important special assessments that should be evaluated for data availability and modeling approaches.

It is expected that many of the special assessments will be confirmed to be technically feasible during Task 2. Although many or most of the special assessments maybe identified as *technically* feasible during Task 2, the fixed time period and resources for completing the REA will ultimately constrain the special assessments that can be conducted in Task 3 to a smaller subset of the technically feasible options. The contractor team will work with the AMT and Technical Team to prioritize the technically feasible special assessments and identify a subset that are expected to be feasible to complete for Task 3 within available time and resources.

During Task 3, the contractor team plans to complete work on a small number of the highest priority assessments before initiating further special assessments. Conducting the assessments in small and staggered groups will ensure that all assessments initiated can be fully completed with all necessary documentation provided and corrections made within available resources. The rationale for this approach is discussed in detail later in the subsequent Task 2 chapter, in the section **Finalize Assessments to be Conducted**.

4.3 Task 2: Data Inventory and Process Models

The feasibility of conducting the assessments in the subsequent Task 3 is dependent on readily available and suitable data and a feasible modeling process. In Task 2, considering the assessments identified for this REA (ecological status, special assessments, etc.), the data sets to be used to conduct these assessments are identified, obtained, and reviewed, and the processes by which the data will be analyzed are developed and characterized in process models. There are two related objectives for this task:

- Inventory and acquire data representing (either directly or as a surrogate) the CAs, CEs, and their indicators and attributes within all conceptual models and evaluate the quality of each of those datasets to ensure sufficient data quality and utility for the assessments.
- Develop process model diagrams that visually represent the primary steps to be taken to translate each assessment into a series of geoprocessing procedures for the assessment, moving from source data to assessment products.

If both adequate data and suitable modeling approaches can be identified, the assessments are considered technically feasible. While the data review and process model development tasks are described sequentially, in reality they are done somewhat in parallel and iteratively. For example, if basic distribution data for CEs and CAs are unavailable, limitations in assessments will be known for those features. However, other types of data needed for assessments may not be known until a process model is developed that can fully explore all of the necessary inputs to an assessment. In such cases, especially for complex models, data availability must be revisited after the draft process model is developed. Additionally, process models are typically developed for the "ideal" data needed to conduct the assessment as stated. Data often falls short of the ideal, and the process model (and assessment) can be revised to reflect the available data.

Data acquisition and review, and process model development will also be completed for a subset of special assessments; as noted in the previous section of the work plan, **Special and Out-of-Scope**

Assessments: Additional Review and Prioritization, the team will focus primarily on evaluating the special assessments identified as high and medium priority by AMT reviewers; the contractor team may further engage with the AMT to further prioritize these to a manageable list. Where data or assessment approaches are determined to be insufficient to provide adequate results for a proposed special assessment, such assessments will be dropped. It is expected that more special assessments will be feasible to conduct on the basis of data availability and appropriate modeling approaches than can be conducted within time and budget constraints.

4.3.1 Data Inventory, Acquisition, and Review

The contractor team will review the final list of selected CEs, their indicators/KEAs, the CAs, and the MQs as finalized in this work plan in order to compile an initial list of data sets needed to conduct the assessments. The contractor team has some data sets in hand and will reach out to appropriate external colleagues and partners to obtain additional data for use in this REA. The team will also work with BLM staff and other REA participants to identify and locate other needed data sets.

The data sets will be requested, compiled, reviewed, and tracked by GIS staff on the contractor team in coordination with ecology staff members, through a formal, organized process as described here. While the contractor team has substantial expertise in spatial analysis and familiarity with data relevant to this ecoregion, the team anticipates that REA participants (AMT and technical team members and others) will have substantial insights into appropriate data sets for use in this REA or will be sources of key data sets. The process for obtaining iterative feedback on available, relevant data for this REA is outlined later in this section under **AMT and Technical Team Review for Task 2**.

Data Inventory and Acquisition

Based on the CEs, CAs, and standard and special assessments identified for this REA, the team will identify data to evaluate for possible inclusion in the assessment to represent CEs and CAs. Working closely with BLM to minimize redundancy in data requests, the responsibility for identifying datasets will be assigned to various team members based on areas of expertise. When possible, we will obtain full datasets including all supporting metadata and reports. When the data are not immediately available, we will request at a minimum the metadata and supporting materials, with sample data as available. As each member of the team works through their list of datasets to obtain, the information will be entered into our internal Master Data List (described below) and the appropriate team experts notified so they can begin the Data Quality Assurance Evaluation.

Data Management

NatureServe's core internal tool to track datasets and conduct the Data Quality Assurance Evaluation is its "Master Data List", which will also be used to prepare materials for data reports to BLM. This internal Master Data List (MDL) will incorporate data templates and materials provided by BLM (note some of BLM's materials are still being finalized and consequently the information here may need to be adjusted somewhat even after the work plan is finalized):

- Attachment 4.1: Data List
- Data Inventory & Tracking Table: Template for all data sets investigated for the assessment
- DMP Appendix 4: Description of Data Quality
- DMP Appendix 9: Data Quality Assurance Worksheet
- DMP Appendix 11: QA/QC Checklist for Data Deliverables

Since the Master Data List is NatureServe's primary tool for managing information about the individual datasets being assessed, as well as tracking status of the work being conducted, the NatureServe project team will add attributes to the Master Data List for its internal data management and tracking purposes, such as:

- information about source data sets and REA-generated datasets (filename, data source, citation, description, data type, scale, ISO category, currentness, data agreements, data restrictions / sensitivity, metadata)
- information about internal data management (filename and location where data resides on NatureServe's servers)
- work status (person requesting the data; data acquisition status and date; person conducting the quality assessment; and review status)
- how data will be used in the REA analyses (type of CE or CA; which special assessment it applies to)

The information captured in the internal Master Data List provides the foundation for the Phase II Task 2 Data Inventory and Evaluation and delivery of the Data Inventory & Tracking Report and Data Quality Assurance Worksheet.

Data Inventory & Tracking Report

The Data Inventory & Tracking Report will characterize data sets that may be used for CE and CA distributions, CE ecological status, ecological integrity, or special assessments. The core of this report will be the Data Inventory & Tracking Form (DITF) that consists of a master data list of all datasets under consideration. The DITF will initially be populated by the "Attachment 4.1: Data List" provided by BLM. Sky Island Alliance has extensive knowledge about data within the ecoregion and will serve as our primary initial conduit to identify existing data sets in addition to the extensive existing holdings of BLM and NatureServe (primarily national and western regional datasets). To enable identification of data suitability for the assessment, the DITF will include information about the intended use(s) of the data, data source, availability of the data and metadata, data currency, scale, and data sharing sensitivity. The DITF will capture all of the information needed to prepare the Available Data Summary for each of the identified conservation elements, as well as a Data Gaps Summary that addresses data incompleteness that could adversely affect analyses. For datasets that have not yet been acquired, a Data Collection Plan will delineate the strategy and timeline for requesting and obtaining these datasets. Because late data acquisition has hampered past REA timelines, we will carefully consider dependencies in our assessment process to identify acquisition deadlines.

NatureServe will prepare three versions of the Data Inventory & Tracking Report: proposed, draft, and final. The first deliverable will be a proposed Data Inventory & Tracking Report consisting of a template DITF spreadsheet based on the DMP, with an initial list of all datasets being considered based on the data list provided by BLM, plus additional datasets to be assessed for suitability. This deliverable will include preliminary summaries of available data and data gaps, as well as a proposed data collection plan. Following review via data discovery webinars and subsequent comments, we will deliver a draft Data Inventory & Tracking Report that includes a complete DITF with all datasets that will be investigated for suitability for inclusion in this assessment, as well as the comprehensive Available Data Summary, Data Gaps Summary, and Data Collection Plan. A third and final Data Inventory & Tracking Report will be delivered that addresses comments from the COR on the draft report.

