

**The Organization and Status of the Department of Interior's Programs and
Studies on Climate Change in the Colorado River Basin**
June 17, 2011

The Colorado River Governance Initiative

Table of Contents:

Introduction	1
Background	2
Programs: CSCs and LCCs	3
<i>Southwest Climate Science Center</i>	3
<i>Southern Rockies and Desert Landscape Conservation Cooperatives</i>	5
Studies	8
<i>Colorado River Basin Water Supply and Demand Study</i>	8
<i>Colorado River Basin Focus Area Study</i>	10
<i>Colorado Plateau and Sonoran Desert Rapid Ecoregional Assessments (REA)</i>	12
<i>Pilot Drought Early Warning System</i>	13
How do these Programs and Studies fit together?	16
Appendices	17
<i>Appendix A: DOI Agencies' Roles for General Water Management and under the SECURE Water Act:</i>	18
<i>Appendix B: Roles and Responsibilities Concept Table for LCCs and CSCs</i>	19
<i>Appendix C: Table of Program and Agencies Similarities and Differences:</i>	20
<i>Appendix D: Players involved in Programs and Studies on Climate Change and the Colorado River Basin</i>	21
<i>Appendix E: Timeline of Programs and Key Events</i>	22

Introduction

Climate change will profoundly affect our water resources, but how, where, and to what degree? These many uncertainties prompted Congress to pass legislation in 2009 that allocated funding and responsibility to Department of Interior (DOI) agencies to investigate these issues from both scientific and management perspectives. The DOI is “uniquely positioned to provide leadership in working toward the goal of sustainable water supplies” (Secretarial Order 3297). In response, the DOI has begun to create a collaborative network among its various agencies and reach outside of the federal government in order to prevent duplication, stretch government resources, and take advantage of the expertise of the many different players involved (See Appendix B).

For the purposes of this report, the focus will be on those aspects of these programs and studies that concentrate on the Colorado River Basin. Much of this information is synthesized from the agencies themselves through a June 8, 2011 event entitled “Colorado River Basin-Wide Federal Studies – An Update” as part of the University of Colorado Law School’s Clyde O. Matz Summer Conference 2011: Navigating the Future of the Colorado River Basin. The programs represented were the Southwest Climate Science Center and the Southern Rockies and Desert Landscape Conservation Cooperatives. The studies represented were the 1) *The Colorado Plateau and Sonoran Desert Rapid Ecoregional Assessment*, 2) the *WaterSMART Colorado River Basin Geographic Focus Study*, 3) *The Pilot Drought Early Warning System for the Upper Colorado River Basin*, and 4) *The Colorado River Basin Water Supply and Demand Study*.

Background

The SECURE Water Act, Title XI Subtitle F of the Omnibus Public Land Management Act of 2009, required the Secretary of the Interior to develop a climate change adaptation program regarding the nation’s water resources. The Act acknowledged that although the States bear the primary responsibility and authority for managing water resources in the United States, the Federal Government should support them, especially in light of the uncertainties due to climate change. It specifically set up a Reclamation Climate Change and Water Program which would coordinate with the National Oceanic and Atmospheric Administration (NOAA) and the United States Geological Survey (USGS), a Water Data Enhancement led by the USGS and NIDIS, a National Water Availability and Use Assessment Program, and authorized grants for

related projects. The Colorado River Basin was one of the eight major “reclamation river basins” selected for study in the SECURE Water Act¹.

In order to implement the SECURE Water Act, in 2010 Secretarial Order 3297 created the WaterSMART Program – Sustain and Manage America’s Resources for Tomorrow. This program’s purpose is “to identify strategies to ensure that this generation and generations to come will have adequate supplies of clean water for drinking, economic activity, recreation, and ecosystem health... each bureau and office will exercise its discretion within the scope of its mission to carry out the purpose of this Order.” The order emphasized coordination with the programs already established by the SECURE Water Act: Reclamation’s Title XVI, the Basin Study Program, and WaterSMART Grants, as well as the USGS’s WaterSMART Availability and Use Assessment Program. More specific goals of the WaterSMART Program included the creation of a WaterSMART Clearinghouse, which will be a public resource providing leadership and assistance to government, NGOs, water users and supplier organizations, scientific entities, and tribal nations; the integration of energy and water policies; and the development of concrete scientific information to support sustainable water supplies². The last comprehensive assessment of national water availability was completed in 1978³.

In addition, Secretarial Order 3289 renamed the DOI’s Climate Change Response Council as the Energy and Climate Change Council and directed the Council to use an integrated approach in addressing climate change, which involved the creation of Climate Science Centers (CSCs) and Landscape Conservation Cooperatives (LCCs)⁴. While the studies are focused exclusively on water issues, these programs are addressing the effects of climate change in general, which includes its effects on water resources. The goals of the CSCs and LCCs are the integration of DOI science and management expertise with various partners, and to provide information and the best management practices available to support strategic adaptation efforts on both public and private lands across the U.S. and internationally⁵. (See Appendix A for the various DOI agencies and their roles under the SECURE Water Act and WaterSMART).

¹ <http://www.gpo.gov/fdsys/pkg/PLAW-111publ11/pdf/PLAW-111publ11.pdf>

¹ <http://www.usbr.gov/climate/SECURE/docs/SECUREWaterReport.pdf>

² http://elips.doi.gov/app_so/act_getfiles.cfm?order_number=3297

³ <http://www.doi.gov/news/pressreleases/Secretary-Salazar-Launches-New-Regional-Climate-Science-Center-and-Water-Census-at-Meeting-of-Colorado-River-Basin-Water-Leaders.cfm>

⁴ http://elips.doi.gov/app_so/act_getfiles.cfm?order_number=3289A1

⁵ <http://www.doi.gov/whatwedo/climate/strategy/upload/Detailed-CSC-LCC-Information.pdf>

