Supporting Documentation for Appendix A "Collaborative Planning and Stakeholder Engagement Meeting Summaries" to the *Greater Grand Canyon Landscape Assessment: A resource condition assessment of Grand Canyon National Park and surrounding region* (2018)

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Affiliation: Landscape Conservation Initiative, Northern Arizona University, Flagstaff, Arizona

Date: March 28, 2018

Meeting Summary
Greater Grand Canyon Landscape Assessment (GGCLA) Workshop # 1
Northern Arizona University, DuBois Center (Bldg 64), Freemont Room
Thursday, October 11, 2012
8:30AM-5PM

Overview
On October 11, 2012, approximately 45 participants met at Northern Arizona University to kick-off the Greater Grand Canyon Landscape Assessment (GGCLA). Objectives of this workshop, the first of a proposed three, included 1) sharing background on GGCLA context, process, and roles; 2) identifying focal resources, threats, and information sources; and 3) discussing stakeholder participation and next steps. The Workshop presentation and meeting handouts are available as **Attachments A and B** of this document

Key outcomes of this workshop included:
- The group supported the project approach and timeline
- The participants developed a list of resource values and threats prioritized based on importance
- Participants discussed the relevance of the project products to management decisions beyond park boundaries and as a tool for Grand Canyon National Park (GRCA) as well as other organization's decision making processes
- Participants provided input on the extent of the analysis area
- Participants shared additional data sources that might be relevant to the landscape assessment, and volunteered for technical workgroup participation

Next Steps and action items:
- Follow-up via meeting summary- Core Team (NAU LCI and GRCA project staff)
- Additional outreach- Core Team and All; please share information about this effort with your organizations and networks
- Convene technical workgroups to review and develop data- Core Team will send additional information, all are welcome to participate

GGCLA Workshop #1 Meeting Summary

Opening remarks and introductions
Tim Jarrell, (GRCA Acting Deputy Superintendent), welcomed the group. He highlighted the many challenges faced by Grand Canyon National Park, such as visitor impacts, endangered species and climate change, and the goal of creating a management system so that the park is sustained for future generations. He stated that it is important to take people's concerns into account and appreciated people's involvement in this process, acknowledging that over 20 groups were represented as workshop participants.

Meeting participants and the project Core Team introduced themselves. A full list of participants can be found in **Attachment C**.

GGCLA background
Todd Chaudhry, GRCA Ecologist and GGCLA Project Manager, provided background on the GGCLA effort:

- GGCLA is being funded through National Park Service (NPS) Natural Resource Condition Assessments (NRCA) and Concession Franchise Fees (CFF).
- Grand Canyon National Park is partnering with Northern Arizona University (NAU) Landscape Conservation Initiative (LCI) to create a landscape-scale, ecosystem based assessment.
- The objective is to synthesize and mobilize existing resource data and information, provide sound science and an ecosystem-based approach for park decisions, focusing on stewardship in high priority areas.
- This is a great opportunity for collaboration, and collaboration is not constrained by NEPA; this is not a decision document but a tool as part of the NPS planning process.
- The NRCA process uses a hierarchical framework to assess conditions and trends of natural resources, assess threats to resources, identify data gaps, and produce a written report with GIS products
- The GGCLA will have additional elements: collaboration with stakeholders, assessment of cultural resources, and assessing contiguous lands outside of the park, pending approval of park neighbors. The process will identify priority areas based on values and threats, and identify future research and monitoring needs.
- Items outside the scope of the effort include a comprehensive assessment of all resources, analyzing alternative futures (e.g. climate change), and identifying specific management actions.

Tom Sisk, NAU Professor and GGCLA Principal Investigator, provided an overview of the project process. The group reviewed the process diagram (**Attachment B**) and discussed the project:

- The collaborative process being proposed today goes beyond a typical Resource Condition Assessment
- Plan to create collaboratively developed visual representations (maps) to demonstrate the focal resources and threats for use in future workshops, and to identify eventual opportunities for collaborative resource management
- Involvement is important because of the commitment of GRCA to use the products. Your input will be incorporated in the final report and maps, allowing collective work toward conservation in the park and the surrounding region

- The GGCLA is planned as a two year project, concluding in 2014
- Q: Who is responsible for mobilizing this effort into future resource management planning and decision making?
    - Upper management of GRCA has committed to bringing it forward. Stakeholder involvement will also help hold GRCA accountable. GRCA hopes this process can build a foundation of collaborators for future efforts
- Q: What is the status of the backcountry management plan (BMP)? Will the products be incorporated into that plan?
    - The timing is not in perfect alignment; however, the two processes will be coordinated through data sharing and development and we hope that results from the GGCLA will help inform future management decisions under the BMP.
- The collaborative prioritization process will be based in valued landscape features (e.g. springs and wetlands, archeological sites, wildlife habitat), and threats (e.g. invasive/non-native species, erosion, habitat fragmentation). These values and threats are developed based on the experience, knowledge and perspective of our group. Areas can be prioritized for management attention based on a shared sense of high value resources that face a perceived high level of threat.
- Examples of past participatory prioritization processes developed by the LCI include *Northern New Mexico Landscape Assessment* and the *Kaibab Forest Health Focus*
- Q: Will there be a chance for non-technical people to participate?
    - All can participate in the workshops; we hope that everyone will help decide on the information and data that is included. Participation in technical workgroups is encouraged (but not required) for all
    - Workshops will be iterative; each time data products are developed, they will be brought back to the group for feedback and refinement.
- Q: How will decisions be made based on the outcomes of the project? What about for the full landscape area?
    - NPS can make decisions only in the park, but no boundaries exist for air, water and climate change. We want to be prepared for bigger, landscape-scale decisions. We want to inform park management decisions, but we're also trying to have a dialogue, and pave the way for committed stakeholders to have a voice in the decision-making process.

The group discussed roles and responsibilities, as well as stakeholder involvement:

- GRCA ultimately has final decision, but is opening up the process to early stakeholder engagement, and commits to use stakeholder input from this project
- NAU LCI is working with GRCA to complete the GGCLA and to develop stakeholder engagement and mapping prioritization. NAU LCI partners with Conservation Science Partners (CSP), a nonprofit with high- end analytical capabilities.
- Neighboring landowners; there is good representation, and we have contacted all neighbors. We hope for more participation, and that people in this room with share information with other stakeholders. We'd like to increase tribal involvement
    - There are opportunities to reach out to Tribes through resources like the Institute for Tribal Environmental Professionals (ITEP), Brown River Conservation Services, and Cooperative Ecosystem Studies Unit (CESU) tribal partners

The group discussed elements that participants hope to gain from this process:

- Participants expressed hope that there is willingness and interest from all landowners/managers to think about how these products can be used in decision making; there can be value to landowners and managers besides GRCA
    - There are certain limitations for the project, but this convening might motivate tighter communication amongst neighbors, extending the project's value. There is no reason why data and analysis for this effort must be constrained to GRCA if others are interested in having this product inform their decisions.
    - Ultimately this needs to be useful for all involved. We need buy-in from neighbors for extending analysis.
- These products could also be a powerful interpretive tool for visitor information, including through GRCA's website

Park conceptualization and analytical framework

Mark Nebel, GRCA GIS Coordinator and GGCLA Core Team Member, shared information on the concept of park management areas. The park is divided into four conceptual areas: above the rim, below the rim/inner canyon, the river corridor and developed areas. For management purposes, these areas are sub-divided , primarily by geomorphic attributes. Mark shared maps at the HUC10 and HUC12 scale (i.e. Hydrologic Unit Codes following the National Watershed Boundary Dataset) to provide an initial concept of the potential scale of analysis for discussion:

- There was sentiment that scale should be expanded
    - To consider subsurface watersheds
    - To be more inclusive of larger tributary watersheds (e.g. Kanab Creek)
    - To account for area of cliff faces/habitat
    - To account for wildlife species and other resources that are dependent upon larger landscapes
- However, scale is not necessarily rigidly bound
    - Scale may differ for different resources or threats, but may be limited by data availability
    - Maps do not all have to have the same boundary, but it is necessary to identify the principal area of interest
    - Scale will be dependent on the values and threats identified; challenge is delivering information at a form, scale and extent to address the issues that emerge
- There is a need for park neighbors to participate and support the scale as it applies to assessment on their lands

Identifying and ranking resources and threats

Participants broke into small groups and rotated between facilitated breakout sessions to discuss resource values and threats specific to different areas of the greater Grand Canyon landscape: the river corridor, below the rim, and above the rim. After all rotated through the groups, the facilitation teams summarized and listed all identified values and threats. Participants then used dot stickers to identify the six values and six threats they saw as most important across all those listed.

The resource values and threats that were top priorities selected by the group based on total number of dots are shown below in Table 1. These initial results will be analyzed by the Core Team in coming weeks, and the information will be used to inform which focal resources are

selected for assessment, and which data layers are developed for the stakeholder spatial prioritization process.

Table 1*: The top 5 resource values and threats selected by Workshop #1 participants for Grand Canyon areas above the rim, below the rim, and in the river corridor as measured by total dots per item. Several items contain more than 5 selections because of ties.*

	Values		**Threats**
Above the Rim	Natural disturbance regimes (fire)		Industrialization: pollution, noise, light, air quality, water, energy development
Above the Rim	Large, intact ecosystems		Invasive species of vegetation and wildlife
Above the Rim	Biodiversity		Resource extraction: water development, logging, mining
Above the Rim	Scenery/viewshed		Unnatural fire regimes
Above the Rim	Water sources/wetlands		Loss of traditional/historic knowledge
			Climate change
	Values		**Threats**
Below the Rim	Seeps and springs		Groundwater withdrawal
Below the Rim	Wilderness		User impacts
Below the Rim	Biodiversity		Invasive plants and animals
Below the Rim	Archeological resources		Over flights
Below the Rim	Quiet and natural sound		Climate change
	Values		**Threats**
River Corridor	Native fish and wildlife populations		Altered hydrologic regime; changes in fish habitat, flow
River Corridor	Wilderness: dark skies, soundscapes, solitude		Invasive and nuisance species
River Corridor	Springs, seeps, hanging gardens and tributary canyons		Climate change and natural drought regimes
River Corridor	Archeological resources		Politics of power generation
River Corridor	Threatened, endangered and endemic species		Water temperature changes
River Corridor	Unique vegetation communities; habitat for wildlife such as mature mesquite and migratory corridors		Mining related water pollution
River Corridor	Recreation values: beaches, camping, boating, scenery		

Data overview

Todd Chaudhry and Tom Sisk described the next steps, available data and potential for data development moving forward.

- The group identified values and threats that are most important to them. The next step will be to filter the list based on data that is available and the ability to develop new data.
- GRCA existing spatial and tabular data are being evaluated. Lists are available in your packet
- The suitability of data for the GGCLA will be evaluated using a range of criteria (e.g. metadata, purpose, methods, quality, extent, time period, gaps, ownership, access).
- There are opportunities to use spatial models to derive landscape coverages and to link remotely sensed imagery with field data.
- Opportunity to create data products that integrate multiple management issues in shared spatial databases
- These opportunities also require a willingness to share data, adopt new approaches and utilize new data
- Between now and the next workshop, the technical workgroups will focus on data that can be provided by participants, what exists, and what can we generate. There is a high technical capacity but we need to be focused
- Participants can let the Core Team know what data they have that may be relevant to the assessment by filling out the form in their packet. Where groups cannot share data, there may be a chance to use it to validate other data sets

Wrap-up and next steps

Communications

- There will be future opportunities to provide input.
- Communication plan will be developed; email list, website or a wiki are options, as are virtual meetings

Technical work and future workshops:

- In spring of 2013 the plan is to hold a second workshop and to bring back spatial data products applicable to the values and threats identified today in order for the group to overlay and analyze the data to prioritize areas.
- A year from now a third workshop will be held to finalize products and discuss relevance to future management discussions.
- The process will work best if there is continuity through the meetings; we encourage people to continue representing their groups for consistency.
- In the interim, technical workgroups will be convened to review and develop data. Participants can express interest on sign-up sheets; the Core Team will follow up shortly
- A number of participants indicated a strong interest in expanding the scale of the GGCLA. As there is interest in expanding detail or spatial extent of this work, consider identifying commonalities and pooling our resources to do so; there are currently finite resources in terms of time and funding.

Adjourn

Tom Sisk thanked everyone for their energy and participation, and the meeting adjourned at 4:45PM.

Attachment A: Workshop #1 Presentation

Greater Grand Canyon Landscape Assessment

Workshop #1
October 11, 2012
NAU DuBois Center, Flagstaff, AZ



Grand Canyon National Park
Division of Science & Resource Management

Northern Arizona University
Landscape Conservation Initiative

Agenda

- 9:00-9:30 Opening remarks & introductions
- 9:30-11:00 GGCLA background
- 11:00-11:15 Break
- 11:15-12:00 Park conceptualization & analytical framework
- 12:00-12:30 Catered lunch
- 12:30-3:00 Small group breakout sessions
- 3:00-3:30 Break
- 3:30-3:45 Ranking focal resources and threats
- 3:45-4:15 Data overview
- 4:15-5:00 Next steps
- 5:00 Adjourn



Background

- Funding via NPS NRCA & CFF
- CESU Agreement between GRCA & NAU LCI
- Landscape-scale, ecosystem-based, interdisciplinary, spatially-explicit, & collaborative
- Assess conditions, trends, & threats to focal natural & cultural resources
- Develop maps of resources & high priority areas for management

Objectives

- Synthesize & mobilize existing resource data & information
- Provide sound scientific foundation & ecosystem-based approach for park decision making
- Focus stewardship in high priority areas
- Provide opportunities for stakeholder collaboration
- Identify data gaps & research/monitoring needs

NPS Planning Process

- Foundation Statement (2009)
- General Management Plan (1995)
- Natural Resource Condition Assessment (Pending)
- Resource Stewardship Strategy (TBD) (Resource Management Plan 1997)
- Specific Management Plans (Pending/TBD) (e.g. Backcountry, Fisheries, Caves)

Natural Resource Condition Assessments

NRCA Standard Elements	GGCLA Additional Elements	Outside of Scope
Use multi-disciplinary approach	Collaborate with stakeholders	Assess conditions of all park resources
Use existing data (incl. qualitative/quantitative)	Assess cultural resources	
Use hierarchical study framework	Assess contiguous lands outside of park (pending approval)	Conduct robust quantitative analysis for all focal resources
Assess current conditions & trends of natural resources re: reference conditions	Conduct integrated spatial analysis	
Assess threats to resources	Identify priority areas based on values & threats	Analyze alternative futures (e.g. climate change)
Describe methods, assumptions & level of confidence in results	Identify future research & monitoring needs	Identify specific management strategies & actions (i.e. subject to compliance)
Identify data gaps		
Produce written report & GIS products		

Greater Grand Canyon Landscape Assessment

Participatory Analysis Diagram

Collaborative Process

Workshop 1
- Review objectives & scope
- Identify focal resources & threats

Workshop 2
- Review & refine resource assessments
- Conduct initial prioritization

Workshop 3
- Review & refine draft spatial analysis
- Identify opportunities for collaborative resource management

Technical Workgroups
Develop resource assessment frameworks & datasets

Ongoing coordination & information exchange

Technical Workgroups
Develop integrated analytical framework

Resource Condition Assessment

1. Define focal resources
2. Identify indicators & threats
3. Compile, assess, & process data
4. Develop spatial layers
5. Assess resource conditions & trends
6. Conduct integrated spatial analysis & prioritization

Final Report & Maps
Resource conditions & priority areas

Future resource management planning and decision making



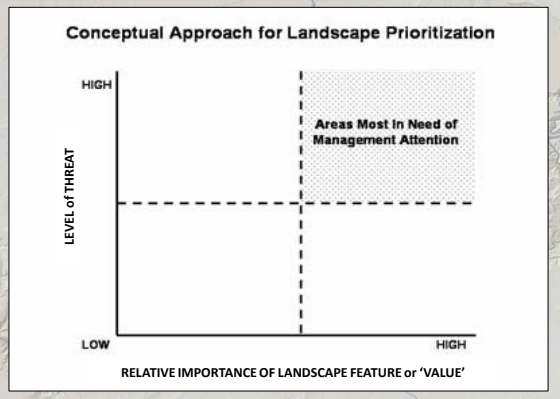
Key Terms and Concepts
Resource Condition Assessment Example

Focal Resource	• Humpback Chub (*Gila cypha*, Endangered) 
Indicators	• Abundance (est. # in GRCA) • Distribution (est. # spawning aggregations in GRCA)
Current Conditions/Trends	• ~9,000-12,000 (2011 est. CI/trend increasing) • ≥ 1 (1 verified/trend unknown)
Reference/Desired Conditions	• Minimum Viable Population (pending analysis) • Multiple (outside of LCR)
Threats	• Non-native predation/competition • Altered thermal regime • Connectivity

Key Terms and Concepts
Collaborative Prioritization Objective

Landscape Features "Values"	• Springs and wetlands • Archeological sites • Wildlife habitat
Threats	• Invasive/non-native species • Erosion/flooding • Habitat fragmentation

Identifying Areas for Management Attention

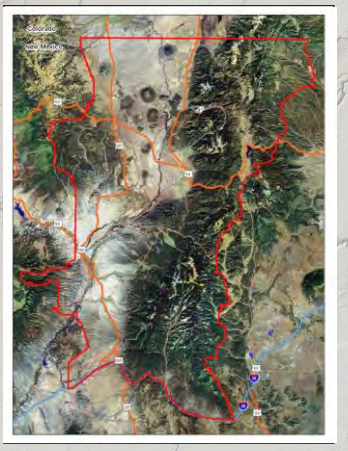


Participatory Planning for Landscape Conservation

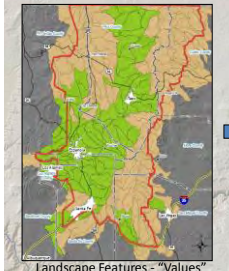
Examples of process and products

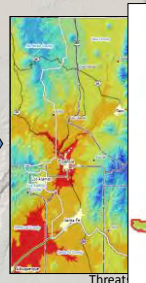
Northern New Mexico Landscape Assessment

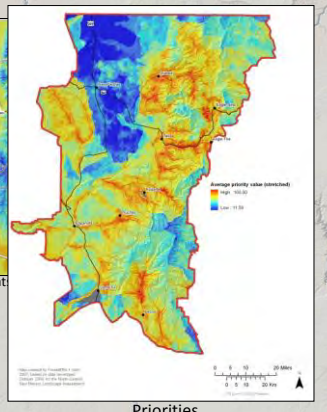


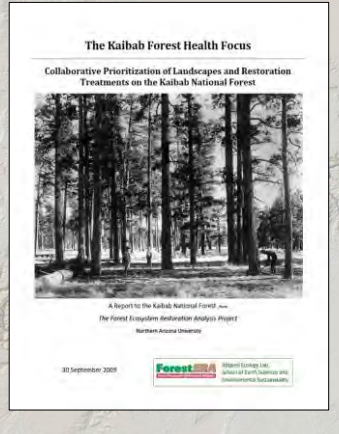
Northern New Mexico Landscape Assessment
Taos Workshop, 2006


Landscape Features - "Values"


Threat


Priorities

Kaibab Forest Health Focus, 2009


The Kaibab Forest Health Focus

Collaborative Prioritization of Landscapes and Restoration Treatments on the Kaibab National Forest

A Report to the Kaibab National Forest

The Forest Ecosystem Restoration Analysis Project

Northern Arizona University

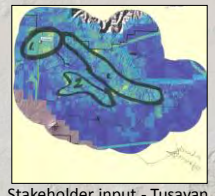
30 September 2009

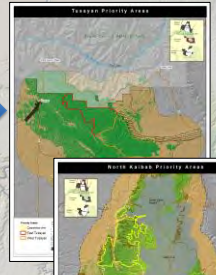
ForestERA

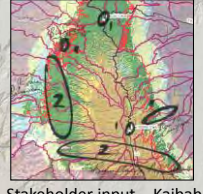
Goals

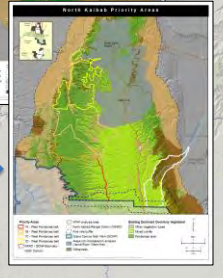
- Downscale previous landscape assessments to project level
- Pre-NEPA collaboration- Include all stakeholders in dialogue and participatory analysis
- Identify high priority areas for forest attention and provide guidance on treatments

Collaborative Mapping – with Scientific Support


Stakeholder input - Tusayan

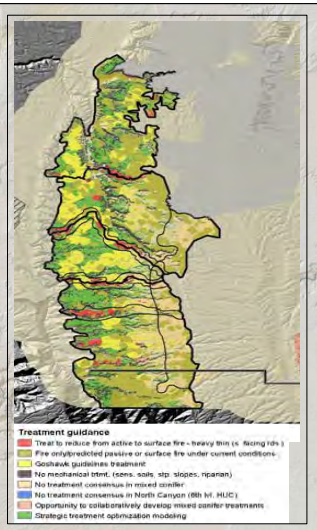


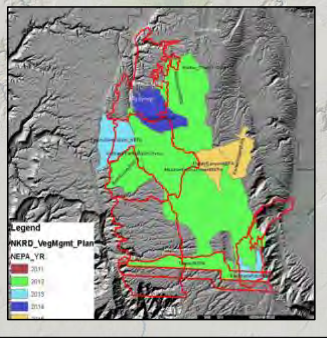

Stakeholder input – Kaibab Plateau



Kaibab Forest Health Focus

→ Moving toward Applications in Planning





Greater Grand Canyon Landscape Assessment

Participatory Analysis Diagram

Collaborative Process

Workshop 1
- Review objectives & scope
- Identify focal resources & threats

Technical Workgroups
Develop resource assessment frameworks & datasets

Workshop 2
- Review & refine resource assessments
- Conduct initial prioritization

Ongoing coordination & information exchange

Technical Workgroups
Develop integrated analytical framework

Workshop 3
- Review & refine draft spatial analysis
- Identify opportunities for collaborative resource management

Resource Condition Assessment

1. Define focal resources
2. Identify indicators & threats
3. Compile, assess, & process data
4. Develop spatial layers
5. Assess resource conditions & trends
6. Conduct integrated spatial analysis & prioritization

Final Report & Maps
Resource conditions & priority areas

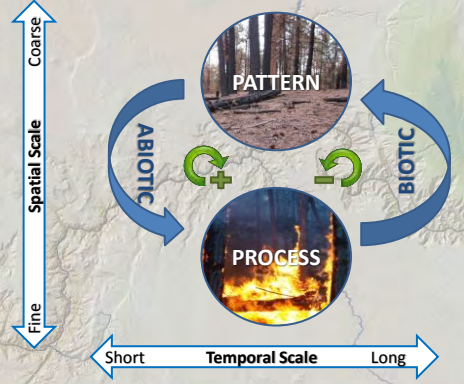
Future resource management planning and decision making

Roles and Responsibilities

- NPS Grand Canyon National Park
- NAU Landscape Conservation Initiative
- Conservation Science Partners
- Neighboring landowners & managers
  - NPS, BLM, USFS, Navajo, Hualapai, Havasupai, State, County, City, Private
- Other stakeholders
  - E.g. trust agencies, public/private sectors, academia, special interest groups



Landscape Ecology 101

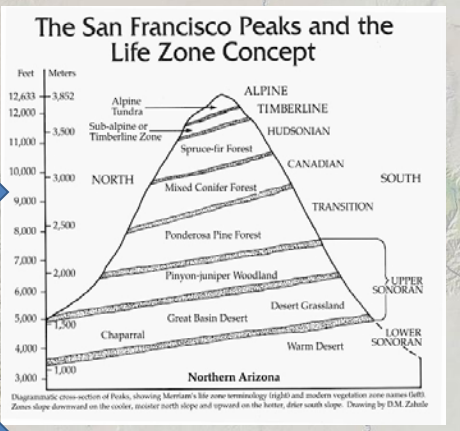


Regional-scale Drivers



Image: desertbotany.info

Landscape-scale Drivers



Highest ~ 9,165'

Lowest ~ 1,150'

Local-scale Drivers



Springs



Seeps



Native Vegetation





Natural Resources





BIODIVERSITY	
Animals	**Species**
Birds	356
Mammals	91
Fish	17
Reptiles & Amphibians	57
Crustaceans	33
Mollusks	37
Invertebrates	8,480 (known)
Extirpated	10
Plants	
Vascular	1,750
Mosses	64
Lichens	195
Fungi	167
Endemic plants	9
Non-native	192
Vegetation formations	6 types
Extirpated	1





Cultural Resources

- 4,330 Number of documented archeological sites
- 12,000 Approx. age of oldest known artifacts
- 50,000 Estimated number of archeological sites within park



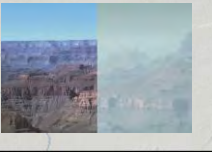


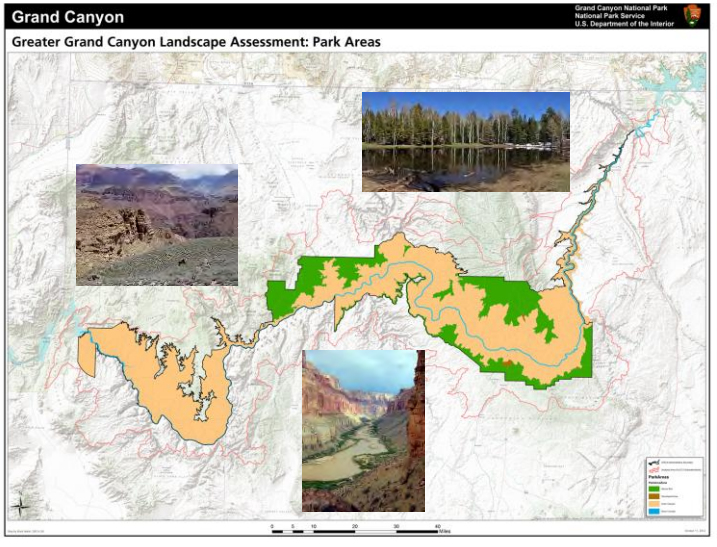
Threats

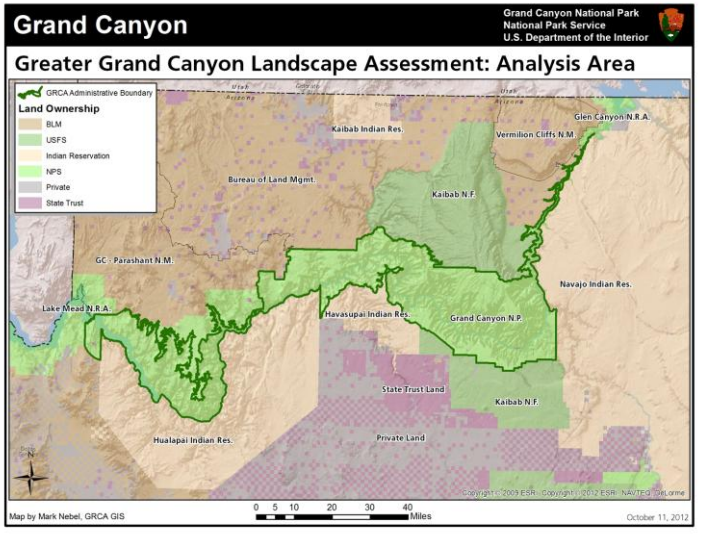
Internal-external / local-global

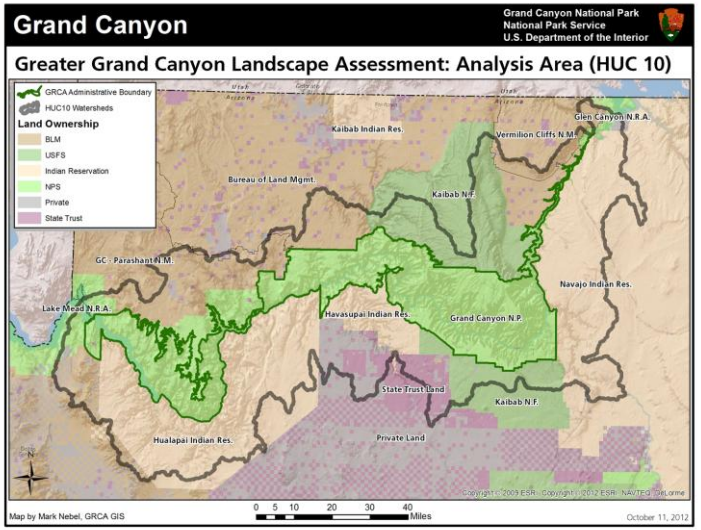
- Dam operations
- Extirpated native species
- Non-native species
- User impacts
- Poaching/theft
- Altered disturbance regimes
- Mining
- Regional water usage
- Water pollution
- Air pollution
- Climate change

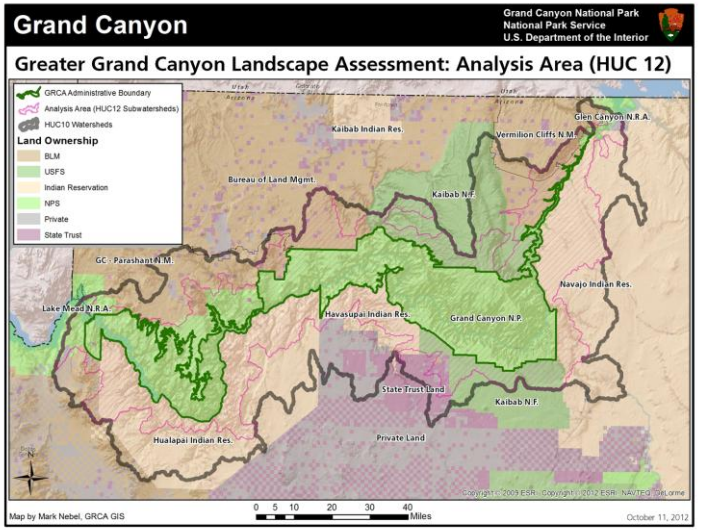

Image: BOR











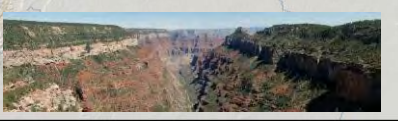
Small Group Breakout Sessions

- Goal: Discuss & identify focal resources & threats
- Assemble into assigned groups
  - Red, orange, yellow, green, blue, or purple
- Rotate 40 min through each geographic area/room as instructed in colored handout
- Staff will compile lists of resources/threats for ranking after the break



Ranking Focal Resources and Threats

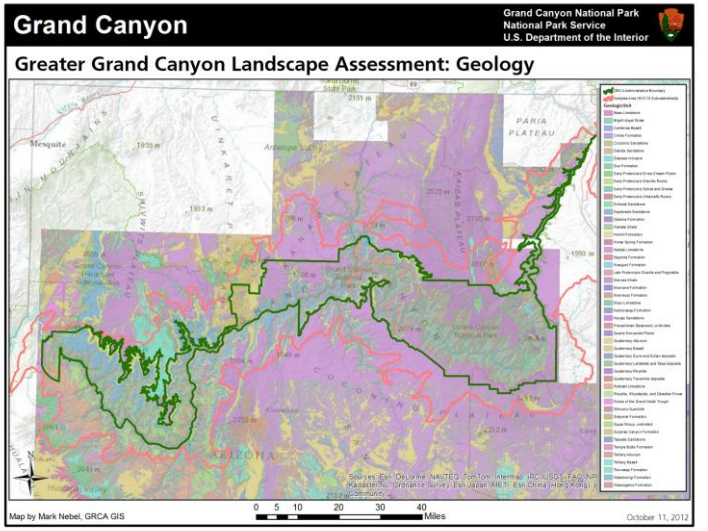
- Goal: Identify highest priority focal resources & threats for you/your organization
- Each person has 12 dots to select what they think is most important
- Please put 6 dots on values and 6 dots on threats
- You decide the distribution of dots across the geographic regions
- One dot per item and color doesn't matter
- GRCA employees please mark a slash (/) on all of your stickers
- Data will be analyzed & used to decide upon subset of focal resources & threats to include in assessment

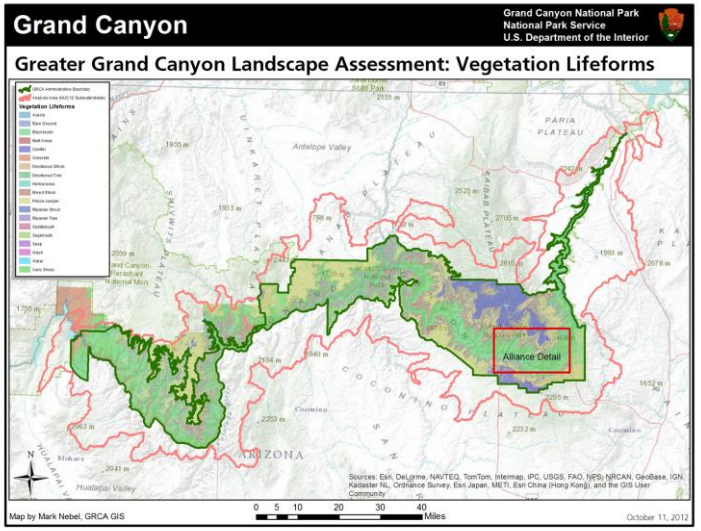


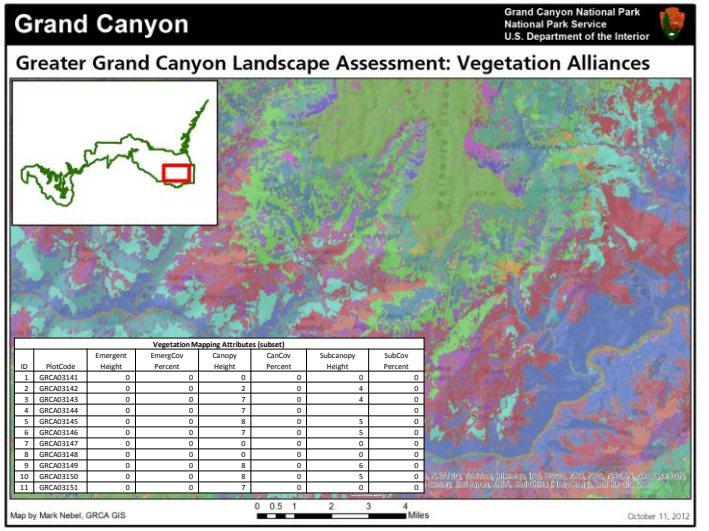
Data Overview

- Information sources
  - Spatial/tabular, in-house/external, in/out of GRCA, published/gray literature, SMEs, TEK
- Attributes
  - Metadata, purpose, methods, quality, extent, time period, gaps, ownership, access, contacts
- Development
  - Assessment criteria, QA/QC, tabular to spatial, mosaicing, deriving
- Availability & sharing

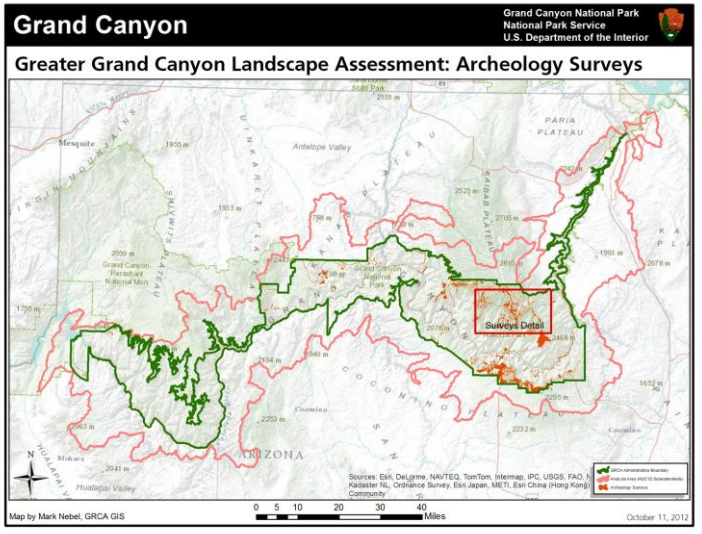


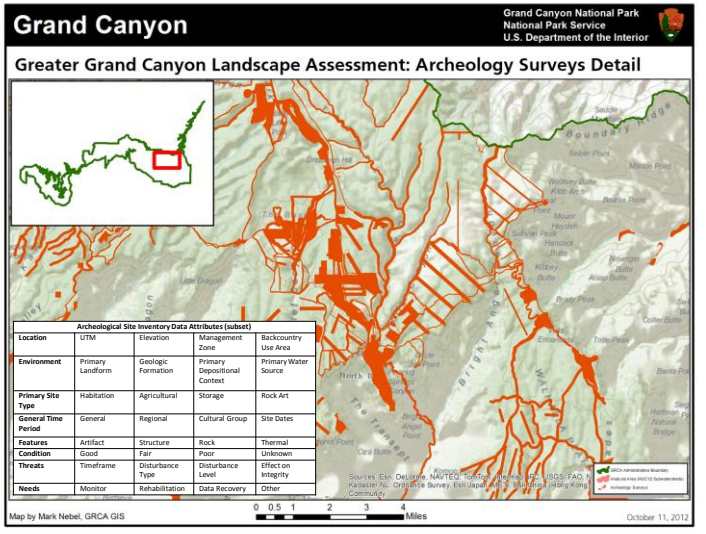






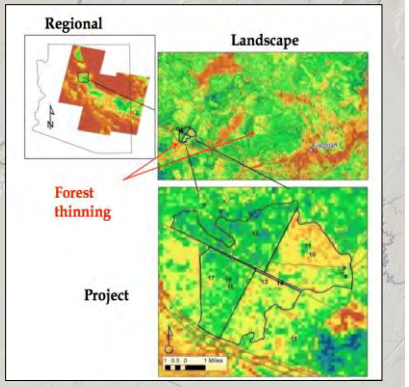
ID	PlotCode	Emergent Height	EmergCov Percent	Canopy Height	CanCov Percent	Subcanopy Height	SubCov Percent
1	GRCA03141	0	0	0	0	0	0
2	GRCA03142	0	0	2	0	4	0
3	GRCA03143	0	0	7	0	4	0
4	GRCA03144	0	0	7	0		0
5	GRCA03145	0	0	8	0	5	0
6	GRCA03146	0	0	7	0	5	0
7	GRCA03147	0	0	0	0	0	0
8	GRCA03148	0	0	0	0	0	0
9	GRCA03149	0	0	8	0	6	0
10	GRCA03150	0	0	8	0	5	0
11	GRCA03151	0	0	7	0	0	0

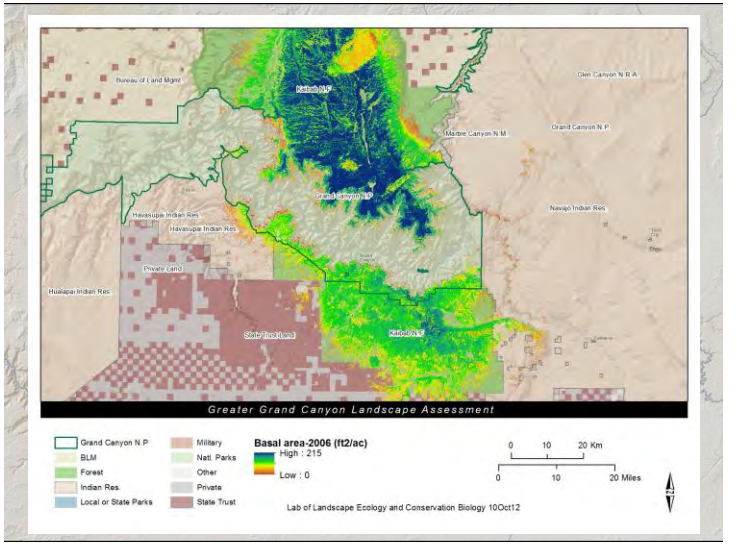




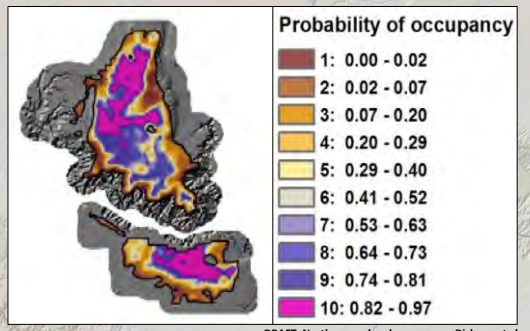
Spatial Models to Derive Landscape Coverages
Example: Forest Structure

- Scalable data products allow integration of multiple management issues in shared spatial database
- Great efficiencies can be realized through adoption of new techniques for linking field data to remotely sensed imagery
- Requires a willingness to share data, adopt new approaches, and utilize new data to guide management



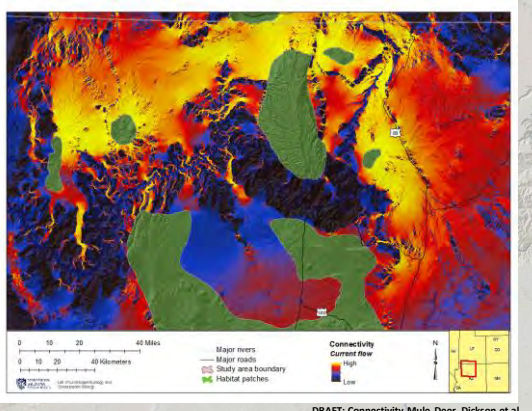


Derived Data Product: Goshawk Occupancy



DRAFT: Northern goshawk occupancy, Dickson et al.

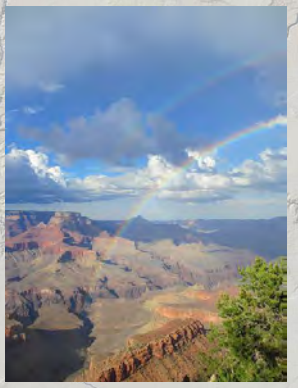
Derived Data Product: Mule Deer Habitat Connectivity



DRAFT: Connectivity-Mule Deer, Dickson et al.

Next Steps

- Communications
  - Email list
  - Website?
- Technical Workgroups
  - Topics
    - Focal resource
    - Analytical
    - Others?
  - Membership
    - SMEs
    - Stakeholders?
- Workshops
  - #2- Spring 2013
  - #3- Fall/Winter 2013






Thank you for your participation!

Attachment B: Workshop #1 Handouts

Greater Grand Canyon Landscape Assessment (GGCLA) Workshop #1
Northern Arizona University, DuBois Center (Bldg 64), Freemont Room
Thursday, October 11, 2012

AGENDA

Objectives

- *Share background on GGCLA context, process, and roles*
- *Identify focal resources, threats, and information sources*
- *Discuss stakeholder participation and next steps*

8:30- 9:00 Sign-in and coffee

9:00-9:30 Opening remarks and introductions

9:30-11:00 GGCLA background
- Objectives and scope
- Process overview
- Roles and responsibilities
- Questions and discussion

11:00-11:15 Break

11:15-12:00 Park conceptualization and analytical framework

12:00-12:30 Catered lunch

12:30-3:00 Small group breakout sessions- identifying focal resources and threats

3:00-3:30 Break

3:30-3:45 Ranking focal resources and threats

3:45-4:15 Data overview
- Data sources, attributes and development
- Park spatial and tabular datasets
- Data availability from partner organizations

4:15-5:00 Next steps
- Communications
- Technical Workgroups
- Workshops

5:00 Adjourn

Greater Grand Canyon Landscape Assessment

Participatory Analysis Diagram

Collaborative Process

Workshop 1
- Review objectives & scope
- Identify focal resources & threats

Workshop 2
- Review & refine resource assessments
- Conduct initial prioritization

Workshop 3
- Review & refine draft spatial analysis
- Identify opportunities for collaborative resource management

Technical Workgroups
Develop resource assessment frameworks & spatial layers

Ongoing coordination & information exchange

Technical Workgroups
Develop integrated analytical framework

Resource Condition Assessment

1. Define focal resources
2. Identify indicators & threats
3. Compile, assess, & process data
4. Develop spatial layers
5. Assess resource conditions & trends
6. Conduct integrated spatial analysis & prioritization

Final Report & Maps
Resource conditions & priority areas

Future resource management planning and decision making

Data and Participation Information

Name | Organization

Email | Phone Number

☐ I have data applicable to the GGCLA.