Data Quality Assurance Evaluation

The contractor team will acquire and review datasets identified in the Data Inventory & Tracking Report, based on their availability and potential suitability for use in the assessment, except those that have been categorized by BLM as required for use in the REA. This will be a technical review of geospatial (and possibly tabular) data using the Data Quality Assurance Worksheet (DMP "Appendix 9") to assess suitability for the REA and BLM standards, with the addition of a *Comments* field for each of the eleven Data Quality Assurance Evaluation criteria. This *Comments* field allows the expert conducting the data review to explain the assignment of one of the following confidence ratings: Very High, High, Moderate, Low, and Unknown. We will evaluate the data technical quality, quantity, and type to assess the fitness of the data to meet the REA objectives and compliance to BLM's requirements, as specified in the BLM REA Data Management Plan. The Data Quality Assurance Evaluation will include the assessment of specific data characteristics and issues of interest such as geo-referencing with sufficient accuracy, data transformations, data duplication, data conflation, and failure to recognize inaccuracies. NatureServe's evaluation also includes information on the intended use of the data, and the suitability of the dataset for these uses. Based on the information in the data evaluation attributes, NatureServe will then assign an Overall Data Confidence Rating, again accompanied with comments where relevant. Data Quality Assurance Evaluation is a review of actual geospatial data and therefore can only be completed for data that is physically in hand.

The data evaluation process employed by NatureServe will also encompass metadata. The metadata review includes an evaluation of whether the metadata are incomplete (missing key information), minimally complete (has abstract, purpose, currentness, scale, projection, attribute definitions, and contacts), or accepted (the data have robust, complete metadata). The reviewer can enter comments about the metadata, particularly if there are incomplete areas or questions that need to be resolved.

Through experience with BLM REAs and countless other assessments, the contractor team recognizes that data quality varies considerably. Accordingly, we will be focusing the Data Quality Assurance Evaluation on the concept of "fitness for intended use," consistent with the BLM data quality protocols, rather than assigning a fixed threshold that dictates what data will and will not be used in the REA.

A complete data catalog will be generated representing the datasets value to critical management issues based upon data scale and accuracy, issue of data edge matching, completeness, consistency, projection and positional inaccuracies, validity and classification level, and temporality. This information will be used to document the suitability of datasets for specific uses in the REA assessment, document data limitations, and help identify targets for future data collection and improvement efforts.

We will prepare three versions of the Data Quality Assurance Evaluation: proposed, draft, and final. The proposed Data Quality Assurance Evaluation will consist of a template spreadsheet based on DMP Appendix 9, with complete data evaluations for a small number of datasets that have already been acquired by NatureServe, as a sample. Following review by the technical team and subsequent comments, we will deliver a draft Data Quality Assurance Evaluation that includes data evaluations completed for the majority of the proposed datasets in the DITF. A third and final Data Quality Assurance Evaluation will be delivered that consists of data evaluations for any remaining data sets that are subsequently acquired, and incorporates comments from the COR on the draft report.

4.3.2 Process Model Development

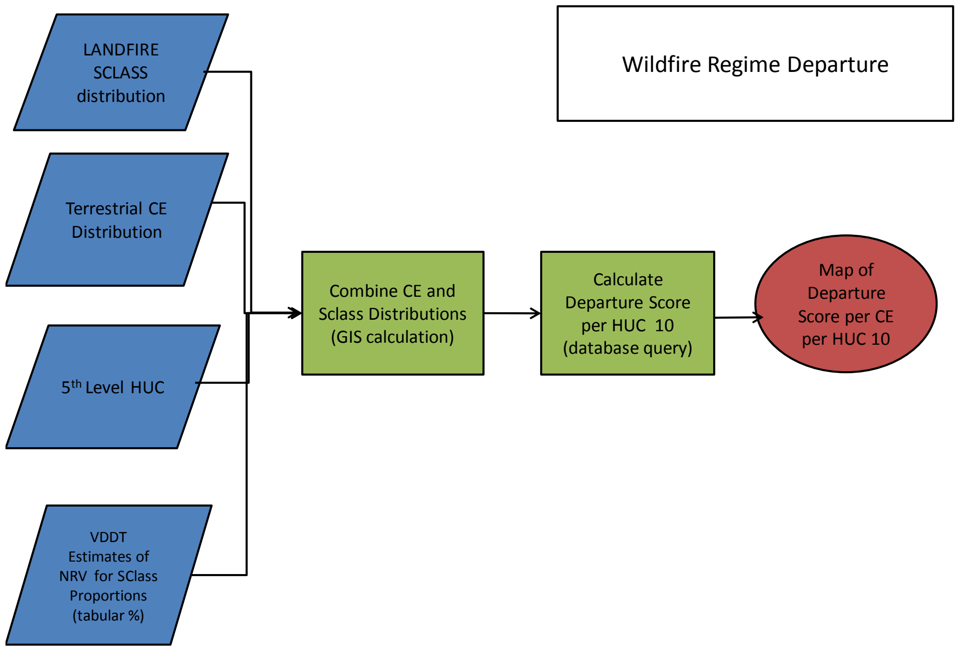
Process models are the bridge between the conceptual models and the various technical geoprocessing models (e.g., Vista tool, Python script, ModelBuilder model (.tbx)) used to conduct the assessment geoprocessing. The goal of the process model is to illustrate the workflow for each assessment, including specifying the geospatial datasets to be used, key processing steps required to complete each analysis, and the desired products (e.g., map illustrating spatial analysis results, tabular summary). A process model will be developed for each type of assessment associated with the CE conceptual models and for other assessments not associated with a single CE; we anticipate several common process models for CEs. The format and level of detail for the documentation to be developed in Task 3 that describes the geoprocessing steps for each assessment is still being finalized; that documentation might logically be added later to the process model diagrams to serve as simple narrative explanation. BLM and the contractor team will consider this idea further and make a determination.

Where suitable data are confirmed or expected to be available, process models will be drafted for CE status indicators/KEAs, CE x CA intersections as appropriate, ecoregional integrity assessments, and special assessments of high to moderate priority. There may be limited modeling to develop spatial distributions for CEs or CAs (e.g., Maxent modeling to obtain predicted habitat for a species CE); in those cases, process models will be provided. For existing CE and CA distribution data, as with other existing data sets to be used in the REA, process models are not provided. Also note that process models may incorporate by reference other process models that may be embedded within them.

While the contractor team has substantial expertise in spatial analysis and approaches for ecological assessments, the team anticipates that REA participants (AMT and technical team members and others) will have critical insights into appropriate assessment approaches for various components of this REA. The process for obtaining iterative feedback on the contractor team's proposed assessment approaches as illustrated by the process models is outlined later in this section under **AMT and Technical Team Review for Task 2**

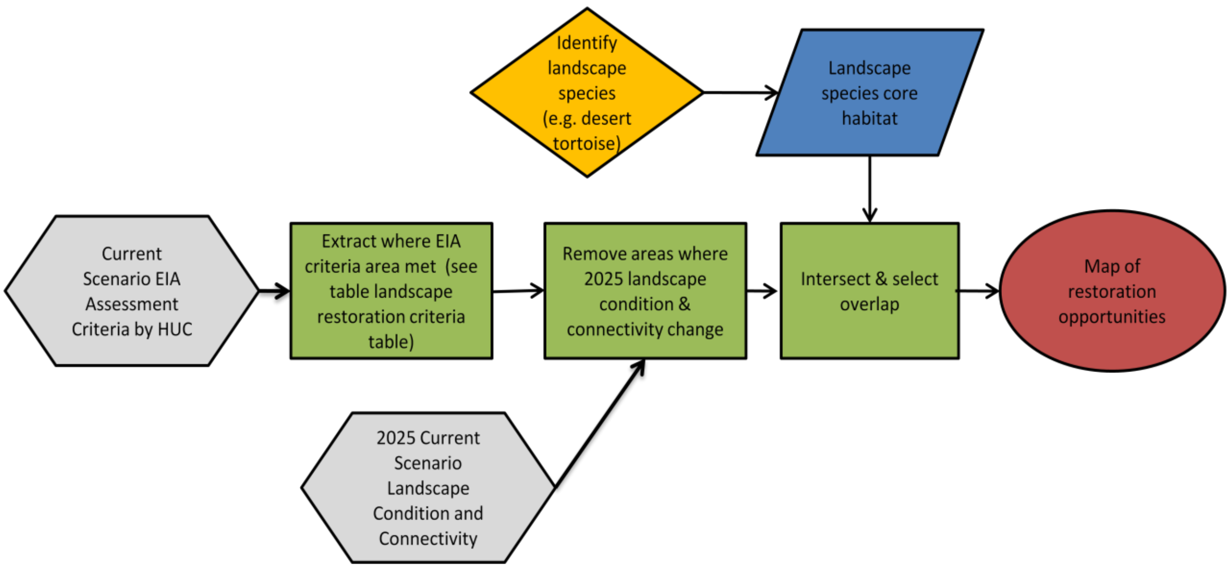
Concurrent with data acquisition and review, ecology subteam members will review the CE conceptual models and the identified indicators/KEAs to begin developing diagrams that illustrate the overall flow of spatial analysis steps that will be taken in order to assess indicators/KEAs for each of the CEs. The example diagram in Figure 4-10 illustrates the steps for performing calculations and other processing steps on relevant data sets in order to estimate the degree to which an ecological system's fire regime has departed from its natural range of variability; the degree of departure is one of the potential indicators of ecological status for fire-dependent ecosystems.