Programs: CSCs and LCCs

Southwest Climate Science Center

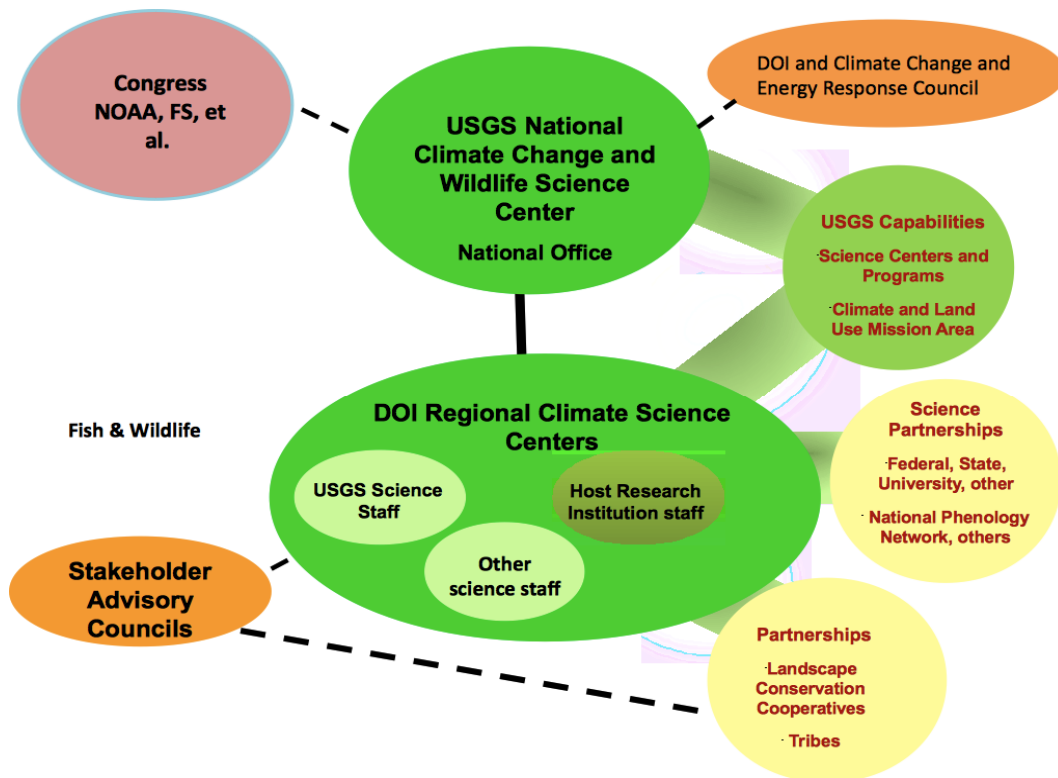
Lead Agency: USGS

Website: http://www.doi.gov/whatwedo/climate/strategy/Southwest_CSC.cfm

Contact: Dr. David Busch, USGS, dave_busch@usgs.gov

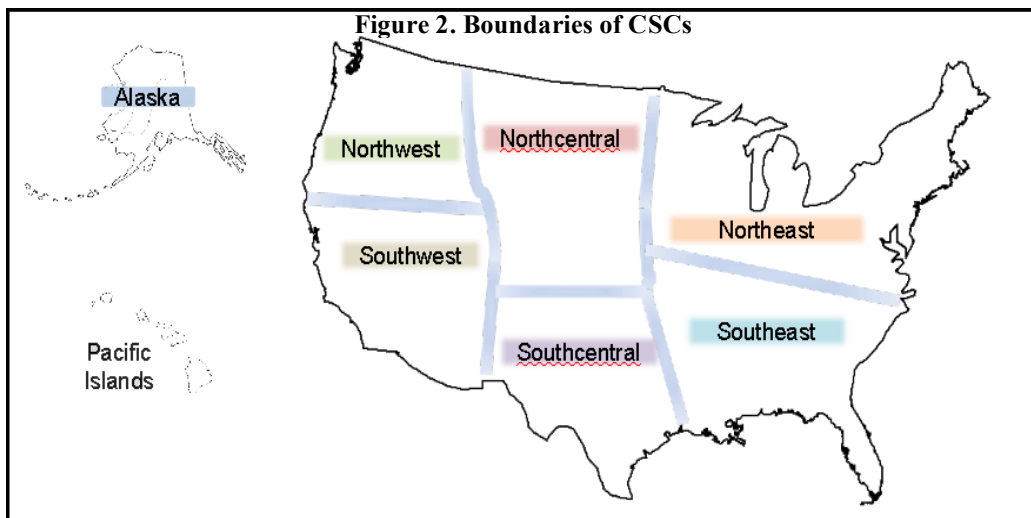
The DOI created 8 regional CSCs in 2010 as part of the agency’s goal to “take the lead in protecting our country’s water, land, fish, and wildlife, and cultural heritage from the dramatic effects of climate change that are already occurring” established by Secretarial Order No. 3289. The CSCs will be regional “hubs” of the National Climate Change and Wildlife Science Center of the USGS and are located at host universities. They are management-driven science partnerships, expertise networks, and research institution-based which focus on synthesis, modeling, assessment, integration, translation, and delivery.

Figure 1. CSCs’ Relationships with other Agencies and Programs



Their goal is to deliver fundamental climate impact science to resource managers on a regional basis. The CSCs will deliver basic climate change impact science to the LCCs in their

regions. Their research priorities will be driven by their associated LCCs (See Appendix B for their relative responsibilities). They will work with (and sometimes generate) downscaled climate models, providing derivative models and tools that link physical forcing factors with biological, hydrological, physical, ecological, and cultural response variables. CSCs will also develop response models and projections for priority ecosystems, species, habitats, and other natural and cultural resources at the regional level⁶.



In 2010, the Northwest, Southeast, and Alaska CSCs were established. In 2011, the Southwest and North Central CSCs were established. The Northeast, South Central, and Pacific CSCs will be established in 2012. The host institutions are competitively awarded \$3 to \$4 million per year per center. The Southwest CSC is based at the University of Arizona, Tucson and has the leadership of other area universities such as UC Davis, UC San Diego, UCLA, University of Colorado, Boulder, the Desert Research Institute of Reno, and the Scripps Institution of Oceanography. It is supported by at \$3.1 million, five-year grant from the DOI. Researchers at these institutions will address regional climate change challenges such as biological and geographical carbon sequestration, climate impacts on agriculture and grazing, ecosystem restoration, fish and wildlife response to climate change, forest resilience, invasive species, protection of cultural resources, renewable energy, wildfire, disease, water availability and water quality for humans and ecosystems.