Please describe: _____

_____

☐ I am interested in participating in technical working groups.

Area of interest: _____

Thank you for your participation. We will follow up with you shortly.

Ground Rules

- Respect the opinions, beliefs and perspectives of others.
- Be candid with your knowledge, values and opinions.
- Allow the ideas of other group members to be expressed without interruptions.
- Listen carefully and ask questions to understand or clarify the ideas and views of others.
- Try not to force your ideas on others; rather, explain why you believe in them.
- Please keep your comments short and to the point.
- Focus on concerns and interests rather than positions.
- Focus on future improvements.
- Commit to giving the process a chance to succeed.
- Allow your facilitator to keep everyone on schedule and following the agenda.

Breakout Groups and Rotation Sequence

You will be assigned to a small group at lunchtime. Please use the flow below to determine where you will go for each of the three breakout sessions.

Groups

Red Group
1:00-1:40PM: River Corridor A, Freemont
1:40-2:20PM: Below the Rim A, Meadow
2:20-3:00PM: Above the Rim A, Southwest

Orange Group
1:00-1:40PM: Below the Rim A, Meadow
1:40-2:20PM: Above the Rim A, Southwest
2:20-3:00PM: River Corridor A, Freemont

Yellow Group
1:00-1:40PM: Above the Rim A, Southwest
1:40-2:20PM: River Corridor A, Freemont
2:20-3:00PM: Below the Rim A, Meadow

Green Group
1:00-1:40PM: River Corridor B, Freemont
1:40-2:20PM: Below the Rim B, Meadow
2:20-3:00PM: Above the Rim B, Agassiz

Blue Group
1:00-1:40PM: Below the Rim B, Meadow
1:40-2:20PM: Above the Rim B, Agassiz
2:20-3:00PM: River Corridor B, Freemont

Purple Group
1:00-1:40PM: Above the Rim B, Agassiz
1:40-2:20PM: River Corridor B, Freemont
2:20-3:00PM: Below the Rim B, Meadow

Facilitation Teams

River Corridor A: Freemont
NPS Facilitator: Deanna Greco
NAU Lab Representative: Tom Sisk
Recorder: Katie Sauerbrey

River Corridor B: Freemont
NPS Facilitator: Donna Richardson
NAU Lab Representative: Tom Sisk
Recorder: Collin Haffey

Below the Rim A: Meadow
NPS Facilitator: Lori Makarick
NAU Lab Representative: Brett Dickson
Recorder: Cassy Rivas

Below the Rim B: Meadow
NPS Facilitator: Greg Holm
NAU Lab Representative: Brett Dickson
Recorder: Cari Kimball

Above the Rim A: Southwest
NPS Facilitator: Jan Balsom
NAU Lab Representative: Jill Rundall
Recorder: Shawn Newell

Above the Rim B: Agassiz
NPS Facilitator: Ellen Brennan
NAU Lab Representative: Sasha Stortz
Recorder: Jessica Beutler

	River Corridor A Freemont	River Corridor B Freemont	Below the Rim A Meadow	Below the Rim B Meadow	Above the Rim A Southwest	Above the Rim B Agassiz
1:00-1:40PM	Red	Green	Orange	Blue	Yellow	Purple
1:40-2:20PM	Yellow	Purple	Red	Green	Orange	Blue
2:20-3:00PM	Orange	Blue	Yellow	Purple	Red	Green

Greater Grand Canyon Landscape Assessment
Workshop #1
October 11, 2012; Flagstaff, AZ

Resources identified in 'Draft Grand Canyon National Park Desired Conditions'

CATEGORY	***RESOURCE***
LANDSCAPE	Patterns
	Processes
VEGETATION	Spruce-Fir
	Mixed Conifer
	Ponderosa Pine
	Meadows
	Pinyon-Juniper
	Montane Shrublands and Interior Chaparral
	Desert Scrub
	Riparian
WILDLIFE	Mountain Lion
	Bighorn Sheep
	Small Mammals
	Mexican Spotted Owl
	California Condor
	Peregrine Falcon
	General avifauna
FISHERIES	Native species
	Non-native species
	Macroinvertebrates
PHYSICAL	Air
	Geologic Resources
	Paleontological Resources
	Soils
	Caves
	Water
CULTURAL	Archeological Sites
	Cultural Landscapes
	Historic Structures
	Traditional Cultural Properties / Ethnographic Resources
VISITOR EXPERIENCE	Recreational Opportunities
	Wilderness
	Soundscape
	Viewscape

Greater Grand Canyon Landscape Assessment Data Inventory

10/9/2012

DATA THEME	DATA TYPE	DESCRIPTION	DATA SOURCE	SPATIAL EXTENT
LANDSCAPE				
Aerial Photography	GIS (Raster)	Ortho-rectified photography (2002 20cm resolution,2005 18cm, 2009 20cm)	GCMRC	River corridor
Aerial Photography cont'd	GIS (Raster)	NAIP 2005, 2007, 2010 color 1 meter resolution	USDA	Statewide
Contours	GIS (Vector)	2-foot interval contours for developed areas of North Rim, South Rim and Desert View	Bohannan Huston	North/South Rim, Desert View
Desired Conditions	Tabular	Description of desired conditions within GRCA	GRCA	Park-wide
Elevation and Terrain	GIS (Raster)	Elevation, aspect, slope (10m and 30m resolutions)	USGS, GRCA	Statewide
Fire	GIS (Vector)	Fire perimeter history	GRCA	Park-wide
Fire con'td	GIS (Vector)	Burn severity, fire treatments, fire effects monitoring	GRCA	Park-wide
Forest Health	GIS (Vector)	Forest insect and disease aerial detection mapping	USDA-FS	Regional
Geographic Names	GIS (Vector)	Geographic Names from the USGS Geographic Names Information System (GNIS)	USGS	Statewide
GeoPolitical Boundaries	GIS (Vector)	Indian reservation, county, land management boundaries; city and town locations	ALRIS	Statewide
GRCA Boundary	GIS (Vector)	Administrative, legislated boundary, in-holdings	GRCA	Park-wide
ISTAR Elevation and Terrain	GIS (Raster)	Elevation, hillshade, slope (1m resolution)	GCMRC	River corridor
Park Areas	GIS (Vector)	Park divided into Areas using topography and drainage features	GRCA	Park-wide
Research Natural Areas	Tabular	List of research natural areas	GRCA	Park-wide
Transportation	GIS (Vector)	GRCA roads, routes and parking	GRCA	Park-wide
Utilities	GIS (Vector)	Power and propane lines, fuel tanks, water and wastewater infrastructure	GRCA	Park-wide
Watershed Boundaries	GIS (Vector)	Watershed boundaries (Hydrologic Units 8, 10, 12)	USGS	Statewide
Wilderness	GIS (Vector)	Actual statewide wilderness areas and proposed GRCA Wilderness (1980, 2008, 2010)	GRCA	Statewide, Park-wide
VEGETATION				
Bryophytes	Tabular	Collections info, site info (slope, aspect, associated species) 2007-2010	SCPN	Park-wide
Colorado River Vegetation	GIS (Vector)	Colorado River vegetation 2002	USGS	River corridor
Dominant Overstory Veg	GIS	Dominant overstory vegetation	GCT,Wood Supply, KFHF	Williams,Tusayan,N. Kaibab
Exotic species	GIS (Vector)	Locations of exotic species monitoring and removal work	GRCA	Park-wide
Exotic species	Tabular	Quantify exotic species infestation by location and subsequent treatment details	GRCA	Park-wide
Forest Structure	Tabular	Tree species, dbh, height 2007	SCPN	North Rim
Forest Structure	GIS	Basal area, canopy cover, tree density	GCT,Wood Supply, GRCA	Park, N Kaibab, Williams, Tusayan
Integrated upland	Tabular	Species cover and frequency, soils, trees, saplings (mixed conifer, P-J ecosystems 2007-2010)	SCPN	East half of Park

DATA THEME	DATA TYPE	DESCRIPTION	DATA SOURCE	SPATIAL EXTENT
Sentry Milkvetch	GIS (Vector)	Population locations and survey locations	GRCA	Park-wide
Special Status Plants	GIS (Vector)	Locations of special status plants (ASTSEP,ERIARI,PHEVAL)	GRCA	Park-wide
Vegetation Classification	GIS (Vector)	Vegetation classification map, Phases 1, 2, 3 (KGA mapping contract)	GRCA	Park-wide
Vegetation Maps	GIS (Vector)	Warren 1982 (parkwide), Brown and Lowe 2001 (statewide), AZGFD 1976 (statewide)	Various	Statewide, Park-wide
Vegetation Transects	GIS (Vector)	Location of vegetation transects used to collect veg ground cover and structure data	GRCA	River corridor
Vegetation Transects	Tabular	Vegetation ground cover and structure data	GRCA	River corridor
WILDLIFE				
Avian Monitoring	GIS (Vector)	Bird Monitoring Patches per GCMRC Terrestrial Ecosystem Monitoring Program	GRCA	River corridor
Avifauna Inventory	Tabular	CRMP avian point counts	GRCA	River corridor
Avifauna Inventory	Tabular	VCP counts, macroplot vegetation, subplot vegetation (mixed conifer, P-J ecosystems 2007-2009)	SCPN	East half of Park
Bighorn Sheep	Tabular	Sheep river observations and habitat description of sheep sightings	GRCA	River corridor
California Condor	Tabular	California Condor observations	GRCA	Park-wide
Condor Activity Zones	GIS (Vector)	Condor Use Areas in GRCA	GRCA	East half of Park
Deer Habitat	GIS (Vector)	Spring, Summer, and Fall Deer Habitat in GRCA	GRCA	South rim primarily
Elk Habitat	GIS (Vector)	Spring, Summer, and Fall Elk Habitat in GRCA	GRCA	South rim
Kaibab Squirrel	GIS (Vector)	Kaibab Squirrel national natural landmark boundary	UofA, GRCA	Regional
Mexican Spotted Owl	GIS (Vector)	Protected activity centers (PACs), critical habitat, regional habitat	GRCA, USFWS	Regional, Park-wide
Mexican Spotted Owl	Tabular	Reproductive monitoring and inventory results	GRCA	Park-wide, Prescribed burn areas
Northern Goshawk	Tabular	Inventory locations and results for Northern Goshawks	GRCA	Prescribed burn areas
Northern Goshawk Nests	GIS (Vector)	Northern Goshawk nests locations	Unknown	East half
Observations and Callouts	Tabular	Incidental wildlife observations and wildlife related problems or issues	GRCA	Park-wide
Peregrine Falcon Territories	GIS (Vector)	Peregrine Falcon Territories in GRCA	GRCA	Park-wide
Pronghorn Habitat	GIS (Vector)	Pronghorn Antelope Habitat in GRCA	GRCA	Park-wide
Pronghorn Movements	GIS (Vector)	Pronghorn GPS tracking data	AZGFD	Regional
Puma	Tabular	GPS tracking data, trapping and capture locations	GRCA	East half of Park
Southwestern Willow Flycatcher	Tabular	Surveys and habitat assessments	GRCA	River corridor
Threatened & Endangered Species	GIS (Vector)	Threatened and endangered species distribution	AZGFD	Park-wide

DATA THEME	DATA TYPE	DESCRIPTION	DATA SOURCE	SPATIAL EXTENT
FISHERIES				
Aquatic macroinvertebrates	Tabular	Macroinvertebrate collection, habitat sampling (Bright Angel, Garden and Hermit Creeks 2009-2011)	SCPN	Select creeks
Fish Management	Tabular	Fish inventory and tracking of non-native fish removal in tributaries; humpback chub translocation monitoring	GRCA	Colorado River tributaries
PHYSICAL RESOURCES				
Air Quality	GIS (Vector)	Air quality monitoring stations	GRCA	South rim
Caves	GIS (Vector)	Cave entrances and cave extents	GRCA	Park-wide
Caves	Tabular	Inventory and descriptive information	GRCA	Park-wide
Colorado River miles	GIS (Vector)	Colorado River miles and tenth mile points	GCMRC	Colorado River
Geology	GIS (Vector)	Geologic units	USGS	Statewide
Geology cont'd	GIS (Vector, Raster)	Geologic features (faults, fractures, sinkholes, volcanic) and geologic maps	USGS	Regional
Hydrology	GIS (Vector)	Springs and seeps, Colorado River centerline	GRCA, GCMRC	Park-wide
Hydrology cont'd	GIS (Vector)	Rivers, streams, rapids, lakes, ponds, marshes, playas, wiers, dams, gaging stations	USGS	Regional
Mineral Withdrawl	GIS (Vector)	BLM and USFS Lands affeccted by the proposed mineral withdrawl		Regional
Mines	GIS (Vector)	Mine (point locations)	Bureau of Mines	Regional
Modeled Colorado River shore	GIS (Vector)	GCMRC modeled Colorado River shoreline (various discharge rates)	GCMRC	80% of CO River
Paleontology Monitoring	Tabular	Monitoring and assessment of paleontological resources	GRCA	East half of Park
Springs	Tabular	Water quantity and quality, vegetation (richness, density, cover), vertebrates, disturbances 2005	SPCN, GCT	East half of Park
Soils	GIS (Vector)	Generalized soils and NRCS soil surveys	USSCS	Regional, Park-wide
Stock Tanks	GIS (Vector)	Stock tank represented as points and stock tank perimeters	GRCA	Park-wide
Stream Flow	Tabular	Stream flow measurements (GRCA gages)	GRCA	Unknown
Water Quality	Tabular	pH, Spec. Cond., Temp., baro pressure, DO, Alkalinity, turbidity, discharge, major ions, trace elements, nutrients. (Schnutz, Cottonwood Creek, Saddle Horse, Buckhorn, Hotel, Santa Maria, Robbers Roost Springs 2005-2006)	SCPN	Select springs
Water Temperature	Tabular	Water temperature measurements	GRCA	Unknown
CULTURAL RESOURCES				
Archeological Data	GIS (Vector)	Archeological sites, site boundaries, surveyed areas, Colorado River sites	GRCA	Park-wide
Archeological Data	Tabular	Description of site, artifacts and special projects; photos of cultural resources	GRCA	Park-wide
Archeological Data cont'd	Tabular	Identification of threats to site, integrity of site and any treatments	GRCA	Park-wide
Ethnography	Tabular	Data describing significance and/or utilization of resources to tribes	GRCA	Regional

DATA THEME	DATA TYPE	DESCRIPTION	DATA SOURCE	SPATIAL EXTENT
Historic Districts	GIS (Vector)	Historic districts in GRCA	GRCA	South rim
VISITOR EXPERIENCE				
Access Points	GIS (Vector)	Equine access, ingress/egress points and pack raft routes	GRCA	Unknown
Backcountry Use Areas	GIS (Vector)	Backcountry use areas	GRCA	Park-wide
Backcountry Toilets	GIS (Vector)	Backcountry toilets	GRCA	Park-wide
Campsites	GIS (Vector)	Campsite facilities, campsite boundaries, campable areas, campsite trails	GRCA	Park-wide
Canyoneering Routes	GIS (Vector)	Canyoneering Routes	GRCA	Unknown
Closed Areas	GIS (Vector)	Areas closed to visitor use	GRCA	Unknown
CRMP Management Zones	GIS (Vector)	CRMP Management Zones for planning purposes	GRCA	River corridor
Management Activity History	Tabular	Digital catalog of hard-copy reports and notes relating to past management activities	GRCA	Park-wide
Noise	GIS (Vector)	Ambient sound levels and noise standard zones	GRCA	Regional, Park-wide
Overflights	GIS (Vector)	Air tour routes, flight and no-flight zones, airport and helipad locations	GRCA	Regional
River Campsites	Tabular	River campsite assessment, mitigation and monitoring (CRMP)	GRCA	River corridor
River Campsites cont'd	Tabular	River campsite occupancy and visitor experience	GRCA	River corridor
Trails	GIS (Vector)	Trails represented by lines	GRCA	Park-wide
User Density	GIS	User presence density	GRCA	Unknown
Visitor Use	Tabular	Visitor use estimates using backcountry permit data	GRCA	Park-wide

	Data is Documented
	Data in Development
	Data is Not Documented
	Data Not Evaluated
	Data to be Developed

GREATER GRAND CANYON LANDSCAPE ASSESSMENT
SCOPE OF WORK

PROJECT ABSTRACT:

The National Park Service's Natural Resource Condition Assessments (NRCAs) evaluate current conditions for a subset of natural resources and resource indicators in national park units. NRCAs also report on trends in resource condition (when possible) and relevant threats, identify critical data gaps, and characterize a general level of confidence for study findings. This project will conduct an NRCA for Grand Canyon National Park. Since it will also include cultural resources and resources on adjacent lands within contiguous watersheds, this project is referred to as the Greater Grand Canyon Landscape Assessment (GGCLA). The project will result in a report, an improved data management structure and capability, and a set of Geographic Information System (GIS) maps that: identify key resources and indicators, provide an interdisciplinary and landscape-scale overview of resource conditions using a spatially-explicit modeling framework, document data gaps and resource management issues, provide an opportunity for stakeholder engagement, and provide a sound scientific foundation for park decision making, planning, and stewardship.

SCOPE OF WORK:

Introduction

As the world's greatest eroded canyon and a place of international significance, the Grand Canyon of the Colorado River warrants the highest level of stewardship. Grand Canyon National Park (GRCA) encompasses over 1.2 million acres and contains several major ecosystems**.** Its great biological diversity can be attributed to the presence of five of the seven life zones and three of the four desert types that occur in North America. The canyon's watershed also contains over 1000 significant seeps, springs, and tributaries, including relatively undisturbed remnants of dwindling ecosystems that serve as ecological refugia, such as desert riparian communities. Over 1,500 plant, 355 avian, 89 mammalian, 47 reptilian, 9 amphibian, and 17 fish species are found in the park, including numerous rare, endemic, and threatened or endangered species. The park also contains significant cultural resources, including hundreds of known archeological sites and countless cultural artifacts.

Despite the protection afforded by its status as both a National Park and World Heritage site, the natural and cultural resources of the Grand Canyon watershed are threatened by a range of stressors, both within and outside of the park boundaries. These include past, current, and potential future dam operations, extirpation of native species, introduction of non-native species, user impacts, uranium mining, altered disturbance regimes, regional water usage, and climate change. Many of these same resources and threats are shared by contiguous park units and other lands, including Glen Canyon (GLCA) and Lake Mead (LAKE) National Recreation Areas and Grand Canyon-Parashant National Monument (PARA), thus necessitating a watershed-scale approach to stewardship that attempts to transcend both administrative boundaries and bureaucratic barriers.

In recognition of its numerous mandates to preserve and protect park resources, the NPS along with its partners, has been implementing a range of on-the-ground activities aimed at protecting and restoring resources within the Grand Canyon watershed. Some stewardship activities to date include the removal of non-native trout and translocations of the endangered humpback chub, removal of invasive plant species and replanting of native vegetation, archeological excavations and stabilizations, and integrated resource monitoring. While much progress has been made to date, the scope and complexity of natural, cultural, and recreational resource management issues within the Colorado River watershed, and the

limited resources available to address these issues, necessitate a more strategic and integrated ecosystem-based approach.

Overview

The Natural Resource Condition Assessment (NRCA) provides an ideal framework to integrate the vast amount of resource data that is currently available for GRCA and adjacent lands, but to date have primarily been used on an *ad hoc* basis to inform management. With the relatively recent hiring of a full-time ecologist and data manager along with other staff, SRM now has the internal capacity to help lead an ambitious effort to integrate databases, conduct a landscape assessment, and develop an approach to bring the full power of this information to bear on resource management efforts in an efficient manner. Desired conditions for the full range of natural and cultural resources at GRCA are currently being developed by park staff. These desired conditions, along with existing planning documents (incl. General Management Plan (NPS 1995), Resource Management Plan (NPS 1997), Foundation Statement (NPS 2009)) will provide the base for the NRCA. Once the NRCA is completed, it will provide a robust foundation for GRCA to develop a Resource Stewardship Strategy, since the current Resource Management Plan is outdated. Within this broader context, the NRCA will ultimately allow GRCA to identify critical resource and threats, develop and prioritize specific stewardship strategies (incl. protection, mitigation, restoration) based on desired conditions, and identify meaningful measures of success within an interdisciplinary, adaptive management framework. This effort will attempt to build upon, and not duplicate, a range of previous collaborative efforts in the region, such as the Grand Canyon Native Fish Restoration Workshop (July 7-9 2010) and Kaibab Forest Health Focus (Sisk et al. 2009). It will also help to strengthen existing partnerships and foster new working relationships with regional stakeholders.

Objectives

This project is focused on conducting an interdisciplinary NRCA for GRCA and lands within contiguous watersheds using the best available scientific data, information, and indigenous knowledge for both natural and cultural resources. Accordingly, this project will be subsequently referred to as the Greater Grand Canyon Landscape Assessment (GGCLA). This information will be integrated and synthesized using a spatially-explicit modeling approach, with the ultimate goal of 'mobilizing' scientific information to better support park decision making, planning, and stewardship.

The project will result in a report, an improved data management structure and capability, and a set of Geographic Information System (GIS) maps that:

- Identify key natural resources and indicators for assessment, based on desired conditions, input from subject matter experts and multiple stakeholders, and available data.
- Provide an interdisciplinary overview and better understanding of current resource conditions and trends.
- Use a spatially-explicit modeling framework to integrate information from diverse datasets and prioritize areas (e.g. subwatersheds) for strategic stewardship based on focal resource values, current/desired conditions, stressors/threats, vulnerability/risk, and opportunity.
- Describe park resources in a landscape/regional context.
- Document high-priority data gaps and resource management issues.
- Provide a forum for meaningful participation and input from subject matter experts, conservation groups, Tribes, and other stakeholders.
- Provide an opportunity for students to participate in project activities (e.g. literature searches, data mining, workshops, meetings) and gain real-world experience in natural resource management.
- Provide a sound scientific foundation for resource management and communication that has multi-stakeholder buy-in.

Project findings will assist park managers as they work to:

- Implement an ecosystem-based approach towards resource management by integrating different disciplines.
- Focus limited staff/resources on implementing strategic management actions for high priority resources and subwatersheds.
- Develop and justify project proposals for internal/external funding sources.
- Prepare environmental compliance documentation (e.g. NEPA, ESA Section 7) and meet associated permit requirements.
- Develop the new Backcountry Management Plan and Resource Stewardship Strategy for GRCA.
- Engage in watershed- or landscape-partnerships and education efforts.
- Meet performance reporting requirements (e.g. Government Performance and Results Act).
- Provide a model to other park units and partners working on similarly complex resource management issues within the Colorado Plateau and other ecoregions.

Methods

The GGCLA will be interdisciplinary, ecosystem-based, landscape-scale, ownership-blind and spatially-explicit; and it will be based on a multi-stakeholder, collaborative process. The project and products will adhere to NRCA guidance on process, outline, content, format, and GIS/digital data standards (NPS 2012). At the beginning of the process we will evaluate existing assessment and planning frameworks to determine which is most appropriate given our objectives and specific resource issues and needs at GRCA. These will include but not be limited to The Ecological Integrity Assessment Framework (Unnasch et al. 2008), Conservation Action Planning (TNC 2007), and Participatory Landscape Analysis (Sisk et al. 2006). Components of more than one of the frameworks may be used during different phases of the assessment process, as appropriate, but a common language for key terms and concepts will be agreed upon to facilitate communication throughout the project (e.g. focal resource/conservation target, vital sign/key ecological attribute, measure/indicator). To the extent possible, the process will resemble similar efforts in the southwestern region, such as the Kaibab Forest Health Focus, that have successfully engaged many of the same stakeholders, agencies and organizations that have an ongoing interest in and commitment to Grand Canyon National Park (e.g., U.S. Forest Service, Grand Canyon Trust, Arizona Game and Fish Department, among others).

The GGCLA will be an iterative (although not necessarily linear) process that will consist of the following primary phases: project scoping; outreach; data inventory and needs assessment; data development, compilation and processing; spatial analyses, stakeholder review and iterative engagement; peer review, and reporting. Specific Products and Milestones along with tentative completion dates are outlined in Table 1, but will be modified as needed to meet overall project objectives and be subject to the availability of funding and other constraints. Methods for each project phase are briefly described below, but the overall approach requires flexibility in matching specific methods to the needs of GRCA managers and stakeholders, as the project develops.

Project scoping: GRCA's desired conditions (in draft) and the Vital Signs and measures developed by the Southern Colorado Plateau Network will help to define the broad scope of the GGCLA, direct an initial inventory of information sources (e.g. spatial/tabular data, published and gray literature, etc.), and assess their suitability for subsequent analyses (e.g. metadata, quantity, quality, scale, currency). During this phase we will also conduct outreach to identify a diverse group of stakeholders from neighboring lands and jurisdictions, and from the community of interest that is tightly linked to the Grand Canyon. At this time, we will also identify potential scientific collaborators and seek one-on-one input from other experienced individuals who hold particular knowledge of value to the assessment effort. Throughout the project we will clearly define objectives for each phase to provide a context for participation (i.e. ensure that the right people are involved at the right times).

Outreach: We will host a multi-stakeholder workshop (#1) with representatives from federal (incl. GLCA, LAME, PARA), state, and local agencies, American Indian tribes, non-profit organizations, academia, and other key stakeholders. This first workshop will communicate and refine the objectives of the assessment effort by taking a big-picture look at the greater Grand Canyon landscape. We will employ a hybrid approach, employing the Conservation Action Planning approach (TNC 2007) and drawing on experiences from Participatory Landscape Assessment (Sisk et al. 2006) to identify focal resources (i.e. a manageable subset of the full suite) and landscape values, based on both stakeholder input and the exploration of available data. Resource indicators, reference conditions, stressors, and threats will also be identified through structured discussion, drawing on processes developed, tested, and refined during previous efforts by NPS, TNC, and NAU.

Data inventory and needs assessment: A series of subsequent subject matter expert working group meetings, focused on specific resource disciplines, will be held to compile and more rigorously assess existing data sources, develop methods for analysis, and assign roles and responsibilities for working group products (e.g. resource summaries, spatial layers). A second interdisciplinary workshop (#2) will be held to review and integrate the above products. Both the workshop and working groups can be easily and inexpensively held in Flagstaff, AZ, since most of the key stakeholders and subject matter experts are from organizations based in the local area. Results from these meetings will complement the initial, internal data inventory and assessment conducted by GRCA and the Landscape Conservation Initiative at NAU.

Data development, compilation, and processing: While the assessment will draw largely on existing data resources, it is likely that limited development of new data will be required to adequately integrate disparate data sources in a spatial analytical framework. For example, introduction of remotely sensed data may improve the efficiency and efficacy of data integration by providing a more flexible overarching data frame that will allow greater inference from existing layers and tabular data archives. NAU will lead efforts to develop any necessary new data, in conjunction with GRCA's data manager and project leader, ensuring compatibility with existing information and NPS data management practices.

Spatial analysis: Once the working group products have been completed, preliminary spatial analyses will be conducted. Layers will be developed for focal resources, incorporating information on current, reference, and desired conditions, and including some measures (at least qualitative assessments) of data confidence. Critical data gaps that cannot be filled through the assessment effort will be identified to help guide future monitoring and research efforts. A hierarchical framework will be used that nests different focal species, resources, and landscape features by common attributes and commensurate spatial scales. A series of maps will be produced that depict both individual and composite focal resource conditions and associated attributes.

Stakeholder review and iterative engagement: A final workshop (#3) will be held to evaluate the preliminary products and use them, along with best professional judgment (incl. Traditional Ecological Knowledge), to rate current condition status, threats, and opportunities for proactive stewardship. Current condition layers will be compared to reference and desired conditions to determine ecological departure, which will be coupled with coincident resource values, threats, and opportunities to guide final analyses. The outcomes from this workshop will include a prioritization of subwatersheds (or other spatial delineations, as appropriate) for management attention, and to identify appropriate stewardship activities to achieve multiple natural resource objectives in an efficient manner.

Peer review and reporting: Once the final analysis is completed the NRCA report will be drafted, peer reviewed, and finalized for submittal in accordance with NPS guidance. An Addendum may be written that includes information on cultural resources and resource conditions outside of the park boundaries, since under current guidance these cannot be included in the formal NRCA report. In the interim, GRCA

staff will work with NPS NRCA staff to determine if this current restriction can be waived, in which case all of the products of the GGCLA can be included in one final report.

Products and Schedule

The tentative timeframe for this project will run from July 2012 through December 2014, pending availability of funding and associated changes in project scope. While the timing and sequencing of products and milestones is likely to change as the project develops, we anticipate the following tasks unfolding over a 2-year work period, followed by peer review and publication of results.

Table 1. Project Products and Milestones	**Completion Date**
Develop and submit CPCESU Task Agreement.	July 2012
Conduct outreach to identify potential collaborating scientists, subject matter experts, and interested stakeholders.	September 2012
Inventory existing spatial and tabular data on resource conditions and associated attributes and initiate literature review.	September 2012
Hold initial multi-stakeholder workshop (#1) to identify subset of focal resources and associated attributes.	October 2012
Refine scope and objectives, choose assessment frameworks, develop study design and methods, identify information needs, and develop data selection criteria.	December 2012
Hold focal resource/subject matter exMarchpert working group meetings and interdisciplinary subject matter expert workshop (#2).	March 2013
Address unmet data needs; develop new spatial data that are needed to meet specific assessment priorities.	April 2013
Compile and process spatial and tabular data for focal resources, conduct QA/QC, prepare metadata, integrate results from literature review.	July 2013
Conduct preliminary multi-resource spatial analyses.	October 2013
Hold final multi-stakeholder workshop (#3) for input and peer review.	November 2013
Conduct final analyses including prioritization of focal resources and draft NRCA report and spatial layers following NPS guidance (incl. Addendum).	March 2014
Conduct peer review of NRCA products (incl. Addendum).	May 2014
Finalize and submit NRCA report and spatial layers (incl. Addendum).	September 2014
Project wrap-up	December 2014

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Greater Grand Canyon Landscape Assessment

Vegetation TWG Meeting Summary
March 26, 2013

The first meeting of the GGCLA Vegetation Technical Work Group (TWG) was held on March 26th, 2013, to begin refining the scope and approach to assessing vegetation focal resources, specifically rare plants and riparian vegetation.

Acronyms and symbols

GGCLA: Greater Grand Canyon Landscape Assessment

GRCA: Grand Canyon National Park

LLECB: Lab of Landscape Ecology and Conservation Biology (NAU)

MNA: Museum of Northern Arizona

NRHP: National Register of Historic Places

NAU: Northern Arizona University

SCPN: Southern Colorado Plateau Network

TWG: Technical Work Group

*indicates an action item

Outcomes and Action Items

The TWG outcomes included guidance on how to conceptualize riparian communities and rare plant assemblages, along with some ideas for indicators, and resources for moving forward. The ideas will be used to further research existing vegetation assessment frameworks and to develop a framework appropriate for the Grand Canyon region. The following next steps were identified:

- All: Review the data lists compiled in the meeting handouts and contact Ronda Newton (ronda_newton@nps.gov) with suggestions on additional data sources
- GGCLA Core Team: Use TWG input to identify or develop an approach for assessing riparian communities and rare vegetation
- The GGCLA core team will keep the TWG informed through email and one-on-one meetings as need. The work group may reconvene after a more defined framework is developed

Meeting Participants

William Austin (USFWS), Joel Barns (Prescott College), Ron Hiebert (NAU), Jeri Ledbetter (Museum of Northern Arizona/Spring Stewardship Institute), Jean Palombo (NPS), Judy Springer (ERI), Larry Stevens (Museum of Northern Arizona/Spring Stewardship Institute)

GGCLA Core Team: Todd Chaudhry, Santiago Garcia, Mike Kearsley, Mark Nebel, Lori Makarick (Grand Canyon National Park); Cerissa Hoglander, Cari Kimball, Sasha Stortz (Northern Arizona University)

Meeting Summary
Introduction and Background

Todd Chaudhry provided background on the GGLCA project, the process for selecting the focal resources, which started with a stakeholder workshop in October 2012, and the purpose of the TWGs. Work groups are tasked with refining the scope of the assessment, identifying the best condition indicators and reference/desired conditions, identifying potential or known threats, identifying information and data needs that exists, and synthesizing the information to assess current conditions and trends.

The group first considered assessment of Riparian communities:

Refining the scope of an assessment of Riparian Communities: The group discussed how to distinguish between mainstem and tributaries:

- While it's hard to find streams on the Colorado Plateau that are in "reference condition", Grand Canyon tributaries are some of closest you can get in the world; it's good to focus on them.
- Given all of the resources that are already focused on assessing the condition of the mainstem (e.g. through Glen Canyon Dam Adaptive Management Program and Grand Canyon Monitoring and Research Center/USGS), it was suggested that this assessment focus on the tributaries.
- In response, some suggested that rather than excluding mainstem, there could be more "feasible desired conditions," some of which have been identified through adaptive management program and in the Long-term Experimental and Management Plan (LTEMP) for operation of GCD.
    - There is a gap between LTEMP effort and what is needed for a GGCLA assessment (e.g. prioritization of sub-reaches for active management/restoration), however, there will be some useful sub-products (e.g. modeled effects of flow regimes). Project has similar timeline to this GGCLA effort.
- Tributaries and mainstem are ecologically connected; might consider transmission of invasive plant propagules through wind and water flow (both up/downstream).

The group discussed using an assessment framework based on riparian conceptual models (e.g. Scott et al. 2005); processes, as well as species, need to be monitored.

- Key processes include base flows, presence of flooding and after-flooding effects on invertebrates, near-shore environment, and suspended succession. Absence of fire is also a key feature of tributaries- erosion from above rim fires is a threat.

The group discussed the physical characterizations of riparian communities

- Low order streams (stream order 0-3) are abundant in GRCA. Less is known for higher order streams.
- Water availability varies spatially and temporally.
- Solar aspect an important influence on vegetation community types.
- Spring boundaries may be distinguished from tributaries. The boundary can be defined by 2° difference in temperature away from spring. Faunal communities are distinct between springs and tributaries (some recent work on transition b/w springs/streams done in Death Valley)
- Structural characteristics of riparian communities include geomorphology, sedimentation pattern, shape of bank, vegetation on riparian terracing.

Potential Riparian Community Indicators

The following potential indicators were discussed:

- Macroinvertebrates- Shore bugs including shore flies, littoral macroinvertebrates, dragonflies, tiger beetles.
- Invasive species (aerial extent)
    - Exotic annual grasses- For example, *red brome* (for modeling, extremely aspect dependent, preferring north facing slopes)
    - Other important invasives include *cheatgrass* (incl. effects on fire risk/frequency), Pampas grass, ripgut brome, Bermuda grass.
- Ratio of native/non-native vegetation could be a good indicator of ecosystem health. However, this needs to be framed in terms of compositional, structural, or functional contribution of non-natives.
    - Challenges: Aerial extent of riparian communities is constantly shifting from flood events and other disturbance.

    - Most riparian systems are very narrow (i.e., 10m) and minimum mapping unit (MMU) for the park vegetation map is= ½ hectare. However, GRCA has some mapped riparian areas and other sources are available that map springs (e.g. from MNA).
- **Rare stream vegetation associations** such as patches of water birch may be important indicators. Although below the MMU, NPS may have information or can pull out information for specific species, etc.
- The **Riparian Stream Rapid Assessment indicators (i.e. Jones/Stevens et al. from Colorado Plateau Biennial Conference)** included hydrological landform processes, soil quality, erosion potential, soil compaction, non-native animals, native plants, potential for restoration and resource value, sources for non-native species adjacent to area and seed bank as indicators.

Riparian Community Threats

The following threats to riparian communities were discussed:

- Evaluate stressors in terms of ecological processes - for example, upstream indirect (e.g. livestock grazing above origin) rather than direct stressors (e.g. dams) may be present.
- Erosion can lead to increased sedimentation, adversely affecting **water quality**, **aquatic vegetation**, and **macroinvertebrates**.
- Potential threat layers could be human foot traffic along shorelines, grazing allotments, OHV use—can compact soil, trample of native vegetation, etc. Can reduce the area of **native vegetation cover** or affect **sensitive species (e.g. macroinvertebrates)**.
- **Climate change.**

Resources, References and Data Sources

- NPS' Restoration Rapid Assessment Tool (RRAT)
- Grand Canyon Wildlands Council (GCWC) assessment efforts
- **Riparian Stream Rapid Assessment**
- National hydrographic dataset – stream classifications, however rare stream types may be poorly represented.
- Rosgen classification systems of streams and rivers are also typically used.
- Wild and Scenic assessment conducted by Joel Barnes (1998-2004) for perennial tributaries in GRCA (46 total). This included qualitative description of riparian vegetation along surveyed segments.

The group then turned their discussion to rare plants.

Refining the scope of an assessment of rare plants: defining rarity

The group discussed the scope of the assessment:

- Rarity is challenging to define, as it depends on scale/geography/community type, and somewhat overlaps with endemic and special status species.
- There may be biases associated with defining rare species since dependent upon survey effort (often based on limited number of voucher specimens).
- NPS is developing a list of park and regional endemics that are prioritized. T&E listed species are also included on that list. This list could be a starting point.
    - For rare plants in GRCA, there is a body research available on 8-10 plants.
- Challenge: Understanding rare plant species distribution is challenging, locations are probably only 20% known.

- For inherently rare species, should the goal be that their population numbers increase or that their extant population is sustainable or maintained? What are the (reasonable) desired conditions?
- Rare plants as an indicator: Are rare plants an indicator or a focal resource? Rare species associations could be an indicator of ecosystem health but could also be climate change indicators.
- Rare plants as a focal resource: Are rare, endemic, listed species used as indicators or are they the focal species in and of themselves? There is an inherent value in things that are rare. May need to concentrate on **species with a very narrow niche** (which is a driver of rarity or endemism), as these species may be most sensitive to climate change.

Another approach: Important vegetation communities and assemblages

- The flipside to rare/endemic/listed species are **reference assemblages, ecologically important species and culturally important species and resources** (i.e., traditional collection and collection trends).
- "Textbook" examples of vegetation associations are important (e.g.ponderosa pine on Powell Plateau, desert riparian communities), as well as ecologically important ones (e.g. cottonwood/riparian as incl. in Wild and Scenic criteria).
- GRCA may be last intact riparian system in AZ, region, or world. **Vertical habitats** and **rim/edges** may be unique characteristics or habitats for GRCA and incl. rare/listed spp (e.g. sentry milk-vetch).
- **Desert scrub habitat** may have the most rare/endemic species, but is usually a low management priority: focus here could add value, especially at the landscape scale.

Potential Rare Plant Indicators

- Listed species
- Rare plant species and their pollinators
- **Sentry milk-vetch:** Recovery objectives are number of populations, number of individuals, and self-sustaining (quantified).
- **Pediocactus bradyi-** could serve as surrogate for other climate –sensitive spp.
- Genetics
- **Geology** is directly related to plants/vegetation associations.

Resources, References and Data Sources

- ERI @ NAU has monitored endemic species in which USFS is interested, has identified specialized soil types, as well as has targeted riparian areas. May need to move from single species (costly) to **assemblages.**
- Most recent studies include Desert Botanical Garden using collections and **predictive models of where endemic species could occur** in AZ. We could use these habitat suitability maps to identify priority areas based on both actual and predicted occurrences.
- Crystal Krause's thesis/dissertation @ NAU MPCER on rare plants, connectivity and dispersal rates.
- BLM is doing a resource condition assessment and many listed species overlap and could be relevant.
- Conservation Measures for Plant Health: CPC book/reference
- Field Guide to Special Status Species of Grand Canyon (NPS 2000)
- Ongoing work by MNA on rare spp. of Kaibab NF
- ESA listing documents (esp. re: threats)

Conclusion

The group discussed next steps and action items (see page 1), and adjourned.

Greater Grand Canyon Landscape Assessment (GGCLA)

Vegetation Technical Workgroup Initial Meeting Outline

Tuesday, March 26, 2013

Objectives and expectations

The Technical Workgroup will help to identify appropriate condition indicators, compile and evaluate data/information sources, develop assessment criteria and methods, and assess the conditions and trends of focal resources within its respective discipline. The workgroup will be facilitated by GRCA/NAU staff and will include other subject matter experts (SMEs) and stakeholder representatives, depending upon interest and availability. Participants will be expected to actively engage in the workgroup, including providing sound technical guidance, doing 'homework' in preparation for meetings, and helping to develop work products (e.g. literature reviews, spatial layers, condition assessments, etc.). Subsequent meetings (incl. conference calls/webinars) will be determined on an as needed basis. Specific objectives for the initial meeting include the following:

- Refine scope of assessment for focal resources (e.g. fine-/coarse-filter, ecosystemic-/taxonomic-level).
- Identify and assess preliminary condition indicators and reference/desired conditions.
- Identify and assess known/potential threats.
- Identify appropriate spatiotemporal scale(s) of analysis.
- Develop condition assessment criteria (e.g. indicator ranges/thresholds) and analytical approach (e.g. quantitative/qualitative score, spatial modeling).
- Identify and assess information/data needs, sources, and gaps.
- Identify specific tasks, products, roles, responsibilities, and timelines.

Focal resource(s)

Focal resources were identified based on input from participants during the GGCLA Workshop on October, 11th, 2012 and subsequent discussions amongst GRCA and NAU staff. Desired condition statements, indicators, reference conditions, and targets are from the 'Draft Grand Canyon National Park Desired Conditions' (2012) and references therein. *Denotes NPS Southern Colorado Plateau Network Vital Signs and Measures in the following tables as outlined in Thomas et al. 2006. TBD - To be determined based on GRCA and/or other relevant data sources (incl. workgroup products). Spatial and tabular datasets include those developed or acquired by GRCA.

Data table color codes are as follows:

Documented	In Development	Not Documented	Not Evaluated	To be Developed

Research studies listed include relevant permitted research conducted in GRCA since 1958. Research results (e.g. reports, publications, datasets) are not necessarily readily available for all those listed.

Riparian Communities (mainstem/tributaries)

Desired Condition (subject to GCD influence):

The diversity, quality, abundance and distribution of riparian habitats in the Colorado River corridor is maintained at or above the levels found in Grand Canyon in surveys prior to the passage of the Grand Canyon Protection Act (1992). Patches of vegetation dominated by native species occur in strands at a range of elevations below the pre-Glen Canyon Dam high water mark. The high levels of native diversity and productivity of these patches is maintained by access to water and nutrients from the hyporheic zone. Wildlife populations, including mammal, avian, herpetofaunal and arthropod, are supported in these riparian habitats and sustained at levels that contribute to a functioning community.