Figure 4-10. Example of a process diagram for assessing an indicator of ecological status for a CE, reported using 5th-level watersheds. "HUC 10" refers to 10-digit HUCs, which are 5th-level watersheds.



For the special assessments of high to moderate priority and having sufficient data for assessment, the team will explore whether modeling or other assessment approaches are available to provide a useful result. For those with both adequate data and modeling approaches, team members will similarly develop process diagrams illustrating how the special assessments could be conducted. The process diagram shown in Figure 4-11 provides an indication of type of processing steps that might be utilized to conduct a special assessment. This particular example illustrates how projections of future landscape condition (modeled from projections of future change agent distribution) might be used to identify areas having potential for restoration for particular species CEs.

Figure 4-11. Example of a process diagram illustrating an analysis that would be considered a special assessment.



4.3.3 Finalize Assessments to be Conducted

As the work of evaluating the *technical* feasibility of the assessments in Task 2 concludes, the contractor team will work with the AMT to finalize the assessments that are feasible with available resources to conduct through the geospatial analysis of Task 3. The geospatial work that will take place in Task 3 can be characterized in these three categories and will be conducted in approximately the order listed:

1. Improvements to the input data for the standard and special assessments – the CE and CA distribution data within available resources
2. Standard REA assessments that are confirmed technically feasible for geospatial analysis
    a. Simple overlays or intersections of CAs with CEs
    b. CE ecological status
    c. ecological integrity
3. Special assessments that are confirmed to be technically feasible, of highest priority, and feasible within available resources

Each of these categories of geospatial processing or assessment will require a certain amount of REA resources. Aside from technical feasibility, the resources required for each of these will all help determine which special assessments can be conducted in this REA. Considerations around the resource requirements for each of these three categories are summarized below.

Improvements to Input Data (CE and CA Distributions)

As the team reviews data and process models and determines the technical feasibility of both standard and special assessments, another consideration will be improvements to CE and CA distribution data that will be used as inputs to these assessments. The general guidance with REAs is that existing and readily available data will be used. However, existing data sets may require manipulations or enhancements to make the assessments feasible, which will also require time and resources. For example, if the AMT desired to use a combination of roads data sets from BLM's NOC, BLM District Offices, USFS, and Homeland Security to ensure that all local and unpaved roads are represented as fully as possible for the ecoregion (as opposed to using a single, national roads data set that requires no further processing), this would potentially require the attributes in the four (or more) roads data sets to be reviewed and "cross-walked" in preparation for compiling the data into a single data set for use in assessments. Once compiled, the compilation methods must be documented in accordance with BLM requirements for the REAs. Another example is that the accuracy of a CE's spatial distribution might need to be improved by using an elevation threshold to ensure that it is not appearing in locations outside of its elevation range. Again, in addition to the identification of methods for improving the data and the actual geoprocessing, the resulting dataset would need to be documented in accordance with REA requirements. A third and resource-intensive example is modeling invasives species distributions. It would be possible to model predicted habitat for a small group of similar invasive species (e.g., certain grasses); this would provide a comprehensive, modeled, predicted extent for one component (i.e., certain grasses) of the invasives CA. However, this requires fairly significant modeling and could be considered an assessment in itself, even though it fits under the category of "CA distribution." It is likely that a number of improvements to existing CE and CA distribution data will be desired. While likely relatively small in scope, they will require some amount of REA resources and will need to be considered in the equation when determining which assessments are feasible within available resources. Because the CE and CA distributions are foundational to the REA, these improvements will be initiated first during Task 3 to support standard assessments, after confirmation by the Technical Team and BLM.

Standard Assessments

Assessments that fail either the available data or feasible model evaluations during this task will be documented according to the specific reasons they cannot be assessed. This includes **both** standard REA assessments such as ecological status, as well as the special assessments. The remaining **standard** REA assessments that are technically feasible are then considered confirmed for geoprocessing in Task 3. Geoprocessing for the standard assessments will also be initiated first during Task 3, either concurrent with or pending completion of agreed-upon improvements to CE and CA distributions.

Special Assessments

Once a geospatial modeling effort gets underway, issues frequently arise that require additional resources to satisfactorily complete the model. While some issues can be identified in advance with careful review of the data to be used, many issues do not become apparent until the modeling work is well underway or sometimes until the model is complete and the results have been reviewed. Rather than concurrently initiating, say, ten of the special assessments, the contractor team's goal is to initiate a very small subset of the highest priority special assessments and carry them through to a reasonable degree of completion prior to initiating the next small subset. The goal is to ensure that each special assessment initiated can be carried through to completion, with adequate time for necessary fixes and the required full documentation, and can provide a set of final results with high confidence in the quality.

With this in mind, special assessments that are identified as *technically* feasible in this task will be reviewed by the contractor team and AMT to re-confirm their relative priority. The contractor team will work with the AMT to identify the first small group of special assessments to be initiated in the subsequent task (Task 3), and confirm the preferred priority/ordering of initiating subsequent assessments.

4.3.4 AMT and Technical Team Review for Task 2

This task forms the foundation for the actual assessments to be completed; therefore, review and feedback by REA participants is critical. Evaluating the appropriateness and availability of data and modeling approaches is a relatively technical task, as well as an iterative and overlapping process. To arrive at the best available data and approaches that fit within the REA scope, the contractor team recommends a set of thematically organized review webinars, with technical team members as the primary participants, to get feedback on proposed data and process models, rather than an AMT workshop focused on these topics. Technical team members would include both interested "core" technical team members, as well as staff members in their agencies who have been identified by the core members as having the expertise and time to contribute input at this stage in the REA.

The review webinars are currently planned to be organized around 1) data discovery/identification, 2) process models, and potentially 3) confirmation of improvements to CE and CA distribution data. Within these groupings, they will also be thematically organized. Three data discovery/identification webinars have been confirmed and organized according to these themes:

- Species data
- Water/hydrology/aquatic CEs (and associated CAs)
- Upland CEs, as well as fire, invasives, grazing, development, and related CAs

Because the identification and selection of data sets to use for analysis and the development of appropriate process models are closely linked and iterative, there may be some overlap in content in subsequent webinars if needed. In each of the webinars, technical team members will review and provide feedback on the proposed data and process models as provided by the contractor team. Process model presentation will focus primarily on the nature of the assessment products so that participants can comment on their relative utility for management and suggest alternatives if necessary. The team anticipates that the webinars to get feedback on proposed data and process models will result in recommendations for 1) modifying the proposed data sets or process models; 2) new data sets and potential assessment approaches not yet proposed by the contractor team; and 3) data sets or assessment approaches that should be dropped entirely. The input from these webinars will inform the development of **draft** versions of the Data Inventory and Tracking Report, Data Quality Assurance Worksheet, and relevant process models. The contractor team proposes to work with relevant technical team members via email and smaller conference calls to obtain additional review on the draft versions of the data sets and process models if necessary.