⁶ <http://www.doi.gov/whatwedo/climate/strategy/upload/Detailed-CSC-LCC-Information.pdf>

Southern Rockies and Desert Landscape Conservation Cooperatives

Lead Agencies: USFWS and Reclamation

Websites:

Southern Rockies LCC: <http://www.doi.gov/lcc/Southern-Rockies.cfm>

Desert LCC: <http://www.usbr.gov/WaterSMART/lcc.html>

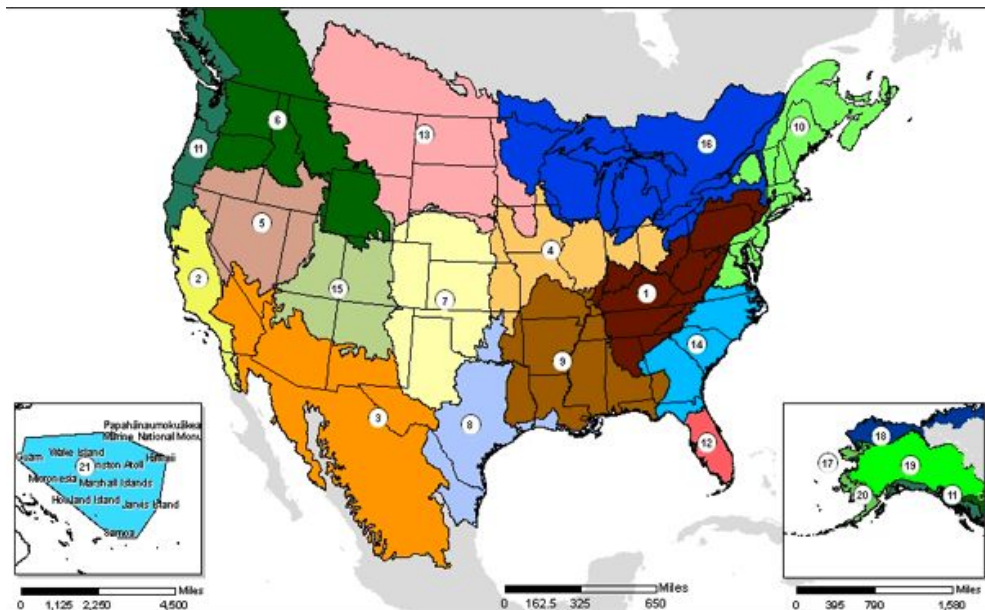
Contacts:

Southern Rockies LCC: Kevin Johnson, USFWS, kevin_m_johnson@fws.gov; Avra Morgan, Reclamation, aomorgan@usbr.gov

Desert LCC: Christina Vojta, USFWS, Christina_vojta@fws.gov; Avra Morgan, Reclamation, aomorgan@usbr.gov

Landscape Conservation Cooperatives (LCCs) are applied conservation science partnerships focused on a defined geographic area that inform on-the-ground strategic conservation efforts at landscape scales. LCC partners include DOI agencies, other federal agencies, states, tribes, non-governmental organizations, universities and others. They are self-directed partnerships that will be led by a Steering Committee comprised of management representatives from governmental entities at all levels and non-governmental organizations who want to be a part of the Committee. USFWS and Reclamation are the two DOI agencies leading the effort.

Figure 3. Boundaries of LCCs

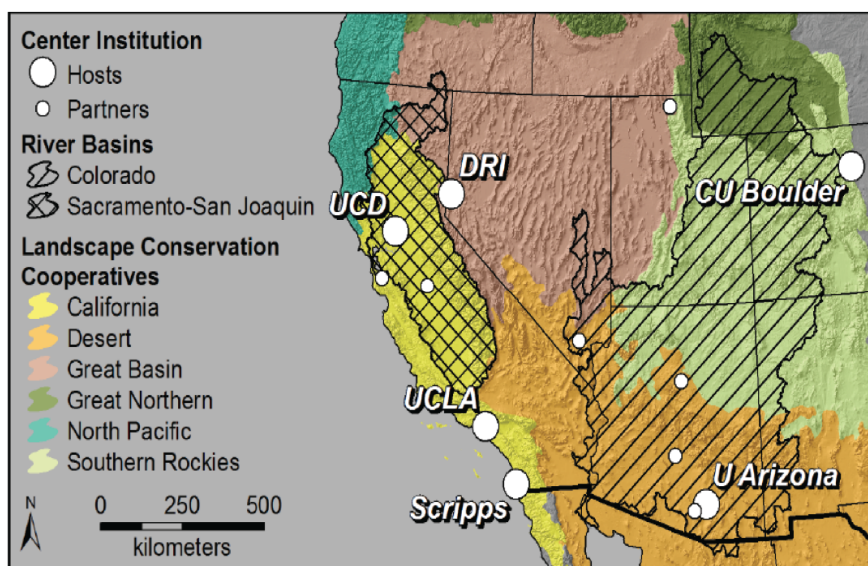


LCCs will enable resource management agencies and organizations to collaborate in an integrated fashion within and across landscapes. They will provide scientific and technical

support to inform landscape-scale conservation using adaptive management principles. LCCs will engage in biological planning, conservation design, inventory and monitoring program design, and other types of conservation-based scientific research, planning and coordination. LCCs will play an important role in helping partners establish common goals and priorities, so they can be more efficient and effective in targeting the right science in the right places. Products developed by LCCs will inform the actions of partners and other interested parties in their delivery of on-the-ground conservation. They will work closely with the CSCs in their geographic areas (See Appendix B for their relative responsibilities).

LCCs will comprise a seamless national network focused on helping conservation agencies and organizations maintain landscapes capable of sustaining abundant, diverse and healthy populations of fish, wildlife and plants. Without duplicating existing partnerships, the LCCs in the network will accomplish conservation objectives that no single LCC, nor any agency or organization, could accomplish alone. All LCCs will perform basic core functions and provide the same general kinds of products and services that will help partners meet shared landscape-scale objectives. Although the roles of LCC members will vary from one LCC to another, depending on their responsibilities, interests, and organizational capabilities, each LCC will be an integral component of the national network, with consistent structure, governance and operations⁷.

Figure 4. LCCs in the Colorado River Basin



⁷ <http://www.fws.gov/southwest/AboutUs/LCC/index.html>

Two LCCs occupy the region of the Colorado River Basin: the Southern Rockies LCC, mainly in the upper basin, and the Desert LCC, mainly in the lower basin. Resource management issues already developed by the Southern Rockies LCC include the conservation of sensitive species across a broad range of habitats, such as the Uinta Basin hookless cactus, greater sage grouse, several Colorado River fishes, Gunnison prairie dog, bighorn sheep, aspen, and yellow-billed cuckoo; protecting major ecosystems, including alpine tundra, subalpine, and montane forests, pinon-juniper woodlands, desert shrublands, and grasslands; and evaluating the impacts from climate change, energy development, invasive species, and altered ecological processes⁸.

The Desert LCC is in the process of developing a governance and operations plan. Some of the resource management issues the Desert LCC will be examining are the effect of long-term drought on the composition, abundance, and distribution of species, the effect of reduced water availability on vegetation, wildlife, and human populations; changes in ecosystem productivity, structure, and composition resulting in changes in the rate of carbon sequestration and amount of carbon stored as biomass; changes in fire frequencies and intensities, and the relationship to invasion of non-native grasses; and effects of warming on insect outbreaks and tree mortality⁹. Both LCCs have been holding outreach meetings to engage potential LCC partners on the benefits of participating in an LCC. Both are also offering Applied Science Grants Funding Opportunity for proposals that will help resource managers analyze and adapt to climate change and other stressors across the landscape.