Periodic disturbance in the form of flooding and sediment deposition cause turnover of individuals and patches with a frequency that decreases with elevation above the level of base flow. High flows reach levels similar to pre-dam flows rarely. System-wide productivity and diversity are occasionally reduced due to longer-term disturbance from reduced annual flow volumes or extended droughts, but disturbance from human activities, including trampling of vegetation, broken branches, disturbance of soil crusts, etc. are maintained at or below levels of impairment.

Indicator	***Reference Condition***	***Target***
Areal extent of vegetation	Tamarisk: 600 acres Other/native: 1900 acres (GRCA 2012)	Tamarisk: 300 acres (decreasing) Other/native: 2000 acres (increasing)
Cover of native and non-native species (native vegetation types) (%)	71% native 29% nonnative (Kearsley et al, 2001-2005)	90% native 10% nonnative
Richness of native species (%)	70% richness of native species (Kearsley et al, 2001-2005)	At least 85% richness of native species
Populations and areal extent (target only) of key rare plant species (#)	TBD (Phillips et al 1987, herbarium collection through 2011)	# of populations and areal extent, by key species, are stable or increasing
Neotropical avifauna diversity and abundance	TBD	TBD
Yellow-billed cuckoo	TBD	TBD
Areal extent of southwestern willow flycatcher habitat	TBD	TBD

Riparian Communities (mainstem/tributaries)

Desired Condition (NOT subject to GCD influence):

The diversity, quality, abundance and distribution of riparian habitats outside the Colorado River corridor are maintained. Patches of vegetation dominated by native species occur in strands at springs and along washes throughout the park. High levels of productivity are maintained by access to water from springs and perennial tributaries. Wildlife populations, including mammal, avian, herpetofaunal and arthropod, are supported in these habitats and sustained at levels that contribute to a functioning community.

Natural drivers of regeneration, including flash floods, browse by native wildlife and competitive interactions, determine the composition and structure of these habitats. Hydrologic patterns which support native species are conserved. Insect and disease damage are within endemic levels. Fire is extremely rare and does not play a role in structuring riparian communities. Disturbance from human activities, including trampling of vegetation, broken branches, disturbance of soil crusts, etc. are maintained at or below levels of impairment.

Indicator	***Reference Condition***	***Target***
Areal extent of vegetation	Tamarisk: 600 acres Other/Native: 7500 acres (KGA 2012)	Tamarisk: 200 acres (decreasing) Other/Native: 7500 acres (increasing) Total target = 8,000 acres
Cover of native and non-native species (native vegetation types) (%)	90 % Native 10 % Nonnative (GRCA 2012)	90% native 10% nonnative
Richness of native species (%)	18.2 species / tenth-acre plot; 16.2 (90%) native, 2 (10%) nonnative (GRCA 2012)	At least 95% richness of native species
Populations and areal extent of key rare plant species (#)	TBD	# of populations and areal extent, by key species, are stable or increasing
Neotropical avifauna diversity and abundance	TBD	TBD

GRCA Riparian Communities Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Southwestern Willow Flycatcher Habitat Assessment	Tabular	The purpose of this study is to identify potential Southwestern Willow Flycatcher habitat.	Janice Stroud-Settles Grand Canyon National Park Wildlife Biologist	Unknown	Colorado River corridor; river mile 0 to 280	Identify potential Southwestern Willow Flycatcher habitat along the Colorado River corridor. Qualitative description of tamarisk density at sites.	Documentation in process of being completed. Qualitative descriptions of habitat characteristics.	In process of being documented.	Unknown
Exotic Plants	Tabular	Contains information about the presence and management of exotic plant species in Park. The data set is not a systematic survey of exotics plants. The main goal of project is to control exotic plant populations in targeted areas of the Park.	Lori Makarick Grand Canyon National Park	2002 - present	Developed areas on rim, inner canyon and river corridor	Identify areas where exotic plant species are found and treated including frequency and extent of control. Possibly look at effectiveness of control in sites with enough data.	Does not represent valid presence / absence of exotic plants within the ark. Does not represent complete distribution of exotic plants within the Park. Data have not been thoroughly vetted.	Entries contain site specific information including slope, aspect, elevation, light exposure, surface water and associated plant species. Entries include identification of exotic plant species, the areal extent of the exotic plant population and the percent cover of the species, along with the geographic location (UTM center point) of the population. If control actions are taken, information about the number of plants controlled, aerial cover removed, area treated, treatment type, plant phenology, and specific information about control actions that might be useful to determine future management action needs. If herbicide is used, the type, mixture and amount are recorded.	Moderate to high effort extracting data from complex data structure and vetting data thoroughly.

GRCA Riparian Communities Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Vegetation Transects	Tabular	Contains information about ground cover, vegetation cover and vegetation structure measurements taken along 50m transects. The intent is to monitor changes in these measurements. Most transects are placed in river camps. 448 transects have been created, 202 of which have been sampled at least 5 times.	Lori Makarick Grand Canyon National Park	2000 - present	Majority of sites in river corridor; some on rim and inner canyon	Quantify and describe vegetation characteristics for river campsites primarily.	Great majority of data is in river campsites. Data collection methods have changed limiting use of some data. Data have not been thoroughly vetted.	Entries contain site specific information including slope, aspect, elevation, bearing, light exposure, geologic layer and UTM data for the start and end point of the transect, along with a verbal description. Entries include measurements that were taken along a 50m transect at 5,15,25,35,45 m: Daubenmire ground and plant cover (2005-present), vegetation structure method 1 (2004 - 2008), vegetation structure method 2 (2006 - present), soil measurements (2005 - present), and point intercept method for ground and plant species (2000-present). Along with other ancillary data including dominant and associated plant species and photos of transect start and end.	Moderate to high effort extracting data from complex data structure and vetting data thoroughly.
Rare Plants	Tabular	Describes rare plant populations, identifies locations where rare plants are found and characterizes the immediate site.	Lori Makarick Grand Canyon National Park	2004 - 2012	Majority of sites are in eastern half of Park	Identify rare plant locations in the Park. Help create predictive model of rare species.	Does not represent a systematic Park-wide survey for rare plants. Small number of records.	The number of individuals and number of subpopulations is estimated, size of area occupied is estimated, phenology of population is estimated, evidence of reproductive success, evidence of symbiotic relationships, evidence of disease, predation or injury are all noted. The site is characterized by measuring ground cover, noting animal use evidence, and noting natural and anthropogenic disturbances.	Simple to convert tabular data to spatial layer.

GRCA Riparian Communities Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Bryophytes	Tabular	Update the bryophyte floristics in Park including expanding the known bryoflora by collecting bryophytes and incorporating modern collections since the 1940s, report the local distribution and microhabitat specificity of each species, and report regions and substratum types supporting high regional diversity. The study sought to determine if bryophyte communities differed significantly within three forest types - pinyon-juniper, ponderosa pine, and mixed conifer forests. Sampling occurred along trail corridors.	Southern Colorado Plateau Network	2008 - 2009 (field work) 2007 - 2010 (specimen collection)	Eastern half of Park	Identify hot spots of bryophyte diversity in Park. Identify the locations of rare species. Regionally or locally rare species may warrant special attention. Bryophyte communities can be described generally using the 3 forest types sampled.	Field sampling limited to trail corridors. Results indicate microhabitat and microclimatic variation are more important drivers of distribution and abundance of rock bryophytes.	Compiled and reviewed existing collections and contributed new specimens collected from 2007 to 2010. Over 1,310 new specimens were collected. Collections were summarized spatially into 6 collection regions - North Rim, South Rim, Inner Canyon, Colorado River, Lake Mead and Marble Canyon. At each of 104 sites, 3 rocks were randomly selected to sample. Rocks had to be at least 1m from trail and be large enough to fill a 100cm x 1cm quadrant. Species cover was estimated to the nearest 1 cm^2.	Unknown
Vegetation Mapping	Tabular	The Vegetation Mapping Project was intended to sample, classify, describe and accurately map the plant communities comprising the Park. The tabular data contains classification plot and observation point data collected during project fieldwork. Classification plot data was used to create a classification of vegetation alliances and plant associations for GRCA. Observation points are used to inform the photo-interpretation/image processing phase of the project.	Mike Kearsley Grand Canyon National Park	2007 - 2009	Park-wide	Describe vegetation characteristics across a wide variety of vegetation communities park-wide. Describe fire fuels information across a wide variety of vegetation communities park-wide.	Snapshot in time data.	Classification plot and observation point tables contain basic information on plot or point location, visit specific information, overall vegetation characteristics, species and strata-specific data related to a plot or point, details on stems, height, crown width, and other tree attributes, environmental features and conditions (including ground cover) of plot or point, details on photos taken of plot or point, and final determination of plot vegetation association as determined by NatureServe.	Simple to convert tabular data to spatial layer.

GRCA Riparian Communities Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Vegetation Photopoints	Digital Photos/ Tabular	Archive of digital photos taken during data collection efforts for exotic plant, vegetation transect, vegetation restoration monitoring and rare plant monitoring. Intent is to visually capture changes in a site and vegetation through time. Photos details are recorded to facilitate re-taking photos in the future.	Lori Makarick Grand Canyon National Park	2000 - present	Park-wide	Visual representation of sites and pre and post treatment or restoration efforts.	Large storage requirements - 7Gb	Photo details are recorded to facilitate re-taking photos in the future - view number, photo description, bearing, height and time. Restoration monitoring: Photos taken of pre-treatment and post-treatment at restoration sites. Vegetation transects: Photos taken at transect start and end. Pre or post treatment is noted. Exotic plant control: Photos taken of pre and post treatment. Rare plant monitoring: Photos taken of rare plant site and if applicable, pre and post treatment.	Simple to create spatial point layer of photopoints. Management of dataset not simple due to storage requirements of photos.

GRCA Riparian Communities GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Stock Tanks	GIS (Vector)	Stock tank (pts and polys) within GRCA	GRCA GIS	updated 2/7/2013	GRCA	local unnatural water sources	Some features not field-verified	Digitized from NAIP or high-res imagery	
CRMP/Veg Transects	GIS (Vector)	Veg Transect Locations in CO River Corridor	GRCA Veg Program	2007	GRCA CO River Corridor	CO River Veg	Only at CRMP Campsites	Resource GPS	Moderate work on tabular end, but linking with GIS layer would be simple
Stanton Photopoints	GIS (Vector)	Pt locations of Stanton (1889-1890) photos and re-photos by Webb in 1995	USGS, Robert Webb	1889-1995	CO River Corridor	Photographs made in Grand Canyon a century ago may provide us today with a sense of history; photographs made a century later from the same vantage points give us a more precise picture of change in this seemingly timeless place. Between 1889 and 1890, Robert Brewster Stanton made photographs every 1-2 miles through the river corridor for the purpose of planning a water-level railroad route and produced the largest collection of photographs of the Colorado River at one point in time. Robert Webb, a USGS hydrologist conducting research on debris flows in the Canyon, obtained the photographs and from 1989 to 1995 replicated all 445 of the views captured by Stanton, matching as closely as possible the original camera positions and lighting conditions. Grand Canyon, a Century of Change assembles the most dramatic of these paired photographs to demonstrate both the persistence of nature and the presence of humanity. Unexpected longevity of some plant species, effects of animal grazing, and expansion of cacti are all captured by the replicate photographs. More telling is evidence of the impact of Glen Canyon Dam: increased riparian vegetation, new marshes, aggraded debris fans, and eroded sand bars.	GRCA does not have the photos, but USGS should	inferred from publications and GRCA staff knowledge	unknown

GRCA Riparian Communities GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Burn Severity	GIS (Vector)	Burn Severity for GRCA Fires	GRCA Fire	2001-2011	GRCA	Fire effects on Riparian Areas	Only where fires have occurred; only data since 2011	MODIS satellite	Minimal
Fire History	GIS (Vector)	Perimeters of historic fires in GRCA	GRCA Fire	1910-2012	GRCA	Fire effects on Riparian Areas	earlier data (pre-1950) is of questionable accuracy	aircraft GPS since 1998; earlier data unknown	Minimal
Springs Seeps	GIS (Vector)	Springs and Seeps in GRCA and vicinity	GRCA Hydrology	updated 12/19/2012	GRCA and vicinity	Important areas of Riparian Veg	Point locations only; most have not been inventoried	Rec GPS; USGS 1:24K quad maps	Unknown to link to Inventory data
National Hydrography Dataset	GIS (Vector)	Hydrography	USGS NHD	downloaded 10/6/2012	GGCLA Analysis Area sub-basins	All surface-water related analysis	1:24K	USGS 1:24K topo maps; USGS PBS maps	None
Watershed Boundary Dataset	GIS (Vector)	Watershed Boundaries	USGS	downloaded 10/6/2012	GGCLA Analysis Area sub-basins	Potential as analysis units	not as significant above the rim	USGS 1:24K topo maps; USGS PBS maps	None
National Elevation Dataset	GIS (Raster)	Digital Elevation Data; derivatives Aspect, Slope	USGS; Mosaic and Derivatives by GRCA GIS	downloaded 1/1/2009	most of GGCLA Analysis Area; remainder available from USGS	Any analysis where Elevation, Aspect, and Slope affect Riparian environments	modeled at 10m cell size	Diverse source data	Moderate to download and mosaic additional data to completely cover the Analysis Area; potentially High if other derivations or models are needed

GRCA Riparian Communities GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Transportation	GIS (Vector)	Road and Trails	GRCA GIS; BLS; USFS	updated 3/13/2013	most of GGCLA Analysis Area	Analysis where road density or proximity affect Riparian environments	Data outside GRCA is incomplete and from different sources, with different attributes	Varied, but with feature-level metadata	Significant to compile from various sources to a single standard over entire Analysis Area
Vegetation Map	GIS (Vector)	Vegetation (Associations)	GRCA	9/12/2012	GRCA and GC-Parashant NM	ID and analysis of Riparian and other Vegetation types at Association to Lifeform scales	1-hectare minimum mapping unit size; Does not cover entire GGCLA Analysis Area; only a small fraction of polygons field-verified	NAIP imagery (2007 and 2010) segmentation , CART analysis, and field editing	None
Vegetation Plots	GIS (Vector)	Vegetation Classification Plots	GRCA	2007-2008	GRCA and GC-Parashant NM	Detailed Vegetation Plot data, corresponds with Vegetation Map data	Plot data is in a separate SQL Server database, but easily linked; only 76 (3.4%) of Plots are in a Riparian Lifeform types	Rec GPS (+/- 5 meters)	Minimal
Biotic Communities Of The Southwest	GIS (Vector)	Biotic Communities	Brown and Lowe; Nature Conservancy; ALRIS; IMADSES; NMCFWRU	2004	Arizona	Landscape-scale biological analysis	1:1 million scale; very broad units	Scan and digitize paper map	None
Colorado River Vegetation USGS 2002	GIS (Vector)	Riparian Vegetation along the CO River Corridor	GCMRC	2002	CO River Corridor	Analysis of Riparian Vegetation within the CO River Corridor	CO River Corridor only; there is an outlier in southern AZ that suggests entire dataset	Ground surveys and image processing	Minimal to Moderate, depending on review of the data outlier

GRCA Riparian Communities GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
							should be re-checked		
Natural Vegetation AZ Game And Fish Dept 1976	GIS (Vector)	Natural Vegetation	AZ Game and Fish	1976	Arizona	Broad-scale vegetation analysis	Large data gaps in GGCLA Analysis Area	Digitized from drawn maps?	Unknown
Vegetation Warren 1982	GIS (Vector)	Vegetation types	UA and NPS (Warren, Recihhardt, and Mouat)	1982	GRCA	Vegetation Analysis	GRCA extent only; Doesn't appear to have Riparian Veg types; Newest GRCA Veg mapping (2012) is judged better	Unknown	None
Veg 2000	GIS (Vector)	Vegetation for FARSITE modeling	GRCA	2000	Parts of GRCA N and S Rims	Vegetation Analysis	Only covers portions of GRCA; modified from Vegetation_Warren_1982 for FARSITE modeling	Unknown	Unknown
GRCA Soil	GIS (Vector)	Soils of GRCA	USDA-NRCS, SSURGO	1/4/2010	GRCA	Riparian Vegetation can be related to Soil types	GRCA only	Digitized maps	Minimal to Moderate; need to complete migration to geodatabase and Access links; manipulating data through links with Access DB and reference to soil classification descriptions

GRCA Riparian Communities GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
NAIP Imagery	GIS (Raster)	NAIP Imagery mosaic datasets	USDA-NAIP	2005, 2007, and 2010	GRCA and surrounding area	Potential for image analysis	doesn't cover entire GGCLA Analysis Area	Aerial Photography	Minimal as-is; High to perform image analysis, change detection, etc.
PAD-US	GIS (Vector)	US Protected Area Database; GAP Status, Protected Areas, Land Ownership	NPScape, USGS GAP	2/22/2011	GGCLS Analysis area and beyond	Could imply a level of concern regarding Riparian resources	Not all areas within the GGCLA Analysis Area are attributed, or sources clearly identified	Multiple	Minimal, but data currently as Web Service; extraction could be Moderate
Roadless Areas	GIS (Vector)	Areas without Roads ("raw" and "Major Roads"	NPScape, ESRI	2005	GGCLS Analysis area and beyond	A measure of Roads and Road Density, and potential effects on Riparian resources	The ESRI Roads data doesn't accurately reflect the current Road system in GRCA, and perhaps elsewhere	Buffer of existing Roads layers	Moderate to High
Land Cover	GIS (Raster)	Land Cover, Land Cover Change	NPScape, NLCD, NOAA, NALC	2006	GGCLS Analysis area and beyond	Land Cover and Land Cover Change Analysis		Multiple	Unknown
Invasive Plants	GIS (Vector)	Invasive Plants and Treatments	GRCA Veg Program	2013	GRCA	Pressures on Riparian resources from Invasive Plants	Database not yet complete	Varies	Moderate, in development

Riparian Species Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Integrated Land Assessment Project (ILAP) R3 Current Veg Arid Woodland 2012020	GIS (raster)	Random forest-derived estimates of arid woodland current vegetation structure and cover for initial modeling conditions (year 2000)	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	?-2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Integrated Land Assessment Project (ILAP) R3 Current Veg Forest 20110817	GIS (raster)	Random forest-derived estimates of forest current vegetation structure and cover for initial modeling conditions (year 2000)	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	?-2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Integrated Land Assessment Project (ILAP) R3 HUCs pre-modeling	GIS (vector)	6th field, USGS watersheds	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	?-2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Integrated Land Assessment Project (ILAP) R3 Mask 20120410	GIS (raster)	Modeling mask that removes areas of wetland, agriculture, urban and other non-veg categories before modeling rollup	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	?-2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI

Riparian Species Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Integrated Land Assessment Project (ILAP) R3 Model Regions	GIS (vector)	Modeling regions used to define landscape ecological boundaries as indicated by transition probabilities for veg models	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	?-2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Integrated Land Assessment Project (ILAP) R3 Potential Veg Type 20120213	GIS (raster)	Potential vegetation types used to correspond each veg model to an area of the landscape	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	?-2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Integrated Land Assessment Project (ILAP) R3 Soils 20120326	GIS (raster)	Soils derived from NRCS SSURGO and STATSGO and USFS SRI data. Data is averaged across entire soil profile.	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	?-2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Integrated Land Assessment Project (ILAP) R3 HUCs	GIS (raster)	Post-rollup modeling strata aggregated to the HUC from the basic modeling landscape unit of HUC-PVT-Own	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	?-2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI

Riparian Species Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Integrated Land Assessment Project (ILAP) R3 States Modeled Arid 20120509	GIS (raster)	Post-rollup, modeled states (crosswalked from current veg) for arid land models	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	?-2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Integrated Land Assessment Project (ILAP) R3 States Modeled Woodland 20120525	GIS (raster)	Post-rollup, modeled states (crosswalked from current veg) for woodland models	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	?-2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Integrated Land Assessment Project (ILAP) R3 Modeled States Forest 20120604	GIS (raster)	Post-rollup, modeled states (crosswalked from current veg) for forest models	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	?-2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Integrated Land Assessment Project (ILAP) AZ Baseline Mosaic Imagery (13 files)	GIS (raster)	LANDSAT TM cloudless mosaic for AZ, including NDMI, NDVI, and TCW layers	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	?-2012	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI

Riparian Species Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Integrated Land Assessment Project (ILAP) VDDT models database and template Path models database (3 files)	database (*.mdb)	Database files for VDDT and template Path models for AZ Colorado Plateau (files prefaced by ACP*)	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	?-2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
BLM Rapid Ecoregional Assessment (REA) - Mojave Basin and Range	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
BLM Rapid Ecoregional Assessment (REA) - Colorado Plateau	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Sagemap Database - Sagebrush Distribution	GIS (raster)	Current distribution of 10 sagebrush vegetation types and associated vegetation in the western US	The Nature Conservancy, Natural Heritage Program, NatureServe	1980-2001?	Great Basin region in intermoun tain West, excluding AZ and NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Sagemap Database - Cheatgrass Invasion Risk	GIS (raster)	Risk model of invasive cheatgrass threats (low to high risk) to sagebrush habitats in scrubland ecosystems	US Geological Survey, US Forest Service, Oregon State University (Knick et al.)	1980-2002?	Great Basin region in intermoun tain West, excluding AZ and NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Sagemap Database - Pinyon-Juniper Expansion	GIS (raster)	Risk model of invasion of native shrublands (primarily	US Geological Survey (Wisdom et al.)	2004	Great Basin	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA

Riparian Species Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Risk		sagebrush ecosystems) by juniper and pinyon pine			region in intermountain West, excluding AZ and NM				QUALITY TASK 3: Clip raster to GGCLA AOI
Vegetation Drought Response Index (VegDRI)	GIS (raster), other data products in development	Vegetation drought response index (eMODIS or AVHRR VegDRI), weekly geospatial model that depicts drought stress on vegetation within coterminous US (can be eMODIS or AVHRR based)	US Geological Survey - EROS, High Plains Regional Climate Center, US Department of Agriculture	2008 to present	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
TNC Southwest Biotic Communities	GIS (vector)	TNC developed a digital version for the whole of David E. Brown and Charles H. Lowe's 1981 map	The Nature Conservancy (TNC)	1981	Southwest US	Defines biotic communities	TBD	TNC developed a digital version for the whole of David E. Brown and Charles H. Lowe's 1981 map	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
TNC Arizona Grasslands	GIS (vector)	Extent, condition, and distribution of grassland types in Arizona	The Nature Conservancy (TNC)	TBD	AZ, portions of Mexico and NM	Habitat type and quality	TBD	Quality of grasslands define by expert interviews and field verification, classifications detailed in metadata	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
AGFD Research Branch - via AZ State Land	GIS (raster)	Riparian vegetation associated with perennial	AGFD Research Branch via AZ State Land Department	1993-1994	AZ	Riparian vegetation	TBD	LANDSAT TM digital satellite	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA

Riparian Species Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Department Riparian - Riparian Vegetation		waters						data and Multiple Resolution Videography used to generate maps in 1993-1994	QUALITY TASK 3: Clip raster to GGCLA AOI
USGS-NPS Vegetation Characterization Program / Vegetation Inventory	data products in development	Classification, description, and mapping of vegetation communities in national park units to be available online when completed for relevant national park units.	USGS-NPS	data products in development	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
LANDFIRE - Existing Vegetation Type	GIS (raster)	Complexes of plant communities	Landscape Fire and Resource Management Planning Tools	2008	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
LANDFIRE - Existing Vegetation Cover	GIS (raster)	Vertically projected percent cover of the live canopy layer for a specific area	Landscape Fire and Resource Management Planning Tools	2008	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
LANDFIRE - Existing Vegetation Height	GIS (raster)	Average height of the dominant vegetation	Landscape Fire and Resource Management Planning Tools	2008	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Southwest Regional Gap Analysis Project	GIS (raster)	Southwest Regional Gap Analysis Project, landcover data for Southwest	USGS Gap Analysis Program	2004?	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
National Land Cover	GIS (raster)	National Land Cover	USGS Multi-resolution Land	2006?	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA

Riparian Species Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Database (NLCD) - Land Cover		Database, landcover data	Characteristics Consortium						TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
National Land Cover Database - Land Cover Change (NLCD)	GIS (raster)	National Land Cover Database, landcover change data (2001-2006)	USGS Multi-resolution Land Characteristics Consortium	2001-2006	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
AVIRIS Infrared Remotely-sensed Imagery	GIS (raster)	Airborne Visible/Infrared Imaging Spectrometer overflight imagery available for specific regions of the US	NASA Jet Propulsion Laboratory	1992-2006	specific regions of US only	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
MODIS Normalized Difference Vegetation Index (NDVI)	GIS (raster)	MOD 13 Normalized Difference Vegetation Index (NDVI) data for 16-day basis derived from bands 1 and 2 of the MODerate-resolution Imaging Spectroradiometer, 250-m resolution	NASA	2001-2013	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
eMODIS Percent of Average Seasonal Greenness (PASG)	GIS (raster)	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
NOAA GIMMS Normalized Difference Vegetation Index (NDVI)	GIS (raster)	Global Inventory Modeling and Mapping Studies (GIMMS), Normalized Difference Vegetation Index (NDVI) dataset derived from AVHRR imagery data	Global Land Cover Facility	1981-2006	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
AVHRR Normalized Difference Vegetation	GIS (raster)	AVHRR 7- or 14-day composite Normalized	USGS	1989-present	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA

Riparian Species Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Index (NDVI) Composites		Difference Vegetation Index data, 1-km resolution							QUALITY TASK 3: Clip raster to GGCLA AOI
AVHRR Percent of Average Seasonal	GIS (raster)	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
USFS Mapped Atmosphere – Plant – Soil System (MAPSS) Potential Change in Vegetation Density	GIS (raster)	Model output data of shifts in vegetation density (leaf area) based on availability of water and energy for growth, 10-km resolution	USFS	2008?	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
USFS Mapped Atmosphere – Plant – Soil System (MAPSS) Simulated Ecosystem and Water Resources Impacts	GIS (raster)	Model output data of shifts in vegetation density (leaf area) and runoff, 10-km resolution	USFS	2008?	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
USFS Mapped Atmosphere – Plant – Soil System (MAPSS) Simulated Percent Change in Leaf Area Index	GIS(raster)	Model output data of shifts in percentage change in leaf area index, 10-km resolution	USFS	2008?	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
LANDFIRE - Environmental Site Potential	GIS (raster)	Vegetation that could be supported at a given site based on the biophysical environment	Landscape Fire and Resource Management Planning Tools	2008	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
USFS Fire Record Database - Fires	non-spatial data spreadsheet (*.txt or *.fw9)	Fire records for state of Arizona by land management agency including fire name, code, type, and location (based on individual DI-1202 fire reports completed for every fire occurring on US	USFS	Varies by region (range within 1972-2011)	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

Riparian Species Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
		public lands).							
USFS Fire Record Database - Weather	non-spatial data spreadsheet (*.txt or *.raw)	Fire records for state of Arizona by land management agency and related weather by weather station.	USFS	Varies by weather station (range within 1950-2012)	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
PRISM Data	GIS(raster)	Normal precipitation, maximum temperature, minimum temperature, and dew point data 1971-2000 or 1981-2010 at 800-m resolution or monthly data 1890-present at 4-km resolution	PRISM Climate Group	1971-2000, 1981-2010 OR 1890-present	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Western Regional Climate Center (WRCC) Local Climate Data Summaries for Western US	non-spatial database (ASCII or *.csv)	Average monthly temperature, precipitation, and wind metrics with other weather details for each weather station	Western Regional Climate Center	varies by station	any national weather station	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS US Drought Monitor	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS Precipitation Derivatives	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
NOAA National Climate Data Center (NCDC) Land-based Datasets - Quality Controlled Local Climatological Data	non-spatial database (ASCII or *.csv)	Daily, hourly, or monthly summary data for each weather station, including temperature and precipitation metrics, degree days, sunrise and sunset times, air pressure, and wind	NOAA	varies by station	any national weather station	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

Riparian Species Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
		speed							
USGS Dynamical Downscaled Regional Climate	GIS (raster)	Dynamical downscaled regional climate for Pacific Southwest and Southern Rockies	USGS	1968-2099	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
North American Regional Climate Change Assessment Program (NARCCAP)	GIS (raster)	50-km resolution climate change scenario simulation output from multiple regional climate models nested within multiple atmosphere-ocean general circulation models for 30-year current and future periods	North American Regional Climate Change Assessment Program	free registration needed for data access	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
UCAR Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC) / climate scenario generator (SCENGEN) Regional Climate Models	GIS (raster)	Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC) carries through calculations at the global-mean level using the same upwelling-diffusion, energy-balance climate model that has been and is employed by IPCC while a regional climate scenario generator (SCENGEN) uses these results, together with spatially detailed results from the CMIP3/AR4 archive of AOGCMs, to produce spatially detailed information on future changes in	UCAR	free registration needed for data access	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI

Riparian Species Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
		temperature, precipitation and MSLP, changes in their variability, and a range of other statistics							
USGS Geologic Map of Upper Parashant Canyon	GIS (raster)	Geologic map of the upper Parashant Canyon area that covers part of the Colorado Plateau and several large tributary canyons that make up the western part of Arizona's Grand Canyon.	USGS	1976?	Mojave County, AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
KFHF Kaibab Forest Health Focus Project (Williams, Tusayan, North Kaibab, AZ)	TBD	Kaibab Forest Health Focus Project	TBD	2006	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Wood Supply Project (Williams, Tusayan, AZ)	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Grand Canyon Trust Kane and Two Mile Ranches Project (North Kaibab Plateau, AZ)	TBD	TBD	TBD	2006-2012	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

GRCA Permitted Research Studies – Riparian Vegetation

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Allan	Gery	GRCA-00253	NAU	8/5/08 - 9/30/08 7/1/06 - 7/30/07 10/1/04 - 6/1/05	Using Biotechnology to Restore Riparian Habitats in the West: Genetic and Genomic Studies of Biodiversity and Drought Tolerance	http://eco.confex.com/eco/2007/techprogram/P3579.HTM
Bills	Donald	GRCA-00188	USGS	1/20/06 - 3/30/06 4/1/03 - 12/1/05	Measuring ephemeral spring flow and geochemical changes at the South Rim of the Grand Canyon using electronic resistance sensors.	Final report received. 12 p./80 p. NRInfo Ref Code 2169062, 2169064, 2169067. Electrical resistance sensors record spring flow timing, Grand Canyon, Arizona – Ground Water Vol. 44 No. 5; September-October 2006 (pages 630-641); Determining ephemeral spring flow timing with laboratory and field techniques: applications to Grand Canyon, Arizona / by Eric A. Adams, 2005 NAU master's thesis. Cline Library GB1207.A436 2005.
Breck	Stewart	GRCA-00010	Riparian Wildlife Consultants	3/28/00 - 12/31/00	Beaver, River Otter, and Muskrat Inventory: Colorado River Through the Grand Canyon.	NRInfo Ref Code 558335. GRCA Library Call # QH96.8.B5 B74 2000.
Breck	Stewart	GRCA-00509	USDA/APHIS	9/11/08 - 9/29/08	Modeling beaver occupancy and riparian habitat along the Colorado River in Grand Canyon National Park.	Final report not received.
Christensen	Kerry	GRCA-00093, GRCA-00230, GRCA-00231	Hualapai Tribe	5/1/06 - 9/14/08 4/15/04 - 12/31/07 3/13/97 - 12/31/97	Southwestern Willow Flycatcher Surveys on Upper Lake Mead by the Hualapai Tribe/Hualapai Terrestrial Resource Monitoring in lower Grand Canyon	GRCA Library Call # QK147 .C47 T73 1998, QL696 .P289 C47 2007, QL677.4.C47 H83 1998.
Hall	Robert	GRCA-00273	University of Wyoming	5/1/10 - 5/1/11 10/1/09 - 12/31/09 5/1/08 - 5/1/09 3/1/06 - 12/30/07	Linking whole-system carbon cycling to quantitative food webs in the Colorado River	Final deliverable might be in GCMRC library.

GRCA Permitted Research Studies – Riparian Vegetation

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Hart	Robert	n/a	USGS	3/22/00 - 12/31/03	Detailed Hydrogeologic Assessment of South Rim Area, Grand Canyon National Park	NRInfo Ref Code 568450, 657942. GRCA MC # GRCA 80840. Might be: "Assessment of Spring Chemistry along the South Rim of Grand Canyon in Grand Canyon National Park, Arizona" or "Chemical Characteristics of Ground-Water Discharge at Selected Springs, South Rim Grand Canyon National Park, Arizona".
Hill	Carol	GRCA-00221	University of New Mexico/UA	6/16/04 - 12/31/07 9/20/99 - 12/31/03 11/18/96 - 12/31/98	Origin and timing of ore mineralization and cave development in Grand Canyon National Park and vicinity	No final report received. NRInfo Ref Code 558315. GRCA Library Call # QE86 .G73 H55 2008. 2 folders; "Bat Diversity, Resource Use and Activity Patterns along A Sonoran Desert Riparian Corridor" thesis by Debbie Buecher [2007]
Holmes	Jennifer	GRCA-00311	USGS Colorado Plateau Research Station	5/1/07 - 12/30/08	Pilot Monitoring Surveys to Support of Long-Term Monitoring of Bird Communities in National Park Service Units of the Southern Colorado Plateau Network	NRInfo Ref Code 2166020.
Jamison	Levi	GRCA-00575	UA	5/16/11 - 5/16/12	Colonization of GRCA by the Northern tamarisk beetle (Diorhabda carinulata)	Final report not received.
Kavanaugh	David	GRCA-00507	California Academy of Sciences	7/15/08 - 7/20/08	Phylogenetic relationships among the Nearctic species of the carabid beetle genus Nebria Latrielle (Insecta: Coleoptera: Carabida) based on analyses of morphological and molecular data.	A new species of Nebria Latreille (Coleoptera: Carabidae: Nebriini) from the Grand Canyon, Arizona by David H. Kavanaugh Annals of Carnegie Museum Jul 2008 : Vol. 77, Issue 1, pg(s) 1-5 doi: 10.2992/0097-4463-77.1.1.

GRCA Permitted Research Studies – Riparian Vegetation

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Kearsley	Michael	GRCA-000032	NAU	6/30/00 - 12/31/02	Effects of steady vs. fluctuating flows on creation of "vegetated shoreline" for juvenile fish and exotic recruitment into newly available habitat.	GRCA Library Call # QH541.5 .R52 P678 2002. Responses of riparian vegetation to two contrasting managed flow regimes of the Colorado River in Grand Canyon, AZ / Marianne E. Porter and Michael J. C. Kearsley.
Kearsley	Michael	GRCA-00105	NAU	4/27/01 - 12/31/05 4/27/01 - 12/31/03	Inventory and monitoring of terrestrial riparian biological resources in Grand Canyon: an integrated approach	GRCA Library Call # QH541.5 .R52 K43 2005. NRInfo Ref Code 2168602.
Kearsley	Michael	GRCA-00008	NAU	3/23/00 - 12/31/01	Review, assessment, and recommendations regarding riparian vegetation monitoring Grand Canyon.	NRInfo Ref Code 558303. GRCA MC # GRCA 79083. GRCA Library Call # QH541.5 .R52 K437 2001.Review assessment and recommendations regarding terrestrial vegetation monitoring in the Colorado River Corridor of Grand Canyon : final report / Michael J.C. Kearsley and Tina J. Ayers.
Kearsley	Michael	n/a	NAU, GCMRC	5/27/97 - 12/31/97	Second Year Transition Monitoring of Riparian Plant Habitats in Grand Canyon National Park, Arizona	NRInfo Ref Code 558193, 558172. GRCA Library Call # TC557 .A62 K43 1998; QK147 .K43 S43 1999. Terrestrial Vegetation Work for 1997 Steady Low and High Flows, Draft Final Report, Michael Kearsley and Tina Ayers [NAU, 1998]; Second year transition monitoring of riparian vegetation from Glen Canyon Dam to Pearce Ferry : draft 1997 final report / Michael J.C. Kearsley and Tina J. Ayers ; John R. Spence.
Kennedy	Theodore	GRCA-00207	GCMRC	10/1/03 - 12/31/05	Terrestrial-Aquatic linkages in the Colorado River Ecosystem: is leaf litter from riparian vegetation a significant source of carbon to the aquatic food web?	GRCA MC # GRCA 87632. Final deliverable might be in SCRE Report.

GRCA Permitted Research Studies – Riparian Vegetation

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Kubly	Dennis	n/a	Arizona Game and Fish Department	3/25/95 - 12/31/95	Kanab ambersnail surveys and reintroduction feasibility assessment in the Grand Canyon	NRInfo Ref Code 558246. GRCA Library Call # QL430.5 .S87 K36 1997b. See also the studies of Jeff Sorenson (Dan Cox) and Larry Stevens on the Kanab Ambersnail. 801-524-3715 dkubly@uc.usbr.gov.
Melis	Theodore	GRCA-00329	GCMRC	2/1/08 - 6/30/08	Science Activities for Potential 2008 Experimental High Flow at Glen Canyon Dam	GRCA MC # GRCA 106089, 106090, 106091, 106092, 106093, 106094, 106095, 106096, 106097, 106098, 106099, 106100, 106276, 106277, 106278, 106280, 106281, 106282, 106283, 106284, 106288. NRInfo Ref Code 2170353, 2170356, 2170357, 2170358, 2170359, 2170360, 2170362, 2170365, 2170366, 2170368, 2170370, 2170372, 2170373, 2170374, 2170375, 2170376, 2170378, 2170379, 2170380, 2170381.
O'Brien	Gary	n/a	Grand Canyon River Guides, Inc.	5/13/99 - 12/31/00	Adopt-A-Beach Program	NRInfo Ref Code 2170241. GRCA Library Call # TC175.2.O27 E44 2000, TC175.2 .O27 E44 1999 c.1-2.
Parnell	Rod	GRCA-000003	NAU	2/16/00 - 12/31/00 3/9/98 - 12/31/99	A Proposal to Monitor Changes in Fine-Grained Sediment Deposits throughout the Colorado River Ecosystem in Glen, Marble, and Grand Canyons During Fiscal Years 1998 and 1999	NRInfo Ref Code 558201. GRCA Library Call # TC557 .A62 S36 2000 c.1-2. 40 pgs. "Sand deposition in the Colorado River Ecosystem from flooding of the Paria River and the effects of the November 1997, Glen Canyon Dam test flow" 2000.
Ralston	Barbara	GRCA-00182	GCMRC	4/1/03 - 7/31/05	Alliance-level Vegetation Inventory Map of the Colorado River Ecosystem	Maybe in SCRE report: GRCA 87632 or might be QH541.5 .R52 R35 2007 (Vegetation Database) or might be GCMRC library. GRCA MC # GRCA 87632.

GRCA Permitted Research Studies – Riparian Vegetation

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Ralston	Barbara	GRCA-00319	USGS	5/1/08 - 6/15/09	Vegetation Inventory Map of the Colorado River Ecosystem for Change Detection	GRCA Library Call # QH541.5 .R52 R35 2007. Might be in GCMRC library bralston@usgs.gov 928-556-7455.
Ralston	Barbara	n/a	GCMRC	1/24/00 - 12/31/00	Terrestrial Ecosystem Protocol Evaluation of Orientation Program	Final deliverable might be in GCMRC library.
Rihs	John	GRCA-00017	NPS	12/15/04 - 2/28/05 5/1/00 - 12/31/03 3/28/00 - 12/31/03	Protection of Springs and Seep Resources of the South Rim, Grand Canyon National Park	NRInfo Ref Code 659915. Digital final report received. 64 pgs.
Rubin	Spencer	GRCA-00581	NAU	6/6/11 - 8/1/12	Wetland Plant Communities and Historic Settlement Disturbance on the Colorado Plateau: Baseline Data for Conservation	Final report not received.
Shannon	Joseph	GRCA-00071	NAU	1/1/05 - 12/30/10 1/1/03 - 12/31/05 11/10/97 - 12/31/02	Monitoring the Aquatic Food Base of the Colorado River and Tributaries	NRInfo Ref Codes 2170339, 2170343, 2170344, 2170345, 2170346, 37736.
Simms	Ron	GRCA-00136	United States Bureau of Reclamation	8/27/01 - 12/31/06 5/4/99 - 12/31/00	Aerial Digital Photography and LiDAR for Lake Mead Delta Area, Arizona; Status, distribution, and habitat affinities of the Southwestern willow flycatcher along the Lower Colorado River.	NRInfo Ref Code 558282. GRCA MC # GRCA 79064. 83 pgs. "Status, distribution, and habitat affinities of the Southwestern willow flycatcher along the Lower Colorado River." 1/2001.
Sisk	Thomas	GRCA-00551	NAU	5/20/10 - 12/20/11	Ecological Impacts of Bison and Implications for Cross-Jurisdictional Management in the Grand Canyon Region	NRInfo Ref Code 2185796. Thesis (92 pgs.) saved in Sisk file. See Ronda for raw data. GRCA Library Call # QL737.U53 R45 2012. GRCA MC # GRCA 108902.
Spence	John	n/a	Glen Canyon National Recreation Area	4/17/98 - 12/31/00	Proposal to monitor southwestern willow flycatcher, riparian breeding avifauna, and overwintering avifauna along the Colorado River from Glen Canyon Dam to Lake Mead, 1998-1999.	NRInfo Ref Code 558327, 565722.

GRCA Permitted Research Studies – Riparian Vegetation

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Stevens	Larry	n/a	NAU	9/1/90 - 9/30/92	The Ecology of Aquatic Diptera in the Colorado River below Glen Canyon Dam	NRInfo Ref Code 36417, 37737. GRCA MC # 68582. GRCA Library Call # TC557 .A7 G52 B55 1992. "The Effects of Glen Canyon Dam on the Aquatic Food Base in the CO River Corridor in GC, AZ."
Waring	Gwendolyn	GRCA-00527	GCMRC/USGS	6/1/09 - 12/1/09	The Natural History of Western Honey Mesquite along the Colorado River in Grand Canyon	Final report not received.
Webb	Robert	GRCA-00537	USGS, WRD	4/19/11 - 4/19/12 9/1/10 - 12/31/10	Repeat Photography of the Colorado River Corridor: The Stanton Photographs Revisited after 20 years	NRInfo Ref Code 165129.
Webb	Robert	GRCA-00111	USGS Water Resources Division	8/1/01 - 12/31/06	Long-term monitoring of coarse-grained sediment input, storage, and impacts to physical habitats throughout the main channel of the Colorado River Ecosystem.	NRInfo Ref Code 657488, 2170544.
Wiele	Stephen	GRCA-00164	USGS Water Resources Division	2/1/02 - 1/31/05	Development of a management tool for predicting multi-dimensional and 1-dimensional sand transport in the Colorado River ecosystem.	NRInfo Ref Code 657084, 2170558. GRCA Library Call # QE571 .W5 2007. 16 pgs. Report location- Water Resources Research, vol., 43, W02425, doi: 10.1029/2005WR004824, 2007.
Willey	David	GRCA-00229	Montana State University	8/5/08 - 8/5/09 3/1/04 - 7/1/08	Surveys for Mexican Spotted Owls in Grand Canyon National Park	NRInfo Ref Code 558333. GRCA Library Call # QL696 .S83 W554 2000.
Yard	Helen	GRCA-00011	SWCA, Inc. Environmental Consultants	1/1/00 - 12/31/01	Bottom-up Structuring of Avian Communities in the Grand Canyon: In Search of Arthropod Indictors.	NRInfo Ref Code 565878.