Following the completion of the draft versions of the data and process models, the contractor recommends the 4th AMT workshop be held as a webinar to update the AMT on the data sets and process models and prioritize special assessments as described in the previous section. Given the substantial overlap between the AMT and core Technical Team membership, it is assumed that interested AMT members will have participated in the previous webinars on the details of the data and process models. The primary goals of this workshop will be to 1) get final confirmation on the data and process models to be used in Task 3; and 2) refine the prioritization of the feasible special assessments to guide assessment work in Task 3. This webinar would cover all of the thematic areas and be divided into sessions (e.g., a morning session on ecological status, afternoon on special assessments for hydrology and climate, etc.) Table 4-11 summarizes the products to be reviewed, along with the webinars or other venues for reviewing them, and estimated timing of review.

Table 4-11. List of Task 2 products for review, review venues, reviewers, and estimated timing of review.

Product	Review Venue or Process	Reviewers	**Estimated Timing** (subject to change unless otherwise noted)
• **Proposed** data sets • **Proposed** Data Inventory Report, Data Quality Assurance Worksheet	Data discovery webinars	**Technical Team**	September 12 September 26 (dates confirmed)
Proposed process models	Process model webinars	**Technical Team**	October 16 October 22
Draft data sets, process models, and associated reports/summaries/worksheets **Prioritization of special assessments**	**AMT workshop 4 WEBINAR**	**AMT** and **Technical Team**	November 21-22
Final data sets, process models, and associated reports/summaries/worksheets	Review on your own	• BLM NOC • AMT • Technical Team	Finalize by January 10, 2014

4.3.5 Task 2 Deliverables

Below is a brief list of the major deliverables for this task; each was described in more detail above.

- **Data Inventory & Tracking Report**: This report will be based on the conceptual models and assessment questions identified in Phase I, Task 2 that identify the CEs, CAs, and preliminary set of MQs for which data will be needed. The core of this report will be the Data Inventory & Tracking Form (DITF) that consists of a master data list of all datasets under consideration. This report will also include an **Available Data Summary** for each of the identified conservation elements and a **Data Gaps Summary** that addresses data incompleteness that could adversely affect analyses. For datasets that have not yet been acquired, a simple **Data Collection Plan** including deadlines for receiving the data will be included in this report.

- **Data Quality Assurance Worksheet**: The team's review of acquired datasets identified in the Data Inventory & Tracking Report for their suitability for use in the REA will be tracked in the Data Quality Assurance Worksheet.

- **Process Models**: The process models will be compiled in a separate document for this task and later incorporated into the methods appendix for the final REA report.

In addition to the documents listed above, a key outcome of this task will be the revised prioritization of the special assessments.

4.4 Task 3: Geoprocessing Models, Analysis, and Results Data Packages

4.4.1 Geoprocessing Models and Geospatial Analysis

Following confirmation of data sets and process models and final prioritization of special assessments (Task 2), the next step is to convert the process models into functioning geoprocessing models and conduct the various assessments. There are four main objectives for this task:

1. Develop geoprocessing models based on the process models completed in Phase II, Task 2 for the standard assessments and selected special assessments
2. Conduct the geospatial analyses using the geoprocessing models and document the processes involved
3. Generate and interpret findings for each assessment
4. Assemble and deliver data packages for each geoprocessing model, containing all data and associated documentation required to recreate each geoprocessing model

As noted in Task 2, the geospatial analyses will take place in approximately this order, with overlap in some areas:

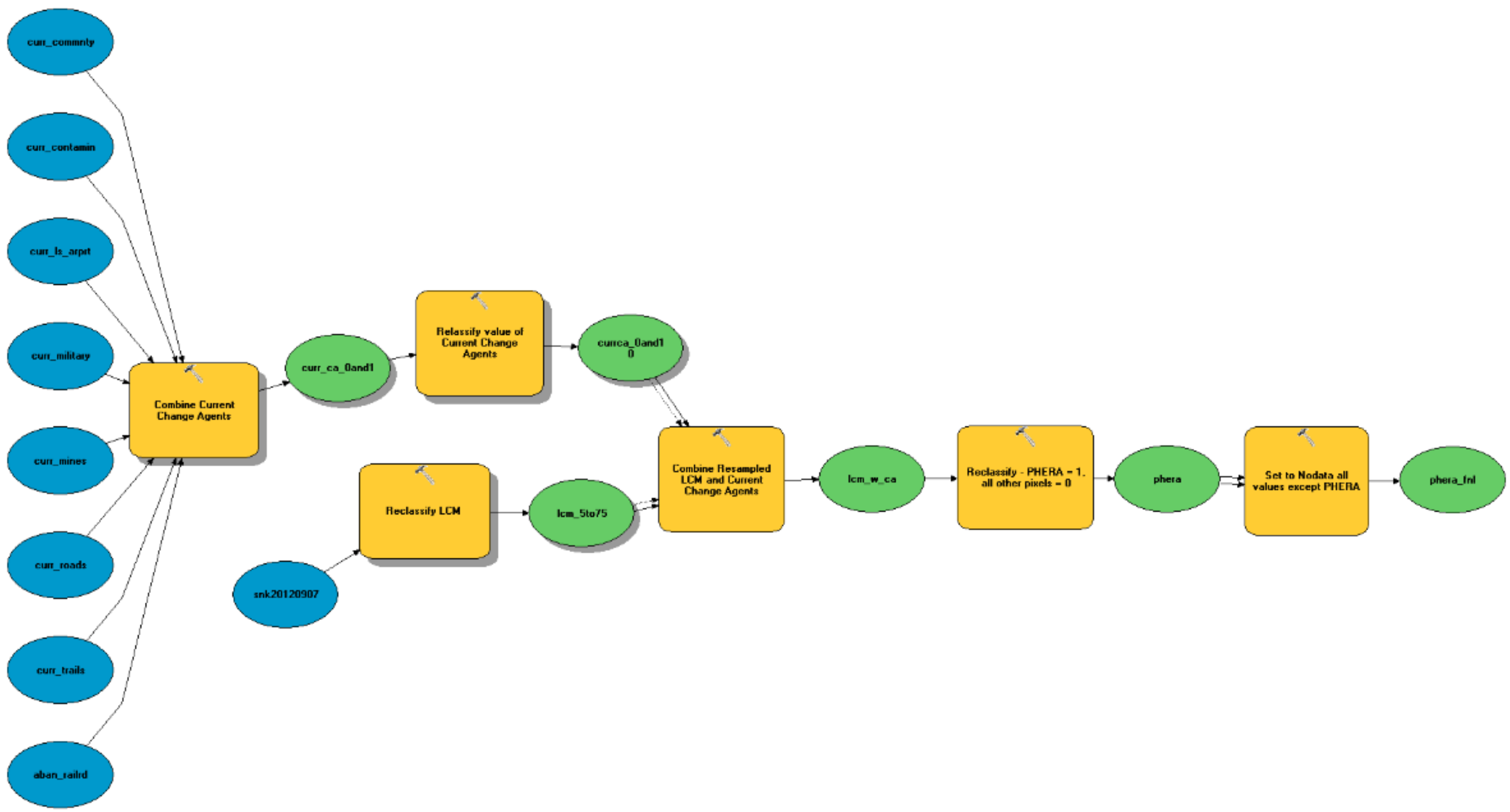
1. Improvements to CE and CA distribution data
2. Standard REA assessments
    a. Simple overlays or intersections of CAs with CEs
    b. CE ecological status
    c. Ecological integrity
3. Special assessments
    a. First small group of high-priority assessments
    b. Subsequent high and then moderate-priority assessments as resources permit

Whereas process models graphically depict the workflow for transforming the source data to assessment products, geoprocessing models are the actual tools or computer code that perform analytical processes in a geographic information system (GIS). Our objective will be to use “off-the-shelf” geoprocessing models as much as possible to reduce the amount of custom model development and to deliver more stable models to BLM for later updates of results.