⁸ <http://www.usbr.gov/WaterSMART/docs/SRockiesLCC%20Fact%20Sheet%20Final.pdf>

⁹ http://www.usbr.gov/WaterSMART/docs/Desert_Fact_Sheet.pdf

Studies

Colorado River Basin Water Supply and Demand Study

Leader: Reclamation

Partners: Tribes, Stakeholders, Nongovernmental Organizations

Website: <http://www.usbr.gov/lc/region/programs/crbstudy.html>

Mission: Analyzing the water supply and demand imbalances throughout the Colorado River Basin and the adjacent areas of the Basin States that receive Colorado River water through 2060, assessing options for resolving imbalances, and developing recommendations for future consideration to address current and projected imbalances.

Timeline: 2009 - Study Proposal Accepted; 2010 - Water Supply Assessment, Water Demand Assessment; 2011 - System Reliability Analysis; 2012 - Development & Evaluation of Options, Develop Findings and Recommendations, Final Report

Funding: Cost-shared 50-50 between Basin States and WaterSMART

Estimated Cost: \$2 million

Contacts: Lower Colorado Region - Terry Fulp, tfulp@usbr.gov

Upper Colorado Region - Dave Trueman, dtrueman@usbr.gov

Figure 5. Basin Study Map



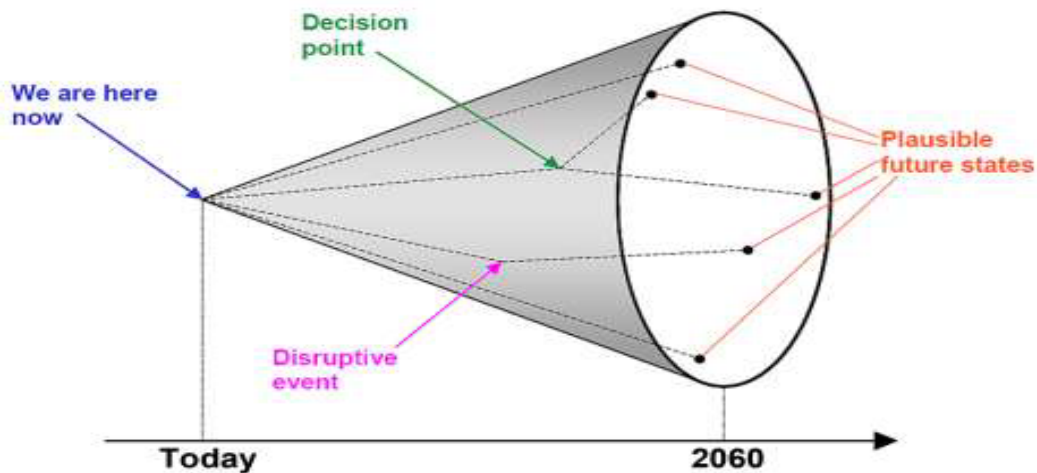
The Colorado River Basin Water Supply & Demand Study, projected to be complete in July 2012, will define current and future imbalances in water supply and demand in the Colorado River Basin and the adjacent areas of the Basin States that receive Colorado River water for approximately the next 50 years, and will develop and analyze adaptation and mitigation strategies to resolve those imbalances. The Study will characterize current and future water supply and demand imbalances in the Basin and assess the risks to Basin resources, such as water allocations under the Law of the River; hydroelectric power generation; recreation; fish, wildlife, and their habitats; water quality including

salinity; flow and water dependent ecological systems; and flood control¹⁰.

A scenario planning process has been used to guide the development of scenarios that provide a broad range of projections of future water supply and demand. The process involves the identification of the key forces that will likely drive future water supply and water demand, ranking of the driving forces as to their relative importance and uncertainty, and using the most highly uncertain and highly important driving forces to identify various themes and storylines (narrative descriptions of scenarios) that describe how water supply and water demand may evolve in the future.

A set of four scenarios focused around these critical uncertainties was constructed that represents a broad range of plausible future conditions with respect to water supply in the Basin through the next 50 years: Observed Record Trends and Variability; Paleo Record Trends and Variability; Observed Record Trends and Increased Variability; and Downscaled GCM Projected Trends and Variability.

Figure 6. Scenario Development Approach



The scenario development approach identified ten critical uncertainties affecting the future of water demand: population and distribution; agricultural land use; agricultural water use efficiency; municipal and industrial water use efficiency; water needs for energy generation; institutional and regulatory conditions; flow-dependent ecosystem needs for Endangered Species

¹⁰ <http://www.usbr.gov/lc/region/programs/crbstudy/CRBasinStudy.pdf>

Act-listed species; other flow-dependent ecosystem needs, social values affecting water use; and water availability due to tribal water use and settlement of tribal water rights claims¹¹.

The Study will publish three Interim Reports in addition to a Draft Final Report that will be made available for comment by project participants and other stakeholders for incorporation into the subsequent report, as appropriate.

Colorado River Basin Focus Area Study

Leader: USGS

Partners: Stakeholders and Reclamation

Goal: Creating a “water census” that will become a water budget delivered as a web-based map with scales relevant to the user

Timeline: 2011 - Receive funding and begin initial planning stages, 3-year study

Funding: WaterSMART, \$1.5 million

Contacts: Bret Bruce, Focus Area Study Coordinator, USGS, bbruce@usgs.gov

This study is designed to complement Reclamation’s Colorado River Basin Supply and Demand Study – both are a part of the WaterSMART program. It is one of the three Geographic focus studies started this year. The USGS Colorado River Basin Focus Area Study will account for the changing amount, quality, and use of water resources in the Basin, and create a “water census” of the current water availability in the Colorado River. The ultimate goal is to provide the ability to track how the water is used and consumed, and ultimately how it is returned to the environment¹². The Study will follow a predetermined schedule, addressing:

- the current availability of water resources in the United States
- significant trends affecting water availability, including documented or projected impacts as a result of global climate change
- the withdrawal and use of surface water and groundwater by various sectors