Rare Species

Desired Condition: TBD

Vegetation resources are unimpaired for present and future generations and the natural range of genetic variability is protected through the perpetuation of naturally occurring evolutionary processes. Native plant species listed as endangered under the Endangered Species Act are protected and monitored. Traditional collection of plants is recognized as an important tribal use and we are aware of traditional collection trends. Targeted vegetation resources are monitored to ensure availability for current users and future generations.

Indicator	***Reference Condition***	***Target***
TBD	TBD	TBD

GRCA Rare Species Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Vegetation Transects	Tabular	Contains information about ground cover, vegetation cover and vegetation structure measurements taken along 50m transects. The intent is to monitor changes in these measurements. Most transects are placed in river camps. 448 transects have been created, 202 of which have been sampled at least 5 times.	Lori Makarick Grand Canyon National Park	2000 - present	Majority of sites in river corridor; some on rim and inner canyon	Quantify and describe vegetation characteristics for river campsites primarily.	Great majority of data is in river campsites. Data collection methods have changed limiting use of some data. Data have not been thoroughly vetted.	Entries contain site specific information including slope, aspect, elevation, bearing, light exposure, geologic layer and UTM data for the start and end point of the transect, along with a verbal description. Entries include measurements that were taken along a 50m transect at 5, 15, 25, 35, 45 m: Daubenmire ground and plant cover (2005-present), vegetation structure method 1 (2004 - 2008), vegetation structure method 2 (2006 - present), soil measurements (2005 - present), and point intercept method for ground and plant species (2000-present). Along with other ancillary data including dominant and associated plant species and photos of transect start and end.	Moderate to high effort extracting data from complex data structure and vetting data thoroughly.
Rare Plants	Tabular	Describes rare plant populations, identifies locations where rare plants are found and characterizes the immediate site.	Lori Makarick Grand Canyon National Park	2004 - 2012	Majority of sites are in eastern half of Park	Identify rare plant locations in the Park. Help create predictive model of rare species.	Does not represent a systematic Park-wide survey for rare plants. Small number of records.	The number of individuals and number of subpopulations is estimated, size of area occupied is estimated, phenology of population is estimated, evidence of reproductive success, evidence of symbiotic relationships, evidence of disease, predation or injury are all noted. The site is characterized by measuring ground cover, noting animal use evidence, and noting natural and anthropogenic disturbances.	Simple to convert tabular data to spatial layer.

GRCA Rare Species Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Bryophytes	Tabular	Update the bryophyte floristics in Park including expanding the known bryoflora by collecting bryophytes and incorporating modern collections since the 1940s, report the local distribution and microhabitat specificity of each species, and report regions and substratum types supporting high regional diversity. The study sought to determine if bryophyte communities differed significantly within three forest types - pinyon-juniper, ponderosa pine, and mixed conifer forests. Sampling occurred along trail corridors.	Southern Colorado Plateau Network	2008 - 2009 (field work) 2007 - 2010 (specimen collection)	Eastern half of Park	Identify hot spots of bryophyte diversity in Park. Identify the locations of rare species. Regionally or locally rare species may warrant special attention. Bryophyte communities can be described generally using the 3 forest types sampled.	Field sampling limited to trail corridors. Results indicate microhabitat and microclimatic variation are more important drivers of distribution and abundance of rock bryophytes.	Compiled and reviewed existing collections and contributed new specimens collected from 2007 to 2010. Over 1,310 new specimens were collected. Collections were summarized spatially into 6 collection regions - North Rim, South Rim, Inner Canyon, Colorado River, Lake Mead and Marble Canyon. At each of 104 sites, 3 rocks were randomly selected to sample. Rocks had to be at least 1m from trail and be large enough to fill a 100cm x 1cm quadrant. Species cover was estimated to the nearest 1 cm^2.	Unknown
Vegetation Mapping	Tabular	The Vegetation Mapping Project was intended to sample, classify, describe and accurately map the plant communities comprising the Park. The tabular data contains classification plot and observation point data collected during project fieldwork. Classification plot data was used to create a classification of vegetation alliances and plant associations for GRCA. Observation points are used to inform the photo-interpretation/image processing phase of the project.	Mike Kearsley Grand Canyon National Park	2007 - 2009	Park-wide	Describe vegetation characteristics across a wide variety of vegetation communities park-wide. Describe fire fuels information across a wide variety of vegetation communities park-wide.	Snapshot in time data.	Classification plot and observation point tables contain basic information on plot or point location, visit specific information, overall vegetation characteristics, species and strata-specific data related to a plot or point, details on stems, height, crown width, and other tree attributes, environmental features and conditions (including ground cover) of plot or point, details on photos taken of plot or point, and final determination of plot vegetation association as determined by NatureServe.	Simple to convert tabular data to spatial layer.

GRCA Rare Species Database Summary

Data Theme	***Data Type***	***Content Description***	***Source***	***Time Period***	***Spatial Extent***	***Appropriate Uses***	***Limitations***	***Data Methods***	***Use Cost***
Vegetation Photopoints	Digital Photos / Tabular	Archive of digital photos taken during data collection efforts for exotic plant, vegetation transect, vegetation restoration monitoring and rare plant monitoring. Intent is to visually capture changes in a site and vegetation through time. Photos details are recorded to facilitate re-taking photos in the future.	Lori Makarick Grand Canyon National Park	2000 - present	Park-wide	Visual representation of sites and pre and post treatment or restoration efforts.	Large storage requirements - 7 Gb	Photo details are recorded to facilitate re-taking photos in the future - view number, photo description, bearing, height and time. Restoration monitoring: Photos taken of pre-treatment and post-treatment at restoration sites.. Vegetation transects: Photos taken at transect start and end. Pre or post treatment is noted. Exotic plant control: Photos taken of pre and post treatment. Rare plant monitoring: Photos taken of rare plant site and if applicable, pre and post treatment.	Simple to create spatial point layer of photopoints. Management of dataset not simple due to storage requirements of photos.

GRCA Rare Species GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
CRMP / Veg Transects	GIS (Vector)	Veg Transect Locations in CO River Corridor	GRCA Veg Program	2007	GRCA CO River Corridor	Could be linked to CO River Veg survey tabular data	Only at CRMP Campsites	Resource GPS	Moderate work on tabular end, but linking with GIS layer would be simple
Burn Severity	GIS (Vector)	Burn Severity for GRCA Fires	GRCA Fire	2001-2011	GRCA	to the extent that Rare Plants are influenced by Fire	Only where fires have occurred; only data since 2011	MODIS satellite	Minimal
Fire History	GIS (Vector)	Perimeters of historic fires in GRCA	GRCA Fire	1910-2012	GRCA	to the extent that Rare Plants are influenced by Fire	earlier data (pre-1950) is of questionable accuracy	aircraft GPS since 1998; earlier data unknown	Minimal
GRCA Geology	GIS (Vector)	Compilation of Geology GIS in GRCA and surrounding area	USGS, compiled by GRCA GIS	compiled 2013	GRCA, and most of Analysis Area	Some Rare Plant habitats are controlled by underlying Geology	Data compiled from sources at different scales and levels of detail, then aggregated to GRCA Geologic Units; inconsistencies between map sources	mostly digitized from Geologic Maps	Minimal if used as-is; Moderate if source data details need to be de-aggregated
AZ Geology	GIS (Vector)	Arizona Geology	USGS, modified by GRCA GIS	1969 Map	Arizona	Some Rare Plant habitats are controlled by underlying Geology	1:500K scale	digitized from Geologic Map	None
Springs Seeps	GIS (Vector)	Springs and Seeps in GRCA and vicinity	GRCA Hydrology	updated 12/19/2012	GRCA and vicinity	Important areas of Riparian Veg and potentially Rare Plants	Point locations only; most have not been inventoried	Rec GPS; USGS 1:24K quad maps	Unknown to link to Inventory data
National Hydrography Dataset	GIS (Vector)	Hydrography	USGS NHD	downloaded 10/6/2012	GGCLA Analysis Area sub-basins	Rare Plant relationships to surface water	1:24K	USGS 1:24K topo maps; USGS PBS maps	None
Watershed Boundary Dataset	GIS (Vector)	Watershed Boundaries	USGS	downloaded 10/6/2012	GGCLA Analysis Area sub-basins	Potential as analysis units	not as significant above the rim	USGS 1:24K topo maps; USGS PBS maps	None
National Elevation Dataset	GIS (Raster)	Digital Elevation Data; derivatives Aspect, Slope	USGS; Mosaic and Derivatives by GRCA GIS	downloaded 1/1/2009	most of GGCLA Analysis Area; remainder available from USGS	Any analysis where Elevation, Aspect, and Slope affect Rare Plant habitat	modeled at 10m cell size	Diverse source data	Moderate to download and mosaic additional data to completely cover the Analysis Area

GRCA Rare Species GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Vegetation Map	GIS (Vector)	Vegetation (Associations)	GRCA	9/12/2012	GRCA and GC-Parashant NM	Some Rare Plant species are closely related to specific Veg types and/or companion species	1-hectare minimum mapping unit size; Does not cover entire GGCLA Analysis Area; only a small fraction of polygons field-verified	NAIP imagery (2007 and 2010) segmentation, CART analysis, and field editing	None
Vegetation Plots	GIS (Vector)	Vegetation Classification Plots	GRCA	2007-2008	GRCA and GC-Parashant NM	Some Rare Plant species are closely related to specific Veg types and/or companion species	Plot data is in a separate SQL Server database, but easily linked; only 76 (3.4%) of Plots are in a Riparian Lifeform types	Rec GPS (+/- 5 meters)	Minimal
Colorado River Vegetation USGS 2002	GIS (Vector)	Riparian Vegetation along the CO River Corridor	GCMRC	2002	CO River Corridor	Might help to identify Rare Plant habitat within the CO River Corridor	CO River Corridor only; there is an outlier in southern AZ that suggests entire dataset should be re-checked	Ground surveys and image processing	Minimal to Moderate, depending on review of the data outlier
Rare Plants	GIS (Vector)	Rare Plant locations	GRCA Veg Program	2013	GRCA	Analysis of locations of known Rare Plant species in GRCA	Database is not yet complete for some species	Varies	Moderate, in development
HDMS Rare And Endangered Species	GIS (Vector)	Rare and Endangered Species	HDMS	17-May-12	GRCA	Analysis of locations of known Rare and Endangered Plant species in GRCA	GRCA only, but may be acquired for a broader area	Unknown; derived from shapefile and Access database	Moderate; Data includes numerous plant and animal species, and some data is buffered, so some extraction and manipulation is warranted; alternatively, a dataset with broader extent could be requested from HDMS, which would require some processing

GRCA Rare Species GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
GRCA Soil	GIS (Vector)	Soils of GRCA	USDA-NRCS, SSURGO	1/4/2010	GRCA	Some Rare Plant have specific Soil type affinities	GRCA only	Digitized maps	Minimal to Moderate; need to complete migration to geodatabase and Access links; manipulating data through links with Access DB and reference to soil classification descriptions; SSURGO data may be available for a broader area
NAIP Imagery	GIS (Raster)	NAIP Imagery mosaic datasets	USDA-NAIP	2005, 2007, and 2010	GRCA and surrounding area	Potential for image analysis	doesn't cover entire GGCLA Analysis Area	Aerial Photography	Minimal as-is; High to perform image analysis, change detection, etc.
PAD-US	GIS (Vector)	US Protected Area Database; GAP Status, Protected Areas, Land Ownership	USGS GAP	2/22/2011	GGCLS Analysis area and beyond	Could imply a level of concern regarding Rare Plant resources	Not all areas within the GGCLA Analysis Area are attributed, or sources clearly identified	Multiple	Minimal, but data currently as Web Service; extraction could be Moderate
Invasive Plants	GIS (Vector)	Invasive Plants and Treatments	GRCA Veg Program	2013	GRCA	Pressures on Rare Plants from Invasive Plants	Database not yet complete	Varies	Moderate, in development
AZ Endemics	GIS (Vector)	Endemic Plants of AZ	Desert Botanical Gardens	2013	Arizona	Analysis of locations of known Endemic Plant species in GGCLA Analysis Area	Spatial Data not yet available, but expected soon; not yet evaluated	Unknown	Unknown

Rare Species Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Desert Botanical Garden List of Arizona Endemic Taxa	non-spatial data (*.pdf)	List of Arizona endemic plant taxa with federally listed species noted	Desert Botanical Garden GIS-based Analysis of Endemic Plant Distributions in Arizona	TBD	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Desert Botanical Garden Arizona Endemic Taxa by Region	non-spatial data, maps (*.pdf)	Maps of AZ endemic taxa by region	Desert Botanical Garden GIS-based Analysis of Endemic Plant Distributions in Arizona	TBD	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Desert Botanical Garden Arizona Endemic Taxa Distributions	non-spatial data, maps (*.pdf)	Maps of individual AZ taxon distributions	Desert Botanical Garden GIS-based Analysis of Endemic Plant Distributions in Arizona	TBD	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
TNC Southwest Biotic Communities	GIS (vector)	TNC developed a digital version for the whole of David E. Brown and Charles H. Lowe's 1981 map	The Nature Conservancy (TNC)	1981	Southwest US	Defines biotic communities	TBD	TNC developed a digital version for the whole of David E. Brown and Charles H. Lowe's 1981 map	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS-NPS Vegetation Characterization Program / Vegetation Inventory	data products in development	Classification, description, and mapping of vegetation communities in national park units to be available online when completed for relevant national park units.	USGS-NPS	data products in development	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USFS Fire Record Database - Fires	non-spatial data spreadsheet (*.txt or *.fw9)	Fire records for state of Arizona by land management agency including fire name, code, type, and location (based on individual DI-1202 fire reports completed for every fire occurring on US public lands).	USFS	Varies by region (range within 1972-2011)	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

Rare Species Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
USFS Fire Record Database - Weather	non-spatial data spreadsheet (*.txt or *.raw)	Fire records for state of Arizona by land management agency and related weather by weather station.	USFS	Varies by weather station (range within 1950-2012)	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
PRISM Data	GIS(raster)	Normal precipitation, maximum temperature, minimum temperature, and dew point data 1971-2000 or 1981-2010 at 800-m resolution or monthly data 1890-present at 4-km resolution	PRISM Climate Group	1971-2000, 1981-2010 OR 1890-present	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Western Regional Climate Center (WRCC) Local Climate Data Summaries for Western US	non-spatial database (ASCII or *.csv)	Average monthly temperature, precipitation, and wind metrics with other weather details for each weather station	Western Regional Climate Center	varies by station	any national weather station	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS US Drought Monitor	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS Precipitation Derivatives	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
NOAA National Climate Data Center (NCDC) Land-based Datasets - Quality Controlled Local Climatological Data	non-spatial database (ASCII or *.csv)	Daily, hourly, or monthly summary data for each weather station, including temperature and precipitation metrics, degree days, sunrise and sunset times, air pressure, and wind speed	NOAA	varies by station	any national weather station	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

Rare Species Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
USGS Dynamical Downscaled Regional Climate	GIS (raster)	Dynamical downscaled regional climate for Pacific Southwest and Southern Rockies	USGS	1968-2099	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
North American Regional Climate Change Assessment Program (NARCCAP)	GIS (raster)	50-km resolution climate change scenario simulation output from multiple regional climate models nested within multiple atmosphere-ocean general circulation models for 30-year current and future periods	North American Regional Climate Change Assessment Program	free registration needed for data access	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
UCAR Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC)/climat e scenario generator (SCENGEN) Regional Climate Models	GIS (raster)	Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC) carries through calculations at the global-mean level using the same upwelling-diffusion, energy-balance climate model that has been and is employed by IPCC while a regional climate scenario generator (SCENGEN) uses these results, together with spatially detailed results from the CMIP3/AR4 archive of AOGCMs, to produce spatially detailed information on future changes in temperature, precipitation and MSLP, changes in their variability, and a range of other statistics	UCAR	free registration needed for data access	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
USGS Geologic Map of Upper Parashant Canyon	GIS (raster)	Geologic map of the upper Parashant Canyon area that covers part of the Colorado Plateau and several large tributary canyons that make up the western part of Arizona's Grand Canyon.	USGS	1976?	Mojave County, AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI

Rare Species Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
KFHF Kaibab Forest Health Focus Project (Williams, Tusayan, North Kaibab, AZ)	TBD	Kaibab Forest Health Focus Project	TBD	2006	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Wood Supply Project (Williams, Tusayan, AZ)	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Grand Canyon Trust Kane and Two Mile Ranches Project (North Kaibab Plateau, AZ)	TBD	TBD	TBD	2006-2012	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

GRCA Permitted Research Studies – Rare Species

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Ayers	Tina	n/a	NAU	6/20/91 - 9/1/92	Impacts of Glen Canyon Dam on Riparian Vegetation and Soil Stability of the Colorado River Corridor, Grand Canyon, Arizona.	NRInfo Ref Code 64077. Check CA 8021-8-0002 and CA 8041-8-0002, may be a continuum. Stevens LE, Ayers TJ. 1993. The impacts of Glen Canyon Dam on riparian vegetation and soil stability in the Colorado River corridor, Grand Canyon, Arizona; 1992 final report. [No Publisher]. Glen Canyon Environmental Studies, Phase II. Published Report-64077. 175 pgs.
Bye	Robert	GRCA-00113	Universidad Nacional Autonoma de Mexico	5/15/01 - 12/31/02	Taxonomy and Variation in Datura (Solanaceae) in northern Mega Mexico I. Colorado River Basin	NRInfo Ref Code 558300.
Emmel	Thomas	GRCA-8213	University of Florida	7/15/90 - 9/30/91	Evolutionary Biology of Two Endemic Grand Canyon Butterflies	NRInfo Ref Code 16641.
Harper	Kimball	n/a	Brigham Young University	3/30/95 - 10/31/95	Genetic variation among populations of *Arctomecon* (Papaveraceae)	NRInfo Ref Code 627705, 628047. Final report received. 17 pgs. GRCA Library Call # QK495.P22 H37 1995.
Meyer	John	n/a	Creation Research Society	1986 - 1988	The Biological Isolation of Shiva Temple	NRInfo Ref Code 16381.
Stone	Steve	n/a		1985 - 1989	A possible new subspecies of *Hemileuca eglanterina*	Final report not received.

Greater Grand Canyon Landscape Assessment

Caves TWG Meeting Summary
April 2, 2013

The first meeting of the GGCLA Caves Technical Work Group (TWG) was held on April 2nd, 2013, to begin refining the scope and approach to assessing cave resources. Please see page 5-6 for next steps and action items.

Acronyms and symbols

GGCLA: Greater Grand Canyon Landscape Assessment
GRCA: Grand Canyon National Park
LLECB: Lab of Landscape Ecology and Conservation Biology
MNA: Museum of Northern Arizona
NAU: Northern Arizona University
SCPN: Southern Colorado Plateau Network
TWG: Technical Work Group

*indicates an action item

***In attendance*:** Judy Bischoff (Colorado Plateau CESU Research Coordinator), Todd Chaudhry (Project Leader and Senior Ecologist, GRCA) Santiago Garcia (Data Manager, GRCA), Deanna Greco (Physical Science Program Manager, GRCA), Cerissa Hoglander (NAU), Cari Kimball (NAU), Mark Nebel (GIS Coordinator, GRCA), Ronda Newton (Research Permitting Coordinator, GRCA), Jean Palumbo (writer/editor, SCPN and LLECB), Steve Rice (Hydrologist and Cave Resources Manager, GRCA), Graham Schindel (NAU), Sasha Stortz (NAU)

***On the phone*:** Dale Pate (Cave and Karst Program Coordinator, NPS Geological Resources Division), Vincent Santucci (Senior Geologist and Paleontology Program Manager, NPS Geologic Resources Division), Ellen Brennan (Cultural Resources Program Manager, GRCA), Dave Vana-Miller (NPS Intermountain Region Resource Stewardship Branch Chief), Donna Shorrock (NPS Intermountain Region Natural Resource Condition Assessment Coordinator).

1. Introduction and background – Todd Chaudhry

Todd Chaudhry presented background information on the GGCLA, explained the process for selecting the focal resources, which started with a stakeholder workshop in October 2012, and the purpose of the TWGs. Work groups are tasked with refining the scope of the assessment, identifying the best condition indicators and reference/desired conditions, identifying potential or known threats, identifying information and data needs that exists, and synthesizing the information to assess current conditions and trends.

2. Goal of the technical work group (TWG) meetings – Todd Chaudhry

The goal of the technical work group meetings is to refine the scope of the resources identified in Workshop 1, held in October 2012. For this meeting, the goal is to identify what the appropriate condition indicators are and the reference and desired conditions, or at least to decide where to go to find that information. Ultimately we hope that work groups continue to be engaged in providing further guidance throughout the assessment process, especially external subject matter experts.

3. Scope for caves condition assessment – Todd Chaudhry

The team looked at the approaches taken by other parks, for example, Jewel Cave NM, in order to identify what we're going to have to consider as we work through this process. Chaudhry emphasized that what is included in the resource assessment is contingent upon what information is available. Determination of resource condition has to be based on data. If we don't have enough information about a resource, we can target it as a future indicator, but it should not be included for this assessment.

He also emphasized that it is important to be explicit and detailed about what we are talking about, the methods used, the data sources used, the assumptions that were made, and what the confidence level is for the findings.

Questions to think about for this process:

a. What are the **key** indicators to use to assess the condition or health of the resource? A good indicator should be measurable, precise, consistent, and **sensitive** to conditions affecting the resource.

b. What reference values will you use to determine if a resource is in a healthy condition?

c. Can you quantify the current condition, or would it need to be a qualitative assessment? This will depend on our understanding of the resource and on data available. We know some things about caves in GRCA, but we don't know a lot. However, we do know a lot about caves across North America, and we'll have to sift through all of that information.

d. What is your level of confidence in the assessment?

e. Is your rationale scientifically-sound/defensible?

4. Overview of GRCA caves status – Steve Rice

We don't know a lot about GRCA caves. Cave exploration and research has been intermittent through the years. Much of work was done in the '70s and '80s, and then there was a hiatus of about 15-20 years when little to no cave work was done. Only in the last ten years or so has there been a more systematic effort to collect data on caves, to create databases, and create cave maps and photo transects to get a sense of the baseline condition and to begin to do some monitoring.

Challenge is that we have only anecdotal site visit information for several hundred caves. A lot of effort has gone into piecing information together and seeing if it will fit into the database. So what we have now is a small collection of well documented caves, a larger set of partially documented caves, and an enormous set for which we only have location information. We know that we have information about only a small portion of the total number of caves in the park.

We have **documentation on about 500 caves** of varying levels of quality and completeness of data, with about 50 caves that have resource values assigned using the GRCA Cave and Karst Rapid Inventory Assessment protocol. We estimate that this represents 20-25% of what exists in the park. We have a spatial representation of where our cave knowledge is focused. Rice refers to a map posted on the wall and available to those on the phone, with markers for four categories of caves: well-surveyed, moderately-surveyed, poorly surveyed, and unsurveyed cave locations. The vast majority shown on the map in the 5 million acres study area are in poorly surveyed or unsurveyed territory. Karst features are also indicated on the map; they are important for recharge of the large spring systems in the study area. Not sure whether karst features will be evaluated in conjunction with caves or with springs and seeps.

5. What are cave resources? – Steve Rice

The cave is the physical entity, and cave resources are found within. Caves contain biological resources (bats, macroinvertebrates, etc.), physical resources include the cave, hydrologic elements (amount of water, water quality), paleontological resources, and cultural resources.

GRCA has developed a rapid inventory assessment form to provide an initial snapshot of what is in the cave. This helps to determine the significance of the cave, which drives decisions about whether we should revisit the site

and bring a specialist to better evaluate the resources, or take other actions. We need to determine which of the values that are being recorded can be used as indicators of current conditions, or for trend analyses, or as features that might be sensitive to threats and what those threats might be. Fifty-five caves have been assigned a value based on the numerical values given to resources within the caves. **Database has records for about 400 caves. Geodatabase has just over 500 caves.**

- **Types of paleo resources associated with caves** (Vince)
  - marine invertebrates that occur within the limestone
  - Pleistocene/holocene remains of flora and fauna
  - paleokarst remains
- **Scope**: One question to consider is what is the full range of an assessment we can do for each identified resource? On the one hand we can derive basic information for a broader spectrum of caves from spatial data. At the other end of the spectrum – we can look at more of the indicators, but for a smaller subset of caves. In this case, do we use existing assessment framework, or develop some other kind of index?

6. Basic cave information

- Location and accessibility are two pieces of information that can tell us about a caves vulnerability to threat. Easily accessible caves are threatened by human activity. We can derive this information from spatial data.
- Microclimate – very little information. No historic data. Only in the last year has the park started monitoring temperature and humidity in a few caves that get visitation.
- For fauna we have only spotty information, e.g. for bat populations we know of several maternity colonies within the park, some with Townsend's big-eared bats, a species of conservation concern. But, we don't have enough information to talk about changes in populations. A current study by Arizona Game and Fish Department on closed mines could provide baseline information.
- Radon levels in caves are tracked in larger cave operations in other parks (those that get human visitation). Something to consider if and when we open certain GRCA caves to park visitors.
- Steve brought up a caution about information related to GRCA caves – **some of this information will be extremely sensitive** and sharing that information widely would not be acceptable and is in some cases not legal. We can deal with this by keeping such an analysis in-house only and displaying information in a manner that does not reveal sensitive information (e.g. using summary statistics, mapping at a coarse scale). Much of this information will be considered in the backcountry management plan. This will also be a concern for the cultural workgroup, But it's still possible to do a meaningful analysis without giving out UTM coordinates.
- May also use exposed redwall limestone to represent potential cave areas neighboring GC.
- Parashant NM, led by Eathan McIntyre, has been working hard to document their caves in the past few years and have a substantial database. We need to merge our information with theirs. They are also engaged in a NRCA with several parks.
- **Bat Conservation International** has been conducting bat studies all around the park for the Four Forest Restoration Initiative and is finishing up a two-year study. The group is interested in doing a bat study of the park. This could contribute to the broader assessment and also be included in recommendations for future actions as a method to address the data gap in knowledge about bats.

7. Is there an existing framework for assessment? Other existing data?

Does a cave assessment framework exist that we can plug our data into, instead of reinventing the wheel?

- The assessment form used by GRCA when visiting caves provides a starting point, but what else might exist?
- *Dale: a lot of parks are in the same position as GRCA. Could check in a few places to look for such a framework. However, there is a **geological monitoring manual** that has cave related information, but it's a little different than what this project is looking at.
- Vince: from a paleo perspective, there's lots of different methods that academic researchers have developed. Most broadly used databases are **Neotoma Paleoecology Database** for capturing packrat midden data from caves, and **FAUNMAP**, a database of Quaternary fossil mammal occurrences in the US, and many of those are from cave localities. Product of a query is a biogeographic map of distribution. **Much of the Grand Canyon data has been incorporated into FAUMAP and Neotoma.** It was noted that these databases would be worth looking into to provide context for the assessment.

  Currently, GRCA is pulling together paleobotanical information from the park's paleodatabase (Deanna).
- **Other data sources and tools** (Steve): Visitor impact mapping technique has been used to create some maps in GRCA and are outlined in **the Cave Restoration Handbook.** Technique requires a team of 4-5 people spending several hours in a location.

*Also, **Klamath Network** has identified caves as a vital sign (SCPN has not). Could look at what they are doing.

8. Reference conditions/baseline conditions?

- **baseline** – would be a cave that has no human impacts, considered pristine, the reference condition.
- **water quality** – large cave spring systems that drain the Kaibab Plateau pose a threat because people can follow them to the caves. Also, recharge areas are of concern, extend well beyond the park and are affected by land use, climate change.

  *Acknowledge this concern in the report, but deal with the threat analysis in seeps and springs.

9. Getting back to the questions we want to answer in this work group process:

- What indicators do we want to focus on for this assessment? This will be dictated in large part by the data we have. Location and accessibility have been mentioned. What's next that is applicable for the most number of caves? (Todd)*It seems like the framework we are focusing on is those resources within cave systems that are sensitive , directly or indirectly, to human impacts. Boils down to those caves for which we have data on the presence of sensitive resources (falling within any of the categories described), and then doing a threat analysis.* ***The challenge is to roll those categories (biological, paleontological, etc.) into a sensitivity index and how we link the index to the accessibility threat.*** Does a condition index for a cave exist somewhere?

  Judy brought up **microbiology as an indicator** and mentioned the research of Diana Northrup. GRCA has no info on microbiology of its caves, but this kind of information is important to the discussion and should be included as an identified information gap.
- Are there other indicators that we might want to incorporate in future monitoring?

Early on, we debated what's a priority resource and what's an indicator resource? For example, bats might be a good indicator of cave condition, rather than something that we would focus on in its own right.

Graham Schindel, cave management technician, who joined the meeting during the first session introduced himself to the group and described his work for his Master's degree looking at aquifer characteristics of the Kaibab Plateau. Ties into the nexus between caves and springs. Useful in identifying the recharge zones. He'll be doing fieldwork this fall, data collection this November. Some of the information that he will be collecting (lit review, for example) for his thesis would be useful for the assessment.

The park has acquired LiDar data for the Kaibab Plateau

10. Cave Outline (on screen) discussed by Todd Chaudhry. Includes the following:

- the desired conditions statement
- tables that include indicators, reference conditions, and targets
- a summary of spatial and tabular datasets that the park either possesses, or knows about that may be relevant. The list is quite small.
- a list of permitted, cave-related research that's been done in the park since 1960

* Todd asked all to **take a look at the outline and add any datasets or research studies that they may know of that are not on this list, or any other key references that we should consider. Please send them to Steve.** Through this effort, we hope to build a park-wide reference database

*Judy offered to contact any of the PIs that are working on caves and ask them to submit any bibliographies that they have. **Judy will forward them the outline**.

*Vince offered that several museums have collections from the caves at GRCA. Last year he had interns scanning archives associated with Rampart Cave that date from the 30s through the 70s. **Vince could provide this**? The information he has is from the Smithsonian.

*Judy brought up her partners at MNA: Dave and Janet Gillette would be good resources.

11. Where do we go next? (more action items)

- **Vince** offered to be involved in peer review and look for information that would be helpful, as a minimum level of engagement.
- **Steve** suggested that a subset of the group should try to define vulnerability indices, which will be used both for the backcountry plan and the GGCLA.
- **Dale** offered to help out in any way that they could use him. Steve will be the main point of contact for Dale.
- **LLECB** can assist with spatial analysis, particularly areas outside of park
- GRCA will continue reaching out to the tribes through the park's tribal liaison
- **LLECB** can check with the Kaibab NF for any useful layers.
- **GRCA** will follow up with Bat Conservation International, the Hualapai and GC Parashant NM regarding data availability outside the park.
- **Judy** offered to look into having interns work on literature searches.
  Ellen (on phone) emphasized that it would be important to have discussion of caves in archeological group and that we would have tribal involvement – very important to tribal peoples. A way to reach the tribes

would be to address the issues related to caves that are important to tribes, like people going into caves to collect hematite.

12. What types of products do we envision?

Maps, tabular data, descriptive narrative. Concise report is desirable, which could be more of a challenge.

13. How to proceed?

It was left open as to whether to reconvene as a group, or have key people working, and reconvene if needed. Suggested that perhaps the park would work internally on many of these things, particularly as part of the Backcountry Management Plan EIS process, and follow up with folks who have volunteered their help. Possibly have side discussions. When we get to a point where we have a preliminary product and want more formalized input then we can convene the group to bounce ideas off of and get input before we unveil it at the next workshop.

14. Timeframe

- Second stakeholder workshop in the fall – present what the workgroups have put together so far for the resources
- Draft for each resource condition assessment by the end of the year.
- Early next year do more of the integrated spatial analyses
- Completed report is due December 2014.

The meeting adjourned at about 11:00 am

Greater Grand Canyon Landscape Assessment (GGCLA)

Physical Resources – CAVES -- Technical Workgroup Initial Meeting Outline

Tuesday, April 2, 2013

Objectives and expectations

The Technical Workgroup will help to identify appropriate condition indicators, compile and evaluate data/information sources, develop assessment criteria and methods, and assess the conditions and trends of focal resources within its respective discipline. The workgroup will be facilitated by GRCA/NAU staff and will include other subject matter experts (SMEs) and stakeholder representatives, depending upon interest and availability. Participants will be expected to actively engage in the workgroup, including providing sound technical guidance, doing 'homework' in preparation for meetings, and helping to develop work products (e.g. literature reviews, spatial layers, condition assessments, etc.). Subsequent meetings (incl. conference calls/webinars) will be determined on an as needed basis. Specific objectives for the initial meeting include the following:

- Refine scope of assessment for focal resources (e.g. fine-/coarse-filter, ecosystemic-/taxonomic-level).
- Identify and assess preliminary condition indicators and reference/desired conditions.
- Identify and assess known/potential threats.
- Identify appropriate spatiotemporal scale(s) of analysis.
- Develop condition assessment criteria (e.g. indicator ranges/thresholds) and analytical approach (e.g. quantitative/qualitative score, spatial modeling).
- Identify and assess information/data needs, sources, and gaps.
- Identify specific tasks, products, roles, responsibilities, and timelines.

Focal resource(s)

Focal resources were identified based on input from participants during the GGCLA Workshop on October, 11th, 2012 and subsequent discussions amongst GRCA and NAU staff. Desired condition statements, indicators, reference conditions, and targets are from the 'Draft Grand Canyon National Park Desired Conditions' (2012) and references therein. *Denotes NPS Southern Colorado Plateau Network Vital Signs and Measures in the following tables as outlined in Thomas et al. 2006. TBD- To be determined based on GRCA and/or other relevant data sources (incl. workgroup products). Spatial and tabular datasets include those developed or acquired by GRCA.

Data table color codes are as follows:

Documented	In Development	Not Documented	Not Evaluated	To be Developed

Research studies listed include relevant permitted research conducted in GRCA since 1958. Research results (e.g. reports, publications, datasets) are not necessarily readily available for all those listed.

Caves

Desired Condition: Caves and the integrity of cave and karst processes are maintained. Cultural, biological, paleontological, geological, and hydrological components associated with cave and karst features are unimpaired. Management documents encourage high-quality scientific research of caves and karst and provide for cave and karst system education, outreach, and recreation, while recognizing the cultural significance of these features to the associated tribes to Grand Canyon.

Indicator	*Reference Condition*	*Target*
Biological – Bat populations are not disturbed by visitation – Microclimates are maintained – Macroinvertebrate communities are not damaged by visitation	TBD	TBD
Geological – Amount of broken speleothems along travel routes – Amount of marks on flowstone areas – Amount of mud and sand tracking into caves	TBD	TBD
Hydrological – Water quality is not impaired by visitation – Water quality is not impaired by recharge area land use – Impact to cave pools is not occurring	TBD, State and Federal water quality standards	TBD, Water quality parameters do not degrade to where natural processes are impaired or established standards are not met
Paleontological – Existing paleo materials remain in-situ – Paleo-fill in caves are not disturbed – Travel in caves occurs along prescribed paths, no new trailing	TBD	TBD

GRCA Physical Resources – Caves – Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Cave Resources	Tabular	Data set includes cave descriptions, inventory assessments, description of any human impacts and evaluation of resource values. Inventory assessment includes: biological, hydrologic, terrestrial substrate, paleontological / geologic / mineralogical, cultural resources, and recreational.	Steve Rice Grand Canyon National Park	1930 - present	Park-wide	Rate importance of caves based on evaluation of resource values. Resources of special concern can be linked to specific caves. Identify caves subject to human impact.	Represents a small sample of caves that likely exist in the Park.	Caves are described and inventoried using protocol specific to the Park. The protocol is likely to be used as a Park-wide protocol. Protocol collects: detailed cave location information; detailed accessibility information; inventory of biological resources; physical resources including hydrology, lithology, speleothem details and speleogens; paleontological resources; cultural resources; evidence of human impact; evaluation of resource values (1-5); hazard rating to access cave.	Simple to convert tabular data to spatial layer.

GRCA Physical Resources – Caves – GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Watershed Boundary Dataset	GIS (Vector)	Watershed Boundaries	USGS	downloaded 10/6/2012	GGCLA Analysis Area sub-basins	Potential as analysis units	not as significant above the rim	USGS 1:24K topo maps; USGS PBS maps	None
National Elevation Dataset	GIS (Raster)	Digital Elevation Data; derivatives Aspect, Slope	USGS; Mosaic and Derivatives by GRCA GIS	downloaded 1/1/2009	most of GGCLA Analysis Area; remainder available from USGS	Any analysis where Elevation, Aspect, and Slope have controls on Cave locations	modeled at 10m cell size	Diverse source data	Moderate to download and mosaic additional data to completely cover the Analysis Area; potentially High if other derivations or models are needed
GRCA Geology	GIS (Vector)	Compilation of Geology GIS in GRCA and surrounding area	USGS, compiled by GRCA GIS	compiled 2013	GRCA, and most of Analysis Area	Cave locations are controlled by underlying Geology	Data compiled from sources at different scales and levels of detail, then aggregated to GRCA Geologic Units; inconsistencies between map sources	mostly digitized from Geologic Maps	Minimal if used as-is; Moderate if source data details need to be de-aggregated

Cave Database and GIS Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
USGS Geologic Map of Upper Parashant Canyon	GIS (raster)	Geologic map of the upper Parashant Canyon area that covers part of the Colorado Plateau and several large tributary canyons that make up the western part of Arizona's Grand Canyon.	USGS	1976?	Mojave County, AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
USGS Arizona Geology Lithology Map - Geologic Units	GIS (vector), non-spatial data (*.csv)	GIS information of geologic units and structural features in AZ including lithology, age, data structure, and written format	USGS	2005	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS Arizona Geology Lithology Map - Faults	GIS (vector), non-spatial data (*.csv)	GIS information of geologic units and structural features in AZ including lithology, age, data structure, and written format	USGS	2005	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS Digital Engineering Aspects Karst Map	GIS (raster), non-spatial data, map (*.pdf)	Digital coverage map of national-scale karst dataset including fissures, tubes, and caves over 1,000 ft (300 m) long; 50 ft (15 m) to 250+ ft (75 m) vertical extent	USGS (Davies et al. 2004)	2004	National	Identification of cave locations and types at a coarse-scale	Coarse-scale raster coverage rather than vector (point or polygon) data	Karst polygons of original Davies et al. 2004 map (scale 1:7500000) scanned from the stable base negatives of the original, vectorized, edited, and then attributed with unit descriptions	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI

Cave Database and GIS Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Cave-dwelling invertebrates of Grand Canyon National Park	non-spatial data	Literature review and invertebrate inventory table by cave in Grand Canyon National Park	Wynne, J.J., C.A. Drost, N.S. Cobb and J.R. Rihs. 2007. Cave-dwelling Invertebrate Fauna of Grand Canyon National Park, Arizona. In Proceedings of the 8th Biennial Conference of Research on the Colorado Plateau (C. van Riper and M. Sogge, Eds). University of Arizona Press, Tucson, pp. 235-246. PEER REVIEWED.	1975-2001	GRCA	Identification of invertebrate species populations in GRCA caves at a coarse-scale	Information on cave locations and ecologies is limited	Reviewed results of nine studies (1975-2001) which represented surveys of 15 GRCA caves	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Arizona Game and Fish Department Pictoral Key to the Bats of Arizona	non-spatial data (field guide booklet)	Field guide of bat species in AZ including general habitat distribution maps, morphological descriptions, and echolocation signal patterns. Cave roosting or hibernating bats in Mohave and Coconino Counties of AZ	Arizona Game and Fish Department	TBD	AZ	General bat species list for caves in AOI	Spatial data could be available via AGFD but are not readily available from guide	Slides generated by Bruce Taubert and Tim Snow, Arizona Game and Fish Department, and by Merlin D. Tuttle, Bat Conservation International	TASK 1: ACQUIRE DATA; TASK 2: ASSESS DATA QUALITY; TASK 3: TBD

GRCA Permitted Research Studies – Caves

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Alter	Malcolm	GRCA-00519	University of Western Sydney	5/15/09 - 11/30/10	Structural Geology, Hydrogeology, Paragenesis and Mineralogy of the Grandview Breccia Pipe, Grand Canyon National Park.	Final report received. See Ronda for hard copy.
Bain	James	n/a	n/a	5/89 - 9/89	Proposal to Check the Possible Nursery Colony of Townsend's Big-Eared Bat, *Plecotus townsendii*	Final report not received.
Bain	James	n/a	n/a	5/89 - 9/89	Proposal to Check the Possible Nursery Colony of Townsend's Big-Eared Bat, *Plecotus townsendii*	Final report not received.
Baldwin	Christopher	n/a	Sam Houston State University	3/13/96 - 12/31/98	In Search of the Earliest Land Plants.	Final report not received.
Ballensky	Jason	GRCA-00512, GRCA-00525	n/a	1/1/12 - 12/31/13 11/5/10 - 12/31/11 10/1/09 - 11/1/10 6/1/09 - 6/10/09 10/18/08 - 10/26/08	New Cave Inventory in GRCA	Current study. No report received.
Beck	George	GC-13	UA/National Speleological Society	c. 1957 - 1960	Surveys of Grand Canyon Caves	Pittsburgh Grotto Netherworld News, v. 6, n. 1, p. 5-11; National Speleological Society, v. 7, p. 130-136
Beus	Stanley	n/a	NAU	1963 - 1988	Environmental Interpretation of the Surprise Canyon Formation	NRInfo Ref Code 164891. GRCA Library Call # QE 86 .G73 G73 1990 c.1-2.
Bodenhamer	Hans	GRCA-00571	Bigfork High School	3/25/2011 - 3/25/12	Monitoring visitor impacts to Grand Canyon caves with VIP mapping, GIS and student volunteer groups	Final report not received.
Breed	William	n/a	Exxon Co.	10/12/88 - 5/31/89	Biomarker analysis and iridium content of certain upper Proterozoic sediments, Grand Canyon National Park, Arizona.	NRInfo Ref Code 23909. GRCA MC # GRCA 52816, fourth folder, two copies.
Carothers	Steven	n/a	SWCA, Inc.	1992	Archaeological Overview: Grand Canyon National Park	Final report not received.

GRCA Permitted Research Studies – Caves

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Chambers	Carol	GRCA-00270	NAU	7/1/05 - 12/30/06	Foraging and roosting ecology of 5 bat species (spotted, Allen's lappet-browed, and Townsend's big-eared bats, big free-tailed and western mastiff bats) in northern Arizona.	Final report not received.
Cook	David	n/a	NAU	5/89 - 9/90	A Sedimentologic and Petrologic Study of the Awatubi and Walcott Members of the Late Proterozoic Chuar Group, Grand Canyon, Arizona	NRInfo Ref Code 111149. GRCA Library Call # QE653.5 .C65 1991. GRCA MC # GRCA 103421. Sedimentology and shale petrology of the upper Proterozoic Walcott Member Kwagunt Formation, Chuar Group, Grand Canyon, Arizona / by David A. Cook; Also in Cline Library
Davis	Donald	GRCA-00239	National Speleological Society	9/1/06 - 12/30/08 12/1/05 - 7/31/07 6/15/04 - 12/31/05	Exploration and Survey of Silver Creek Cave	No final report received. Only progress report. GRCA Library Call # GB605 .A75 D38 2004 Restricted Access
Drost	Charles	n/a	NPS, National Biological Service	6/27/96 - 12/31/97	Protection of Bat Cave Roosts along the Colorado River Corridor below Glen Canyon Dam	NRInfo Ref Code 559592, 628028. GRCA MC # GRCA 84394
Dunn	Chris	n/a	Northern Arizona Grotto	8/16/00 - 12/31/01	Resource Evaluation, Exploration, and Scientific Observation in Grand Canyon National Park Caves	Final report not received.
Eberz	Noel	n/a	Grand Canyon River Guides, Geological Society of America	4/96 - 12/31/98 5/3/93 - 12/31/93	Redwall Limestone Karst and Colorado River Evolution in Grand Canyon	Final report received. 24 pgs. GRCA Library Call # GB600.3 .A75 E24 1999. GRCA MC # GRCA 78987. NRInfo Ref Code 558358.
Elston	Donald	n/a	USGS	5/14/88 - 5/28/88 5/17/87 - 6/2/87 4/22/84 - 5/8/84 5/3/82 - 5/19/82 4/20/80 - 5/7/80 4/71 [Ongoing]	Proterozoic and Phanerozoic Paleomagnetism	NRInfo Ref Code 6188. Elston, Donald P.; McKee, Edwin H. 1982 "Age and Correlation of the Late Proterozoic Grand Canyon Disturbance, Northern Arizona". Geological Society of America Bulletin. Article: Volume 93, Issue 8. pp 681-699.