Moving from process models to geoprocessing models requires the interpretation of data processing steps into GIS executable functions (Figure 4-12). These functions are then matched first to existing tools and if such tools are unavailable or inadequate, then a custom geoprocessing script is created and tested. More complex geoprocessing models typically require a combination of manual GIS steps that convert source data into inputs to the assessment, potentially some steps from existing tools, and some steps from custom geoprocessing scripts. Per discussions with NOC staff, manual GIS steps to prepare or improve source data will be documented so that users can understand the data, but such steps will not typically be included in delivered models.

Our proposal identified a key role for the NatureServe Vista™ decision support system (DSS) (www.natureserve.org/vista) in conducting a substantial part of typical REA analyses. Vista is a free extension to ArcGIS and has previously been vetted and approved for BLM use. Initial examination of proposed assessments suggests that Vista will be a key tool, especially to conduct assessments involving ecological status. NatureServe's Landscape Condition Model (LCM) was used substantially in the CBR and MBR REAs and that tool is now embedded in Vista to automate its use. Other tools that might be used include Circuitscape or Linkage Mapper for connectivity analyses and NSPECT for hydrologic modeling. Assessment components conducted by off-the-shelf tools will not have accompanying geoprocessing models (this would be redundant with the tool itself) but details on how the tool was applied to support repeatability of the assessment will be provided. Following development and initial testing of geoprocessing models, we will generate sample draft analysis outputs and conduct review with the AMT and TT per the process outlined in the next section, **AMT and Technical Team Review**.

Figure 4-12. Example of a geoprocessing model. This model from the SNK REA was used to identify potential habitat enhancement/restoration areas (PHERA). Landscape condition was modeled with resulting values ranging from 0 to 1, where 0 represents converted landscapes and 1 represents pristine landscapes. The subset of the ecoregion having condition values between 0.5 and 0.75 was assumed to be somewhat degraded but still restorable; these areas were selected and identified as having restoration or habitat enhancement potential.



4.4.2 AMT and Technical Team Review for Task 3

Similar to Task 2, the team will conduct a series of rolling review webinars with Technical Team members and AMT during the development of the geoprocessing models and geospatial analyses; these will also be thematically organized. The goal of the webinars is to ensure that the analysis methods are appropriate and that the analyses provide results that adequately address or "support" the standard and special assessments (and associated MQs) as desired. The team proposes that AMT 5 be held later in the task, after the initial Technical Team webinars on geospatial models and preliminary results, to review the geoprocessing models **in conjunction with** the resulting findings (rather than **prior to** running the actual analyses, as indicated in the SOW). Given that there will have been substantial review of analysis results, a second goal of this workshop will be to further finalize the nature of the final report.

There are several considerations to account for in structuring a workable review process for the deliverables in this task:

- As in other tasks, there is a requirement for the contractor team to provide and the AMT and Technical Team to review 1) proposed, 2) draft, and 3) final versions of both the geoprocessing models for each of the assessments and the actual results of each of the assessments.
- The sequencing of this task is very broadly ordered as 1) preparation of CE and CA distribution, 2) standard assessment of CE ecological status, 3) standard assessment of ecological integrity, 4) initial group of special assessments, and 5) continued special assessments.
- BLM and the contractor agree that if possible, REA data analysis outputs should only be delivered once, in their final form, to BLM's NOC. This is most efficient for all involved in delivering and formally reviewing the data products against BLM's specific requirements.
- The window for completing this task, including the multiple review periods and subsequent contractor team adjustments to the geoprocessing work, is approximately 6 months

The number of reviews (proposed, draft, and final) required in this task, the sequencing of the geospatial processing tasks, and the overall window of time for completing this task (~Jan-June 2014) will make the review process somewhat challenging. Since the Technical Team and AMT reviewed the conceptual process models in the previous task, the rolling review webinars for this task will be focused on the combination of the geospatial processing steps **and** the actual results (rather than having one set of webinars for the geospatial processing, and a separate set to view the results). It will be easier to assess the geospatial steps in light of the results they produce.

The team anticipates the first review webinars to review proposed models and outputs for a subset of assessments, in each of the assessment categories listed below:

- CE ecological status (pilot CEs)
- Ecological integrity
- One special assessment

Based on feedback, the contractor team may revise the modeling approach as appropriate and will provide draft versions of these assessments for review in the fifth AMT workshop. Given how the special assessments will be staggered, there may be proposed versions of special assessments discussed in the fifth workshop; alternately, they may be reviewed through targeted webinars.

Table 4-12 summarizes the approximate approach we suggest to accommodate the necessary review for the range of assessments; this may be adjusted going forward as needed.

Table 4-12. List of Task 3 products to be reviewed, the suggested review venue, and the approximate timing of the review.

Product	Review Venue or Process	Approximate Timing
Proposed GP* models and **example** findings • Vista-based ecological status assessments (up to 3 "pilot" CEs) • Ecological integrity (1 or 2 indicators) • One special assessment	Technical Team/AMT "rolling reviews" via webinars (in lieu of first AMT workshop for this task)	February-March 2014
Proposed and **draft** models and findings for additional special assessments	Continued rolling review calls with subset of Tech Team and AMT	March-May 2014
Draft GP models, **draft** findings/outputs (estimated provided early-mid April) [*These are **not** delivered to the NOC at this point, but simply reviewed as images during AMT workshop 5*]	• AMT workshop 5 (TT and AMT review) • NOC DMT** review	Late April 2014
Final GP models, **final** findings, **final** data packages delivered to the NOC (estimated provided mid-late May)	• Final review by AMT via webinar or other on-line/digital means • Final review by BLM NOC DMT	Late May 2014
Revised final data packages provided, as needed, only to BLM NOC DMT (estimated early-mid June)	Final sign-off by BLM NOC DMT	End of June 2014

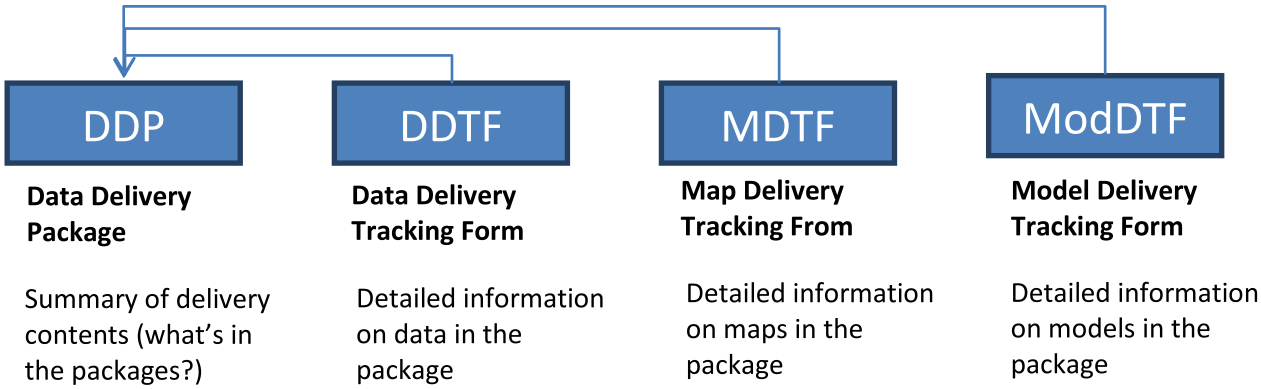
*GP = geoprocessing

**NOC DMT = BLM's National Operations Center (NOC) Data Management Team (DMT)

4.4.3 Task 3 Deliverables: Organization and Delivery

The contractor team will deliver numerous data and associated products for the REA. The three key components of deliverables for this task are 1) source or input data (e.g., CE and CA distributions, base data layers), 2) output data from the assessments, and 3) accompanying metadata and documentation. Source data (e.g., CE and CA distributions, various base data layers) and assessment output datasets will be delivered in thematically organized "data packages." The primary tool that NatureServe will use for tracking delivery of data packages is the suite of tracking templates developed by BLM, which are illustrated in Figure 4-13 and described below. Note that specifications around data documentation and the data delivery process are being updated by BLM and the contractor and will be reflected in an updated BLM REA Data Management Plan for this REA, and in the interim in a working document summarizing the revised specifications and decisions.