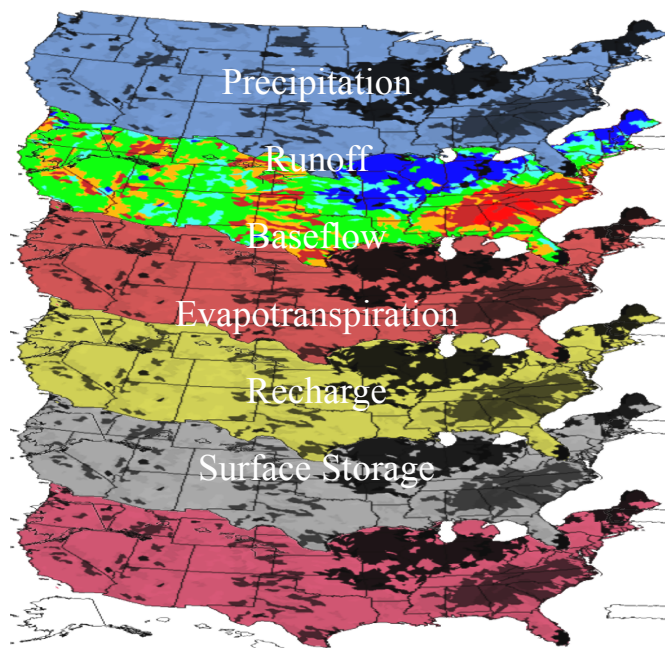


Figure 7. The Water Census Vision

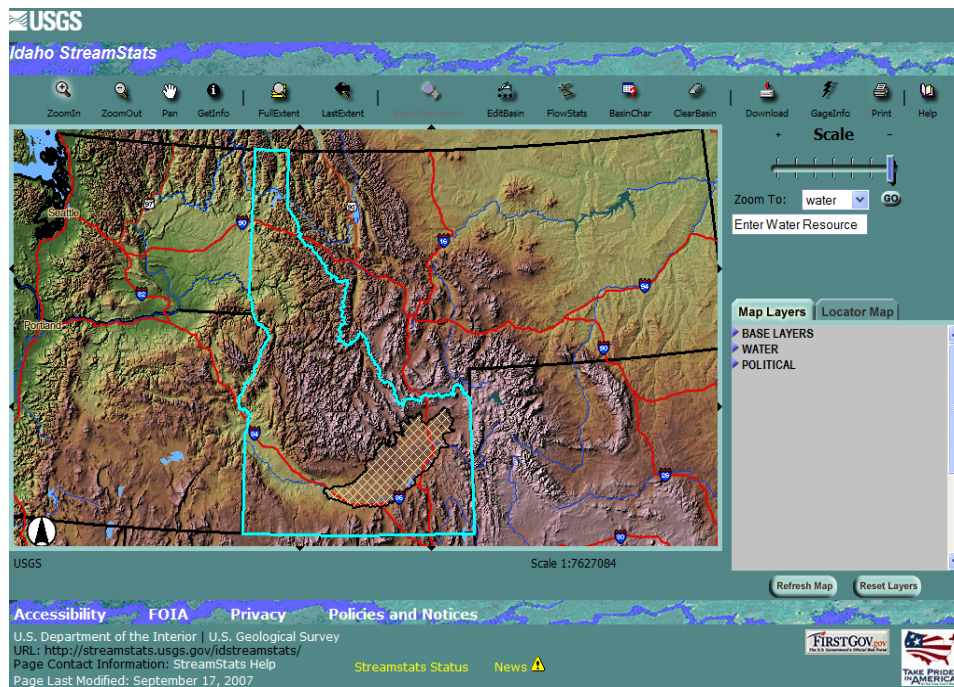
¹¹ <http://www.usbr.gov/lc/region/programs/crbstudy/Report1/StatusRpt.pdf>

¹² http://energy.senate.gov/public/_files/ConnorTestimony042711.pdf

- significant trends relating to each water use sector, including significant changes in water use due to the development of new energy supplies
- significant water use conflicts or shortages that have occurred or are occurring
- each factor that has caused, or is causing, a conflict or shortage

The Study will work with all stakeholders and all inputs to answer technical questions, addressing: hydroclimatic variables (precipitation, sublimation, evapotranspiration); storage in reservoirs, lakes, snow and ice; surface water; and groundwater. Concurrently, the Study will address factors affecting water use in the basin, including ecological needs, water withdrawals, return flows, consumptive uses, and run-of-the-river uses. The resulting web-based map will employ nested design that provides basin-wide coverage with sub-basin detail. From this web-based map, users will select their areas of interest, generate information on water accounting components, and work with the online tool to construct their water budgets and access trend information.

Figure 8. Information Delivery



Colorado Plateau and Sonoran Desert Rapid Ecoregional Assessments (REA)

Leader: BLM

Website: <http://www.blm.gov/wo/st/en/prog/more/climatechange/reas/coloplateau.html>

Goal: To assess factors that may affect, both positively and negatively, the current and future condition of resources of conservation concern on an ecoregional scale.

Timeline: Began in July 2010 and is scheduled for completion in 2012.

Contact: Dr. Karl Ford, BLM, karl_ford@blm.gov

The Colorado Plateau and Sonoran Desert REA is part of seven REAs launched by BLM in 2010 as part of BLM's Concept Landscape Approach. They are called "rapid" because they synthesize existing information and are generally completed within 18 months. They examine ecological values, conditions, and trends within ecoregions, which are large, connected areas that have similar environmental characteristics¹³.

They will assess key ecological values, forecast trends, identify management opportunities, identify data gaps and science needs, and provide information and tools. They will be used to inform resource management for the ecoregion's public lands, create focal areas for conservation and urban development, and implement these priorities through the BLM's state and field offices. They also provide a science-based platform for coordinating multi-agency strategies and do not allocate resources uses or make management decisions. REAs nest within LCC areas and evaluate elements at a finer scale to provide a basis for the larger scale LCCs. Both use a landscape approach that will become more fully integrated as they progress.

There are two phases to REAs: 1) pre-assessment which involves refining management questions, identifying and recommending datasets for analysis, identifying and recommending analytical models and tools, and preparing a work plan; and 2) assessment which involves synthesizing datasets, conducting analyses and generating findings, and preparing the report, maps, and supporting documents. They are led by an Assessment Management Team comprised of federal and state managers, as well as technical specialists from within the ecoregion.