GRCA Permitted Research Studies – Caves

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Emslie	Steven	n/a	Western State College	1995 - 1997	Investigations on the Paleontology and Archaic Archaeology of Grand Canyon National Park	NRInfo Ref Code 573879. GRCA Library Call # QE711.2. S36 2001. Technical Report NPS/NRGRD/GRDTR-01/02 or "Split-Twig Figurines in Grand Canyon, Arizona: New Discoveries and Interpretations." Kiva 61(2):145-173.
Emslie	Steven	n/a	University of California – Santa Cruz	4/15/93 - 12/31/93	An Inventory of Paleontological and Archaeological Resources in Caves at Grand Canyon National Park, Arizona	NRInfo Ref Code 573879. GRCA Library Call # QE711.2. S36 2001
Emslie	Steven	n/a	University of California – Santa Cruz	1991 - 1992	An Inventory of Paleontological and Archaeological Resources in Caves at Grand Canyon National Park, Arizona	GRCA MC # GRCA 68509. NRInfo Ref Code 70780, 573879.
Emslie	Steven	n/a	University of Florida	1984 - 1985	Excavation of Caves in Grand Canyon, Arizona: A Preliminary Report	GRCA MC # GRCA 59002, GRCA 68511, GRCA 68510, Accession Folder GRCA 4597. NRInfo Ref Code 42778, 133471.
Enos	Paul	n/a	University of Kansas, Geology Department	3/12/97 - 12/31/97	Investigation of Possible Paleosols within the Supai Group, Eastern Grand Canyon	NRInfo Ref Code 627920. GRCA Library Call # QE473 .E567 1997. AAPG Search and Discovery Article #90937©1998 AAPG Annual Convention and Exhibition, Salt Lake City, UT.
Gilleland	Tom	GRCA-00037	National Speleological Society – San Diego Grotto	8/28/00 - 12/31/00	Grand Canyon Cave Survey – Footbridge Caves	Not sure of actual report and its contents but report in file in Research Office. GRCA Library Call # GB605 .A75 G73 2000 Restricted Access. GRCA MC # GRCA 79069
Gilleland	Tom	GRCA-00224	n/a	1/1/05 - 12/30/08	Grand Canyon Cave Survey and Rapid Ecological Inventory	GRCA MC # GRCA 79633, GRCA 84747
Gillespie	Robert	GRCA-00137	n/a	9/20/01 - 12/31/01	Inventory of Cave Resource – Cheyava Falls Cave	Final report received. 11 pg. File in Research Office. GRCA Library Call # GB605 .A75 C44 2001 Restricted Access
Hastings	Frank	GC-27	GRCA	1963 - 1964	Petrographic Thin Sections Collection	Final report not received.

GRCA Permitted Research Studies – Caves

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Hill	Carol	GRCA-00221	University of New Mexico/UA	6/16/04 - 12/31/07 9/20/99 - 12/31/03 11/18/96 - 12/31/98	Origin and timing of ore mineralization and cave development in Grand Canyon National Park and vicinity	No final report received. NRInfo Ref Code 558315. GRCA Library Call # QE86 .G73 H55 2008. 2 folders; "Bat Diversity, Resource Use and Activity Patterns along A Sonoran Desert Riparian Corridor" thesis by Debbie Buecher [2007]
Holland	Heinrich	n/a	Harvard University	10/16/87 - 10/24/87	A Study of Some Paleosols in the Grand Canyon	Final report not received.
Hopkins	Ralph	n/a	NAU	8/1/84 - 8/1/85	Depositional Environments and Diagenesis of the Fossil Mountain Member of the Kaibab Formation (Permian), Grand Canyon, Arizona	NRInfo Ref Code 30947. GRCA Library Call # QE674 .H64 1986. QE674.H64 in Cline Library.
Horodyski	Robert	n/a	Tulane University	5/1/91 - 12/31/92 5/12/90 - 5/24/90	Precambrian Paleontology of the western coterminous United States and Northwestern Mexico	GRCA Library Call # QE724 .H676 1988. Precambrian paleontology of the western conterminous United States and northwestern Mexico / Robert J. Horodyski. [dates are off if this is considered final report]
Horodyski	Robert	n/a	Tulane University	5/8/84 - 5/23/84 5/1/82 - 5/1/83 5/19/79 - 5/31/79 5/14/74 - 12/31/74	Stromatolites and Paleobiology of the Proterozoic Chuar and Unkar Groups	NRInfo Ref Code 95745. GRCA Library Call # QE724 .H676 1988.
Hose	Louise	n/a	UC - Colorado Springs	1992	Investigation of Exotic Mineral Deposits in Two Grand Canyon Caves, GCNP	Final report not received.
Hose	Louise	n/a	California State University – Los Angeles	1978	Coral Pipe Development in Silent River Cave, Grand Canyon National Park	Final report not received.
Karlstrom	Karl	n/a	University of New Mexico	1/25/96 - 12/31/99	Precambrian Evolution of Grand Canyon	NR Info Ref Code 2167919, 165329, 2167940, 77409, 165329, 165193, 2167932, 2167938, 2167935, 165316, 2167923, 2167918. GRCA MC # GRCA 52262.

GRCA Permitted Research Studies – Caves

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Kauffman	Erle	n/a	University of Colorado	6/28/83 - 7/7/83	Study of Precambrian trace fossils in the Nankoweap Fomation	NRInfo Ref Code 89490. GRCA MC # GRCA 56991.
Keeler	Raymond	GRCA-00141	National Speleological Society	7/1/03 - 7/31/05 10/25/01 - 12/31/02 1/18/96 - 4/1/98	Continued research in Bat Cave and on the Buttress.	See Robert Pape file #9503-09-002 and also see Donald McFarlane file on Bat Cave. GRCA Library Call # GB605 .A75 K44 1998. GRCA MC # GRCA 70881, GRCA 70882, GRCA 84632
Keeler	Raymond	GRCA-00133	National Speleological Society	2/14/02 - 12/31/03 9/17/01 - 12/31/01	Mapping Roaring Springs and Silent River Caves	Final report not received.
Kenny	Ray	n/a	New Mexico Highlands University	9/1/92 - 12/31/98	The occurrence of Naco Group carbonates in the Grand Canyon, Arizona	NR Info Ref Code 628106. Kenny, R. & Neet, K.E., 1993, Upper Pennyslvanian-Permian (Naco Group) paleosols (north-central Arizona): field and isotopic evidence: Geoderma 58, 131-148; Kenny R. July 1998. Paleoclimate during the Redwall Karst Event, Grand Canyon, Arizona. Park Science v. 18 number 1
Kidwell	Susan	n/a	University of Chicago	9/83 - 5/85	Storm Stratification in the Redwall Limestone	Final report not received.
Kobor	Jeremiah	GRCA-00172	NAU	10/3/02 - 9/1/04	Coupling of a numerical groundwater/surface water flow model with an ecosystem response model for the Redwall-Muav aquifer and associated springs and channels of the South Rim, Grand Canyon, Arizona	Final report received. NRInfo Ref Code 590010. GRCA Library Call # QE86 .G73 K63 2004. QE86.G73 K636 2004 in Cline Library (our copy has weird code all over).
Luiszer	Fred	n/a	University of Colorado	4/20/94 - 12/31/94 6/1/93 - 12/31/93	Analysis of Fe- and Mn-oxide sediments collected from caves in Grand Canyon	Final report not received.
Marchington	Neil	GRCA-00595	n/a	3/3/12 - 3/3/13	Cave Inventory of Pearce Canyon	Current study. File in Research Office. No report received.

GRCA Permitted Research Studies – Caves

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
McFarlane	Donald	n/a	Claremont Colleges	1/18/96 - 3/1/98	Paleoclimatic analysis of a fossil bat guano deposit, Bat Cave, Grand Canyon National Park	Final report received. 14 pgs. Also see Robert Pape and Raymond Keeler files on Bat Cave.
McFarlane	Donald	n/a	Natural History Museum of Low Angeles County	4/22/88 - 6/30/88	Paleoecological Studies on the Ancient Bat Guano of Bat Cave, Mohave Cave, Arizona	"Spatial and temporal expression of vegetation and atmospheric variability from stable carbon and nitrogen isotope analysis of bat guano in the southern United States" 2007 Elsevier, By Christopher Wurster, Donald McFarlane and Michael Bird
McGill	George	n/a	University of Massachusetts - Amherst	1979 - 1980	Age and Mode of Propagation of Joints in Paleozoic Rocks, Grand Canyon, Arizona	Final report not received.
McKinney	Frank	n/a	Appalachian State University	3/4/84 - 3/8/84	Structure, growth and facies distribution of *Bicorbis arizonica* (Condra and Elias), Kaibab Limestone, Grand Canyon National Park	NRInfo Ref Code 119871, McKinney spelled wrong. QE1.F4 n.s. no. 13 in Cline Library
Mead	Jim	n/a	NAU	3/4/99 - 12/31/04	Late Pleistocene Vertebrate Communities in the Lower Grand Canyon, Arizona: Rampart and Muav Caves	Final report received. NRInfo Ref Code 571537. GRCA Library Call # E78 .A7 H65 2007. GRCA MC # GRCA 86418
Mead	Jim	n/a	NAU	6/87 - 6/89	Geographical, mitochondrial, and osteological status of *Crotaphytus* in the Grand Canyon National Park	Final report not received.
Middleton	Larry	n/a	NAU	7/82 - 12/88	Sedimentary Petrology and Depositional Systems of the Bright Angel Shale, Grand Canyon, Arizona	Final report not received.
Pape	Robert	GRCA-00141	UA	10/26/01 - 12/31/02 1/18/96 - 3/1/98	Baseline biological inventory for Bat Cave, Grand Canyon National Park	No final report after 1998 // Also see Ray Keeler file and Donald McFarlane files on Bat Cave. 1998 final report - 50 pgs. GRCA Library Call # RA GB606.B38 P3 1998. GRCA MC # GRCA 70881 and GRCA 84631.

GRCA Permitted Research Studies – Caves

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Pendall	Elise	n/a	UA Laboratory of Tree Ring Research	5/26/95 - 9/30/97	Reconstruction of Seasonality of Precipitation and Paleoclimate from H_2 and O_2 Composition of Tree Rings	Precipitation seasonality recorded in D/H rations of pinyon pine cellulose in the southwestern United States: by Elise Gislaine Pendall. NRInfo Ref Code 627913. GRCA Library Call # QC984 .S85 P46 1997
Phillips	Arthur	n/a	MNA	1979 - 1986	Paleoecology of the Lower Grand Canyon	Final report not received.
Polyak	Victor	GRCA-00533	UNM-Albuquerque	4/1/10 - 2/1/11	Incision History of Grand Canyon from Speleothems	NRInfo Ref Code 2170755
Preslo	Lynne	n/a	Woodward-Clyde Consultants	1982 - 1986	Spring Sampling in Marble Canyon, Paradox Basin Project (PBP)	Preliminary hydrologic budget studies, Indian Creek watershed and vicinity, Western Paradox Basin, Utah: technical report by Thackston, John W.; Mangarella, Peter A.; Preslo, Lynne M. 1986
Rice	Steve	GRCA-00592	GRCA	3/26/12 - 9/30/14	Karst Hydrology and Speleology of the Kaibab Plateau	Current study. File in Research Office. No report received.
Rogers	J. David	n/a	UC-Berkeley	1978 - 1980	Investigations of lava dams in the Inner Gorge of the Grand Canyon and the affects of change on channel hydraulics and river channel processes	NRInfo Ref Code 76183
Rose	Eben	n/a	MNA/NAU	4/24/98 - 12/31/00	Ichnology of the Bright Angel Shale	QE656 .R674 2003 [in Cline Library] Depositional environment and history of the Cambrian Tonto Group, Grand Canyon, Arizona / by Eben Christopher Rose.
Schopf	J. William	n/a	UC - Los Angeles	1985 - 1987	Geologic Studies of the Nankoweap, Galeros, Kwagut, and Sixty Mile Formations of Basalt Canyon, Nankoweap Butte and Carbon Canyon, Grand Canyon National Park	Final report not received.

GRCA Permitted Research Studies – Caves

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Siders	Melissa	GRCA-00078	USDA-Forest Service, N. Kaibab Ranger District	8/1/98 - 12/31/00	Spotted and western mastiff bat roost surveys, and general bat inventory.	NRInfo Ref Code 558322. GRCA Library Call # QL737.C5 S53 2000. Long Foraging Distance for a Spotted Bat (Euderma Maculatum) in Northern Arizona by Michael J. Rabe, Melissa S. Siders, C. Richard Miller and Tim K. Snow The Southwestern Naturalist, Vol. 43, No. 2 (Jun., 1998), pp. 266-269
Springer	Abe	GRCA-00405	NAU	8/1/07 - 12/31/08	Delineation of Recharge Areas, Groundwater Flow Pathways, and Travel Times on the Kaibab Plateau	abe.springer@nau.edu http://www.agu.org/cgi-bin/SFgate/SFgate?&listenv=table&multiple=1&range=1&directget=1&application=fm08&database=%2Fdata%2Fepubs%2Fwais%2Findexes%2Ffm08%2Ffm08&maxhits=200&="H53E-1135"
Stevenson	Gene	n/a	n/a	1981 - 1984	The Paradox: A Pull-apart Basin of Pennsylvanian Age	Final report not received.
Summa	Catherine	n/a	Winona State University	8/1/98 - 12/31/99	Collecting representative Grand Canyon rock specimens for educational use at Winona State University, Winona, Minnesota.	Final report not received.
Walchle	Michael	n/a	n/a	1986	Correspondence about Cave Geology Research in Remote Portions of Grand Canyon	Final report not received.
Walker	Nicholas	n/a	Brown University	4/1/95 - 6/30/95	Detrital Zircon Ages of Neoproterozoic Supracrustal Rocks	Final report not received.
Ward	R.V.	n/a	GRCA, NBS	6/27/96 - 12/31/98	Survey of state and federally-listed rare bat species along the Colorado River through Grand Canyon National Park.	NRInfo Ref Code 559592. P.I. changed from Jim Peterson to R.V. Ward.
Wohl	Ellen	n/a	UA	2/9/89 - 3/6/89 11/1/88 - 11/30/88	Paleofloods Studies in Marble Canyon	Final report not received.

GRCA Permitted Research Studies – Caves

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Wynne	J. Judson	GRCA-00328	Merriam-Powell Center for Environmental Research- NAU	3/15/08 - 12/31/10	Ecological Inventory of Caves at Grand Canyon National Park	Final report not received.

Greater Grand Canyon Landscape Assessment

Springs and Seeps TWG Meeting Summary
April 2, 2013

The first meeting of the GGCLA Springs and Seeps Technical Work Group (TWG) was held on April 2nd, 2013, to begin refining the scope and approach to assessing springs and seeps resources. Please see page 10 for next steps and action items.

In attendance: Todd Chaudhry (Project Leader and Senior Ecologist, GRCA); Santiago Garcia (Data Manager, GRCA); Deanna Greco (Physical Science Program Manager, GRCA); Cerissa Hoglander (NAU); Mike Kearsley (Biologist, GRCA); Cari Kimball (NAU); Jeri Ledbetter (Springs Stewardship Institute); Steve Monroe (Hydrologist, SCPN); Mark Nebel (GIS Coordinator, GRCA); Jean Palumbo (writer/editor, SCPN and LLECB); Steve Rice (Hydrologist and Cave Resources Manager, GRCA); Graham Schindel (Cave Technician, GRCA; Graduate Student, NAU); Abe Springer (NAU School of Environmental Sciences and Sustainability); Larry Stevens (Springs Stewardship Institute); Sasha Stortz (LLECB, NAU); Megan Swan (Botanist, SCPN); Cynthia Valle (Hydrologist, GRCA)

Acronyms and symbols

GGCLA: Greater Grand Canyon Landscape Assessment

GRCA: Grand Canyon National Park
LLECB: Lab of Landscape Ecology and Conservation Biology (NAU)

MNA: Museum of Northern Arizona

NRHP: National Register of Historic Places

NAU: Northern Arizona University

SCPN: Southern Colorado Plateau Network

TWG: Technical Work Group

*indicates an action item

On the phone: Ellen Brennan (Cultural Resources Program Manager, GRCA); Tom Lincoln (Director for Cultural Resources, IMR); Christie Landrum(Director for Indian Affairs and American Culture, IMR)

1. Background and purpose (Todd Chaudhry).
Todd presented background information on the GGCLA, explained the process for selecting the focal resources, which started with a stakeholder workshop in October 2012, and the purpose of the TWGs. Work groups are tasked with refining the scope of the assessment, identifying the best condition indicators and reference/desired conditions, identifying potential or known threats, identifying information and data needs that exists, and synthesizing the information to assess current conditions and trends.

Note: For seeps and springs, if we want to look at the potential impacts on groundwater resources, we may have to expand the study area.

2. Objectives for the meeting (Todd Chaudhry)

- Briefly talk about what defines a spring ecosystem, what are the main indicators, what are the measures associated with those, and how do we assess the condition of springs.
- Discuss any information and data needs that we will want to document in the NRCA. This will help the park's outreach in engaging the research community.
- Identify next steps, responsibilities, working together to move forward.

3. Scope of the springs and seeps condition assessment (Todd Chaudhry)
Todd presented several other condition assessments of varying scope and report styles.
He presented some questions to keep in mind:

- What are the **key indicators**? What's most important is that it's sensitive. We will want to include descriptive data as background information for springs and seeps ecosystems, but good indicators will be those that are sensitive to changes in the environment and stressors. These are the things that will tell you the most about the condition of that resource.
- What are reference values? Are there acceptable ranges we can identify for a given indicator for seeps and springs? Or are we just looking more at trends? Or is it more of a qualitative assessment?
- What is our level of confidence? We want to be explicit.
- What is our rationale? We want to be really clear about the rationale we used, and about what assumptions have gone into it.

Todd pointed out the map on the wall of the distribution and status (inventoried or not) of identified seeps and springs in the park and in the adjacent areas.

4. Review different assessment systems that have been used inside and outside the park. What are some common indicators across those? What scale of analysis should we use? Do we want to focus a more detailed assessment on the springs and seeps that we know more about, or do we want a broader, coarser scale of assessment of conditions across the analysis area.

Questions? Abe Springer asked about the connection to the I&M Network. Todd explained:

- SCPN has been involved in natural resource condition assessments, helping to facilitate them with some of the smaller parks in the network.
- Lisa Thomas and SCPN staff met with Todd and his team early on in this process to discuss how they could collaborate.
- SCPN has datasets that would be useful to the effort and some of the final products of the assessment will be useful to the network.
- Finally, the network put a lot of effort into identifying vital signs for network parks.

5. Springs assessment framework (Larry Stevens)

They have taken a springs database and modified it so that it can answer management questions about springs. Started the Springs Stewardship Institute with MNA to provide these tools to whoever wants to do springs-related work.

<u>Springs background information:</u>

- **Conceptual ecosystem model** – helpful for understanding the array of concerns that might affect springs. An ecosystem model is a bottom-up model, with physical external driving variables, like climate, geology, and aquifer factors affect both the geomorphology of the landscape and the microsite, which affects the microclimate.

  In turn, these interactions affect the productivity and disturbance regime at a spring, which can be highly variable. Springs can also be affected by human impacts of recreation and visitation, grazing. These factors feed into the creation of an array of microhabitats at a spring. How the spring is colonized is a function of trophic interactions. This will change through time. Some springs are highly dynamic. This assortment of processes and components feeds into the ecosystem goods and services...

- **Types of springs** – influence management decisions. There are about a dozen types of springs and 11 of these are found in GC. Hillslope springs are quite common, springs that come up from the floor of a channel, gushing springs and many hanging gardens in GC. No geysers.
- **Features of springs** – microclimate, microhabitats. Microhabitats that form at springs depend on aspect. Many springs in GC, like Vasey's Paradise, are on east facing slopes that protect them from the hot afternoon sun. Springs are complicated habitats, and an area around a spring can have many microhabitats, each of which may support its own suite of species, that may or may not interact with each other. This is what allows for so much biodiversity around springs.
- **Importance of springs within the GC region**, as hotspots of endemic and regional biodiversity. ---Ten percent of the ~1800 plants in GC are spring specialists. Several are endemic to GC. Many dozens of rare species of plants are found around springs.

  -GC has many undisturbed springs. In the landscape surrounding GC 90% of springs have been decimated by human activity.

  -There is a 100-500 fold higher species concentrations at springs. Springs occupy .003% of the area but have 24% of the total species.

  -10.5 % of flora in GC is nonnative, and this is a threat to springs. Anytime you get a disturbance by springs, nonnatives come in.

  -Fauna at springs include a whole suite of unique sensitive and some endangered species that are spring specialists. Humpback chub breed at the outflow of springs. Masked club-skimmer dragonfly is specific to about a half dozen springs in the area.
- **Cultural aspects of springs** – Springs are rich archeologically. Though not closely studied in GC, it has been in the surrounding area. Springs as ambush sites for big game is a common theme. Many tribes began to live near springs.
- **Historical significance of springs** – Springs have had quite a lot of impact on the North Rim, which was a heavily grazed landscape until creation of the park. Some historical features include scooped out ponderosa trunks near springs , which served as troughs and are rapidly disappearing. Also stories of the springs in the diaries of Mormon settlers. Not much history has been compiled about use of springs.

<u>How do we approach inventorying springs?</u>

- **Level 1** approach – Where are they? In large landscapes this is a big deal.

  In GC, high concentrations of springs can be found on escarpment edges, where the edges of the aquifer are exposed and the water flows out.

  Note: Arizona is remarkable in that it is the second driest state, but has the highest concentration of springs of any state.
- **Level 2** – involves sending a team in to do a detailed assessment of the site: water flow, water chemistry, hydrogeology, flora, fauna, associated human artifacts/remains, paleontological and archeological elements. Level two protocols (presented on www.springstewardship.org) can be used for

inventorying and monitoring. Consistent use of these methods can yield important trend data. Important to have long-term record to defend aquatic resources in GC.

Larry presented visual representation of various data related to these variables:

-From Kaibab NF surrounding GC that shows strong negative relationship between specific conductance and elevation. Higher elevations sites have higher water quality. Lower elevation sites very polluted ("dangerous even for cows to drink").

-West side of the Kaibab uplift has pretty strong gradients of water quality; east side not so strong. These don't include data from GC.

-Williams District – mostly springs flowing out of basalt flows, water quality remains high.

-Geomorphic diversity and complexity of a site matter. The more complex a site is, the more plant species it's likely to host because of the many microhabitats.

-Same goes for size. The bigger the spring is the more species the spring is likely to support.

- **Springs ecosystem assessment protocol**, using the Level 2 data, is very much in line with the NRCA process outlined before; natural resource condition scores vs. human risks.

  -This process can be done very quickly or very intensively.

  - Involves 42 variables in 6 categories: (1) flow and water quality, (2) geomorphology, (3) habitat, (4) species, (5) human impacts, and (6) administrative context (not necessarily associated with the integrity of the springs). These can be used in different combinations, for example you can score the 42 variables for both condition and risk (84 variables); or you can just score the 6 categories if you know a little about the site and are just wanting to rank them for your park. Or you can give the whole site a condition and risk score, if you feel comfortable with that level of brevity.

  -Ranks the condition or value of a resource against the risk to it, on a scale of 0 to 6 (the best).

  * Those sites of high natural resource condition and high risk would also be those most deserving of management action.

  Larry presented and discussed sample data from Alberta as an illustration.

Question: Are all 42 of those variables part of the Level 2 assessment?

Answer: No. The springs ecosystem assessment protocol comes into play after the inventory is done. Some of the variables from the inventory are automatically generated and put into the scoring process, but many of them have to be scored by hand. The administrative context has to be scored after discussion with a manager.

In summary, a huge amount of information can be generated from a spring; putting four experts on a spring for two hours generates a lot of data. How do you handle that data? How do you keep it in line for doing a landscape assessment? For example, for GC, you might have a thousand springs or more.

So **Jeri** created a database information management system to accommodate all this data.

5. Springs database (Jeri Ledbetter)

- In building the database Jeri started out with the park service database, but the end product bears no resemblance.

- Jeri described the database as she demonstrated on screen how it functions. It is a relational database, not a geodatabase, but could easily be joined to one.
  10,000 springs in Arizona are in this database, although not all springs have survey data.
  Survey information is associated with a project and includes:
  - microhabitat
  -soils
  -litter depth
  -geomorphology is copied
  -vegetation data

  Some of the things you can do with the database:

  -You can see all the springs that have a particular vegetation type or species of animal associated with it

  - You can calculate the cover totals of different species

  -You can create reports and export to excel, pdf...

- Jeri described a project completed in December—**Kaibab Springs Project**
  -First gathered all existing data they could find and put into the database and then went out into the field.
  -Developed an online web mapping application for this project. Can open in ArcMap or can use a simple interface. Can click on a spring and a window will pop up showing all the survey data that they collected for that spring; can access the report for the spring.
- Doesn't have information for all GC springs. Goal is to have all the information in one place and make it accessible.

Questions?

- Todd: So most of the data you have in the database, as well as the geodatabase, is outside the park in the N. Kaibab Ranger District?

  Jeri has been working on a springs geodatabase for 4 years. Pulled together data from many different sources, and some of it did not match up. Jeri has been going from land area to land area, trying to reconcile data, but has not yet completed that for the entire state. Also went on a GC river trip and marked the springs that they saw from the river

  Steve Monroe mentioned that SCPN has a separate springs database which was constructed from the springs inventory project that Abe Springer and Larry Stevens did, but has evolved a bit since then. Long term SCPN will likely go with a different database for monitoring.

- Todd: Is the database publicly available? **(Sensitive information issue)**

  No. It is currently a desktop application. Made an attempt to put it in a cloud and use the Access front end, which didn't really work. Trying to convert to an online database, but not done yet.

  Part of the issue here is the sensitive information that is in the database—tribal data, mountain lion locations. Want land managers to have access, but not everybody.

  When people know where a spring is, likelihood of damage to the site, including introduction of invasive species, is greater.

Todd mentioned that this has been a subject of discussion in other meetings and that we want to provide summary information for the landscape assessment so that you can get a sense of the condition of the springs without revealing sensitive data that went into making that assessment.

6. Taking stock of where we are...discussions

- Todd stated that he would like to see something similar to what Larry, Jeri and Abe have developed for springs for all the resources in the park; providing a synthetic framework for assessing the condition of resources.** Would like to find out what the commonalities are among springs databases, where we can reconcile databases, if there are possibilities for data sharing for the purposes of this assessment.

- Steve Rice **– protocols that the park uses are modified versions of the protocol developed by Abe and Larry**. The park did a pilot project 2004, 2005 in the canyon, based on a river trip, to use the protocol in the field and see how it worked. A lot of the blue dots on the map in Marble Canyon came from that period of time.

  Since then, the parked worked with SCPN and took the protocol and modified it over time so that a small crew in a rugged hiking environment could more realistically complete them. Ultimately a number of different iterations were developed, based on the number of people, and differing levels of expertise. All this results in differing levels of completeness of inventories.

  For a few years partnered with Grand Canyon Trust on a springs stewardship program and trained volunteers how to collect data based on the protocols and made several trips, generally along the Bright Angel Creek drainage off the North Rim...

  GC doesn't currently have a standalone database to house this information. Data has either been entered into the SCPN database, or remains at GC, not in a database. Water quality information is input into NPStoret database, but that doesn't include biological or geomorphic data. Springs inventory effort at the park has slowed dramatically, due to lack of funding, time...

- Larry mentioned that a couple of the Indian tribes are using the protocols as their standards.
- Abe said the Forest Service takes a broader approach, including wetlands and other water bodies along with springs in their approach. An exciting development has been to take that and use it to prioritize management actions .
- Steve Monroe said that **SCPN's work closely parallels what Steve Rice described because the network is working closely with the park**. Taking the Level 2 protocol described earlier and tweaking it to meet our needs. SCPN realized that it could not do everything in the protocol, especially in light of all the other vital signs that we must focus on as well, and so has had to step back our effort on springs, and can't take on an assessment. So, in the past couple of years, **SCPN's efforts have been focused on developing a springs and seeps monitoring protocol.** As part of that, SCPN and the park have identified a small set of high priority springs to focus on for monitoring. Over time the list got smaller and smaller to focus on high visibility springs, ones that are either sensitive indicators of diverse habitat, or potential climate change, or different activities, including a few on the South Rim and a few on the North Rim.
- Steve Rice added that basically what they had been doing is more baseline data collection.
- Todd asked, of the data collected in the park using the I&M protocol, how many might fit into that scoring framework?

- Steve Rice responded we don't have many sites that have been inventoried to that level.
- Steve Monroe said that SCPN's focus had been more on vegetation.
- Todd asked what are the broad categories of data that were collected that would fit into the categories that Larry identified.

  -flow measurement
  -baseline vegetation to species level
  (some of this was inaudible)
  -percent cover
  -temperature
  Basically, the metrics that SCPN is using is very similar and can be used to populate the database.
  Jeri can import water quality data
- Steve M. asked Larry if the **metrics were weighted?**
  - Larry's response was that it can be weighted, but not currently set up that way.
  - He also said that vegetation is not always a good indicator for springs because of their dynamic nature and gave a hanging garden as an example.
  - Part of their scoring system is the naturalness of the disturbance regime.
- Abe stated that there are many types of vulnerability assessments. Larry has really led with the development of the SEAP as compared to
  - proper functioning conditions
  - water management indicators that the forest service has
  - watershed condition framework that the forest service has at the national level.
  He feels comfortable that this assessment is more applicable to springs than some of the other assessments.
- A question was asked about whether **reliability** was dependent on how recent the data was. Abe said that their methods crystallized in 2005 when they did the survey of the springs in the parks on the Colorado Plateau, which allowed them to see an array of sites and get a sense of impacts.
- A point was made that monitoring was assessment of condition over time. Steve Monroe added that context was important, not just looking at the spring itself.
- Todd related that point to the question of **how do you spatially define a spring system**. He asked whether they used polygons or points to define springs and Jeri said mostly point data. He also noted that riparian communities are likely to be a focal resource for the assessment within the Vegetation category and that we will have to decide on if and how to include or separate them from spring/seep systems since there is clear overlap between the two (also refer to notes from Vegetation Technical Workgroup holed on 3/26/13).
  -Abe made the point that springs don't lend themselves to remote sensing tools because of their size and complexity, also some seeps/springs are along vertical cliffs and are not picked up in 2-dimensional remote imagery.
- There was a discussion of **recording instruments in the field**, electronic devices, data sheets, tablets. Jeri had some success with tablet, but still had to use paper. Larry mentioned that there is a QA/QC function in the database.
- Todd asked about progress of data entry and Jeri responded that **there was a pretty big backlog for entering data about springs in the park.**

- Abe noted that the evaluation area did not include the whole groundwater area and Todd asked if there was a way to delineate the groundwatershed.
  - Abe said for the south side, yes, but for the north not so well.
  - Todd said that they wanted to identify what the threats are within the broader watershed, such as uranium mines *** Asked if Graham would try and pull watershed information together for the north rim as part of his Masters project.**

7. Threats to watersheds and springs identified:

- groundwater pumping on the southside
- pipeline proposed from Lake Powell to St. George
- large well operations on the North Kaibab
- grazing
- forest thinning
- uranium mining
- things that connect isolated springs can bring the threat of nonnative species
- catastrophic wildfire- Todd mentioned that one of the TWGs would deal with landscape processes, which would include fire.

- **Reference conditions?**
- **SEAP** system doesn't really deal with reference conditions and need longer-term datasets to establish. That's one of the frustrations for the FS, we don't have reference sites to compare restoration to, but based on the general lack of disturbance within the park relative to the rest of the southwest its seeps/springs could be used as a reference
- Abe indicated that a lot of work has been done on springs in ponderosa communities along the Mogollon Rim and could provide some useful reference information.

8. Springs as cultural properties

- Christine (on the phone) reiterated that many of the **springs are important cultural properties for the tribes** and expressed confidence that the park would work with the tribes on this project. ***She offered the services of her office to help work with the tribes.**

  Todd reported that they have not had much response from the tribes. Only someone from the Hualapai tribe participated in the initial work group and will be participating in the cultural work group. To compensate, the park has started to conduct more targeted outreach.

  The point was made that within the drainage network that supports GC, we know of 4 sites that are places where different tribes say that either humanity emerged onto the earth, or are where the spirits of the dead go. The spiritual significance of springs to tribes may be so important that they may not want to talk about it.

  Todd said that we can have more discussion of how much of our own knowledge of tribal values can be included in the assessment, without pinpointing them on a map.

- **Past spring assessments on tribal lands?**
  - Larry has worked with four tribes surrounding GC, funded through MNA.
  - Developed a cultural worksheet for the tribes to provide details as to why these sites are important.

- Springs were a sacred part of the landscape for every tribe they talked with.
- We would have to work with tribes directly if we wanted to do a broader assessment and include tribal lands. Maybe they would share at the subwatershed scale.
- Steve Monroe mentioned that SCPN has been doing springs work in Canyon de Chelly, where the tribe plays a significant role. * **He suggested that they might confer with the NPS at CACH about their experience working with the Navajo Nation.**

9. Springs and seeps outline.

- the desired conditions statement
- tables that include indicators, reference conditions, and targets
- a summary of spatial and tabular datasets that the park either possesses, or knows about that may be relevant.
- a list of permitted, springs-related research that's been done in the park

Todd asked that all review the information and asked that if participants noticed anything missing, please let him know.

10. Timeline for the project

- Second stakeholder workshop in the fall – present what the workgroups have put together so far for the resources to a broader group. This will be an opportunity to get more input into the prioritization of things to develop a stakeholder priority layer to include in our spatial analysis.
- Draft for each resource condition assessment by the end of the year.
- Early next year do more of the integrated spatial analyses.
- Completed report is due December 2014.

11. In summary

Todd said that the Springs and Seeps work group is further along in identifying indicators and a reasonable assessment framework than the groups for the other resources, and that what the Springs Stewardship group has developed is the type of process that the assessment is aiming for all the resources.

He said that we have all the pieces we need to do an assessment for seeps and springs, but that some of the pieces may not fit together without some work. Asked for feedback as to what the next steps should be and who might be able to do it.

- Through the cooperative agreement with NAU, the project has the spatial analysis capability.
- Park has program managers and technical specialists that can help with some of the pieces.
- The project can also bring in additional help as needed.

12. Next steps

- **Get the data for GC springs entered into the SEAP database.** Is this something that Larry and Jeri could do, or would they essentially teach the project how to do it, and then someone on the project would enter the data?
  - Larry mentioned that there is a working relationship between the park and MNA, and said that they were very interested in working the project. They are very concerned with the issues that concern the

park. ***Steve Rice and Jeri and others will get together and look at the data and figure out steps needed to reconcile the different datasets, develop a spatial layer for the analysis area, and conduct a landscape scale condition assessment.**
- Jeri mentioned that the plant data can be a problem, but Steve Rice said there isn't much plant data.
- Jeri said they can get interns at MNA to enter data, and Todd said that the same capability was available at LLECB. Will involve training. Might be able to get funding from other sources as well.

- **Grand Canyon as a literary landscape.** Look for reports and writings about these sites. This might be difficult to accomplish. There was discussion about how this type of information could be linked to the database.
- **Vertebrate database**. This database can contribute information about spring specialist species. Jeri periodically imports this information into the SEAP database.
- **Compile a bibiography.** Can **use some of the backcountry plan sources** for this as well as **white paper developed by Steve Rice in response to proposed Tusayan development**. ***Graham Schindel can help in this effort.**
- There are **regional groundwater flow models for this area (**Abe**).** USGS has run a scenario for that model out 1000 years. Only simulates a couple of springs. It could be focused on springs along the South Rim of the GC. Doesn't give ecosystem response, just the discharge of the spring.***Contact Don Bells at USGS.** Can be used as an indicator of trends. There is no scenario of the future that shows an increase in discharge from the springs.
- **Identify a few important sites to focus on**.
- Uranium EIS and Canyon Forest EIS (i.e. initial Tusayan development proposal) will have some usable background information and help guide our threat analysis, e.g. potential effects on water.
- **Vegetation associations**. There are only a few vegetation associations for springs, but there might be some specialized associations related to springs and seeps. ***Mike Kearsley could look to see if there are any Park Specials identified in the GRCA Vegetation Map.**
- **What issues face springs as a result of climate change?** Water quality changes? The project is still trying to decide how to deal with climate change. Might be a matter of identifying an "off the shelf" model, e.g. Oregon State has a step down model.

Todd extended an open invitation to the group to participate further in the many next steps outlined here. Feel free to contact Todd or Steve Rice about how to help. We can move forward in smaller groups and then reconvene later if necessary.

Meeting adjourned at 4:00 pm.

Greater Grand Canyon Landscape Assessment (GGCLA)

Physical Resources – WATER RESOURCES -- Technical Workgroup Initial Meeting Outline

Tuesday, April 2, 2013

Objectives and expectations

The Technical Workgroup will help to identify appropriate condition indicators, compile and evaluate data/information sources, develop assessment criteria and methods, and assess the conditions and trends of focal resources within its respective discipline. The workgroup will be facilitated by GRCA/NAU staff and will include other subject matter experts (SMEs) and stakeholder representatives, depending upon interest and availability. Participants will be expected to actively engage in the workgroup, including providing sound technical guidance, doing 'homework' in preparation for meetings, and helping to develop work products (e.g. literature reviews, spatial layers, condition assessments, etc.). Subsequent meetings (incl. conference calls/webinars) will be determined on an as needed basis. Specific objectives for the initial meeting include the following:

- Refine scope of assessment for focal resources (e.g. fine-/coarse-filter, ecosystemic-/taxonomic-level).
- Identify and assess preliminary condition indicators and reference/desired conditions.
- Identify and assess known/potential threats.
- Identify appropriate spatiotemporal scale(s) of analysis.
- Develop condition assessment criteria (e.g. indicator ranges/thresholds) and analytical approach (e.g. quantitative/qualitative score, spatial modeling).
- Identify and assess information/data needs, sources, and gaps.
- Identify specific tasks, products, roles, responsibilities, and timelines.

Focal resource(s)

Focal resources were identified based on input from participants during the GGCLA Workshop on October, 11th, 2012 and subsequent discussions amongst GRCA and NAU staff. Desired condition statements, indicators, reference conditions, and targets are from the 'Draft Grand Canyon National Park Desired Conditions' (2012) and references therein. *Denotes NPS Southern Colorado Plateau Network Vital Signs and Measures in the following tables as outlined in Thomas et al. 2006. TBD- To be determined based on GRCA and/or other relevant data sources (incl. workgroup products). Spatial and tabular datasets include those developed or acquired by GRCA.

Data table color codes are as follows:

Documented	In Development	Not Documented	Not Evaluated	To be Developed

Research studies listed include relevant permitted research conducted in GRCA since 1958. Research results (e.g. reports, publications, datasets) are not necessarily readily available for all those listed.

Water Resources

Desired Condition:

Hydrologic integrity of park waters (surface and ground waters) is improved and/or maintained to support natural geomorphic processes of fluvial and aquifer systems and to support native life.

Indicator	***Reference Condition***	***Target***
Spring aquatic invertebrate species richness*	TBD	TBD
Spring exotic invertebrate species abundance*	TBD	TBD
Spring native plant richness*	TBD	TBD
Spring exotic plant species cover*	TBD	TBD
Spring flow*	TBD	TBD
Spring habitat area*	TBD	TBD
Spring habitat complexity*	TBD	TBD

GRCA Physical Resources – Water Resources – Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Springs and Seeps	Tabular	9 GRCA springs were sampled to Level 2 Inventory protocol: Dripping Springs, Buck Farm Canyon Spring, Upper Butte Fault Spring, Lower Butte Fault Spring, 70 Mile Spring, Stone Creek Spring, Thunder River Spring, Nettle Spring, Warm Springs	Southern Colorado Plateau Network (data source)	Spring 2005	Park-wide	Identify potential or observed natural or anthropogenic disturbances. Examine patterns in geomorphology characteristics. Examine patterns in vegetation community composition, diversity, exotic species presence and sensitive species occurrences. Examine patterns in invertebrate community composition and diversity.	Very limited number of springs sampled and single visit to each spring.	Level 2 protocol includes the following: spring location information; detailed site description; photograph(s); sample riparian and aquatic plant communities; sample terrestrial and aquatic invertebrate communities; conduct geologic/geomorphic and hydrogeochemical analyses; discharge rates; and conduct wildlife observations.	Simple to convert tabular data to spatial layer.
Water Quality	Tabular	7 GRCA springs were sampled to Level 1 Inventory protocol: Schmutz Spring (3x), Cottonwood Creek North Rim (2x), Saddle Horse Spring (3x), Buckhorn Spring (2x), Hotel Spring (2x), Santa Maria Spring (3x), Robbers Roost Spring (3x)	Southern Colorado Plateau Network (data source)	2005	Park-wide	Identify springs with poor water quality. Identify springs with good water quality.	Very limited number of springs sampled.	Field measurements included pH, specific conductance, temperature, barometric pressure, dissolved oxygen, alkalinity, turbidity, and discharge rate. USGS National Water Quality Laboratory analyzed for major ions, trace elements, nutrients, uranium, cyanide and mercury.	Simple to convert tabular data to spatial layer.