Figure 4-13. Illustration of BLM's proposed revised templates for tracking data package deliveries, individual data sets in the data packages, map deliveries, and model deliveries.



To facilitate clear and transparent communication between NatureServe and BLM, this REA will pilot the use of a secure project SharePoint site as the primary location for these tracking templates that will be updated by NatureServe for each Data Delivery Package, and by BLM to document the data QC progress.

The first data package delivered will be a test delivery that will enable NatureServe and BLM to collaboratively review the delivery process and make any adjustments as needed to the process and/or technical aspects of the delivery packages. The test delivery package will include an example assessment with source and output data, generated within the standard ArcGIS environment, as well as a Vista project containing an example assessment.

Our goal is to deliver each data package a single time, and BLM will request redelivery of datasets only if the data have significant problems; the team will not deliver a draft version of data as described in the SOW and proposal, just a final version. To facilitate the tracking of any redelivered datasets, the data tracking templates include attributes to identify particular datasets as "redelivery", with the date and reasons for the redelivery. All redelivered data packages will include the new date of redelivery directly in the filename. Once individual datasets, models, and maps have been reviewed by BLM and accepted as "passing" the QC criteria that are laid out in the delivery templates, the entire data package for that set of deliverables will be set by BLM to "pass" and accepted as final.

1) Data Delivery Package (DDP): DDP_Template.xlsx

This is the "top level" information to be included with each data delivery package; it includes summary information about data, maps, and models being delivered. As the summary of the data package as a whole, this tracking spreadsheet will include information derived from the detailed data, map, and model tracking forms described below.

2) Data Delivery Tracking Form (DDTF): DDTF_Template.xlsx

The datasets in the Data Delivery Tracking Form contains a subset of the "Data Inventory & Tracking Form" (DITF) list of all source datasets that were considered and evaluated for inclusion in the analyses. The DDTF contains detailed information about 1) all of the individual source datasets that were used in analyses, **as well as** 2) all output datasets derived from the assessments. Since these datasets are being used in various maps (MXDs) and models, the DDTF will cross-reference map and model delivery tracking forms. Delivery of large suites of data (such as for climate change datasets or ecological status assessments) will be streamlined through a single entry in the DDTF that clearly describes the total number of datasets, as well as through a single metadata and layer (LYR) file for the suite of related records.

3) Map Delivery Tracking Form (MDTF): MDTF_Template.xlsx

The MDTF contains detailed information about individual maps (MXDs), and will be referenced in the DDP. In the initial data delivery packages, the goal is to include the majority of the MXDs that will be used as the starting point for generating report graphics. However, since many of the data packages will be delivered well in advance of the final REA report, the maps in the mxds will not be exact matches of the final report graphics and it will not be possible to include in the MDTF the "Figure(s) from Final Report".

If there are a small number of new maps created for the final report that include new analyses not already delivered, NatureServe will deliver as a new data package the data, MXDs, and layer (LYR) files for those maps. Report maps that are a slight variation of already delivered materials (such as changes to the colors in symbolization) will not require the delivery of a new MXD and related materials. In some situations, it will be acceptable to deliver only LYR files for report maps, without needing to redeliver MXDs or the underlying data.

4) Model Delivery Tracking Form (ModDTF): ModDTF_Template.xlsx

This tracking spreadsheet is for detailed information about individual analysis models being delivered, with cross-references to the DDP and DDTF. The majority of assessments for the MAR REA will be completed in NatureServe Vista. Some of these models are standard NatureServe Vista tools, such as the Landscape Condition Model, and will not be documented or delivered as separate models. However, some assessments that will address specific MQs will be modeled in Vista as Scenario Evaluations. These Scenario Evaluations will be delivered within the final Vista project and will be tracked in the ModDTF.

ArcGIS ModelBuilder models (.tbx) will not be created, nor delivered, for any additional assessments completed outside NatureServe Vista. GIS modeling for assessments is often complex and data is commonly brought in and out of ArcGIS into other software (e.g., Access, Circuitscape), or manually revised, making it difficult to create a properly working ModelBuilder model. In addition, minor changes to attribute names or structure or overall file names in updated versions of a data set would require a model user to review the .tbx and adjust accordingly to be able to run it. Periodic updates to ArcGIS software and the ability to re-run ModelBuilder models developed in previous versions of ArcGIS is also a concern. Therefore, ArcGIS ModelBuilder is used by NatureServe staff when an assessment is very straightforward or when a client wishes to invest significant time in building a robust, debugged, and fully documented ModelBuilder model (.tbx) for analysis that will be repeated again and again in the relatively near future.

Any additional assessments conducted outside NatureServe Vista will be described in a text document of the model methodology that includes clearly identified source data inputs (following BLM REA file-naming conventions), detailed processing steps, and outputs (following BLM REA file-naming conventions), with a level of detail that would permit a qualified GIS analyst to readily repeat the analysis. A test model methodology document will be delivered to BLM for review and discussion to ensure an adequate and workable level of detail. This type of detailed model methodology documentation will only be completed for "assessment" modeling. Any "pre-assessment" GIS analysis prep work conducted during the MAR REA to improve or enhance source data for use in assessments will simply be documented in the process steps of the source metadata (i.e., no source data, models (.tbx) or additional documentation used for this type of "pre-assessment" GIS analysis prep work will be delivered).

4.5 Task 4: Final REA Report

The final REA report is intended to be a high-level, stand-alone document highlighting the major findings of the REA. The appendices will contain a wealth of detail on data and methods, and will serve as a critical accompaniment to the data products resulting from the REA. The final REA report is intended to build on the pre-assessment report (Harkness et al. 2013); much of the main body of the pre-assessment report is expected to go into the main body of the final report. Similarly, the CE conceptual models in the appendix of the pre-assessment report are expected to be incorporated as appendices in the final report as well.

4.5.1 Task 4: Process and AMT and Technical Team Review

Developing the final report for the REA is conceptually straightforward. The team will document detailed methods, data gaps, and other pre-output information in appendices of the final report during Tasks 2 and 3. Process models and detailed geoprocessing documentation are suggested to be included in these appendices. These detailed appendices will be used to create a high-level summary of methods and data gaps in the main body of the report.

To the extent possible, as assessments are completed, reviewed, and finalized, the team will review and interpret the findings and summarize this in the results section of the final report. This will take place largely in the time frame of Task 4, but will begin in Task 3 to the extent possible.

Two versions of the report will be delivered to BLM: draft and final. While the detailed appendices will be drafted earlier, the contractor team plans to deliver the two drafts within the 3-month time frame of Task 4.

The draft report outline is based on the contents outlined in the Statement of Work. The chapter headings are preliminary; they describe the content expected to be contained in each chapter. Chapters 5-8 reflect content that will be included, but not necessarily with this precise structure.

1. Executive Summary
2. Introduction
3. Ecoregional resource concerns and management questions (use Current Issues and MQs summaries from Pre-Assessment Report)
4. Brief summary of the methodologies used in the investigation
5. Summary of ecoregion conditions regarding conservation elements and change agents
6. Results and findings of output products regarding status and potential for change
    - Current Conditions
        - Ecological Status
        - Ecological Integrity
        - Other Assessments of Current Condition
    - Future Conditions
        - General summary of projected future conditions (at a minimum, climate projections)
        - Ecological Status – to the extent possible to assess
        - Other Assessments of Future Conditions
    - Specific answers to management questions concerning species, terrestrial and aquatic systems, and change agents
        - Some (if not most?) of these may be woven into the Ecological Status and Ecological Integrity and Other Assessments components in this chapter

7. Applications of the REA
8. Lessons learned from the REA, and what next steps could be taken
9. Appendices describing datasets, tools, models, and processes used for the assessment.
    - CE conceptual models
    - Process models and accompanying geoprocessing documentation
    - Other methods documentation (including from the Pre-Assessment Report, e.g., CE selection process)
    - Data gaps/information needs
    - Original MQs
    - List of all special assessments considered

4.5.2 Task 4 Deliverables

Tangible deliverables for this task are listed here:

- Final REA report
- Responses to comments on report
- Three brochures
- Other REA documentation per Statement of Work:
    - Working documents
    - Background documents with index
    - Other, non-spatial data sets as appropriate

Other key deliverables for this final task include a series of at least three results webinars communicating the key processes and findings from the REA. These will be held for a few different audiences: BLM management, BLM state or district offices, and partners. These will be scheduled sufficiently ahead of time to ensure that key BLM staff and others are able to participate.