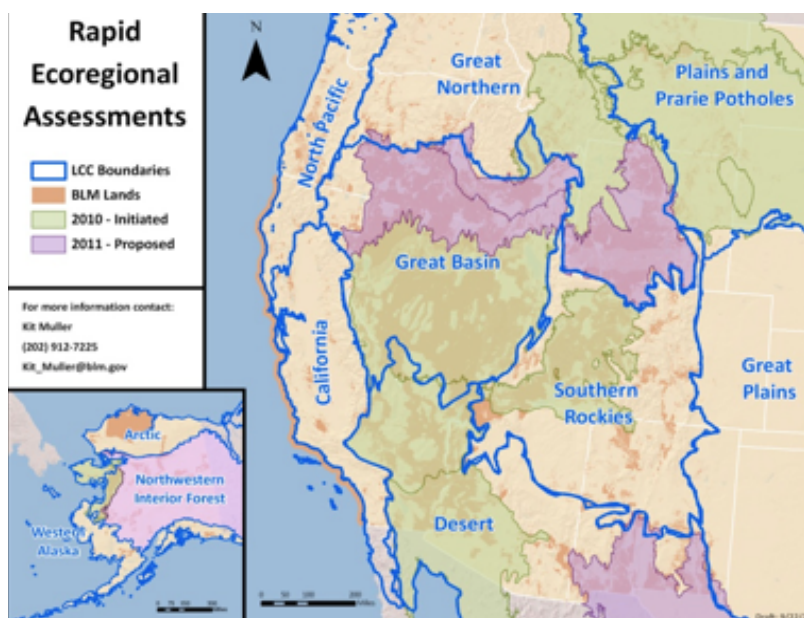
Task 1 of the Colorado Plateau REA was completed in September 2010. It resulted in the refinement of related management questions and developed a conceptual model to articulate the general relationships between conservation elements, change agents, and environmental context. Conservation elements are defined as resources of conservation concern within an ecoregion.

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http://www.blm.gov/pgdata/etc/medialib/blm/wo/Communications_Directorate/public_affairs/landscape_approach.P ar.84084.File.dat/REAintroduction.pdf

These elements are first refined through a “coarse-filter” of the dominant and regionally significant vegetation types that represent all the major ecosystem types of the region, then they are further refined through a “fine filter” of regionally significant individual or assemblages of species. Change agents, both natural and anthropogenic, are defined as disturbances on the landscape that can influence ecosystem health. The REA addresses three conservation resources (aquatic ecosystems, terrestrial ecosystems, native species) and four change agents (fire, development, invasive species, and climate change).

Figure 9. REAs in the Colorado River Basin



Pilot Drought Early Warning System

Leader: NIDIS – NOAA and USGS

Partners: NWS-CBRFC, WWA, Basin States, Tribes, Stakeholders

Website: <http://www.drought.gov/portal/server.pt/community/ucrb>

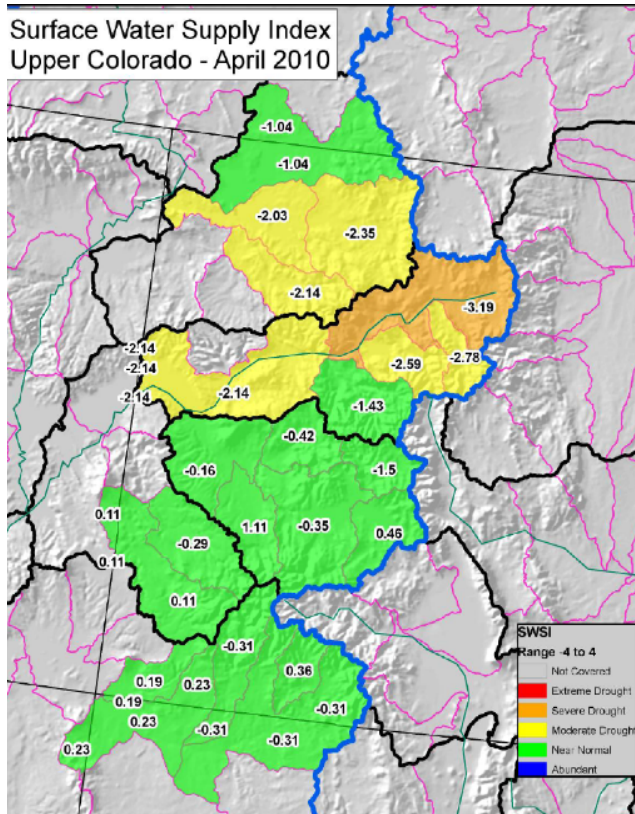
Mission: Incorporating drought monitoring and prediction information in partnership with users and federal, state, regional, and local agencies.

Timeline: 2008 - Pilot study scoping and selection, define criteria and assess partner interest and capacity for pilots; 2010 - Pilot study implementation; 2011 - Initial early warning prototypes; 2012 - Pilot study assessment and follow-on work

Contacts: Dr. James Verdin, USGS

The National Integrated Drought Information System (NIDIS) was created by the NIDIS Act in 2006. NIDIS is based on the concept that drought management should be risk-based, and

Figure 10. Surface Water Supply Index



aimed at better quantitative monitoring, early warning, and prediction. The NIDIS Pilot Drought Early Warning System will provide a major mechanism for the Upper Colorado River Basin to prototype various approaches for developing early warning and information for proactive drought risk reduction. The goal of the pilot program will be to incorporate drought monitoring and prediction information in partnership with users and federal, state, regional, and local agencies in a collaborative process for basin drought monitoring. The Pilot program will support research, applications, and services through drought indicators and triggers, assessment of gaps, and facilitated web access.

The Pilot program for the Upper Colorado River Basin is one of three

programs across the United States (along with California and the Apalachicola-Chattahoochee-Flint Basin) that will serve to achieve improved capabilities in water resources planning and management to deal with climate change on a nation-wide scale. These Pilot programs will serve as examples for other zones implementing drought monitoring systems and will follow an agreed upon protocol:

- Assess capacity for conducting pilot projects in different administrative units and drought types.
- Explicitly engage multiagency entities, State Climatologists, and Agricultural Extension and Natural Resources Conservation Service personnel as communication and dissemination resources. Identify complementary activities across criteria for effective early warning systems design.
- Choose the unit or units of analysis within the respective watershed or state.

- Select federal-state-local sub-team for implementation across early warning subsystems in each setting.
- Conduct capacity assessment in the context of early warning system criteria. Assess how the present system has responded in the context of recent droughts and how it would respond in the context of major events retrospectively, vertically, and horizontally.
- Revisit steps to date and adjust protocol as needed for particular contexts, sectors, and community considered.
- Develop and test monitoring and forecast tailoring at appropriate scales of warning, drought risk assessment tools, and early warning products and services.
- Refine the Drought Portal regionally and locally to provide timely surface observations and forecasts on a regional basis for planning and decisionmaking with respect to drought events.
- Re-evaluate response potential for recent droughts, past significant events and projections of long-term changes.
- Test transferability to a state, watershed, or locale that has limited localized observational capacity and early warning infrastructure. Coordinate and improve monitoring and forecasting sub-systems in that location¹⁴.