GRCA Physical Resources – Water Resources – GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Burn Severity	GIS (Vector)	Burn Severity for GRCA Fires	GRCA Fire	2001-2011	GRCA	Fire effects on Springs/Seeps	Only where fires have occurred; only data since 2011	MODIS satellite	Minimal
Fire History	GIS (Vector)	Perimeters of historic fires in GRCA	GRCA Fire	1910-2012	GRCA	Fire effects on Springs/Seeps	earlier data (pre-1950) is of questionable accuracy	aircraft GPS since 1998; earlier data unknown	Minimal
Springs Seeps	GIS (Vector)	Springs and Seeps in GRCA and vicinity	GRCA Hydrology	updated 12/19/2012	GRCA and vicinity	Springs/Seeps locations and Inventory	Point locations only; most have not been inventoried	Rec GPS; USGS 1:24K quad maps	Unknown to link to Inventory data
National Hydrography Dataset	GIS (Vector)	Hydrography	USGS NHD	downloaded 10/6/2012	GGCLA Analysis Area sub-basins	All surface-water related analysis	1:24K	USGS 1:24K topo maps; USGS PBS maps	None
Watershed Boundary Dataset	GIS (Vector)	Watershed Boundaries	USGS	downloaded 10/6/2012	GGCLA Analysis Area sub-basins	Potential as analysis units	not as significant above the rim	USGS 1:24K topo maps; USGS PBS maps	None
National Elevation Dataset	GIS (Raster)	Digital Elevation Data; derivatives Aspect, Slope	USGS; Mosaic and Derivatives by GRCA GIS	downloaded 1/1/2009	most of GGCLA Analysis Area; remainder available from USGS	Any analysis where Elevation, Aspect, and Slope have controls on Springs/Seeps locations	modeled at 10m cell size	Diverse source data	Moderate to download and mosaic additional data to completely cover the Analysis Area; potentially High if other derivations or models are needed
Transportation	GIS (Vector)	Road and Trails	GRCA GIS; BLS; USFS	updated 3/13/2013	most of GGCLA Analysis Area	Analysis where road density or proximity affect Springs/Seeps environments	Data outside GRCA is incomplete and from different sources, with different attributes	Varied, but with feature-level metadata	Significant to compile from various sources to a single standard over entire Analysis Area

GRCA Physical Resources – Water Resources – GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Vegetation Map	GIS (Vector)	Vegetation (Associations)	GRCA	9/12/2012	GRCA and GC-Parashant NM	ID and analysis of Seeps/Springs related Vegetation types at Association scale	1-hectare minimum mapping unit size; Does not cover entire GGCLA Analysis Area; only a small fraction of polygons field-verified	NAIP imagery (2007 and 2010) segmentation, CART analysis, and field editing	None
Vegetation Plots	GIS (Vector)	Vegetation Classification Plots	GRCA	2007-2008	GRCA and GC-Parashant NM	Detailed Vegetation Plot data, corresponds with Vegetation Map data	Plot data is in a separate SQL Server database, but easily linked; only 76 (3.4%) of Plots are in a Riparian Life form types	Rec GPS (+/- 5 meters)	Minimal
GRCA Geology	GIS (Vector)	Compilation of Geology GIS in GRCA and surrounding area	USGS, compiled by GRCA GIS	compiled 2013	GRCA, and most of Analysis Area	Springs/Seeps locations are often controlled by underlying Geology	Data compiled from sources at different scales and levels of detail, then aggregated to GRCA Geologic Units; inconsistencies between map sources	mostly digitized from Geologic Maps	Minimal if used as-is; Moderate if source data details need to be de-aggregated
Rare Plants	GIS (Vector)	Rare Plant locations	GRCA Veg Program	2013	GRCA	Rare Plants that are associated with Springs/Seeps ?	Database is not yet complete for some species	Varies	Moderate, in development

GRCA Physical Resources – Water Resources – GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
HDMS Rare And Endangered Species	GIS (Vector)	Rare and Endangered Species	HDMS	17-May-12	GRCA	Rare Plants that are associated with Springs/Seeps ?	GRCA only, but may be acquired for a broader area	Unknown; derived from shapefile and Access database	Moderate; Data includes numerous plant and animal species, and some data is buffered, so some extraction and manipulation is warranted; alternatively, a dataset with broader extent could be requested from HDMS, which would require some processing
AZ Endemics	GIS (Vector)	Endemic Plants of AZ	Desert Botanical Gardens	2013	Arizona	Rare Plants that are associated with Springs/Seeps ?	Spatial Data not yet available, but expected soon; not yet evaluated	Unknown	Unknown

Water Resources Database and GIS Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Integrated Land Assessment Project (ILAP) R3 HUCs	GIS (raster)	Post-rollup modeling strata aggregated to the HUC from the basic modeling landscape unit of HUC-PVT-Own	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	?-2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Integrated Land Assessment Project (ILAP) R3 Lump HUC Own 20120326	GIS (raster)	Post-rollup (and small-area lumping) modeling strata aggregated to the HUC-Owner from the basic modeling landscape unit of HUC-PVT-Own	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	?-2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Integrated Land Assessment Project (ILAP) R3 Lump HUC PVT 20120327	GIS (raster)	Post-rollup (and small-area lumping) modeling strata aggregated to the HUC-PVT from the basic modeling landscape unit of HUC-PVT-Own	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical	?-2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI

Water Resources Database and GIS Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
			Report PNW-GTR-xxxx						
Integrated Land Assessment Project (ILAP) R3 Lump HUC PVT Own 20120319	GIS (raster)	Post-rollup (and small-area lumping) modeling strata of our finest modeling landscape unit (HUC-PVT-Own)	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	?-2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
National Land Cover Database (NLCD) Land Cover	GIS (raster)	National Land Cover Database, landcover data	USGS Multi-resolution Land Characteristics Consortium	2006?	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
National Land Cover Database (NLCD) Land Cover Change	GIS (raster)	National Land Cover Database, landcover change data (2001-2006)	USGS Multi-resolution Land Characteristics Consortium	2001-2006	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Arizona Natural Infrastructure Composite GIS - Open Space and Sensitive Biological Lands	GIS (raster)	State-wide dataset including sensitive biological lands and waters (areas supporting core habitat or providing corridors for wildlife as identified by 5 scientific studies) and open space plans (areas with existing or proposed designation for outdoor recreational use as identified by multiple county and municipal governments and community open space plans)	TNC Center for Science and Public Policy	2008	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
USFS MAPSS Mapped Atmosphere-Plant-Soil	GIS (raster)	Model output data of shifts in vegetation density (leaf area) and runoff, 10-km resolution	USFS	2008?	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to

Water Resources Database and GIS Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
System - Simulated Ecosystem and Water Resources Impacts									GGCLA AOI
PRISM data	GIS(raster)	Normal precipitation, maximum temperature, minimum temperature, and dew point data 1971-2000 or 1981-2010 at 800-m resolution or monthly data 1890-present at 4-km resolution	PRISM Climate Group	1971-2000, 1981-2010 OR 1890-present	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Western Regional Climate Center (WRCC) Local Climate Data Summaries for Western US	non-spatial database (ASCII or *.csv)	Average monthly temperature, precipitation, and wind metrics with other weather details for each weather station	Western Regional Climate Center	varies by station	any national weather station	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS US Drought Monitor	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS Precipitation Derivatives	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
NOAA National Climate Data Center (NCDC) Land-based Datasets - Quality Controlled Local Climatological Data	non-spatial database (ASCII or *.csv)	Daily, hourly, or monthly summary data for each weather station, including temperature and precipitation metrics, degree days, sunrise and sunset times, air pressure, and wind speed	NOAA	varies by station	any national weather station	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

Water Resources Database and GIS Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
USGS Dynamically Downscaled Regional Climate	GIS (raster)	Dynamical downscaled regional climate for Pacific Southwest and Southern Rockies	USGS	1968-2099	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
NARCCAP North American Regional Climate Change Assessment Program	GIS (raster)	50-km resolution climate change scenario simulation output from multiple regional climate models nested within multiple atmosphere-ocean general circulation models for 30-year current and future periods	North American Regional Climate Change Assessment Program	free registration needed for data access	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Applied Climate-Change Analysis: The Climate Wizard Tool Future Climate (2050s and 2080s)	GIS (raster)	statistically downscaled regional climate model based on one of the following scenarios: High A2, Medium A1B, Low B1; output based on one of 16 model options, an ensemble mean, or ensemble percentiles and can be map of averages or map of change for precipitation or average temperature	TNC	projection to 2050s or to 2080s	Global, National, State	Regional climate predictions up to 2089	0	statistically downscaled regional climate models based on one of 16 model options, an ensemble mean, or ensemble percentiles	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
UCAR MAGICC / SCENGEN Regional Climate Models	GIS (raster)	Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC) carries through calculations at the global-mean level using the same upwelling-diffusion, energy-balance climate model that has been and is employed by IPCC while a regional climate scenario generator (SCENGEN) uses these results, together with spatially detailed results from the CMIP3/AR4 archive of AOGCMs, to produce spatially detailed information on future changes in temperature, precipitation and	UCAR	free registration needed for data access	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI

Water Resources Database and GIS Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
		MSLP, changes in their variability, and a range of other statistics							
USGS National Atlas Streams	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS National Atlas Waterbodies	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS National Atlas and NHD Waterbodies	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS National Atlast Waterbodies	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS Watersheds HUCS	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS WaterWatch 7-day Average Streamflow	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS National Water Information System (NWIS) Groundwater	non-spatial data (tabular, graph)	Current conditions at selected sites based on most recent data from on-site automated recording equipment (15-60 minute intervals)	USGS NWIS	present	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

Water Resources Database and GIS Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Data Current Conditions									
USGS National Water Information System (NWIS) Groundwater Data Historical Observations	non-spatial data (tabular, graph)	Current conditions data at active and discontinued recording sites from 10/1/2007 to present	USGS NWIS	2007-present	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS National Water Information System (NWIS) Groundwater Data Daily Data	non-spatial data (tabular, graph)	Summary of all data for each day, including mean, median, maximum, minimum, or other derived value for period of record	USGS NWIS	present	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS National Water Information System (NWIS) Groundwater Statistics (Daily, Monthly, Annual)	non-spatial data (tabular, graph)	Statistics computed from approved daily mean data at each site, including historical daily values for specific time periods	USGS NWIS	present	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
ADWR Groundwater Basins	GIS (raster)	GIS layer of Groundwater basins, areas which enclose a relatively hydrologically distinct body or related bodies of groundwater described horizontally by surface description	ADWR	TBD	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
ADWR Groundwater Subbasins	GIS (raster)	GIS layer of Groundwater subbasins, areas which enclose a relatively hydrologically distinct body or related bodies of groundwater within a groundwater basin described horizontally by surface description	ADWR	TBD	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
ADWR	GIS (raster),	State-wide groundwater data consisting of field-	ADWR	TBD	AZ	TBD	TBD	Field-verified	TASK 1: ACQUIRE DATA

Water Resources Database and GIS Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Groundwater Site Inventory	non-spatial data (*.csv)	verified data regarding wells and springs						data regarding wells and springs collected by personnel from Hydrology Division's Basic Data Section, USGS, and other cooperating agencies	TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
ADWR Surface Watersheds	GIS (raster)	ADWR watersheds defined as an elevation or divide separating the catchment area, or drainage basin, of one river system or group of river systems from another system or group of systems	ADWR	TBD	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Spring Stewardship Institute Springs Inventory Database	non-spatial data (*.mdb)	Springs inventory data including location (categorical and spatial), as well as survey information: date, time range, site polygons (microhabitat descriptions entered the first time a site is surveyed), survey polygons (microhabitat descriptions at the time of the survey), soils (substrate percentages, litter, and wood cover), geology (geologic descriptions), solar pathfinder data collected and results of calculations, water flow measurements (with measurement method and location), water quality data (with location of measurements), flora (vegetation cover), invertebrates collected or noted, vertebrates collected or noted (or evidence such as scat, tracks, feathers, nests, etc.), images (scans of sketch map, representative photograph, other images),	Springs Stewardship Institute	present	AZ	Information on all springs in AOI outside of GRCA	TBD	Database populated by detailed surveys guided by SEAP and other requirements described at Springs Stewardship Institute website	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
		scores for condition of and risk to site in seven categories (based on SEAP), cultural values, and quality control information for data collection and data entry							
Arizona Statewide Freshwater Assessment GIS Data Package	GIS (raster)	Four GIS datasets mapped to stream-based hydrography in AZ, including habitat for 33 native fish species, former and current perennial surface flow for AZ rivers, distribution for threatened and endangered species that require aquatic or riparian habitats, and Wild and Scenic river designations	TNC Center for Science and Public Policy	2010	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI

GRCA Permitted Research Studies – Water Resources

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Beus	Stanley	n/a	NAU	8/27/90 - 7/1/92	The Influence of Variable Discharge Regimes on Colorado River Sediment Deposits below Glen Canyon Dam (Stability of Colorado River Sand Beaches)	NRInfo Ref Code 65009. Only draft report and quarterly reports; Also see Charles Avery.
Bills	Donald	GRCA-00188	USGS	1/20/06 - 3/30/06 4/1/03 - 12/1/05	Measuring ephemeral spring flow and geochemical changes at the South Rim of the Grand Canyon using electronic resistance sensors.	Final report received. 12 p./80 p. NRInfo Ref Code 2169062, 2169064, 2169067. Electrical resistance sensors record spring flow timing, Grand Canyon, Arizona – Ground Water Vol. 44 No. 5; September-October 2006 (pages 630-641); Determining ephemeral spring flow timing with laboratory and field techniques: applications to Grand Canyon, Arizona / by Eric A. Adams, 2005 NAU master's thesis. Cline Library GB1207.A436 2005.
Corbett	Robert	n/a	University of Akron	8/9/87 - 8/19/87 8/15/86 - 9/15/86	Efflorescent Minerals and the Composition of Seeps from Which They Come	Gable, Dolores J.; Burford, Arthur E.; Corbett, Robert G. "The Precambrian Geology of Casper Mountain, Natrona County, Wyoming with a Section on Geochemistry of its Groundwater." Reston, VA. Dept. of Interior, USGS, viii, 50 pgs.
Foust	Richard	GRCA-00144	NAU	4/1/02 - 12/31/03	Correlation of Spring-discharge to Groundwater Source Using 234U/238U Isotope Ratios	NRInfo Ref Code 558329.
Hart	Robert	n/a	USGS	3/22/00 - 12/31/03	Detailed Hydrogeologic Assessment of South Rim Area, Grand Canyon National Park	NRInfo Ref Code 568450, 657942. GRCA MC # GRCA 80840. Might be: "Assessment of Spring Chemistry along the South Rim of Grand Canyon in Grand Canyon National Park, Arizona" or "Chemical Characteristics of Ground-Water Discharge at Selected Springs, South Rim Grand

GRCA Permitted Research Studies – Water Resources

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
						Canyon National Park, Arizona".
Hofknecht	Greg	n/a	NAU	5/21/80 - 10/15/80	Benthic Aquatic Macroinvertebrates Sampling	QL162 .H64 in Cline Library
Johnson	Roy	n/a	MNA	9/1/79 - 12/31/81	A Survey of Present and Future Impacts of Water Depletions and Additions on the Aquatic and Terrestrial Habitats of Roaring Springs, Bright Angel, Garden and Pipe Creeks, Grand Canyon National Park.	GRCA MC # GRCA 68621. NRInfo Ref Code 123249.
Kearsley	Michael	GRCA-000032	NAU	6/30/00 - 12/31/02	Effects of steady vs. fluctuating flows on creation of "vegetated shoreline" for juvenile fish and exotic recruitment into newly available habitat.	GRCA Library Call # QH541.5 .R52 P678 2002. Responses of riparian vegetation to two contrasting managed flow regimes of the Colorado River in Grand Canyon, AZ / Marianne E. Porter and Michael J. C. Kearsley.
Keeler	Raymond	GRCA-00133	National Speleological Society	2/14/02 - 12/31/03 9/17/01 - 12/31/01	Mapping Roaring Springs and Silent River Caves	Final report not received.
Kobor	Jeremiah	GRCA-00172	NAU	10/3/02 - 9/1/04	Coupling of a numerical groundwater/surface water flow model with an ecosystem response model for the Redwall-Muav aquifer and associated springs and channels of the South Rim, Grand Canyon, Arizona	NRInfo Ref Code 590010. GRCA Library Call # QE86 .G73 K63 2004. QE86.G73 K636 2004 in Cline (our copy has weird code all over).

GRCA Permitted Research Studies – Water Resources

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Meretsky	Vicky	GRCA-00294, GRCA-00066	Indiana University	5/25/06 - 7/30/07 6/3/02 - 12/31/03 6/1/01 - 12/31/01 5/15/98 - 12/31/00 5/12/97 - 12/31/97	Short- and long-term variability in vegetation patterns at seeps and springs.	NRInfo Ref Code 664016. Might be QH102 .A75 2008 "Aridland springs in North America : ecology and conservation" edited by Lawrence E. Stevens and Vicky J. Meretsky ; with a foreword by Gary Paul Nabhan.
Monroe	Stephen	GRCA-00561	NPS	12/1/10 - 12/31/11	Synoptic Water Quality Sampling Events at Garden Creek and Pipe Creek in GRCA	Final report not received.
Monroe	Stephen	GRCA-00557	NPS	7/27/10 - 12/31/11	Inventory of Spring Ecosystems in the Grand Canyon Region, Arizona	Final report not received.
Monroe	Stephen	GRCA-00259	USGS	3/1/05 - 3/1/06	Level 1 Baseline Water-Quality Inventory of Selected National Parks of the Southern Colorado Plateau Inventory and Monitoring Network, Four Corners Region	GRCA Library Call # TD223.9 .M33 2006. http://pubs.usgs.gov/of/2006/1300/ author is Jamie Macy.
Rice	Steve	GRCA-00592	GRCA	3/26/12 - 9/30/14	Karst Hydrology and Speleology of the Kaibab Plateau	Current study. File in Research Office. No report received.
Rihs	John	GRCA-00017	NPS	12/15/04 - 2/28/05 5/1/00 - 12/31/03 3/28/00 - 12/31/03	Protection of Springs and Seep Resources of the South Rim, Grand Canyon National Park	NRInfo Ref Code 659915. Digital final report received. 64 pgs.
Ross	Lanya	GRCA-00156	NAU	6/1/02 - 12/31/04	An interpretive groundwater flow model for the Redwall-Muav aquifer, Kaibab Plateau, Arizona	GB1198.3.A6 R67 2006 [in Cline Library] "Interpretive three-dimensional numerical groundwater flow modeling, Roaring Springs, Grand Canyon, Arizona" by Lanya E. Ross.
Rubin	Spencer	GRCA-00581	NAU	6/6/11 - 8/1/12	Wetland Plant Communities and Historic Settlement Disturbance on the Colorado Plateau: Baseline Data for Conservation	Final report not received.
Schaar	Melissa	GRCA-00555	UNLV	1/1/11 - 4/1/12 7/15/10 - 12/31/10	Occurrence and Mobility of Uranium and Other Elements in Grand Canyon Groundwater and Springs	Final report not received.

GRCA Permitted Research Studies – Water Resources

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Sisk	Thomas	GRCA-00551	NAU	5/20/10 - 12/20/11	Ecological Impacts of Bison and Implications for Cross-Jurisdictional Management in the Grand Canyon Region	NRInfo Ref Code 2185796. Thesis (92 pgs.) saved in Sisk file. See Ronda for raw data. GRCA Library Call # QL737.U53 R45 2012. GRCA MC # GRCA 108902.
Spence	John	n/a	NPS, GLCA	7/24/97 - 12/31/98	Characterization and identification of water-quality and biotic components in isolated springs along the Colorado River Drainage, Utah, and Arizona.	NRInfo Ref Code 170163, 558349. Possible deliverable: https://ojs.lib.byu.edu/ojs/index.php/wnan/article/viewFile/1299/1156.
Springer	Abe	GRCA-00267	NAU/GCWC	8/01/05 - 2/28/06	Northern and southern Colorado Plateau NPS springs ecosystem inventory	GRCA MC # GRCA 79709, GRCA 83655, GRCA83656, GRCA 83671, GRCA 84372, GRCA 84378. GRCA Library Call # SB615 .T25 N66 2006.
Springer	Abe	GRCA-000029	NAU	5/18/00 - 12/31/01	Rates and amounts of discharge from seeps and springs of the Redwall-Muav Aquifer, Grand Canyon, Arizona	GRCA Library Call # QE86.G73 K477 2002 (PI- James A. Kessler). Some of this study's data was used in a 2006 presentation at the Rocky Mountain Section- 58th Annual Meeting.
Springer	Abe	GRCA-00405	NAU	8/1/07 - 12/31/08	Delineation of Recharge Areas, Groundwater Flow Pathways, and Travel Times on the Kaibab Plateau	http://www.agu.org/cgi-bin/SFgate/SFgate?&listenv=table&multiple=1&range=1&directget=1&application=fm08&database=%2Fdata%2Fepubs%2Fwais%2Findexes%2Ffm08%2Ffm08&maxhits=200&="H53E-1135".
Stevens	Lawrence	GRCA-00130	Grand Canyon Wildlands Council	8/1/01 - 12/31/02	Inventory, Assess and Recommend Recovery Priorities for Arizona Strip Springs, Seeps, and Natural Ponds	Final report received. NRInfo Ref Code 558290. GRCA MC # 83656. Report Title: Biological inventory and assessment of ten South Rims springs in Grand Canyon National Park: draft final report, 2003.

Greater Grand Canyon Landscape Assessment

Cultural TWG Meeting Summary
April 23, 2013

The first meeting of the GGCLA Cultural Technical Work Group (TWG) was held on April 23rd, 2013, to begin refining the scope and approach to assessing cultural resources, which include archeological and ethnographic resources.

In attendance: Jan Balsom (Deputy Chief of Science and Resource Management, GRCA); Ellen Brennan (Cultural Program Manager, GRCA); Peter Bungart (Dept. of Cultural Resources, Hualapai Tribe); Todd Chaudhry (Project Leader and Senior Ecologist, GRCA); Jen Dierker (Archeologist, GRCA); Helen Fairley (Archeologist, Grand Canyon Monitoring and Research Center, USGS); Santiago Garcia (Data Manager, GRCA); Cerissa Hoglander (NAU); Ian Hough (Archeologist, GRCA); Mark Nebel (GIS Coordinator, GRCA); Jean Palumbo (writer/editor, SCPN, NAU); Jane Rodgers (Deputy Chief Science and Resource Management, GRCA); Jill Rundall (NAU); Sasha Stortz (NAU); Charlie Webber (Archeologist, GRCA). *On the phone*: R. Brooks Jeffrey (U of A).

Meeting summary

I. Introduction and background of the Greater Grand Canyon Landscape Assessment project (see the Scope of Work at http://lci.nau.edu/projects/GreaterGrandCanyonLandscapeAssessment_Docs.aspx).

II. Technical Work Groups (TWG) include subject matter experts and stakeholders. Goals of the TWGs include: identify focal resources, appropriate condition indicators, known and potential threats, and information gaps to guide research and monitoring in the future.

III. Overview of what is currently known about cultural resources in Grand Canyon NP (GRCA).

- Six percent of the park has been inventoried for archeological (arch) resources, identifying 4,255 sites, of which 2,221 are in "good" condition. The park uses the Arizona State Museum Standards to identify arch sites. Data about these sites including their condition are maintained in the NPS Archeological Sites Management Information System (ASMIS)) and the Grand Canyon Archaeological Site Database. The Grand Canyon Archaeological Site Database contains information not included in ASMIS that relate to more in-depth research needs.
- The *List of Classified Structures*, a national database, lists 898 historic buildings and structures in GRCA. As of 2012, 862 of those were listed in good condition.
- Sixteen cultural landscapes have been identified in GRCA.

Acronyms and symbols

ASMIS – Archeological Site Information Management System

GGCLA: Greater Grand Canyon Landscape Assessment

GRCA: Grand Canyon National Park

LLECB: Lab of Landscape Ecology and Conservation Biology (NAU)

MNA: Museum of Northern Arizona

NRHP: National Register of Historic Places

NAU: Northern Arizona University

SCPN: Southern Colorado Plateau Network

TWG: Technical Work Group

*indicates an action item

Definitions

Cultural landscapes within the NPS are defined as a geographic area[s], including both natural and cultural resources, associated with a historic event, activity or person. Their significance is based on eligibility for inclusion on the National Register of Historic Places (NRHP).

Ethnographic landscapes within the NPS context are broader, do not depend on NRHP eligibility criteria for their existence, and importantly, are identified and defined by the cultural groups associated with them rather than by historic preservation professionals. Ethnographic landscapes' significance derives from the roles they play in the associated communities' own traditional histories.

Traditional cultural properties (TCPs) are places of cultural significance to American Indian and other ethnic groups but also rooted in the NRHP.

Source: NPS Cultural Resources, 2001

- The park has recently begun to focus attention on ethnographic resources through grey literature searches. These data have been placed into the park's ethnographic database. More than 400 entries are listed in the database covering a wide range of resource types including plants, animals, water sources, archaeological sites, topo-graphic features, and landscape areas. Work continues in this field. Consultation activities and reports from the park's traditionally associated American Indian Tribes and contractor generated reports, will continue to add to this data set. Some of the information is available in GIS format. The park plans to use the existing cindition assessment framework used for archeological sites. *This is an area that needs continued attention..

IV. Data and databases.

- All 4,255 identified sites are in the GRCA database, in varying levels of completeness. Funding has been received in 2013 to support an employee to enter and update site records in the data-base to the fullest extent possible.
- An ethnographic database has been created, but a framework to guide the collection and recording of ethnographic data has not been established. Grey literature research has resulted in over 400 records in the database, recording important plant, animal, water, topographic, landscape, and archaeological resources in the park.
- Maps based on the work of Saul Hedquist and T. J. Ferguson (2012) show the known locations of some ethnographic resources in and around GRCA by tribal group. However, it was compiled from literature and other data sources and although it has some limitations, it is a good starting point.

V. Tribal involvement is critical for identifying ethnographic resources and landscapes. However, tribal participation has not yet generally been forthcoming. One problem is that tribes are reluctant to divulge sensitive knowledge. The GGCLA is an opportunity for tribes to provide input into the management of ethnographic resource at a landscape scale without specifically identifying the ethnographic resources that make such landscapes important..

VI. Some possible ethnographic focal resources were identified (although it was noted that all focal resources in the GGCLA are likely to have ethnographic value)

- georitual landscapes
- historic gathering places
- travel corridors
- geologic features
- viewsheds

VII. Other data sources

- Hopi tribe conducts condition assessments annually
- The Hualapai, Zuni, Southern Paiute, and Navajo participate in the river corridor monitoring
- The Hualapai maintain an archeological GIS database – the Hualapai Cultural Atlas
- The Zuni have conducted a large landscape mapping project for the A'shiwi Museum.

VIII. Indicators of condition of ethnographic resources.

- use proxies
- Condition of natural features, native plants and animals, health of springs and other features. If the natural envi-ronment is in good shape, natural processes are functioning as they should, natural soundscapes and viewsheds are protected, we will have gone a long way toward preserving ethnographic resources in the park.
- evaluate the components of the ethnographic landscape

- for travel corridors, might be the presence of roads, ease of access, modern intrusions
- land ownership
- use the seven elements of National Register integrity for sites

IX. Next steps

Action Items

1. Decide what the cut-off is for historic landscapes. Will the 50 year rule be applied for the assessments? ? Yes. 50 years old or older.

2. Develop an assessment framework for ethnographic resources.

3. Identify focal resources and state the basis for those decisions.

4. For the Hualapai Tribe, Peter to provide coarse grain information on areas of high arch site density that would include the geophysical/environmental context. We need to see if we can get additional information from other tribes.

5. Take ethnobotanical information provided by tribes and add it to vegetation and ethnographic databases, then map where culturally significant plants occur on the landscape.

6. Historic gathering places was suggested as an ethnographic resource. Will need to check the literature. Ellen will look for such references in the ethnographic database.

7. Contact Jim Enote about the Zuni landscape mapping project for A'shiwi Museum.

8. Core team should pull information about the National Register and Bulletin 38 and link it to data available to assessment.

9. LLECB to send out a newsletter updating participants and the tribes on the progress of the project.

10. Todd and Ellen and Janet to determine what is the best way to approach the tribes based on suggestions from Peter, that we make presentations about the assessment before the different tribes.

11. Ellen to find out if there is any sensitivity about the information on trails from the Hopi and Zuni.

Meeting detail

1. Introduction and background – Todd Chaudhry

Todd Chaudhry presented background information on the GGCLA, explained the process for selecting the focal resources, which started with a stakeholder workshop in October 2012, the collaborative nature of the assessment, and the purpose of the TWGs. Work groups are tasked with refining the scope of the assessment, identifying the best condition indicators and reference/desired conditions, identifying potential or known threats, identifying information and data needs that exists, and synthesizing the information to assess current conditions and trends. For complete details, see http://lci.nau.edu/ggcla.aspx.

2. Goal of the technical work group (TWG) meetings – Todd Chaudhry

- Todd presented an analysis of the hump-backed chub as an example of an analysis of a focal resource.

  Analysis includes: describe current conditions (from recent data, what are you comparing them to? how are you going to rate them as being good or bad? or improving or degrading?), identify reference and desired conditions, be explicit about threats (management tends to focus on this), but we want to make clear the link between the threat and the attributes of the focal resource, and what we can do about it.

- This gets back to the prioritization concept, we're identifying the focal resources, which have value (to stakeholders and to NPS). Some have higher value than others, some may be more threatened. With limited resources, need to focus on high value resources that are highly threatened.
- The scale of the analysis will depend on the resource being assessed, and the data available for that resource. But for the overall assessment, stakeholders felt that we should broaden the scope to include the park as geologically defined and to include relevant watersheds. Todd described the assessment area.
- The goals of the cultural technical work group meetings are to
    1. refine the scope of the resources identified in Workshop 1. We can discuss what are archeological resources, ethnographic resources. Will focus more on the ethnographic since not much work has been done on defining this.
    2. identify what the appropriate condition indicators are. For archeological resources there is a framework for this used nationally, so we should utilize this. For ethnographic resources, though, we may be breaking new ground as far as identifying those indicators and determining how to assess their condition.
    3. identify known and potential threats to those resources.
    4. identify condition assessment criteria for ethnographic resources, since that doesn't exist.
    5. identify information needs and gaps to guide more targeted research and monitoring in the future.

Ultimately we hope that work groups continue to be engaged in providing further guidance throughout the assessment process. We see the core staff in the park and at NAU actually doing the assessment, with input from external subject matter experts.

3. Questions

How do desired conditions fit in this process? (J. Rodgers)
GRCA identified draft desired conditions for most resources in the park about a year ago, still in draft stage. Todd sees this process as helping to better identify indicators for resources. For example, for cultural/ethnographic resources, we've identified very generally what those indicators are and the desired conditions of those indicators. By the end of today's workshop, we'll have a better sense of what those indicators are and what are the appropriate reference conditions and we can revisit the desired conditions through this process. Within the context of the report, we can be more explicit about what those are for the resources.

Rural historic landscapes aren't captured in the 16 cultural landscapes (J. Balsom).
You have ethnographic landscapes from a tribal perspective, you also have ethnographic landscapes from an early pioneer western developmental landscape, e.g. railroad corridor. Don't want to lose sight of these. Todd said these can be identified with point data and turned into a GIS layer which can be overlaid on the assessment area.

T*ime periods? (Brooks) Is there a cut-off date? Is the 50-year rule being applied here?*
What are the periods of significance? This has not been defined for the cultural resources.* Basically up to the Cultural TWG to make this decision.

4. Overview of cultural resources in GRCA – Ellen Brennan

- *6% of the park has been systematically inventoried for archeological (arch) resources*. Within that, 4,255 arch sites identified, of which 2,221 are in "good" condition. GRCA uses the national framework, the Arch Site Management Information System (ASMIS) to identify arch sites, record their condition and monitor their condition over time. While there is some flexibility as to how we may look at arch sites to gain information about their condition, they do follow a national framework, so there's not a lot of flexibility in how we address recording and observing site condition.

- *The List of Classified Structures, a national database, lists 870 historic buildings and structures in GRCA.* Arch sites are sometimes part of that database. It records condition in a slightly different way than ASMIS. So we have two, somewhat collaborative, somewhat competing ways of looking at arch resource condition, but they're both a national framework that's managed by NPS.
- *Sixteen cultural landscapes are identified in GRCA,* some are rural landscapes; some are developed landscapes, like the Grand Canyon Village National Historic Landmark, one of the most important in the nation. Also have some smaller ones: Hermit's Rest, Desert View, and some on the North Rim.
- *Ethnographic cultural landscapes.* NPS has not yet done a very good job of identifying, nor deciding how to track the condition and what's important about those landscapes. The interaction between the GGCLA, looking at the natural resource base and cultural landscapes comes together very nicely, because ethnographic cultural landscapes include all aspects of the environment, including natural resources. We have a chance to talk about what we should be looking at to make sure that we are choosing the right measures for maintaining those cultural landscapes.
- *Previous work on ethnographic resources:* T.J. Ferguson and others; tribal partners have shared some information about ethnographic resources. 96 ethnographic cultural landscapes have been identified. The Hopi tribe identified a lot of individual arch sites as TCPs. These are not included in the count, yet. According to the Hopi, all Puebloan sites are TCPs.
- *Areas that have been surveyed for arch resources tend to be in developed areas* where park actions could have adverse effects on resources, and in areas where fire management activities are likely to occur.
- *Defining arch sites.* To identify an arch site, the park uses the Arizona State Museum Standards which describe certain criteria to be met when identifying an arch site vs. an isolated occurrence.
- *The park has augmented the ASMIS by adding the Elements of Integrity* that provide measure of significance for qualification for the National Register (NR). One key element of site assessment is whether or not a site may need management action to address a threat to its integrity, which can diminish its eligibility for the NR.
- *The park has set protocols for arch monitoring and protocols for mitigation processes.* Some of this could apply to ethnographic resources, but not all of them, so *this is an area where focused attention is needed.

5. Discussion of data and databases

- State of GRCA arch site database: *all 4,255 identified sites are recorded in the database, with GIS data.* The records are of varying completeness. For example, some sites were recorded in the 1960s and are not as well documented as those recorded more recently. Have been working with NAU to update and correct the spatial data for arch sites in GRCA.
- Don't have an established framework to guide the collection and recording of ethnographic data, or to monitor their conditions. Most of the info we have comes from the traditionally associated tribes. We will probably never know what all those resources are because some of that information is sensitive and just won't be shared.
- *Ethnographic data is maintained in an ethnographic database*, which has been worked on over the last year. Contains arch sites, geographic locations, water sources, plants and animals that have traditional significance.
- Maps based on T. J. Ferguson's work: location of known ethnographic resources in and around GC; spatial distribution of resources by tribal group (Southern Paiute has most – 36, then Havasupai, Navajo, Hopi).

6. Questions and comments about the cultural resources overview.

- We have a lot of work to do, mostly in regards to ethnographic resources: how we define what's important about them, and what we should be doing to monitor and manage them into the future.
- *Background on the 6% of the park that was surveyed*. Most of the surveying done was management focused. If there is going to be a park undertaking or some kind of construction activity, we want to find out what the cultural resources are in the area to be affected. It is a biased dataset, focused on particular areas, like developed corridors, river corridors. Plateau lands, mesa lands that are outside developed corridors, and not in areas where fire management activities are planned, don't have a lot of survey.
- Map with the distribution of ethnographic resources by tribe was compiled from a literature review and is far from accurate. Ellen acknowledged that lack of ethnographic information is a big shortcoming in our knowledge of GRCA (a lot less than the 6% of the park surveyed for arch sites has been done on ethnographic resources). She pointed out that the GC itself is a TCP for all traditionally associated tribes, and that encompasses everything within the canyon.

7. Information on ethnographic resources should come from tribal evaluations, because tribes have been using this landscape for thousands of years, but right now that is a big missing piece.

- Challenges for tribal participation.
    - Tribes have only been participating in these types of collaborative efforts in the past 20 years or so since the Glen Canyon studies. The Hualapai tribe and other tribes have more and more become active participants through the adaptive management, the monitoring program, and traditional ecological knowledge efforts. Maybe that will accelerate as time goes on.
    - Tribes have reservations about divulging sensitive knowledge. More likely to be divulged in the context of undertakings for actions, like the high flow experiments.
- The landscape assessment process provides an opportunity for the tribes to provide input at a scale that does not divulge sensitive information. If the Hualapai tribe will delineate on a map, or give feedback on the data the park has, whether the landscapes are representative of the landscapes as the tribe sees them, without necessarily identifying the resources that make it an important cultural landscape. If the tribes can rank their cultural landscapes, that is information that can be used on a broad scale for this project.
- The Hualapai tribe maintains an archeological GIS database, which Peter says is perpetually 90% complete. Periodically, "stuff comes out of the woodwork where there's work that's been done that we don't have integrated". **We can probably provide coarse grain information about where we have high site density, what are the geophysical/environmental context of those.
- A tribal spatial layer could encompass a whole suite of cultural resources. Tribal priorities, regardless of what's informing them, can be brought into the prioritization process. The information that is going to be pulled out in this process is going to help inform our decision-making in the future, and it's a way for tribes to engage proactively, instead of reactively to proposals.

8. Possible ethnographic focal resources

- *Viewshed* (e.g. Red Butte) and the *georitual landscape* have come up in discussions with many of the tribes when looking at the effects of uranium mining. We could do some analyses that identify the landscapes that are relevant for multiple geological and other features in the viewscape. There are gateway areas (Deer Creek, for example) that are georitual locations.

- Brooks: Do we develop a management protocol that asks what actions take place in the viewshed between the park, as a point of reference, and the georitual landscape features that are on the horizon that would be impacted by activity of the park. Does the park take an advocacy role on uranium mining—it's a huge issue.

9. How will the landscape assessment be used?

- The assessment will explicitly identify what we don't know and what type of research and monitoring will help to shift us from having low confidence in our assessment of ethnographic resources to a medium confidence.
- NPS has been working on creating a framework for cultural resource assessments. The project had a conference call with them a few months ago, to find out where they were at and what the framework was looking like. The park service is leaning towards a symbology that distills the information down into a management-friendly format. From our data we can see that we don't know much.
- Also, if our assessment indicates that ethnographic resources are of significant concern, and maybe trending downward, then that's a red flag for management. Using this symbology, a manager should be able to flip through the assessment and easily pick out the red flags, which can alert them to significant threats for which we will need to engage others to help deal with.
- A benefit of taking a collaborative approach is that we're not going to be able to tackle big issues like uranium mining and wind power development that threatening visual landscapes and other resources alone, as an individual park. With a collaborative approach, we can engage and seek help from stakeholders outside of the park.
- Todd provided an example from the Saugus Ironworks which conducted a cultural resource condition assessment. The approach that they have taken has focused more on the state of the knowledge of those resources, as opposed to the condition of those resources. He made the point that the archeological resources condition assessment framework developed at the national level is the level we need to get to for the resources we are including in this assessment. For ethnographic resources, we need to get there some way or another. These overall assessments are going to direct what we may or may not need to do as park managers.

10. We need to develop an assessment framework for ethnographic resources.

- What are the indicators that we will use to determine whether an ethnograpic resource is in good condition?
- This framework can be used for monitoring the condition of the resource over time.
- Once you have a framework, then you can plug in the information that you collect. The hard part is coming up with that framework.
- Yellowstone does a report on the state of the resources every year, updating the information on those resources.
- Jan said that was something they have wanted to do, but they haven't had the framework to do it.
- Todd said he felt that the process they were implementing for this assessment (collaborative, etc.) should lend a lot of confidence in the results for the superintendent.

11. Where we are today in regards to cultural resources.

- We need to start looking at ethnographic resources knowing that there isn't a framework, and knowing the

state of our knowledge about that resource is not where we would like it to be. We need to start setting up that framework.

- Ellen repeated the objectives for today's meeting of the cultural resource work group (see #2 above)

12. More about the GRCA ethnographic database.

- The ethnographic database is the result of a national initiative about 10 years ago to identify the ethnographic resources in the parks and who they were important to. The person who was developing that database passed away and the national effort fell by the wayside. Three years ago, GRCA took the database got it up and running, and started populating it.
- The database contains over 400 entries, mostly from gray literature, and it includes information like plants, animals, locations, all from mostly within Grand Canyon, water sources that are important to our traditionally associated tribes.
- For example, for a plant species, there is a listing of all the cultural groups that have expressed an interest or significance for that plant species. For some categories there is location information, for example, water sources. Some of this information could be cross-linked to our other assessments—vegetation, for example.
- For the future, want to keep working on that database and share it with the tribes, so they can get the information out of it, but also help us fill it out more and weed out incorrect information.

13. Other data gathering efforts

- Hopi tribe conducts condition assessments annually.
- The Hualapai participate in the river corridor monitoring. Peter does not participate directly in this monitoring, but he is aware that they revisit arch sites and look at springs and riparian areas. They also do ethnobotany studies which were led by Art Phillips (long-time Grand Canyon botany expert) for a number of years. Carrie Cannon, on his staff, has taken up the reins on that project and is working with the Hualapai and the Southern Paiute. They find a lot of trash from river trips also, that really offends the tribe.
- For the Hualapai, one of the culturally sensitive plants is mesquite, which is important for food and other resources. Peter described the mesquite zone. Historically, pre-dam, the floods would periodically inundate the mesquite zone and cause the mesquite to regenerate and propagate. Because of the dam, water doesn't get that high anymore. The tribe is surveying the historic highwater line to see how that is affecting the population of mesquite. Will it survive? Will it migrate downward (towards the water?) And that's just one target resource.
- The Zuni have conducted a large landscape mapping project for the A'shiwi Museum. *Contact Jim Enote.
- Jan mentioned that they focused a lot on the river corridor because the park has a lot of information about this area, but the landscape of the park goes so much beyond that little sliver, and there are a lot of resources out there that are of great concern.
- The park has the following vegetation data for the greater landscape:
    - updated vegetation map
    - good idea of the distribution of mesquite beyond the river corridor
    - years of monitoring data for tamarisk removal work

- for those resources that we have no data for, we can do more of a qualitative analysis with the help of the tribes.

14. Mountain lions – considering areas outside of the assessment area

- Travel corridors, compel us to look outside of the defined boundaries of the assessment. For example, mountain lions are a focal resource. We know they are wide-ranging, and they will need dispersal corridors. We may not be able to explicitly define those expanded areas, but we may qualitatively consider them in our discussions.
- *Question*: What's the basis for picking the mountain lion as a focal species? The question was asked in the context of determining why we would focus on particular types of ethnographic resources as the basis for framing this assessment.
- *Answer:* Mountain lions were identified as a focal resources because 1) they are the top predator in the system, 2) they are a species that GRCA has been monitoring in partnership with USGS, so data are available, 3) stakeholders identified it as a focal resource, maybe because it is a charismatic species, or their agency mission mandates a focus (AZGFD, for example).
- **For ethnographic resources, it's up to the people in this room to identify focal resources, and what are we basing our decisions on.*

15. All focal resources in the GGCLA are likely to have some tribal significance.

- Peter pointed out that if you were to ask tribes about a resource, like the mountain lion, tribes would likely start talking about some of the old stories—origin stories. Brings the cultural significance of mountain lions to light. He mentioned the effort to interview tribes in southeastern Arizona to solicit input into the plan to reintroduce Mexican gray wolves, and to learn about the significance of wolves to the tribes. Todd stated that he would like to have tribal input for every focal resource identified for the assessment.

16. Prioritizing areas with high arch site densities.

- It was suggested that we need to start prioritizing areas in the landscape for assessment and one way to do that might be to look at areas of high arch site densities. Ellen said that site clusters are captured in the GRCA GIS data.
- Some culturally important areas don't have arch sites. It was pointed out that sites of cultural significance aren't always areas with high density of arch sites—San Francisco Peaks is sacred to many tribes, but no sites on it because it was sacred.
- Can we identify those special areas, like places of origin, that don't have arch sites? We can only identify some of them. Some sites are common knowledge, e.g. Little Colorado River (LCR) confluence. Also, traditional use lands, like pasture lands, which are really important to the Havasupai people, and for which there are some arch sites associated
- Possible pitfalls of asking tribes about these areas. Peter brought up that if we are going to discuss these areas, like LCR, the tribes might ask us to take some action, like stop people from going there. Similarly Red Butte, (a traditional cultural property for several tribes, including the Havasupai) is getting a lot of attention because of Canyon Mine. This case exemplifies the dilemma of tribes engaging in the process because they want to see these places protected. So they provide information, and in the case of Red Butte, feel betrayed in the end when the USFS gave the ok to proceed with the mine (it is in litigation now). It was pointed out that the input from the tribes did have some impact on Secretary Salazar's decision to designate the 1 million acre

withdrawal area to protect Grand Canyon's watershed from new uranium mining impacts.