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6 Glossary

Areas of Critical Environmental Concern (ACEC): Areas within the public lands where special management attention is required to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources or other natural systems or processes, or to protect life and safety from natural hazards (FLPMA 1976).

Assessment Management Team (AMT): BLM's team of BLM staff and partners that provides overall guidance to the REA regarding ecoregional goals, resources of concern, conservation elements, change agents, management questions, tools, methodologies, models, and output work products. The team generally consists of BLM State Resources Branch Managers from the ecoregion, a POC, and a variety of agency partners depending on the ecoregion.

Attribute: A defined characteristic of a geographic feature or entity.

Change Agent (CA): An environmental phenomenon or human activity that can alter/influence the future status of resource condition. Some change agents (e.g., roads) are the result of direct human actions or influence. Others (e.g., climate change, wildland fire, or invasive species) may involve natural phenomena or be partially or indirectly related to human activities.

Coarse Filter: A focus of ecoregional analysis that is based upon conserving resource elements that occur at coarse scales, such as ecosystems, rather than upon finer scale elements, such as specific species. The concept behind a coarse filter approach is that preserving coarse-scale conservation elements will preserve elements occurring at finer spatial scales.

Community: Interacting assemblage of species that co-occur with some degree of predictability and consistency.

Conservation Element (CE): A renewable resource object of high conservation interest often called a conservation target by others. For purposes of this TO, conservation elements will likely be types or categories of areas and/or resources including ecological communities or larger ecological assemblages.

Development: A type of change (change agent) resulting from urbanization, industrialization, transportation, mineral extraction, water development, or other non-agricultural/silvicultural human activities that occupy or fragment the landscape or that develops renewable or non-renewable resources.

Ecological Integrity: The ability of an ecological system to support and maintain a community of organisms that have the species composition, diversity, and functional organization comparable to those of natural habitats within the ecoregion.

Ecological Status: The condition of a criterion (biological or socio-economic resource values or conditions) within a geographic area (e.g., watershed, grid). A rating (e.g., low, medium, or high) or ranking (numeric) is assigned to specific criteria to describe status. The rating or ranking will be relative, either to the historical range of variability for that criterion (e.g., a wildland fire regime criterion) or relative to a time period when the criterion did not exist (e.g., an external partnerships/collaboration criterion). (also see *Status)*

Ecoregion: An ecological region or ecoregion is defined as an area with relative homogeneity in ecosystems. Ecoregions depict areas within which the mosaic of ecosystem components (biotic and abiotic as well as terrestrial and aquatic) differs from those of adjacent regions (Omernik and Bailey 1997).

Ecosystem: The interactions of communities of native fish, wildlife, and plants with the abiotic or physical environment.

Element Occurrence: A term used by Natural Heritage Programs. An element occurrence generally delineates the location and extent of a species population or ecological community stand, and represents the geo-referenced biological feature that is of conservation or management interest. Element occurrences are documented by voucher specimens (where appropriate) or other forms of observations. A single element occurrence may be documented by multiple specimens or observations taken from different parts of the same population, or from the same population over multiple years.

Extent: The total area under consideration for an ecoregional assessment. For the BLM, this is a CEC Level III ecoregion or combination of several such ecoregions plus the buffer area surrounding the ecoregion. See *grain*.

Fine Filter: A focus of ecoregional analyses that is based upon conserving resource elements that occur at fine scale, such as specific species. A fine-filter approach is often used in conjunction with a coarse-filter approach (i.e., a coarse-filter/fine-filter framework) because coarse filters do not always capture some concerns, such as when a T&E species is a conservation element.

Fire Regime: Description of the patterns of fire occurrences, frequency, size, severity, and sometimes vegetation and fire effects as well, in a given area or ecosystem. A fire regime is a generalization based on fire histories at individual sites. Fire regimes can often be described as cycles because some parts of the histories usually get repeated, and the repetitions can be counted and measured, such as fire return interval (NWCG 2006).

Fragmentation: The process of dividing habitats into smaller and smaller units until their utility as habitat is lost.

Geographic Information System (GIS): A computer system designed to collect, manage, manipulate, analyze, and display spatially referenced data and associated attributes.

Grain: Grain is the native resolution of spatial datasets; for most source datasets used in REAs, such as species or ecosystem distributions, it will be a 30-meter raster. In some cases the grain or resolution may be 90-meter, or some other value divisible by 30 meters.

Grid Cell: When used in reference to raster data, a grid cell is equivalent to a pixel (also see *pixel*). When a raster data layer is converted to a vector format, the pixels may instead be referred to as grid cells.

Habitat: A place where an animal or plant normally lives for a substantial part of its life, often characterized by dominant plant forms and/or physical characteristics (BLM 1990).

Heritage: See *Natural Heritage Program.*

Heritage Program: See *Natural Heritage Program.*

Hydrologic Unit: An identified area of surface drainage within the U.S. system for cataloging drainage areas, which was developed in the mid-1970s under the sponsorship of the Water Resources Council and includes drainage-basin boundaries, codes, and names. The drainage areas are delineated to nest in a multilevel, hierarchical arrangement. The hydrologic unit hierarchical system has four levels and is the theoretical basis for further subdivisions that form the *watershed boundary dataset* 5th and 6th levels. (USGS 2009).

Indicator: Components of a system whose characteristics (e.g., presence or absence, quantity, distribution) are used as an index of an attribute (e.g., land health) that are too difficult, inconvenient, or expensive to measure (USDA et al. 2005).

Inductive Model: Geo-referenced observations (e.g., known observations of a given species) are combined with maps of potential explanatory variables (climate, elevation, landform, soil variables, etc.). Statistical relationships between dependent variables (observations) and independent explanatory variables are used to derive a new spatial model.

Invasive Species: Species that are not part of (if exotic non-natives), or are a minor component of (if native), an original community that have the potential to become a dominant or co-dominant species if their future establishment and growth are not actively controlled by management interventions, or that are classified as exotic or noxious under state or federal law. Species that become dominant for only one to several years (e.g. short-term response to drought or wildfire) are not invasives (Modified from BLM Handbook 1740-2, Integrated Vegetation Handbook).

Key Ecological Attribute (KEA): An attribute, feature, or process that defines and characterizes an ecological community or system or entity; in conjunction with other key ecological attributes, the condition or function of this attribute or process is considered critical to the integrity of the ecological community or system in question. In the BLM REAs, various analyses will be conducted to calculate scores or indexes indicating the status of key ecological attributes for various Conservation Elements (CEs).

Landscape Species: Biological species that use large, ecologically diverse areas and often have significant impacts on the structure and function of natural ecosystems (Redford et al. 2000).

Management Questions: Questions from decision-makers that usually identify problems and request how to fix or solve those problems.

Metadata: The description and documentation of the content, quality, condition, and other characteristics of geospatial data.

Model: Any representation, whether verbal, diagrammatic, or mathematical, of an object or phenomenon. Natural resource models typically characterize resource systems in terms of their status and change through time. Models imbed hypotheses about resource structures and functions, and they generate predictions about the effects of management actions. (Adaptive Management: DOI Technical Guide).

Native Plant and Animal Populations and Communities: Populations and communities of all species of plants and animals naturally occurring, other than as a result of an introduction, either presently or historically in an ecosystem (BLM Manual H-4180-1).

Native Species: Species that historically occurred or currently occur in a particular ecosystem and were not introduced (BLM 2007b).

Natural Community: An assemblage of organisms indigenous to an area that is characterized by distinct combinations of species occupying a common ecological zone and interacting with one another (BLM 2007b).