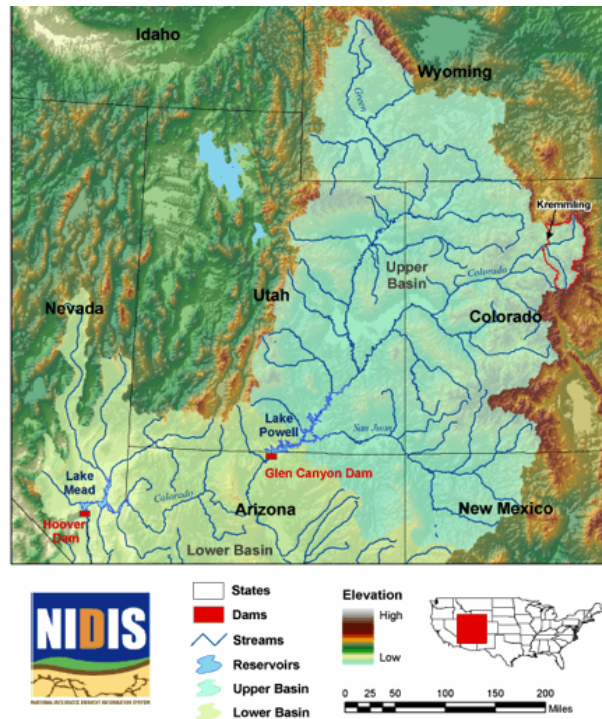


Figure 11. Map of NIDIS Upper Basin Pilot

One of the main features of the NIDIS study is the weekly webinar. Each webinar features several presenters who present data and other input from multiple federal agencies and state and local partners. They cover Upper Colorado River basin precipitation, SNOTEL snowpack and water-year precipitation updates at varying elevations, USGS streamflow updates, CBRFC streamflow forecasts, selected reservoir level updates and historic context, soil moisture conditions, precipitation outlook for the upcoming week, and assessment and recommendations for weekly updates to the U.S. Drought Monitor¹⁵.

¹⁴ <http://www.drought.gov/imageserver/NIDIS/content/whatisnidis/NIDIS-IPFinal-June07.pdf>

¹⁵ http://www.drought.gov/imageserver/NIDIS/newsletter/NIDIS_Newsletter_Winter_2011.pdf

How do these Programs and Studies fit together?

These programs and studies overlap in the personnel, agencies, and groups involved. For example, the USGS is the lead agency on both the Southwest CSC and CO River Basin Geographic Focus Study, in addition to being the co-lead in NIDIS (along with NOAA). The Bureau of Reclamation is the lead agency of the Basin Study Program as well as being closely involved with the LCCs. However, each program or study has a unique goal and/or scale and as a result the overlap in personnel, agencies, and groups is complementary (See Appendix A, C, and D). The two programs, the CSCs and the LLCs, will help link the various studies together as well as involving all DOI agencies. LCCs and CSCs are ongoing in their operation and cover a broader area than the other studies represented here. The REAs cover an area slightly smaller than the LCCs and CSCs, because they assess factors at the ecoregional level. The remaining studies are all focused on the Colorado River Basin level. The two studies, *The Colorado River Basin Supply and Demand Study* and *The Colorado River Basin Geographic Focus Area Study*, address different time frames: the former is looking to the future while the latter is dealing with present and past trends, although the Basin Supply and Demand Study will incorporate much of the present and past data. The NIDIS study is at the finest scale with data collection and outreach at the local level.

The benefit of having this wide array of scales, goals, and players is that the complicated and very uncertain problem of how our water resources will be affected by climate change is being addressed from multiple angles and areas of expertise. The Colorado River Basin is an area of contention even in times without water shortages. As the Bureau of Reclamation's *Colorado River Basin Supply and Demand Study*'s Interim Report reminds us, climate experts expect the Southwestern United States to be drier in the future, droughts to occur with greater severity than those seen in the past, and that the average yield of the Colorado River could be reduced by as much as 20 percent due to climate change. Increasing demands, coupled with decreasing supplies, will certainly exacerbate imbalances throughout the Basin. Consequently, knowledge of what to expect and how to respond provided by these studies is essential¹⁶.

¹⁶ <http://www.usbr.gov/lc/region/programs/crbstudy/Report1/StatusRpt.pdf>

Appendices

Appendix A: DOI Agencies' Roles for General Water Management and under the SECURE Water Act:

DOI Agency	General Role in National Water Management	Role under the SECURE Water Act
<i>Reclamation</i>	Working to stretch the nation's limited water resources, reduce conflict and facilitate solutions to complex water problems	LCCs, CSCs and, the Basin Study Program. Reclamation's activities represent a comprehensive and coordinated approach to identifying risks and impacts associated with current and future climate, working with stakeholders to identify and implement adaptation and mitigation strategies and collaborating to identify the best available science.
<i>USGS</i>	Helping our nation adjust its management of water by providing scientific publications, data, maps, and application software on water resources	USGS is coordinating with stakeholders and partners through its implementation of the WaterSMART Availability and Use Assessment (Geographic Focus Studies) and through involvement in implementing CSCs and LCCs.
<i>USFWS</i>	Engaging in water-resource planning, management and research that conserves, protects, and enhances our nation's fish, wildlife, and plants	Providing leadership for the LCCs.
<i>BLM</i>	Managing water resources and water-dependent environments on public lands to promote healthy, productive ecosystems that support is multiple-use mission	As part of its landscape approach for managing public lands, the BLM will conduct Rapid Ecoregional Assessments (REAs) and work with partner agencies and stakeholders to develop broad-level management strategies for the public lands in an ecoregion. Contribute information to the WaterSMART Clearinghouse.
<i>NPS</i>	Managing the water resources and water-dependent environments that occur within our national parks to preserve their natural and cultural values	NPS is participating in the implementation of USGS WaterSMART Availability and Use Assessment with an emphasis on the USGS Colorado River Pilot Study and implementation of the environmental needs component in National Park units.