- *Todd pointed out that one value of this assessment is that when these issues come up, the park will be prepared because it will have already gathered all the pertinent information in a collaborative way.*

16. Previous study on ethnographic resources (T.J. Ferguson et al.) may be incomplete (missing a lot of information) but is a good place to start for the assessment.

- For example, it was identified that songscapes are important to the Southern Paiute – ambient sounds in the land.

17. Recommendation to link ethnobotanical information to vegetation databases so as to be able to map locations of culturally significant plants. Also, Desert Botanical Gardens modeled rare plant species for the whole state (probability models). Can use this to pinpoint potential location of species we might consider as focal species.

18. To begin the second half of the meeting, Todd posed this question: If we look at the resources identified in the broader landscape assessment through an ethnographic framework, are we missing anything?

- We want to know what defines ethnographic resources, specifically what are those indicators and what data are available to help form our assessment of them?
- We need to include geologic features, which is place-based, potentially has a georitual component, and also has a viewshed component. (Include under "landscape")
- Ellen stated that ethnographic resources include the landscape as a whole, and basically all the resources identified in the workshop. Look at the information we have –what is our knowledge base for these features? What do we know about the condition of these resources, and where do we need to go to gain more knowledge of and assess the condition of these resource types?
- Viewsheds and soundscapes are included under "visitor experience" along with "wilderness". Could go under "landscape". There is a lot of overlap in terms of categories where resources have been put. Some felt that "viewsheds" could be its own category and visitor experience might be more inclusively defined as "user experience".
- It was suggested that the cultural component should be added as a resource to each focal resource.
- "*Travel corridors*" should be added. They are used by wildlife; used by people through time; they focus where the arch sites occur; they link areas. We have good data on trails and routes, and Ellen has started working with Mike Linden on the Kaibab, who is working with the Hopi and Zuni about travel routes to GRCA. This is a broader focus than looking at recreational trails. Will have to find out if there is any sensitivity about the information on trails from the Hopi and Zuni.
- "Places of historic events or gathering/meeting places" should be included. A story about Havasupai going to a place in Cameron, which was important to them because that's where they met with the Navajo. For them it was historically important. This information could be in the literature, or the ethnographic database. Could fit under "travel corridors"?

19. Todd provided an update on the vegetation work group – still in the process of refining the scope of the vegetation resource.

- Probably will be including riparian communities, desert scrub communities (encompasses a lot of endemic and rare species). The endemic species, more broadly will probably be rolled into the biodiversity resource component. We're also going to look at rim habitat. Forest and upland communities will be covered under "fire."
- He suggested that we can look more specifically at the ethnobotanic aspect and identify a suite of species that don't fall under riparian communities and desert scrub.

20. Brooks suggested that we use the framework established by NPS for cultural landscape inventory. We are using similar or parallel terminology.

Codified in NPS Director's Order #28. Includes the following categories:

- natural systems and features
- spatial organization
- land use
- circulation?
- topography
- vegetation
- buildings and structures
- ? and vistas
- small scale features

Brooks added that he has used "spatial organization" as a category in the past, to capture how various groups organized their perceived world.

21. Todd presented the slide with the outline of the NPS Cultural Resource Condition Assessment framework, which is not consistent with the Director's order just mentioned.

Resource categories include:

- archeological resources
- cultural anthropology
- cultural landscapes (the categories that Brooks read from the Director's order all fit under cultural landscapes)
- historic structures
- museum collections...

Condition indicators tend to be more knowledge-based. What do we know about these, what documents exist, what's the needs assessment?

22. For ethnographic resources we want to find out what are those elements about their condition that we should consider?

- How do we evaluate travel corridors? Have they been interrupted by roads? Have they been modified? Has access been blocked? Are there modern intrusions that detract from user's experience?
- Use elements of integrity of the National Register (NR) for arch resources. Could also use for ethnographic resources, but would not work for resources like vegetation
- Management priorities are based on eligibility for the NR and data potential.
- Power of spatial analysis. For example we can model fire risk across the landscape and see where that intersects with known archeological fire sensitive sites or look at land ownership and associated development potential and threats
- Indicators to consider for geologic features:
    - integrity of the feature
    - qualification for NR status under Bulletin 38
    - potential arch site locations
    - Land ownership as proxy for threat. For example, wind turbines at Perrin Ranch can be seen as a threat to viewshed, visitor experience, night sky viewing (dark skies), (lights were supposed to only go on if there were aircraft in the area, but that's not happening). There are modules in ArcMap for viewshed analysis.

23. How do we assign a condition rating to an ethnographic resource?

- Ian suggested to look at it in gross terms, where you are using proxies instead of assessing individual ethnographic resources. For example in the park you can divide the landscape up into developed areas and undeveloped areas; developed areas tend to have large impacts on resources.
- Another way to assess an ethnographic landscape is to look at all the pieces (i.e. vegetation, etc.), and if, individually, each resource is ethnographically important, then you could consider the landscape where they are found as an important ethnographic resource.
- Ian pointed out that in ASMIS condition definitions for arch sites don't account for cumulative impacts and are based on a narrow time frame. For example, you can have a site that is rated "low impact" over successive years, and you wind up with a site that is rated "good", when it should be considered in poor condition due to the cumulative effects of all those "low impacts". Vice-versa, for a site that is in poor condition, if it doesn't change, it would be considered stable, and a site that is stable could be considered in fair or good condition. However, Ellen said that there is a text field where impacts can be documented in more detail.
- Helen gave the example, if you are tracking a site that has erosion (and a lot of sites have erosion) it is difficult to determine whether new erosion has occurred with the current system and suggested that we might find an alternative way to get at this information. Todd said that we could identify these issues (e.g. erosion) as a "research need."
- Ellen pointed out that they had added the elements of integrity as criteria to manage for to address this issue. When assessing condition of a site, they note which elements are affected by the disturbances that they are seeing.
- Peter suggested that the monitoring protocol could include assess changes since last visit, or over a period of time (5, 10, 20 years for example). Include this as a need to address.

24. Glen Canyon Long-Term Experimental and Management Plan (LTEMP).

- Implemented a structured decision-making process. Asked the tribes to rank different resource categories. Peter reiterated that need to get tribal involvement to evaluate ethnographic resources, the TWG can't decide that. Need to ask the tribes
- What do the tribes value?
- What do they perceive are the threats to those resources they value?
- How would they like to see those resources managed?

25. How to successfully engage the tribes in this process?

- The park has not been successful in getting responses from the tribes after sending letters to the tribal chairman from the park's superintendent, and from GRCA staff reaching out to tribal staff.
- Peter suggested providing an update and asking to do a presentation before the tribes between now and the fall meeting, saying this is what we've done so far... He suggested that the message should be that nothing bad is impending, but we would like to pre-emptively get a handle on what the tribe values and how it would like to see these resources managed. He emphasized to be really clear about the purpose of the assessment.
- Can utilize a similar approach to LTEMP and develop a questionnaire, or possibly work with the LTEMP in a way that is mutually beneficial? (according to the website for LTEMP, The Havasupai Tribe, The Hopi Tribe, The Hualapai Tribe, Kaibab Band of Paiute Indians, The Navajo Nation, and The Pueblo of Zuni are cooperating agencies).
- The decision to include ethnographic resources in the assessment came from other stakeholders and the park. Peter, representing the Hualapai, was the only tribal representative at the workshop.
- There is a concern that if the park works with the Hualapai or other tribes on this assessment, it could create a problem when someone from the tribe opens up the report and sees a depiction of resources on tribal lands. Peter said that he thought the tribe could provide information that is pretty coarse-grained, not specific data. Jan suggested that they could use an intensity map, as was used when working on uranium mining. Each resource category is assigned a color. The darker the color, the more resources there are. Useful when looking at the sensitivity of the land for various resources.

26. Peter provided an overview of the Hualapai Cultural Atlas (2005 – NPS Heritage grant, 2008 continuation grant)

- Started out by plugging in place names from old maps and documents. About 930 place names in the database. A lot of these are along the river.
- Mapped trails, some of which came from General Land Office maps from the 1900s. Also shows some of the trails coming from California. Also gathered information from the work of by anthropologist Henry Dobbins and Bob Euler, who were hired by the Hualapai Tribe in the early 1950s to record the place names for Hualapai places of significance, to protect them from land claims. Some of the trails go to the Rio Grande pueblos.
- Includes over a 1000 archeological sites, most of which are on the reservation.
- High country forested areas are sensitive areas for the tribe.
- Petroglyph sites provided by Don Christianson.
- Plant gathering areas were mapped by Dobbins (most), also mapped were cholla bud collecting areas,

tobacco plants.

- Songscapes, including the Salt Song Trail, for which there were over 200 songs, and significant for numerous tribes.
- Also mapped were settlement areas, and agricultural areas, burial sites.

27. What kind of process would Peter have to go through to get approval to officially share this data at a scale that the tribe would feel comfortable in sharing?

- Response: first talk to Loretta about it, and then, since it's about something that we would share with the outside, we would want to give a council presentation. Peter is actually thinking about trying to put a watered down version of this map online. Smithsonian contact the tribe last week about doing a similar kind of project with the Shoshone Tribe. Todd said that they were interested in having a relative sense of what areas are more important than others to the tribe.

28. Jan mentioned that the park helped the Havasupai Tribe produce a place names map.

29. Additional questions:

- How do we distill all this input and information into actionable items?
- Scope: Do we focus on known sites, or do we try to model potential sites locations, based on what we know about current sites? This is something the park has been wanting to do for some time. The fire-sensitive modeling effort is in a holding pattern. Identified new sites during post-fire monitoring last year, but it was only for mixed conifer and it has been put on hold this year.

30. Some final process points.

- Those people who are heavily involved in the overall project will be responsible for identifying the tasks and following up on what has been discussed here. Will come up with a preliminary framework that will fit into the larger framework.
- In the fall we will have another stakeholder workshop where we will roll out what has come out of the Technical Work groups, and maybe some preliminary products, and an opportunity for the broader stakeholder group to have additional input.
- Still figuring out what types of spatial analyses will be done, but one example is The Nature Conservancy's Ecoregional Assessment, looking at areas of high priority and high opportunity. But, has been cautioned about trying to do an analysis across resources.
- A final point was made to the effect that areas that are sacred to a number of tribes can also be high in biodiversity. Suggested the term "hot spot" to describe them.

Meeting adjourned at about 12:00 pm.

Greater Grand Canyon Landscape Assessment (GGCLA)

Cultural Resources Technical Workgroup Initial Meeting Outline

Tuesday, April 23, 2013

Objectives and expectations

The Technical Workgroup will help to identify appropriate condition indicators, compile and evaluate data/information sources, develop assessment criteria and methods, and assess the conditions and trends of focal resources within its respective discipline. The workgroup will be facilitated by GRCA/NAU staff and will include other subject matter experts (SMEs) and stakeholder representatives, depending upon interest and availability. Participants will be expected to actively engage in the workgroup, including providing sound technical guidance, doing 'homework' in preparation for meetings, and helping to develop work products (e.g. literature reviews, spatial layers, condition assessments, etc.). Subsequent meetings (incl. conference calls/webinars) will be determined on an as needed basis. Specific objectives for the initial meeting include the following:

- Refine scope of assessment for focal resources (e.g. fine-/coarse-filter, ecosystemic-/taxonomic-level).
- Identify and assess preliminary condition indicators and reference/desired conditions.
- Identify and assess known/potential threats.
- Identify appropriate spatiotemporal scale(s) of analysis.
- Develop condition assessment criteria (e.g. indicator ranges/thresholds) and analytical approach (e.g. quantitative/qualitative score, spatial modeling).
- Identify and assess information/data needs, sources, and gaps.
- Identify specific tasks, products, roles, responsibilities, and timelines.

Focal resource(s)

Focal resources were identified based on input from participants during the GGCLA Workshop on October, 11th, 2012 and subsequent discussions amongst GRCA and NAU staff. Desired condition statements, indicators, reference conditions, and targets are from the 'Draft Grand Canyon National Park Desired Conditions' (2012) and references therein. *Denotes NPS Southern Colorado Plateau Network Vital Signs and Measures in the following tables as outlined in Thomas et al. 2006. TBD- To be determined based on GRCA and/or other relevant data sources (incl. workgroup products). Spatial and tabular datasets include those developed or acquired by GRCA. Data table color codes are as follows:

Documented	In Development	Not Documented	Not Evaluated	To be Developed

Research studies listed include relevant permitted research conducted in GRCA since 1958. Research results (e.g. reports, publications, datasets) are not necessarily readily available for all those listed.

CULTURAL RESOURCES

Overall Desired Condition: Cultural resources will be managed so that those resources may be preserved for future generations. Cultural resource management will be carried out in a manner that is consistent with legislative and regulatory provisions and with implementing policies and procedures. Research about, and stewardship of, cultural resources are carried out only after adequate planning and consultation with interested or affected individuals, groups, and other outside entities. Cultural resources management will employ the most effective concepts, techniques, and equipment to protect cultural resources against theft, fire, vandalism, overuse, deterioration, environmental impacts, and other threats without compromising the Cultural resources are managed to maintain their National Register integrity and eligibility (National Park Service, 2006).

Archaeological Resources

Desired Condition: Archaeological resources will be managed in situ and in a manner that maintains their National Register eligibility and integrity. Preservation treatments will include proactive measures that protect resources from vandalism and looting, and will maintain or improve their condition by limiting damage due to natural human agents. Data recovery actions will be taken in the context of planning, consultation, and decision making. Preservation treatments and data recovery activities will be conducted within the scope of an approved research design. Archaeological research will use nondestructive methods of testing and analysis whenever possible. Information about archaeological resources will be incorporated into interpretive, educational, and preservation programs without inappropriate dissemination of location in details. Artifacts and specimens recovered from archaeological resources, along with associated records and reports, will be maintained together in archaeological records and museum collections. Archaeological sites are maintained in current conditions or are improved (National Park Service, 2006).

Indicator	*Reference Condition*	*Target*
Site condition (NPS 2007): **Good:** The site, at the first condition assessment or during the time interval since its last condition assessment, shows no evidence of noticeable deterioration by natural forces and/or human activities. The site is considered currently stable and its present archeological values are not threatened. No adjustments to the currently prescribed site treatments are required in the near future to maintain the site's present condition. **Fair:** The site, at the first condition assessment or during the time interval since its last condition assessment, shows evidence of deterioration by natural forces and/or human activities. If the identified impacts continue without the appropriate corrective treatment, the site will degrade to a poor condition and the site's data potential for historical or scientific research will be lowered. **Poor:** The site, at the first condition assessment or during the time interval since its last condition assessment, shows evidence of severe deterioration by natural forces and/or human activities. If the identified impacts continue without the appropriate corrective treatment, the site is likely to undergo further degradation and the site's data potential for historical or scientific research will be lost. **Destroyed:** The site's formal condition assessment resulted in a professional determination that the site was destroyed or so severely damaged that the data potential/scientific research value was deemed	4,125 archaeological sites identified within Grand Canyon National Park as of 9/30/2011 (Archaeological Site Management Information System, 2011, based on the Grand Canyon Archaeological Site Database). 2,105 sites in good condition 574 sites in fair condition 123 sites in poor condition 1,320 sites have unevaluated conditions	The current conditions of historic properties are maintained at current levels or are improved. The percentage of sites in good condition (as reported in PMDS) is stable or reflects an increase in the number of sites in good condition. The number of sites needing baseline condition data is reduced. **Site Classification Targets (GRCA Site Disclosure Policy, 1995):** *Class IV sites (closed to visitation due to fragility or other factors)* • In situ artifacts, if part of the archeological deposit, are common and artifact piles do not occur • Masonry elements are in natural states of preservation, unmodified by preservation activities or visitor use • Constructed trails are not present. Social trails are not present except where traditional uses continue. Such trails are not highly visible and do not impact cultural deposits • Other visitor-related impacts are not present (graffiti, fire rings, evidence of camping, trash, and waste) • Aspects of integrity are retained *Class III (No guided trips, "self-discovery" by individuals okay. Fragile and unable to support continuous or high visitation)* • In situ artifacts, if part of the archeological deposit, are common and artifact piles are rare or do not occur • Constructed trails are not present. Social trails are obliterated through NPS actions unless necessary for traditional uses • Archaeological and architectural elements show limited evidence of visitor disturbances • Other visitor-related impacts are not present (graffiti, fire rings, evidence of camping, trash, and waste) • Aspects of integrity are retained *Class I and Class II (Open to more frequent visitation, used for interpretive programs and education, generally well-stabilized and well-researched)* • Archaeological sites remain accessible

Indicator	*Reference Condition*	*Target*
insufficient to warrant further archeological monitoring or investigation. A destroyed site is excluded from Government Performance and Results Act (GPRA) and other national level reporting requirements and is recorded in ASMIS in the Local Resource Type field.		• Constructed trails avoid archaeological deposits • Constructed trails are maintained • Architectural structures and features are stable • Site information is current and is available as appropriate for the site (Unkar brochure, Tusayan Ruin guided tours) • Artifacts, if part of the archaeological deposit, are present and collection piles are dispersed immediately upon discovery • Other visitor-related impacts are not present (graffiti, fire rings, trash, and waste) • Aspects of integrity are retained
National Register Eligibility (National Park Service, 2006. National Historic Preservation Act, 1966 as amended)	1 individually listed archaeological site (Tusayan Ruin) 4072 archaeological sites determined eligible for listing on the National Register (Grand Canyon National Park Multiple Properties Nomination of 1984 and Grand Canyon Site Files) 23 sites were determined ineligible for listing on the National Register (Grand Canyon Site Files) 4 sites are recommended as eligible for listing on the National Register (Grand Canyon Site Files) 9 sites are recommended as ineligible for listing on the National Register (Grand Canyon Site Files) 14 sites are unevaluated for National Register eligibility (Grand Canyon Archaeological Site Database and Archaeological Site Files)	The number of sites listed on, or determined eligible for the National Register of Historic Places increases (National Park Service, 2006. National Historic Preservation Act, 1966 as amended). The number of sites needing National Register evaluation is reduced.

GRCA Cultural Resources Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Cultural Resource Sites	Tabular	Description and inventory of cultural resource sites in the Park including condition assessment of resource. Inventories occur for fire compliance, Colorado River Management Plan and Glen Canyon Adaptive Management Program.	Ellen Brennan Grand Canyon National Park	1935 - present	Park-wide	Identify areas in the Park containing cultural resources and their conditions.	Does not represent a systematic Park-wide survey for cultural resources.	Specific field data collection methods vary depending on the project. Consistent information is collected when a resource is discovered. Minimally information will include those required by Archaeological Sites Management Information System (ASMIS).	Moderate effort to extract data from complex database structure.
Cultural Resource Site Threats and Disturbances	Tabular	Identification of potential threats and actual disturbances at a cultural resource sites. Includes the effect that each identified threat could have, or each disturbance is having, on the physical condition of the resource. Relative severity of a disturbance is characterized.	Ellen Brennan Grand Canyon National Park	1930 - present	Park-wide	Map cultural resources showing potential threats and/or severity of actual disturbances. Identify locations that are highly threatened or severely disturbed.	More than half of cultural resource sites have not been assessed in at least 10 years.	Each threat or disturbance entry consists of a threat or disturbance date, threat or disturbance type, area affected, and threat or disturbance effect on the resource. Threats uniquely include threat time frame and disturbances uniquely include disturbance effect level.	Moderate effort to extract data from complex database structure.
Cultural Resource Site Recommended Treatments and Mgt Actions	Tabular	Identifies preservation actions recommended, if any, to mitigate a threat or disturbance of a cultural resource site. Any actual management actions taken are also identified and documented.	Ellen Brennan Grand Canyon National Park	1929 - present	Park-wide	Map cultural resources showing recommended actions and/or actual management actions taken. Identify locations or patterns in management actions.	More than half of cultural resource sites have not been assessed in at least 10 years.	Lists the recommended action(s) or treatment(s) needed to protect and preserve a resource in its intrinsic condition and to recover, through approved research, data and material remains threatened with loss. A management action will be identified and should be documented by a report or memorandum.	Moderate effort to extract data from complex database structure.

GRCA Cultural Resources GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Stock Tanks	GIS (Vector)	Stock tanks within GRCA	GRCA et al.	February 2013	GRCA	Some tanks may have historic value	Doesn't extend beyond park; data not attributed for cultural significance	air photos 18cm-1m resolution; recreation GPS; NHD; USGS DLG	Unknown: Arch staff would need to assess cultural significance; this might already have been done as part of Cultural Sites dataset
Cultural Sites	GIS (Vector)	GRCA Cultural Sites	GRCA	in work	GRCA	Explicit site locations, links to non-spatial databases	Majority of park is unsurveyed	varies	unknown
Cultural Surveys	GIS (Vector)	GRCA Cultural Resource Surveys	GRCA	in work	GRCA	Shows extent of surveying	Majority of park is unsurveyed	varies	unknown
Havasupai Indian Reservation Map	GIS (Vector)	Digitized place names, springs, catchments, trails, and helicopter pads, from BIA reservation map	BIA et al., digitized by GRCA	1976	Havasupai Indian Reservation and Traditional Use Area			Digitized from paper map	unknown
Ethnographic Resources GRCA	GIS (Vector)	Ethnographic Resources for GRCA-related Tribes	School of Anthropology, UofA	2012	GGCLA Analysis Area	extents of Native American historical use		summarize publicly available information	unknown
Fire History	GIS (Vector)	Fire History	GRCA Fire	1910-2010		perhaps a measure of threat to cultural resources		varies; earlier data less reliable	unknown
Havasupai Traditional Use Area	GIS (Vector)	Traditional Use Area within GRCA	GRCA	2012	part of GRCA adjacent to Reservation	important resource area for traditional uses		integrated with GRCA Land data	none
Historic Districts	GIS (Vector)	GRCA Historic Districts	GRCA	2008	South Rim Village and Desert View	historic districts in developed areas		digitized from hand-drawn maps	none
American Indian Tribal Subdivisions	GIS (Vector)	American Indian Tribal Subdivisions	US Census Bureau/TIGER	2007	Arizona		not a legal record	unknown	none

Cultural Resources Database and GIS Summary – External Sources

Data Theme	Data Type	Content Description	Source	Time Period	Spatial Extent	Appropriate Uses	Limitations	Data Methods	Use Cost
National Register of Historic Places - Points	CH	spatial data (vector)	Vector data layer of National Historic Places, including historic buildings	NPS National Register of Historic Places	historic and recent	Not Documented	Spatial locations and names of nationally registered historic places	Additional information on historic places (aside from name and location) included in separate spreadsheet	Publicly available via associated website: http://nrhp.focus.nps.gov/natreg/docs/Download.html#spatial
Coalescent Communities Database (Southwest Social Networks Database)	CH	spatial and temporal data	Basis for Southwest Social Networks Database project which examines the social structure and dynamics of pre-contact Southwest	Archaeology Southwest	post-A.D. 1200	In Development	Could provide spatial data of archaeological resources or sites	Database is not publicly accessible	Not publicly available

GRCA Permitted Research Studies – Archaeological Resources

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Allen	Mary K.			10/10/89 - 12/31/91	Rock Art Investigations in the Western Grand Canyon, Tuweep District	Final report received. 93 pgs. GRCA Library Call # GN799 .P4 A454 1991 c.1-2. GRCA MC # GRCA 68466.
Bailey	Ashley	GRCA-00583	Montezuma Castle National Monument	7/1/11 - 7/1/12	Lithics on the Edge: Flaked Stone Assemblages from Grand Canyon National Park	Final report not received.
Ballensky	Jason	GRCA-00512, GRCA-00525	N/A	1/1/12 - 12/31/13 11/5/10 - 12/31/11 10/1/09 - 11/1/10 6/1/09 - 6/10/09 10/18/08 - 10/26/08	New Cave Inventory in GRCA	Current study. File in Research Office. No report received.
Balsom	Jan	GRCA-00143	GRCA	9/18/01 - 12/31/09 10/1/96 - 9/30/01	Research and Collection of Various Cultural, Historical, Archeological, and Related Physical Specimens within Grand Canyon National Park	Associated permits not able to locate: GRCA-2000-SCI-0038, 9610-01-004 // Chris Coder's reports.
Begay	Tim	GRCA-00244, GRCA-00199	Navajo Nation Natural Resources	8/1/12 - 8/1/13 6/3/11 - 6/3/12 6/2/10 - 6/2/11 6/1/09 - 6/1/10 8/1/06 - 10/30/07 7/20/04 - 7/20/05 8/1/03 - 9/30/03 5/5/00 - 12/31/02	Navajo Nation Annual Consultation/Monitoring River Trip	PI previously Marklyn Chee, Robert Begay, Tony Joe, Timothy Begay. See Ronda for annual reports.
Bodenhamer	Hans	GRCA-00571	Bigfork High School	3/25/2011 - 3/25/12	Monitoring visitor impacts to Grand Canyon caves with VIP mapping, GIS and student volunteer groups	Final report not received.
Bowekaty	Eldred		Zuni Heritage and Historic Preservation Office	7/19/99 - 12/31/01	Cultural Resources Monitoring for FY09	PI previously Loren Panteah. See Ronda for annual reports.
Brennen	Ellen	GRCA-00143	GRCA	2/23/12 - 2/23/14	Research and Collection of Cultural, Historical, Archaeological, and Related Physical Specimens within	Current study. File in Research Office. No report received.

GRCA Permitted Research Studies – Archaeological Resources

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
					Grand Canyon National Park	
Carothers	Steven		SWCA, Inc.	1992	Archaeological Overview: GRCA	Final report not received.
Carter	Sidney	GRCA-00169	Stanford University	10/10/03 - 12/31/04	Examination of the Strontium Isotopic Compositions and Petrographic Characteristics of Geologic Sources of Ceramic Raw Materials in the eastern Grand Canyon.	Geological Society of America Abstracts with Programs, Vol. 36, No. 5, p. 213
Christensen	Don	GRCA-00502		5/15/09 - 5/15/10 5/1/08 - 12/31/08	Rock Art Overview of the Grand Canyon Region	GRCA MC # GRCA 78982, GRCA 79098, GRCA 79741, GRCA 79771, GRCA 79772, GRCA 79773, GRCA 79774. No final report received.
Christensen	Don	GRCA-00022		3/1/02 - 12/31/02 4/8/00 - 12/31/01 3/19/99 - 12/31/00	Rock Art Research and Recordation in Grand Canyon National Park	Final report on disk. 112 pgs. Check if museum has copy "An Overview of Rock Art on the Kanab and Kaibab Plateaus, Northern Arizona" 2007. GRCA MC # GRCA 79772. GRCA Library Call # GN799 .P4 C345 2007 NR.
Dierker	Jennifer	GRCA-00604	NPS-GRCA	8/6/12 - 8/6/13	Remote Sensing of Six Archaeological Sites along the Colorado River	Current study. File in Research Office. No report received.
Downs	William		NAU/MNA	1/83 - 12/90 1/1/83 - 9/1/83 5/16/81 - 6/3/81	Exploration of Grand Canyon Pleistocene Deposits	Final report not received.
Downum	Christian E.		NAU	10/1/93 - 12/31/96	Archeological Monitoring along the Colorado River, Grand Canyon National Park, Arizona.	NRInfo Ref Code 627693. GRCA Library Call # CC136 .G736 2000 c.1-2. This has connection with CA -8005-8-0002; Grand Canyon Monitoring project 1992-1999: synthesis and annual report FY99/Lisa M. Leap,(Et al.): submitted to the department of the Interior, U.S. Bureau of Reclamation.
Draut	Amy	GRCA-00208	USGS	4/1/12 - 4/1/13 5/1/11 - 12/31/11	Assessment of active and inactive aeolian sand in lower Marble Canyon	See Ronda for final deliverable.
Emslie	Steven		Western State College	1995 - 1997	Investigations on the Paleontology and Archaic Archaeology of Grand	NRInfo Ref Code 573879. GRCA Library Call # QE711.2. S36 2001. Try to find:

GRCA Permitted Research Studies – Archaeological Resources

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
					Canyon National Park	Technical Report NPS/NRGRD/GRDTR-01/02 or "Split-Twig Figurines in Grand Canyon, Arizona: New Discoveries and Interpretations." Kiva 61(2):145-173.
Emslie	Steven		University of California – Santa Cruz	4/15/93 - 12/31/93	An Inventory of Paleontological and Archaeological Resources in Caves at Grand Canyon National Park, Arizona	NRInfo Ref Code 573879. GRCA Library Call # QE711.2. S36 2001.
Emslie	Steven		University of California – Santa Cruz	1991 - 1992	An Inventory of Paleontological and Archaeological Resources in Caves at Grand Canyon National Park, Arizona	NRInfo Ref Code 70780, 573879. GRCA MC # GRCA 68509.
Fairley	Helen	GRCA-00545	USGS/GCMRC	4/1/10 - 12/31/10	Research and Development towards a Core Monitoring Program for Cultural Resources in the Colorado River Ecosystem	Final report not received.
Glass	Stephen		Wilderness Studies Institute	3/1/89 - 4/30/89 3/4/88 - 4/30/88	Archaeological Surface Survey and Photographic Inventory of Lower Granite Gorge, Grand Canyon National Park	GRCA Library Call # CC95 .G53 1989.
Greco	Deanna	GRCA-00590	GRCA	10/1/13 - 12/31/14 2/6/12 - 12/31/14	Granite Camp-Monument Creek Pilot Stewardship Project	Previous PI Todd Chaudhry. Current study. File in Research Office. No report received.
Gregg	Susan		NAU	10/10/94 - 9/30/95	Cultural Affiliation Study for Grand Canyon National Park, Arizona	No final report received. Might be restricted.
Gumerman	George	GRCA-00102	NAU	4/12/01 - 12/31/02	Interactive Archaeology of the Colorado Plateau and Grand Canyon: Archaeological and Indigenous Perspectives	Final report received. 4 pgs. See Ronda for report.
Haines	Jeremy	GRCA-00171	California State University	8/30/02 - 10/30/02	Ethnicity and ephemeral Native American archaeological sites in the historic period.	Ethnicity and historic Native American architecture on the Coconino Plateau, Arizona / by Jeremy D. Haines (Thesis – CSU Chico). Special Collections and Archives E98.A63 H356 2003. 165 pgs.
Hill	Carol	GRCA-00221	University of New	6/16/04 - 12/31/07 9/20/99 - 12/31/03	Origin and timing of ore mineralization and cave development	NRInfo Ref Code 558315. GRCA Library Call # QE86 .G73 H55 2008. 2 folders;

GRCA Permitted Research Studies – Archaeological Resources

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
			Mexico/UA	11/18/96 - 12/31/98	in Grand Canyon National Park and vicinity	"Bat Diversity, Resource Use and Activity Patterns along A Sonoran Desert Riparian Corridor" thesis by Debbie Buecher [2007].
Jackson-Kelly	Loretta	GRCA-00245	Hualapai Tribe	8/3/12 - 8/3/13 8/2/11 - 8/2/12 8/1/10 - 8/1/11 9/1/09 - 10/1/09 8/1/08 - 8/1/09 8/1/04 - 8/31/04	Hualapai Cultural Resources Programmatic Agreement (PA) River trip	See Ronda for annual reports.
Larralde	Signa		BOR/PA	3/20/96 - 1/1/97	FY96 Experimental Flood Flow cultural resources monitoring proposal, FY96 experimental flow cultural resources mitigation proposal	Final report received. 53 pgs. GRCA Library Call # CC76.3 .B87 1997. Glen Canyon National Recreation Area : FY97 Grand Canyon Monitoring and Research Center (GCMRC) monitoring of archaeological sites from Glen Canyon Dam to the Paria River Riffle / Tim W. Burchett.
Leap	Lisa	GRCA-00237	GRCA/MNA	9/5/05 - 12/30/08	Archeological excavations at ten sites along the Colorado River in GRCA	NRInfo Ref Code 2170347, 2170348, 2170349, 2170350, 2170351. GRCA Library Call # CC136 .D547 2001, CC136 .L43 2003, CC136 .D5 2005. GRCA MC # GRCA 79763, GRCA 79779, GRCA 73564, GRCA 88690, GRCA 77613.

GRCA Permitted Research Studies – Archaeological Resources

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Melis	Theodore	GRCA-00329	GCMRC	2/1/08 - 6/30/08	Science Activities for Potential 2008 Experimental High Flow at Glen Canyon Dam	GRCA MC # GRCA 106089, 106090, 106091, 106092, 106093, 106094, 106095, 106096, 106097, 106098, 106099, 106100, 106276, 106277, 106278, 106280, 106281, 106282, 106283, 106284, 106288. NRInfo Ref Code 2170353, 2170356, 2170357, 2170358, 2170359, 2170360, 2170362, 2170365, 2170366, 2170368, 2170370, 2170372, 2170373, 2170374, 2170375, 2170376, 2170378, 2170379, 2170380, 2170381.
Mink	Philip	GRCA-00584	University of Kentucky	7/11/11 - 7/10/12	Terrestrial Remote Sensing and Geographic Information System Modeling of Selected Pueblo Period Archaeology Landscapes within Grand Canyon National Park	Final report not received.
Mink	Philip	GRCA-00242	University of Kentucky	6/15/04 - 12/31/05	Testing the effectiveness of ground penetrating radar and non-site archaeology for reconstructing cultural landscapes in the Grand Canyon region, northern Arizona	Final report not received. Might be: "Identifying at-risk heritage resources with GIS: modelling the impact of recreational activities on the archaeological record" by Patrick M. Uphus, Alan P. Sullivan III, Philip B. Mink II in International journal of Risk Assessment and Management V. 6 Number 4-6/2006 p. 330-343.
Mink	Philip	GRCA-00510	University of Kentucky	9/15/08 - 9/15/09	Grand Canyon Indigenous Cultural Landscapes AD 400-AD1250: Phase I Geophysical and Geospatial Mapping and Modeling	Final report not received.
Neal	Lynn		SWCA, Inc.	9/18/96 - 7/31/98	Hopi Point cellular tower archaeological inventory and assessment, Grand Canyon National Park	NRInfo Ref Code 628105. GRCA Library Call # F788 .C8588 2000. GRCA MC # GRCA 79059.

GRCA Permitted Research Studies – Archaeological Resources

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Neal	Lynn		SWCA, Inc.	10/13/98 - 12/31/98	A cultural resource data synthesis	NRInfo Ref Code 628105. GRCA Library Call # F788 .C8588 2000. GRCA MC # GRCA 79059.
Pederson	Joel	GRCA-00326, GRCA-00109	Utah State University	5/1/09 - 5/1/10 5/1/08 - 12/31/09 6/1/01 - 12/31/03	Historic Properties in Grand Canyon National Park; Testing the Utility of Monitoring and Mitigation Strategies for Gully Erosion of Cultural Sites in Grand Canyon	Also associated with GRCA-00109/GRCA-2001-SCI-0017 "Testing the utility of monitoring and mitigation strategies for gully erosion of cultural sites in Grand Canyon" [June 01, 2001-December 31, 2003].
Pederson	Joel	GRCA-00278	Utah State University	7/1/07 - 7/30/08 3/28/07 - 5/28/07 1/1/06 - 1/29/07 9/1/05 - 1/29/07	Development of a Treatment Plan for Selected Cultural Properties along the Colorado River Corridor of the Grand Canyon	Most current not issued? Under Helen Fairley's permit // Final report might be in GCMRC library.
Powell	Shirley		NAU	8/27/90 - 12/27/91 1/92 - 6/96 (??)	Archeological Survey along the Colorado River, Grand Canyon National Park	No final report received.
Rubin	David	GRCA-00208	USGS Pacific Science Center	5/2/10 - 5/2/11 5/1/09 - 5/1/10 1/30/08 - 12/30/10 1/1/07 - 12/30/07 10/1/03 - 12/31/05	Impact of aeolian deposition on preservation of cultural sites along the Colorado River in Grand Canyon National Park	NRInfo Ref Code 660779, 2170377, 2170379, 2170362. U.S. Geological Survey open-file report ; 2007-1001: http://purl.access.gpo.gov/GPO/LPS86803.
Samples	Terry		NAU/MNA	9/10/90 - 6/1/92	Proposal for Collecting Clay Samples within the Grand Canyon National Park along the River Corridor	E78.A7S23 1992 [in Cline Library] "Cohonina archaeology: the view from Sitgreaves Mountain" by Terry L. Samples.
Sucec	David		Utah Humanities Council Research Fellowship	3/15/92 - 12/31/92 6/1/91 - 12/31/91	Utah's First Expressionist Painters (Background Study of Shaman's Gallery)	E78 .U55 K38 1996 in GRCA Main Library and Cline Library.
Sullivan	Alan	GRCA-00322	University of Cincinnati	4/1/12 - 5/1/12 9/20/10 - 12/31/11 9/1/07 - 12/30/09	Satellite-Based Predictive Modeling of Small-Scale Archaeological Phenomena	Final report not received.

GRCA Permitted Research Studies – Archaeological Resources

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Thompson	Kathryn		SWCA, Inc. Environmental Consultants	4/1/98 - 12/31/99	Test and apply a Geomorphic Model related to Erosion of Pre-Dam River Terraces in the Colorado River Ecosystem Containing Cultural Materials.	"Development of Geomorphic Model to Predict Erosion of Pre-Dam Colorado River Terraces Containing Archeological Resources".
Thornton	Jerry			1967	Ecology of the Unkar Delta	NRInfo Ref Code 36734. GRCA MC # GRCA 59062.
Wilcox	David	GRCA-00401	MNA	6/1/07 - 12/30/08	Survey of Walled- and- Unwalled-Pinnacle Sites along the South Rim of Grand Canyon from Comanche to Enfilade Points	NRInfo Ref Code 2170561. Final report received 2009; scanned into E-file and sent to museum; Arch office also has a copy.

INDIGENOUS PEOPLES AND LINKS TO THE CANYON

Guiding Principles: Grand Canyon National Park maintains relationships and conducts meaningful government-to-government consultation with Traditionally Associated Tribes. Park managers respect tribal sovereignty and recognize that tribes have strong historic, cultural, and spiritual connections to the Grand Canyon region; and, that tribal members have knowledge about the lands now managed by the National Park Service. Park planning documents reflect a shared interest by the park and tribes to maintain healthy ecosystems and preserve and protect cultural and natural resources which in turn maintains the integrity of tribal associations.

Traditional Cultural Properties (TCP)/Ethnographic Resources

Desired Condition: Preserve the tangible and intangible elements critical to the integrity of culturally important places identified by Traditionally Associated Tribes. Access to Traditional Cultural Properties and sacred sites for traditional tribal practices is accommodated. Ethnographic and Traditional Cultural Properties identified by traditionally associated tribes and through research of tribal and park publications. Research data are verified by consultation.

Indicator	***Reference Condition***	***Target***
Condition More data are needed to define site condition according to tribal requirements Annual evaluation by tribal monitoring programs via reports that provide assessments and recommendations As appropriate, future documentation and/or nominations to the National Register	TCP = TBD Identification and documentation of TCPs ongoing; occurring on a project by project basis. Newly identified archaeological resources are documented and tribes typically consider these resources as TCPs. Ethnographic resources (Grand Canyon Ethnographic Database as of 3/2012) 38 mammals documented 3 amphibians documented 29 insects documented 87 birds documented 22 reptiles documented 2 fish documented 8 essential sites documented (landscape areas, archaeological sites, and water sources) 4 important sites documented 16 plants documented	The current conditions of TCPs and ethnographic resources are maintained at current levels or are improved. Improvement may include the lessening of visitor impacts or better information/education regarding the site's importance. TCPs and ethnographic resources are preserved in situ whenever possible Constructed trails are not present at TCP's or sacred sites except at well-known and open locations. Social trails are not present except where traditional uses continue (Hopi Salt Mine) Other visitor-related impacts are not present (graffiti, fire rings, evidence of camping, trash, and waste) Archaeological and architectural elements show limited evidence of visitor disturbances. Site information is current and is available as appropriate for the site (Unkar brochure, Tusayan Ruin guided tours) Important natural resources (plant, mineral) are conserved and restored as appropriate to the mission of the National Park Service and to sustain traditional cultural practices Access to sacred sites and opportunities for quiet, solitude, and privacy exist TCPs are preserved for their cultural importance and protected from impacts

GRCA TCPs/Ethnographic Resources Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Ethnographic Resources	Tabular	Database designed by the applied ethnography program in NPS - Ethnographic Resources Inventory (ERI). ERI serves as a guide for identifying what resources may be important to traditionally associated groups, who these associated groups may be and how the resource may be important to the group members.	Ellen Brennan Grand Canyon National Park	2008 - 2012	Park-wide	Identify resources, their uses and associated tribes. Spatially reference some resources.		ERI mandatory information includes: name of ethnographic resource, general category, name of associated group, NPS unit where the resource is located and bibliographic source of documentation for the resource record.	Simple dataset. Limited spatial information for ethnographic resources.

GRCA TCPs/Ethnographic Resources GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Havasupai Indian Reservation Map	GIS (Vector)	Digitized place names, springs, catchments, trails, and helicopter pads, from BIA reservation map	BIA et al., digitized by GRCA	1976	Havasupai Indian Reservation and Traditional Use Area			Digitized from paper map	unknown
Ethnographic Resources GRCA	GIS (Vector)	Ethnographic Resources for GRCA-related Tribes	School of Anthropology, Univ. of Arizona	2012	GGCLA Analysis Area	extents of Native American historical use		summarize publicly available information	unknown
Havasupai Traditional Use Area	GIS (Vector)	Traditional Use Area within GRCA	GRCA	2012	part of GRCA adjacent to Reservation	important resource area for traditional uses		integrated with GRCA Land data	none
American Indian Tribal Subdivisions	GIS (Vector)	American Indian Tribal Subdivisions	US Census Bureau/TIGER	2007	Arizona		not a legal record	unknown	none

TCPs/Ethnographic Resources Database and GIS Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Ethnographic Resources Inventory - Database and GIS Project	spatial and non-spatial data	Inventory of known ethnographic resources in GRCA and surrounding region including known sites, structures, objects, landscapes, and natural resources that have cultural meaning and value to peoples traditionally associated with the GRCA	University of Arizona (Hedquist and Ferguson, School of Anthropology)	2010	GRCA including some surrounding lands	Could provide spatial data of ethnographic resources or sites	Database is not publicly accessible	Database created using three relational tables in Microsoft Access, GIS created from informational database and supplemented with publicly available state and federal data	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
AZSITE Cultural Resource Inventory	spatial data	GIS that provides a consolidated informational network of recorded cultural resources, including prehistoric and historic sites and properties	AZSITE	pre-historic, historic, and recent	AZ	Spatial location and type of site, property, or surface survey	User Application form required, fees may be applicable	Four core agencies collaborating to manage, maintain, develop, and control access to AZSITE database system	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
NPS Cultural Resources Geographical Information System Facility (CRGIS)	spatial data	GIS data based on GPS surveys of national historic places	NPS Heritage Documentation Programs	historic and recent	National	Spatial location and type of cultural resource or site	Not publicly available	Based on GPS surveys of national historic places	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

GRCA Permitted Research Studies – TCPs/Ethnographic Resources

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Albert	Steve		Zuni Tribal Council	5/16/94 - 5/30/94	Collecting plants for traditional purposes	Final report not received.
Begay	Tim	GRCA-00244, GRCA-00199	Navajo Nation Natural Resources	8/1/12 - 8/1/13 6/3/11 - 6/3/12 6/2/10 - 6/2/11 6/1/09 - 6/1/10 8/1/06 - 10/30/07 7/20/04 - 7/20/05 8/1/03 - 9/30/03 5/5/00 - 12/31/02	Navajo Nation Annual Consultation/Monitoring River Trip	PI previously Marklyn Chee, Robert Begay, Tony Joe, Timothy Begay. See Ronda for annual reports.
Dongoske	Kurt	GRCA-00251	Zuni Heritage and Historic Preservation Office, Pueblo of Zuni	8/2/11 - 8/2/12 8/1/10 - 8/1/11 1/1/07 - 12/31/07 10/1/04 - 12/31/05	Zuni Long-term Monitoring of Traditional Cultural Places and Resources Located along the Colorado River through Grand Canyon	See Ronda for annual reports. Previous PI Jonathan Damp.
Haines	Jeremy	GRCA-00171	California State University	8/30/02 - 10/30/02	Ethnicity and ephemeral Native American archaeological sites in the historic period.	Final report received. 165 pgs. Ethnicity and historic Native American architecture on the Coconino Plateau, Arizona / by Jeremy D. Haines (Thesis – CSU Chico). Special Collections and Archives E98.A63 H356 2003.
Jackson	Loretta		Hualapai Tribe Cultural Resource Department	4/15/99 - 12/31/01	Hualapai Tribal Monitoring of Cultural Resources Programmatic Agreement for Glen Canyon Dam Operations	See Ronda for annual reports. NRInfo Ref Code 2170022.
Jackson-Kelly	Loretta	GRCA-00245	Hualapai Tribe	8/3/12 - 8/3/13 8/2/11 - 8/2/12 8/1/10 - 8/1/11 9/1/09 - 10/1/09 8/1/08 - 8/1/09 8/1/04 - 8/31/04	Hualapai Cultural Resources Programmatic Agreement (PA) River trip	See Ronda for annual reports.
Medwied-Savage	Jessica	GRCA-00594	NAU	5/17/11 - 5/15/12	Cultural Resources, Consultation, and Connections to Place at Grand Canyon National Park	See Ronda for final deliverable.