Natural Heritage Program: An agency or organization, usually based within a state or provincial natural resource agency, whose mission is to collect, document, and analyze data on the location and condition of biological and other natural features (such as geologic or aquatic features) of the state or province. These programs typically have particular responsibility for documenting **at-risk species and threatened ecosystems. (See natureserve.org/ for additional information on these programs.)**

Occurrence: See *Element Occurrence*.

Pixel: A pixel is a cell or spatial unit comprising a raster data layer; within a single raster data layer, the pixels are consistently sized; a common pixel size is 30 x 30 meters square. Pixels are usually referenced in relation to spatial data that are in raster format. In this REA, some pixels sizes included 30 x 30 m and 2 x 2 km (also see *Grid Cell*).

Population: Individuals of the same species that live, interact, and migrate through the same niche and habitat.

Rapid Ecoregional Assessment (REA): The methodology used by the BLM to assemble and synthesize that regional-scale resource information, which provides the fundamental knowledge base for devising regional resource goals, priorities, and focal areas, on a relatively short time frame (within 2 years).

Reporting Unit: Because an REA considers a variety of phenomena, there will be many phenomena and process (or intrinsic) grain sizes. These will necessarily be scaled to a uniform reporting unit, which has also been referred to as a *landscape unit* in BLM REA documents. This reporting or landscape unit will be the analysis scale used for reporting and displaying ecoregional analyses. (BLM specifies for the aquatic CEs, distribution and status will be reported at either 6^{th}-level/12-digit hydrologic unit, or 5^{th}-level/10-digit hydrologic unit. For the other CEs and the CAs, distribution will be provided at 30m resolution (or divisible by 30m), and status will be reported at the 4-km cells used for the climate analyses.)

Resource Value: An ecological value, as opposed to a cultural value. Examples of resource values are those species, habitats, communities, features, functions, or services associated with areas with abundant native species and few non-natives, having intact, connected habitats, and that help maintain landscape hydrologic function. Resource values of concern to the BLM can be classified into three categories: native fish, wildlife, or plants of conservation concern; regionally-important terrestrial ecological features, functions, and services; and regionally-important aquatic ecological features, functions, and services.

Scale: Refers to the characteristic time or length of a process, observation, model, or analysis. ***Intrinsic scale*** refers to the scale at which a pattern or process actually operates. Because nature phenomena range over at least nine orders of magnitude, the intrinsic scale has wide variation. This is significant for ecoregional assessment, where multiple resources and their phenomena are being assessed. ***Observation scale***, often referred to as sampling or measurement scale, is the scale at which sampling is undertaken. Note that once data are observed at a particular scale, that scale becomes the limit of analysis, not the phenomenon scale. ***Analysis*** or ***modeling scale*** refers to the resolution and extent in space and time of statistical analyses or simulation modeling. ***Policy scale*** is the scale at which policies are implemented and is influenced by social, political, and economic policies.

Scaling: The transfer of information across spatial scales. ***Upscaling*** is the process of transferring information from a smaller to a larger scale. ***Downscaling*** is the process of transferring information to a smaller scale.

Status: The condition of a criterion (biological or socio-economic resource values or conditions) within a geographic area (e.g., watershed, grid). A rating (e.g., low, medium, or high) or ranking (numeric) is assigned to specific criteria to describe status. The rating or ranking will be relative, either to the historical range of variability for that criterion (e.g., a wildland fire regime criterion) or relative to a time period when the criterion did not exist (e.g., an external partnerships/collaboration criterion).

Step-Down: A step-down is any action related to regionally-defined goals and priorities discussed in the REA that are acted upon through actions by specific State and/or Field Offices. These step-down actions can be additional inventory, a finer-grained analysis, or a specific management activity.

Stressor: A factor causing negative impacts to the biological health or ecological integrity of a Conservation Element. Factors causing such impacts may or may not have anthropogenic origins. In the context of the REAs, these factors are generally anthropogenic in origin.

Subwatershed: A subdivision of a *watershed*. A *subwatershed* is the 6th-level, 12-digit unit and smallest of the hydrologic unit hierarchy. Subwatersheds generally range in size from 10,000 to 40,000 acres. (USGS 2009).

Value: See *resource value*.

Watershed: A watershed is the 5th-level, 10-digit unit of the hydrologic unit hierarchy. Watersheds range in size from 40,000 to 250,000 acres. Also used as a generic term representing a drainage basin or combination of hydrologic units of any size. (USGS 2009).

Watershed Boundary Dataset (WBD): A national geospatial database of drainage areas consisting of the 1^{st} through 6^{th} hierarchical hydrologic unit levels. The WBD is an ongoing multiagency effort to create hierarchical, and integrated hydrologic units across the Nation. (USGS 2009).

Wildland Fire: Any non-structure fire that occurs in the wildland. Three distinct types of wildland fire have been defined and include wildfire, wildland fire use, and prescribed fire (NWCG 2006).

7 List of Acronyms

AADT	Annual Average Daily Traffic
ACEC	Area of Critical Environmental Concern
AMT	Assessment Management Team
AR4	International Panel on Climate Change - Fourth Assessment Report
BLM	Bureau of Land Management
BPS	Biophysical Setting (from LANDFIRE data)
CA	Change Agent
CBR	Central Basin and Range ecoregion
CCVI	Climate Change Vulnerability Index
CE	Conservation Element
CM	Conceptual Model
COR	Contracting Officer Representative
CVS	Conservation Value Summary
CWNA	Climate Western North America
DDP	Data Delivery Package
DDTF	Data Delivery Tracking Form
DEM	Digital Elevation Model
DITF	Data Inventory and Tracking Form (formerly Data Inventory and Tracking Table)
DMP	Data Management Plan
DMT	BLM's National Operations Center's Data Management Team
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior
EIA	Ecological Integrity Assessment
EIS	Environmental Impact Statement
EO	Element Occurrence
EPCA	Energy Policy and Conservation Act
ESA	Endangered Species Act
ESA	Ecological Status Assessment
ESD	Ecological Site Descriptions
EVT	Existing Vegetation Type (LANDFIRE)
FO	Field Office
FRI	Fire Return Interval
GA	Grazing Allotment
GCM	General Circulation Model
GIS	Geographic Information System
HMA	Herd Management Area
HRV	Historical Range of Variation
HUC	Hydrologic Unit Code
ILAP	Integrated Landscape Assessment Project
IPCC	Intergovernmental Panel on Climate Change
KEA	Key Ecological Attribute

LCM	Landscape Condition Model
LF	LANDFIRE (Landscape Fire and Resource Management Planning Tools)
MAR	**M**adrean **Ar**chipelago ecoregion
MBR	Mojave Basin and Range ecoregion
MDL	NatureServe's Master Data List
MDTF	Map Delivery Tracking Form (BLM's)
MLRA	Multiple Resource Land Area
ModDTF	Model Delivery Tracking Form (BLM's)
MQ	Management Question
MRDS	Mineral Resource Data System
NHD	National Hydrography Dataset
NHNM	Natural Heritage New Mexico
NOC	BLM's National Operations Center
NPMS	National Pipeline Mapping System
NRCS	Natural Resources Conservation Service
NREL	National Renewable Energy Laboratory
NRV	Natural Range of Variability
NSPECT	Non-point Source Pollution and Erosion Comparison Tool
NTAD	National Transportation Atlas Database
NWI	National Wetland Inventory
ORV	Off-road Vehicle
PRISM	Parameter-elevation Regressions on Independent Slopes Model
PVT	Potential Vegetation Type
REA	Rapid Ecoregional Assessments
REAWP	Rapid Ecoregional Assessment Work Plan
RegCM	International Centre for Theoretical Physics Regional Climate Model
ROC	Receiver Operating Characteristic
SD	Standard Deviation
SDM	Species Distribution Model
SDR	Southwest Decision Resources
SIA	Sky Island Alliance
SNK	Seward Peninsula – Nulato Hills – Kotzebue Lowlands ecoregion
SOW	Statement of Work (for REA contract)
SSURGO	Soil Survey Geographic Database
STATSGO	State Soil Geographic Database
SWAP	State Wildlife Action Plan
TWI	Topographic Wetness Index
USFS	U. S. Forest Service
USGS	United States Geological Survey