Appendix B: Roles and Responsibilities Concept Table for LCCs and CSCs¹⁷

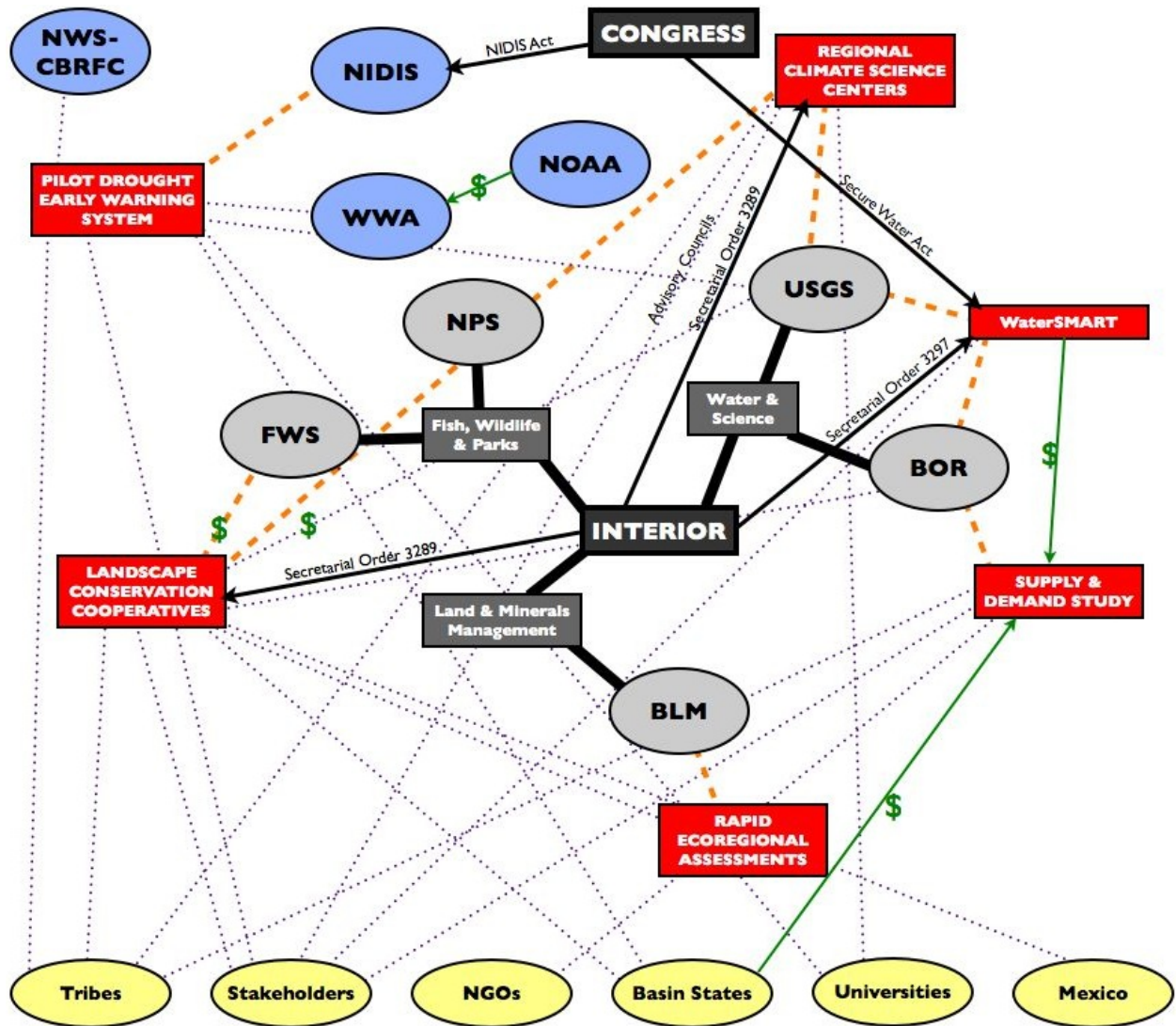
	LCC Lead	Shared	CSC Lead
Partnerships			
Initiate science partnerships; bring groups to the table			X
Initiate resource partnerships; bringing groups to the table	X		
Develop resource goals and desired resource outcomes	X		
Help define resource outcomes and endpoints that can be measured and used to refine future efforts		X	
Articulate priority science needs for specific resource goals/outcomes	X		
Science Development and Delivery			
Determine specific model outputs and endpoints needed to address the specific science questions and priorities (determine feasibility)		X	
Evaluate whether needed forecast/model/information already exists			X
Work with or develop downscaled climate data and models to generate output variables for specific resource questions			X
Develop ecological and other resource models, linking underlying drivers with factors that can be forecast and modeled			X
Develop new data and tools for forecasting large-scale natural, physical, and ecological conditions under different climate scenarios			X
Provide large-scale information, forecasts, models, and tools to the LCCs			X
Science Application			
Apply down-scaled models and other information to generate spatially-explicit options and adaptation strategies	X		
Assess species and habitat vulnerabilities		X	
Determine where to conduct on-the-ground activities to accomplish specific goals	X		
Monitoring			
Develop science-based monitoring strategies that can link resulting data back to models for refinement		X	
Help partners design and implement science-based monitoring programs to determine if resource goals are met and to refine future modeling	X		
Use monitoring results to refine future model and forecasting efforts		X	

¹⁷ <http://www.doi.gov/whatwedo/climate/strategy/upload/Detailed-CSC-LCC-Information.pdf>

Appendix C: Table of Program and Agencies Similarities and Differences:

	Lead Agency	Authorizing Legislation	Goal	Scope/Scale	Overlaps and Connections
Programs					
<i>Southern Rockies and Desert LCCs</i>	USFWS and Reclamation	Secretarial Order 3289	Enable resource management agencies and organizations to collaborate in an integrated fashion within and across landscapes.	Landscape-scale (encompass various ecoregions), 21 total	Very connected with CSCs
<i>Southwest CSC</i>	USGS	Secretarial Order 3289	Deliver fundamental climate impact science to resource managers on a regional basis	8 regions	Very connected with LCCs
Studies					
<i>CO River Basin Demand and Supply</i>	Reclamation	Secretarial Order 3297: WaterSMART, Basin Study Program	Analyzing the water supply and demand imbalances throughout the Colorado River Basin and the adjacent areas of the Basin States that receive Colorado River water through 2060	River Basin	Using USGS data from Geographic Focus Study in developing forecasts. Plans to coordinate with LCCs and CSCs.
<i>CO River Basin Geographic Focus Study</i>	USGS	Secretarial Order 3297: WaterSMART		River Basin	Providing current and historical data on water supply and demand for Reclamation's forecast.
<i>Colorado Plateau and Sonoran Desert Rapid Ecoregional Assessments (REA)</i>	BLM	SECURE Water Act	To assess factors that may affect, both positively and negatively, the current and future condition of resources of conservation concern on an ecoregional scale	Ecoregion (finer scale than LCCs)	Finer scale informs LCCs larger-scale modeling.
<i>Pilot Drought Early Warning System for the Upper Colorado River Basin</i>	NIDIS (NOAA and USGS)	SECURE Water Act	Incorporating drought monitoring and prediction information in partnership with users and federal, state, regional, and local agencies	River Basin – very localized	

Appendix D: Players involved in Programs and Studies on Climate Change and the Colorado River Basin



Appendix E: Timeline of Programs and Key Events