GRCA Permitted Research Studies – TCPs/Ethnographic Resources

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Mink	Philip	GRCA-00242	University of Kentucky	6/15/04 - 12/31/05	Testing the effectiveness of ground penetrating radar and non-site archaeology for reconstructing cultural landscapes in the Grand Canyon region, northern Arizona	Final report not received. Might be: "Identifying at-risk heritage resources with GIS: modelling the impact of recreational activities on the archaeological record" by Patrick M. Uphus, Alan P. Sullivan III, Philip B. Mink II in International journal of Risk Assessment and Management V. 6 Number 4-6/2006 p. 330-343.
Mink	Philip	GRCA-00510	University of Kentucky	9/15/08 - 9/15/09	Grand Canyon Indigenous Cultural Landscapes AD 400-AD1250: Phase I Geophysical and Geospatial Mapping and Modeling	Final report not received.
Pederson	Joel	GRCA-00278	Utah State University	7/1/07 - 7/30/08 3/28/07 - 5/28/07 1/1/06 - 1/29/07 9/1/05 - 1/29/07	Development of a Treatment Plan for Selected Cultural Properties along the Colorado River Corridor of the Grand Canyon	Most current not issued? Under Helen Fairley's permit // Final report might be in GCMRC library.
Phillips	Arthur		Hualapai Tribe	3/18/96 - 12/31/96 9/1/95 - 9/30/95	Hualapai Lower Gorge Environmental Studies	Final report not received.
Seiden	William	GC-22	Indiana University	1960 - 1963	Study of Havasupai Indian Language	GRCA Library Call # PM1311 .S44 1963.

Greater Grand Canyon Landscape Assessment

Wildlife TWG Meeting Summary

May 9, 2013

The first meeting of the GGCLA Wildlife Technical Work Group (TWG) was held on May 9th, 2013, to begin refining the scope and approach to assessing wildlife resources.

In attendance: Bill Austin (USFWS), Todd Chaudhry (NPS), Santiago Garcia (NPS), Jessica Gist (AZGFD), Shaula Hedwall (USFWS), Cerissa Hoglander (NAU), Greg Holm (NPS), Janice Stroud-Settles (NPS), Jennifer Holmes (NAU), Brandon Holton (NPS), Cari Kimball (NAU), Jeri Ledbetter (MNA), Cory Mosby (NPS), Mark Nebel (NPS), Jane Rodgers (NPS), Jill Rundall (NAU), Tom Sisk (NAU), Larry Stevens (MNA), Sasha Stortz (NAU)

Acronyms and symbols

AZGFD: Arizona Game and Fish Dept.

GGCLA: Greater Grand Canyon Landscape Assessment

GRCA: Grand Canyon National Park

LLECB: Lab of Landscape Ecology and Conservation Biology (NAU)

MNA: Museum of Northern Arizona

NAU: Northern Arizona University

SCPN: Southern Colorado Plateau Network

TWG: Technical Work Group

USFWS: US Fish and Wildlife Service

*indicates an action item

Meeting highlights

I. Discussion of indicators and threats for focal resources

- **Mountain lion**
  - Potential indicators: relative densities, survival rates, suitable habitat, kill sites, prey base (see below).
  - Potential threats: over hunting/poaching.
- **Desert bighorn sheep**
  - Potential indicators: Distribution, occupancy, mortality, lambing areas, water sources, forage.
  - Potential threats: Disease from domesticated sheep herds, predation, visitors, feral burros, overflights, climate change.
- **Mule deer**
  - Potential indicators: Distribution, population estimates, forage.
  - Potential threats: Elk.
- **Rocky mountain elk**
  - Considered as a threat to native species (e.g. sentry milk-vetch, mule deer), but could help limit mountain lion predation on bighorn sheep.
  - AZGFD/GRCA hoping to do a survey of S. Rim Elk in the park in late summer 2013 and water sources could be a key indicator.
- **Mexican spotted owl**
  - Potential indicators: Distribution, activity centers/occupancy, critical/suitable habitat, prey base.
  - Potential threats: Habitat degradation/loss (e.g. fire), climate change (e.g. thermoregulation), breeding season disturbance (e.g. noise, smoke).
- **California condor**
  - May be possible to coordinate assessment with Peregrine Fund/Chris Parrish and recent FWS 5-year review.
  - Lead is primary threat to condors, but also a broader ecosystem threat.
- **Northern goshawk**
  - Pros and cons of including as a focal resource were debated (e.g. long-term data on demography, distribution, and prey base vs. being a generalist/widespread species).
  - Reynolds et al. preparing monograph with details on indicators and threats across Kaibab Plateau.
- **Herpetofauna**

  - Focus on herpetofauna in the GRCA region has been relatively limited.
  - Potential focal species include: canyon tree frog, leopard frog, collared lizard, grand canyon pink rattlesnake.

II. Discussion of other potential focal resources

- Peregrine falcon
- Tamarisk beetle (vegetation group may also address this in the context of riparian vegetation impacts)
- Golden and bald eagles
- Avifauna (incl. passerines and waterbirds)
- Bats
- Southwest willow flycatcher
- Lower trophic/prey species (e.g. Kaibab squirrel, chipmunks, kangaroo rats, prairie dogs, shrews)
- Raptor migration corridors
- Invertebrates (e.g. Ants)
- Water resources are key to many of these species and wildlife nexus may be tied to Springs/Seeps assessment for GGCLA. Could add developed water source component (e.g. stock tank) and examine seasonal availability.

III. Discussion of data for focal resources and action items

Potential data sources for focal resources were discussed and need follow-up.

- Ecosystem models and trophic linkages should be developed for different habitats to help identify known/needed information (some already developed by Vankat for mixed conifer/spruce-fir).
- Avifauna data (e.g. peregrine falcon- L. Stevens, forest birds- SCPN, riparian birds- GRCA and GLCA/J. Spence, eagles- AZGFD/T. Jacobson)
- AZDGF/J. Gist has data/reviews for the Flagstaff area including mule deer, elk, a few reptiles, Abert's squirrels, wildlife corridors.
- USFW paper on how to identify focal resources.
- Invertebrate data (MNA/L. Stevens, ants by Wheeler (1905)).
- Condors/lead data (Peregrine Fund/C. Parrish).
- Bighorn sheep/overflights (C. Stockwell thesis).
- Hantavirus (GRCA/C. Chambers et al.).
- Amphibians (C. Drost/E. Nowak/USFWS/AZGFD)

Meeting detail

1. Introduction and background – Todd Chaudhry

Todd Chaudhry presented background information on the GGCLA, explained the process for selecting the focal resources, which started with a stakeholder workshop in October 2012, the collaborative nature of the assessment, and the purpose of the TWGs. Work groups are tasked with refining the scope of the assessment, identifying the best condition indicators and reference/desired conditions, identifying potential or known threats, identifying information and data needs that exists, and synthesizing the information to assess current conditions and trends. For complete details, see http://www.lci.nau.edu/projects/GreaterGrandCanyonLandscapeAssessment_Docs.aspx.

First stakeholder workshop last October was where the focal resources were initially identified.

Second Stakeholder workshop will review and refine resource assessments, conduct initial prioritization.

Third workshop will review and refine draft spatial analysis, identify opportunities for collaborative resource management

Todd presented an example of hump-backed chub assessment as a demonstration of analysis of a focal resource. Analysis includes: describe current conditions (from recent data, what are you comparing them to? how are you going to rate them as being good or bad? or improving or degrading?), identify reference and desired conditions, be explicit about threats (management tends to focus on this), but we want to make clear the link between the threat and the attributes of the focal resource, and what we can do about it.

This gets back to the prioritization concept; we're identifying the focal resources, which have value (to stakeholders and to NPS). Some have higher value than others, some may be more threatened. With limited resources, need to focus on high value resources that are highly threatened.

The scale of the analysis will depend on the resource being assessed, and the data available for that resource. But for the overall assessment, stakeholders felt that we should broaden the scope to include the park as geologically defined and to include relevant watersheds. Todd described the assessment area.

Work groups are tasked with refining the scope of the assessment. Need to identify what are the best condition indicators and reference/desired conditions; what are potential or known threats, what information and data needs exist; hope to synthesize the information to assess current conditions and trends.

Some wildlife species can be considered cultural resources. Want to identify watersheds that are high priority. Also want to identify species that are high priority (don't have the resources to do everything); endemic species

Ultimately we hope that work groups continue to be engaged in providing further guidance throughout the assessment process. We see the core staff in the parks and at NAU actually doing the assessment with input from external subject matter experts.

2. Defining the scope for wildlife condition assessment - Todd Chaudhry

At the end of the day, we want to have a summary of the information for each of our focal resources (what are they, how are they doing, what needs attention). NPS has developed an initial list of Resource Groups (taxa, potential indicators, primary threats)

These include:

- Top predator-prey system (Mt. lion, bighorn sheep, mule deer, rocky mountain elk)
- raptors (Mexican spotted owl, California condor, northern goshawk)
- Herpetofauna (reptiles, amphibians, northern leopard frog)—have often been neglected in the past. Erika Novak at NAU herpetologist has expressed interest in participating

Other considerations, which may be addressed in other work groups, or could be brought into this one include biodiversity, ethnographic resources, mesocarnivores, peregrine falcon (don't have current data), southwestern willow flycatcher (lots of information), avifauna (river corridor- data quality issues), aquatic mammals, bats, invasive species (bison, burros), fish (considered separately).

3. Group discussion of focal resources and scope

Conceptual framework of the assessment

- Is this an opportunity to use ecosystem models? Ecosystem modeling can be a good way of identifying data gaps and ecosystem health, productivity, some of the species can test trophic linkage and habitat connectivity, large scale ecosystem models could be a good way of looking into system health. These would begin as conceptual models. Way of stimulating thought about aspects of the system that might otherwise be overlooked.
- Some work has been done making conceptual models on mixed conifer forests on the north rim. Some of that work has also been done at Bandelier.
- What we're doing here is laying the groundwork to be able to do this sort of ecosystem modeling. First, we need to look at what information exists and organize and integrate this information to make it accessible and useful. Also, hope to prioritize a few of these data to analyze. We will probably fall short of an ecosystem model, but this landscape assessment might be getting us down the road so that in the future that is a more of an attainable goal.
- Looking at species and their trophic relationships could get at this; important not to focus on single species management
- Mule deer forage really important, do we need to incorporate other habitat and/or fire health indicators into this conversation? Or are vegetation and fire groups covering that?
- Chicken or the egg phenomenon—how to deal with talking about aspects of an ecosystem. How to write about one thing before you've addressed all the aspects that it is dependent upon?

Data resources

- Part of the challenge is looking at how the focal resources relate and how management decisions will impact things across the board.
- Is there an opportunity for improving wildlife observation throughout river corridor with river passengers and boatmen?
- **Park has been working with Grand Canyon River Runner's association more to get more data from them about wildlife observations. This is a great resource for us to utilize. We do have a large database of this information from river running observations. It would be good for us to bring those data sets together.***
- **Larry has information on peregrine falcon sightings – would be helpful to share data from that with Park.***
- Delisted species have monitoring programs; are there resources there?
- **Hawk Watch has data that could help on peregrines***

What makes a species a potential focal resource?

- Reasons to select species as a focal resource include: internal park perspective, input from first stakeholder meeting, general interest, and regulatory rationale
- Are these species getting at our indicators? Do they speak to our desired/reference conditions?
    - For example: Tom's three reasons for including goshawk:

      1) It influences a lot of management decisions at the landscape scale

      2) It does indicate broader conditions, like forest health

      3) There's a lot of data
    - A lot of our decisions might be contingent on data. Looking at what data sets are useful and reliable.
    - On the other hand, we don't want to not include something just because we don't have the data. One section of the report will identify what resources are important, but we don't have adequate data for

- From a modeling/GIS perspective. Don't want the presence or absence of data to drive the selection of focal resource. Sometimes, there are surrogate indicators or other information that we can use to pick up on the resource. Sometimes the data you think you need and the data you need are different.
- Reasons to include wildlife species in the assessment might include:
  - Endangered
  - Endemic
  - Extinct/extirpated (grizzly, wolves, jaguar, Sonoran river otter)
  - Exotic
  - Ecologically important (top predator)
  - Economically important (elk, also nonnative)
  - Migratory

Other potential species to include

- Golden eagle? Not endangered, but is protected
- Tamarisk beetle
  - Vegetation group will be looking at the beetle and its impact on the riparian vegetation. EIS on the Glen Canyon dam management decisions will also be looking into this study (on the main stem). Some of that work might be used to inform this GGCLA process as well.
- What about passerine avifauna?
  - Internal dataset for the avifauna is part of the Colorado River management plan.
  - There's 10 years of data by (John Spence?) that might be informative.
  - Some data quality issues in terms of density, but presence/absence might be useful.
  - Passerines - there data below the rim that's not riparian?
  - Broad interest in looking at birds to look at general patterns, which can be really useful.
  - Breeding bird atlas?
  - Species lists for the park are pretty good, but the distribution data is more spotty.
  - There's bird monitoring data on the mixed conifer on the north rim, and one year of monitoring data on the pinyon-juniper on the south rim. Upland monitoring of plants for the purposes of habitat assessment. So there's lots of vegetation monitoring.
  - Thinking of using some of the bird species as indicators for community types within the fire group.

Discussion of focal resources list sent out in advance of meeting

- Focal Resource Assessment examples were sent out in advance of the meeting (Bighorn Sheep, etc.) for people to look at and see what other parks have done. They are brief, but have useful information about how the resources are doing and address the "so what" for management decisions.
- Resources- AZGF has some short literature reviews made for the Flagstaff area. Have them for mule deer, elk, a few reptiles, squirrels.
- Need to look more at the insect species (5000 documented so far, probably about 25000 species in the park) many of them are endemic. Many of them are undocumented. So much biodiversity is invested in insects and it needs to be described. Why not have an ATBI of insects for the park?
- There might be better known and insect taxa that belong on this list (taxaonomic groups) that there might be good distribution data for it. If there was an aggregated way of representing biodiversity using the insects that would be great. If we could introduce invertebrate data into this process, maybe this could illuminate why it's a good reason to use insects as an indicator.
  - Hope to include the invertebrate data as an indicator of springs.
- If you want to keep California condor as a focal species, it might be useful to instead look at lead on the landscape as a more focal resource-specific threat. Condors are not the only species affected by that. Lead on the landscape could be a broader, more useful index. Golden eagles are affected as well.

- Peregrine Fund is the holder of a lot of that information.
- Might also add bats (concerns about white nose syndrome), any information about their occurrence and their persistence will be important to have. Don't know how often Scanton Cave has been monitored. Important to keep monitoring these sites. That will be included in the Cave section, and a research permit exists to continue studying them. Hope to use the preliminary data that they collect in this
- Could include Southwest willow flycatcher. Habitat is limited for this particular species in this area, and it's in flux due to changing water levels and to leaf beetles. Agency is concerned with the species and it's high on their radar screen.
- Back to mammals—might want to include some small mammals, burrowing mammals that are ecologically important (kangaroo rats maybe prairie dogs). Other trophic levels—ecologically important species. Endemic-wise there are a couple of shrews that occur on both rims, maybe check into the cover types that they inhabit. Relatively endemic chipmunks on the north rim. These might serve as prey or create habitat that is important. **Maybe we need to have existing map coverages look at these different trophic levels.***
- Golden eagles? And maybe even bald eagles? There hasn't been any monitoring of the bald eagles in recent years. We used to have one of the largest populations of bald eagles in the SW, but the changing fish management decisions might be impacting these populations. There was a golden eagle nest survey done recently.
- Raptor migration; aren't monitoring how they move through or around the GRCA.
- For migrations, AZGFD has some movement identified, corridors identified where tamarisk might be limiting bighorn movement. Statewide assessment, county-wide assessments, stakeholder data, and some fine scale monitoring (this is where the species accounts would come from).
- Need to think about how we determine whether that the focal resources we identify are the correct species that are indicative of the conditions we're trying to measure and monitor. Maybe want a credible science process to determine if these are the most appropriate species.
    - At the end of the day you're making the best professional judgment for which species to select
    - There is a F&W paper on how to identify a focal resource
    - Taking both a fine and course filter approach to selecting the species and resources and will make sure to provide sound rationale for including the resources that we do include.

Are there rationales we shouldn't use to include species in the list?

- Why elk?
    - Included based on input from the stakeholders, they have big management implications; they interact with other import species that we do want to look at. Including the elk in the discussion of Mountain Lion.
- Perhaps don't include wide ranging species that are not restricted to the Canyon, and not really limited by human activity (ravens for example)
    - Maybe goshawk would be excluded for the same reason. They and the Mexican spotted owl fill a similar focal niche.

4. Discussion of spatial analysis – Tom Sisk

In this project we're really talking about identifying data sources and really building up data resources so that they're useful to efforts in the future. The question is, what do we do with these data? We want to draw inference from the data, and we also want to do more advanced analysis and modeling and develop a richer set of resources.

- Forest ERA landscape assessments (Lab started 8 years ago). Example of Mexican Spotted Owl. Looked at management guidelines for MSO, what sorts of habitat requirements they might have, used that work to develop a simple, wall-to-wall map of predicted roosting habitat. Didn't do this to define where the habitat for direct management decision, but it put on the map a reasonable sense of where good habitat might be. Helps

steer us to where high priority areas might be. Hope we can mobilize the data that's available to both have a sense how resources are doing and also help us identify priority areas

- In the end, this MSO information analysis contributed to the recovery plan. Map had utility beyond what we initially thought. Generate data resources that can be useful to future work.
- Data drawn up using habitat information (forest cover information, etc).
- Map showed that there were some places where restoration efforts would improve MSO habitat, and some places where it would degrade the habitat.
- Try to be clear about what the data shows and how it can be properly used and what it can't be used for so that there's not inappropriate extrapolation
- Work was also done with tassel eared squirrels, passerine bird species richnes map, forage potential in New Mexico

Comment: In this system, of solar radiation and its impacts on productivity are not well understood. The aspect (north or south) is very important. North-facing slopes are far more productive. Topography has a big impact on ecosystem function here more than a lot of places.

- Aspect has a big impact on habitat suitability and also siting of cultural resources
- Will be important to consider in analyses

5. Continued resource condition discussion (post lunch-break)

Todd pointed the group to the wildlife technical working group outline.

Table with draft indicators to point to desired conditions, potential reference conditions. Not an exhaustive list of everything we know about each species. The group began discussion indicators based on the outline.

Mountain lions:

What are some indicators we should be thinking about?

Proposed include: Abundance, survival rate, distribution, suitable habitat, pretty base, connectivity

- Have data about density more than abundance. Have info on survival rates, have distribution, vegetative cover
- Don't have cover class heights
    - Could be inferred from the veg associations and descriptions of the associations. Might be a proxy.
    - Could also use kill sites and look at those data and overlay them with the vegetation and do statistical analysis to determine which veg types are in play
- Prey based data—on South Rim, fairly high density. South Rim cats tend to kill on the rim, North Rim cats tend to kill in the inner canyon more than their Southern counterparts.
- Information on hunting with the number of animals and when and where they were killed. Hunting causes 60-70% of lion deaths of the collared cats outside the park.
- Almost all the cats leave the park. So that's one reason why it's important that the boundaries of the GGCLA are wider than just the park.
- Not sure what this means for management decisions. We have a high density of cats, and lots of deaths associated with hunting. Need to do analysis to think about (for example) whether the hunting tag level is appropriate. How do the densities and survival rates compare to desired and/or reference levels?
- Might think about making a population model of the cats so that it gets at ecosystem health.
- Detectability might be an interesting factor to look at for the cat population. This could have management implications in terms of discouraging cats or encouraging cats from occupying certain areas
- In general, the lion habitat in the GRCA is fairly healthy

- **Potential threats? (Over) hunting/poaching** and whether the females are being hunted. Less concern about disease. Small threat in certain areas in terms of decline of prey base.
- **Big Horn might actually be protected by the number of elk on the south rim**. Elk calves are easy and vulnerable and slow and the big horn sheep have in some ways been afforded protection due to the elk presence.
- Interactions between elk and deer on the south rim? **Now primary prey are the elk,** some mule deer, less big horn predation
- **Elk could be a threat to the GRCA resource (out-competing mule deer), or it could be beneficial---reducing big horn predation**

Prey species

Bighorn sheep

- Game and Fish released a herd in the Paria. No sheep in Marble Canyon before then. Now there's a population in the upper canyon—probably related herds
- Biggest threat to **bighorn is disease introduced from domesticated herds. No disease currently in the Park**
- Sheep are being grazed on Navajo and Hualapai, and on Grand Staircase
- Look at potential for disease susceptibility based on where the bighorn are and how close they are to the domesticated herds/ leased grazing land
- Not sure how **visitor use, back-country use** is impacting the bighorn. Probable threat.
- **Predation** another threat, but not as much as one would predict.
- Backcountry Plan will hopefully address some bighorn sheep issues.
- **Burro impacts** on the sheep?
- Indicators of bighorn sheep? Current data: not a lot of data on the population number, but they're doing **preliminary analysis on fecal samples**. Getting better info on distribution, better info on lambing areas, and good info on the water sources. Not great info on the mortality causes.
- GRCA is one of 10 parks collecting data on desert bighorn sheep (all parks that have desert bighorn sheep in the desert SW). Looking at connectivity in and among herds. Collecting fecal samples for genetic material at all the parks. Hoping to do marked recapture study as well. Fecal sampling has been opportunistic—started to inform occupancy questions such as, "Why are we finding fecal matter here but not there?" (Could it be in relationship to where burros are?)
- Craig Stockwell's thesis dealing with overflights and sheep performance and how those flights impact the sheep feeding habits and habitat occupancy.*
- Forage info might be extractable from the veg layers.
- James Mead is in Kentucky now, but authority on sheep and had large sampled fecal collection
- Since we're not looking at modeling the impacts of climate change, that will be a big information gap. Potentially we could look at simple models that predict areas that will see biggest impacts from climate change
- GRCA has a really unique bighorn habitat. Limitations in extrapolating from studies done elsewhere to this unique habitat.

Mule deer

- Jessica might have more info on this topic

Elk

- Game and Fish hoping to do a survey of south rim elk in the park in the late summer of 2013. Maybe integrate a mule deer survey at the same time.
- Larry has seen them at top of 140-mile canyon.
- Pellets found on and down at Great Thumb.
- There is a GIS layer on water sources, stock tanks, etc.
- Might look at effluent from Desert View too.
- Maricopa point: Elk are impacting sentry milkvetch—seeing hoofprints around those plants.
- Having rim habitat as a focal resource on the south rim within the vegetation working group is important

Extirpated species

- Consider wolves, specifically?

Mexican Spotted Owl (MSO)

- Lots of work done on this species.
- Have occurrence where surveyed, but not abundance. Absence data not reliable (just not seeing the owl the one time you were in a space, doesn't mean they aren't ever there)
- Is MSO in any apparent danger in the GRCA?
- Models predicted more owls than what was surveyed. Some of the data is uncertain. **Owls may or may not be doing well in the GRCA.**
- **MSO can't thermoregulate that well, so climate change could be a real threat**
- What data do we need to determine if the population is in good health? Answer: distribution. Can't build a model until we have more distribution data. Detectability is an issue in the canyon. Reproduction data would also be helpful.
- Have enough data today to take a stab at the numbers, but we don't know if the population is healthy…
- Ecological Management Unit on the CO Plateau—is doing some studies, but that data might not translate well to the GGCLA study area. It is so much larger than the GGCLA
- Might look at small mammal habitat and how it impacts the MSO, but there isn't that much data on small mammals in the canyon. Past studies were mostly checking on hanta virus at the backcountry campsites—done in the early 90s(?)
- Other hantavirus studies done in the Greater GGCLA area (Carol Chambers et al)
- Bats are another food source for the MSO—they'll wait out outside of caves to hunt them
- Threat to the MSO—habitat degradation and destruction, but climate change is probably the biggest threat
- Disturbance poses a big threat to individuals, less to the population as a whole. Can inform management decisions

Condors

- Need to check in with Chris Parish on his work and what's being done. Chris is looking at movement data. Looking at the lead burden and how it's distributed across the landscape. How do surrogate species play into this all? Significant data resource that could be leveraged in a number of ways
- **Lead issue is the main threat** and as long as it's in the system, it's doubtful that there will ever be a self-sustaining population.
- Now condors go to up to the Zion area, initially they stayed around the Kaibab Plateau.

- If lead issue were resolved, **lack of prey could be the next threat**.
- Lead is a big threat to all raptors, as well as also impacts mesocarnivors and scavengers (coyotes, etc.)
- American Bird Conservancy—first petition for listing included a lit review with information about lead in a system.
- Humans also impacted by lead

Goshawk

- Do we want to include goshawk?
- Might it serve to help "umbrella" the four main habitat types in the GRCA?
- Species isn't at risk, but it's a good indicator of mature ponderosa pine forests.
- It's a generalist species, not sure if the management that we're doing in relationship to the species is beneficial to the rest of the system.
- Might be good to have a species that represents a smaller scale process (ex. Kaibab squirrel).
- Maybe have a "**raptorial birds" category that might be a focal theme**… Lump several species together.
- Maybe have some important prey species in relation to the raptors (since we have prey species related to the mountain lion)

Herpetofauna (Reptiles/Amphibians)

- Charles Rost has info on toads and frogs
- Collins work on leopard frog
- UWFWS and AZDGF have work on leopard frog* Shula to send additional reports
- Grand Canyon pink rattlesnake (studies of movement and behavior)
- Assessment reports for amphibians—presence/absence data (Shula to provide)*
- Mid 80s corridor survey (is already on the data list)
- Cryptic species within the canyon tree frog (3 species—one on each rim, one in the corridor)
- Data for GRCA on herpetofauna is pretty spotty. There's probably more going on there than we understand.
- Might look into the info from seeps and springs and on other riparian areas, what kind of inference can be drawn from that info? What conditions can be assessed?
- Collared lizards? Two species, might be an area that could see more research with partners
- Are there some species that USFWS and AZGFD would like push to the top of the priority list based on convergences in our work?

What about **water installations** and how those have been influencing wildlife populations in the park.

- There's a rough database of all the water resources in the park. Might be good to build out this map more. Maybe look at remotely sensed data.
- Challenges associated with installing water: allows species such as elk, coyote to move into spaces they wouldn't normally inhabit, can create dependence for animals on water sources that are unreliable, can create concentrations of prey
- GIS data layer of the forest service of tanks needs cleaning—data is old.
- Don't have the layer right now for Navajo or for BLM
- Cleaning up this data and having a comprehensive study would be a huge undertaking—it would need to be a big priority for a number of management decisions for that to be a worthy use of funds.
- Would need to think through when you're collecting the data as its highly dependent upon season

6. Concluding comments

Those people who are heavily involved in the overall project will be responsible for identifying the tasks and following up on what has been discussed here. Will come up with a preliminary framework that will fit into the larger framework.

- In the fall we will have another stakeholder workshop where we will roll out what has come out of the Technical Work groups, and maybe some preliminary products, and an opportunity for the broader stakeholder group to have additional input.

The meeting adjourned at about 3:00 PM.

Greater Grand Canyon Landscape Assessment (GGCLA)

Wildlife Resources Technical Workgroup Initial Meeting Outline

Thursday, May 9, 2013

Objectives and expectations

The Technical Workgroup will help to identify appropriate condition indicators, compile and evaluate data/information sources, develop assessment criteria and methods, and assess the conditions and trends of focal resources within its respective discipline. The workgroup will be facilitated by GRCA/NAU staff and will include other subject matter experts (SMEs) and stakeholder representatives, depending upon interest and availability. Participants will be expected to actively engage in the workgroup, including providing sound technical guidance, doing 'homework' in preparation for meetings, and helping to develop work products (e.g. literature reviews, spatial layers, condition assessments, etc.). Subsequent meetings (incl. conference calls/webinars) will be determined on an as needed basis. Specific objectives for the initial meeting include the following:

- Refine scope of assessment for focal resources (e.g. fine-/coarse-filter, ecosystemic-/taxonomic-level).
- Identify and assess preliminary condition indicators and reference/desired conditions.
- Identify and assess known/potential threats.
- Identify appropriate spatiotemporal scale(s) of analysis.
- Develop condition assessment criteria (e.g. indicator ranges/thresholds) and analytical approach (e.g. quantitative/qualitative score, spatial modeling).
- Identify and assess information/data needs, sources, and gaps.
- Identify specific tasks, products, roles, responsibilities, and timelines.

Focal resource(s)

Focal resources were identified based on input from participants during the GGCLA Workshop on October, 11th, 2012 and subsequent discussions amongst GRCA and NAU staff. Desired condition statements, indicators, reference conditions, and targets are from the 'Draft Grand Canyon National Park Desired Conditions' (2012) and references therein. *Denotes NPS Southern Colorado Plateau Network Vital Signs and Measures in the following tables as outlined in Thomas et al. 2006. TBD- To be determined based on GRCA and/or other relevant data sources (incl. workgroup products). Spatial and tabular datasets include those developed or acquired by GRCA. Data table color codes are as follows:

Documented	In Development	Not Documented	Not Evaluated	To be Developed

Research studies listed include relevant permitted research conducted in GRCA since 1958. Research results (e.g. reports, publications, datasets) are not necessarily readily available for all those listed.

Mountain Lions

Desired Condition: Ensure that GRCA continues to function as a probable source population for mountain lions in surrounding areas; maintain habitat connectivity and robust prey base.

Indicator	***Reference Condition***	***Target***
Suitable habitat on South Rim occupied	10 sample territories on South Rim occupied (Holton 2011), Arundel et al 2007, Dickson and Beier 2002	TBD
Suitable habitat on North Rim occupied	Partial sample territories on North Rim occupied (Holton 2011, Arundel et al 2007). Determine reference conditions via on-going telemetry studies	TBD
Suitable prey base	(Holton 2011, Mattson et. al 2007, Logan and Sweanor 2000, Ruth and Murphy 2010)	Maintain a healthy native mule deer population on both north and south rims, and bighorn sheep populations in the inner canyon
Sustainable survival rates	(Holton 2011, Mattson et al 2007, Cunningham et al 2001)	Maintain an annual adult survival rate of 70% or greater
Suitable connectivity	(Holton 2011, Arundel et al 2007, Dickson and Beier 2002, Logan and Sweanor 2000)	Maintain corridor (particularly along rim habitat) and primary source habitat

GRCA Mountain Lion Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Mountain Lion Capture Locations	Tabular	Data set includes information on capture locations of mountain lions. A unique identifier is assigned to every mountain lion captured.	Brandon Holton Grand Canyon National Park	2003 - 2010	Eastern half of Park	Identify traps with successful or unsuccessful trapping. Identify locations of multiple captures for individual mountain lions.	Limited number of records.	Data set includes trapping information - trap name, UTM coordinates and narrative description of capture location. Also includes basic mountain lion information such as unique identifier, sex, and weight.	Simple to convert tabular data to spatial layer.
Mountain Lion Trapping Locations	Tabular	Simple data set storing mountain lion trap name and coordinates.	Brandon Holton Grand Canyon National Park	2007 - 2010	Eastern half of Park	Identify locations of mountain lion traps.		Trap locations are re-evaluated yearly. Traps may be removed and new traps may be located.	Simple to convert tabular data to spatial layer.
Mountain Lion Cluster Investigation	Tabular	Limited movement of collared mountain lions was investigated to determine activity type(s), habitat characteristics of area, and weather measurements during cluster period.	Brandon Holton Grand Canyon National Park	2005 - 2009	Eastern half of Park	Explore possible spatial and temporal patterns in activity of mountain lions.	Limited number of records.	Spatial information about the cluster includes cluster centroid coordinates and elevation. Three activity types can be recorded along with confidence in the diagnosis of activity. Aspect, slope and topography are recorded. Recorded vegetation characteristics include percent cover, habitat type, dominant cover type. Latrines, scat, tracks and beds are noted.	Simple to convert tabular data to spatial layer.

GRCA Mountain Lion GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Puma	GIS (Vector)	Telemetry	GRCA	2010-2012?	GRCA	Potential habitat, movements	spatially and temporally limited data	Telemetry	Moderate to High
Stock Tanks	GIS (Vector)	Stock tank (pts and polys) within GRCA	GRCA GIS	updated 2/7/2013	GRCA	Potential as water sources or habitat for wildlife	Some features not field-verified	Digitized from NAIP or high-res imagery	
Burn Severity	GIS (Vector)	Burn Severity for GRCA Fires	GRCA Fire	2001-2011	GRCA	Potential effects on habitat	Only where fires have occurred; only data since 2011	MODIS satellite	Minimal
Fire History	GIS (Vector)	Perimeters of historic fires in GRCA	GRCA Fire	1910-2012	GRCA	Potential effects on habitat	earlier data (pre-1950) is of questionable accuracy	aircraft GPS since 1998; earlier data unknown	Minimal
Springs Seeps	GIS (Vector)	Springs and Seeps in GRCA and vicinity	GRCA Hydrology	updated 12/19/2012	GRCA and vicinity	Potential as water sources or habitat for wildlife	Point locations only; most have not been inventoried	Rec GPS; USGS 1:24K quad maps	Unknown to link to Inventory data
National Hydrography Dataset	GIS (Vector)	Hydrography	USGS NHD	downloaded 10/6/2012	GGCLA Analysis Area sub-basins	Potential as water sources or habitat for wildlife	1:24K	USGS 1:24K topo maps; USGS PBS maps	None
National Elevation Dataset	GIS (Raster)	Digital Elevation Data; derivatives Aspect, Slope	USGS; Mosaic and Derivatives by GRCA GIS	downloaded 1/1/2009	most of GGCLA Analysis Area; remainder available from USGS	Potential habitat modeling	modeled at 10m cell size	Diverse source data	Moderate to download and mosaic additional data to completely cover the Analysis Area; potentially High if other derivations or models are needed
Transportation	GIS (Vector)	Road and Trails	GRCA GIS; BLS; USFS	updated 3/13/2013	most of GGCLA Analysis Area	Potential habitat fragmentation, human access	Data outside GRCA is incomplete and from different sources, with different attributes	Varied, but with feature-level metadata	Significant to compile from various sources to a single standard over entire Analysis Area
Vegetation Map	GIS (Vector)	Vegetation (Associations)	GRCA	9/12/2012	GRCA and GC-Parashant NM	Potential habitat modeling	1-hectare minimum mapping unit size; Does not cover entire GGCLA Analysis Area; only a small fraction of polygons field-verified	NAIP imagery (2007 and 2010) segmentation, CART analysis, and field editing	None
Vegetation Plots	GIS (Vector)	Vegetation Classification Plots	GRCA	2007-2008	GRCA and GC-Parashant NM	Potential habitat modeling	Plot data is in a separate SQL Server database, but easily linked; only 76 (3.4%) of Plots are in	Rec GPS (+/- 5 meters)	Minimal

GRCA Mountain Lion GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
							Riparian Lifeform types		
Biotic Communities Of The Southwest	GIS (Vector)	Biotic Communities	Brown and Lowe; Nature Conservancy; ALRIS; IMADSES; NMCFWRU	2004	Arizona	Potential habitat modeling	1:1 million scale; very broad units	Scan and digitize paper map	None
Colorado River Vegetation USGS 2002	GIS (Vector)	Riparian Vegetation along the CO River Corridor	GCMRC	2002	CO River Corridor	Potential habitat modeling	CO River Corridor only; there is an outlier in southern AZ that suggests entire dataset should be re-checked	Ground surveys and image processing	Minimal to Moderate, depending on review of the data outlier
Natural Vegetation AGFD 1976	GIS (Vector)	Natural Vegetation	AZ Game and Fish	1976	Arizona	Potential habitat modeling	Large data gaps in GGCLA Analysis Area	Digitized from drawn maps?	Unknown
Vegetation Warren 1982	GIS (Vector)	Vegetation types	UA and NPS (Warren, Recihhardt, and Mouat)	1982	GRCA	Potential habitat modeling	GRCA extent only; Doesn't appear to have Riparian Veg types; Newest GRCA Veg mapping (2012) is judged better	Unknown	None
Veg 2000	GIS (Vector)	Vegetation for FARSITE modeling	GRCA	2000	Parts of GRCA N and S Rims	Potential habitat modeling	Only covers portions of GRCA; modified from Vegetation_Warren_1982 for FARSITE modeling	Unknown	Unknown
PAD-US	GIS (Vector)	US Protected Area Database; GAP Status, Protected Areas, Land Ownership	NPScape, USGS GAP	2/22/2011	GGCLS Analysis area and beyond	Potential measure of habitat quality	Not all areas within the GGCLA Analysis Area are attributed, or sources clearly identified	Multiple	Minimal, but data currently as Web Service; extraction could be Moderate
Roadless Areas	GIS (Vector)	Areas without Roads ("raw" and "Major Roads"	NPScape, ESRI	2005	GGCLS Analysis area and beyond	Potential habitat fragmentation, human access	The ESRI Roads data doesn't accurately reflect the current Road system in GRCA, and perhaps elsewhere	Buffer of existing Roads layers	Moderate to High
Land Cover	GIS (Raster)	Land Cover, Land Cover Change	NPScape, NLCD, NOAA, NALC	2006	GGCLS Analysis area and beyond	Potential measure of habitat quality and threats		Multiple	Unknown

GRCA Mountain Lion GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Overflights	GIS (Vector)	Flight Tour Routes and Flight Free Zones	GRCA, FAA	current	GRCA	Noise levels as a threat to habitat		None for current condition; draft NPS Modified Preferred Alternative is restricted	Low
Wilderness	GIS (Vector)	Proposed GRCA Wilderness	GRCA	proposed	GRCA	Measure of protected status and potential measure of habitat quality	Not yet finalized, as part of BCMP	None	Low

Mountain Lion Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Harvest point locations	GIS (vector)	Puma locations from hunter harvests	Brad McRae and AGFD	through 2011	AZ, UT	Habitat models	MOU required; less than 20 locations fall in Analysis area	Hunter volunteer location and tissue sample	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

GRCA Permitted Research Studies – Mountain Lions

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Heins	David	n/a	Millsaps College, Mississippi	1979	Ecologic and systemic investigations of mammals and fishes	Final report not received.
Hoffmeister	Donald	GC-7	University of Illinois	c. 1954 - 1964	The Mammals of Grand Canyon National Park	NRInfo Ref Code 164886. GRCA Library Call # QL719 .A6 H58 1971 c.1-4.

Bighorn Sheep

Desired Condition: Desert bighorn populations are robust, protected, and classified as a sensitive species/species of special concern at Grand Canyon. The distribution and abundance of bighorn at GRCA are maintained at a level indicative of high population viability, ensuring pathways of genetic exchange among metapopulations, and protecting special use areas (i.e. lambing areas). Bighorn forage, water sources, and escape terrain are available within the park across all seasons, and competition for resources with non-native species is eliminated.

Indicator	***Reference Condition***	***Target***
Number and distribution of breeding and lambing areas	TBD (Holton 2012 in prep)	TBD
Number and distribution of water sources other than Colorado River	Seeps and Springs Map (GRCA 2011)	Water flow in seeps and springs remains within historic range of natural variability and are not impacted by non-native burros, back-country users, or modifications to groundwater tapping
Mortality factors	TBD (Holton 2012 in prep, Rominger et al 2004)	TBD
Seasonal movements	TBD (Sappington et al 2007, Holton 2012 in prep)	TBD
Availability of preferred forage	BD (Krausman et al 1989, KGA 2012, Holton 2012 in prep)	TBD

GRCA Bighorn Sheep Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Bighorn River Observations	Tabular	Bighorn observations made in the Colorado River corridor, usually during a river trip. Age and sex are recorded as well as activity. Approximate distance from the river is also recorded.	Greg Holm Grand Canyon National Park	2005 - present	Colorado River corridor	Identify areas where bighorn are seen in the Colorado River corridor.	Limited number of records. Expertise of observers varies widely.	When a bighorn is viewed the following is recorded - river mile and/or coordinates, river side, date, time, total group size, number of each age class, vertical and horizontal distance from the river, activity, weather, river trip information and comments.	Simple to convert tabular data to spatial layer.
Bighorn Collars Deployed	Tabular	Recently initiated project to collar and track bighorn sheep movements. This data set records details on collars deployed.	Brandon Holton Grand Canyon National Park	2012	Colorado River corridor	Identify the number and types of collars deployed.	Only 2 collars have been deployed.	Collared bighorn is given a unique identifier, age and sex are recorded. Detail collar information is recorded including VHF frequency and collar type. Release of sheep is located with UTM coordinates.	Simple dataset. Limited spatial information.

GRCA Bighorn Sheep GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Bighorn Sheep	GIS (Vector)	Telemetry, Observations	GRCA	2012	Colorado River Corridor, primarily	Potential habitat, movements	spatially and temporally limited data	Telemetry, Observations	Moderate to High
Stock Tanks	GIS (Vector)	Stock tank (pts and polys) within GRCA	GRCA GIS	updated 2/7/2013	GRCA	Potential as water sources or habitat for wildlife	Some features not field-verified	Digitized from NAIP or high-res imagery	
Burn Severity	GIS (Vector)	Burn Severity for GRCA Fires	GRCA Fire	2001-2011	GRCA	Potential effects on habitat	Only where fires have occurred; only data since 2011	MODIS satellite	Minimal
Fire History	GIS (Vector)	Perimeters of historic fires in GRCA	GRCA Fire	1910-2012	GRCA	Potential effects on habitat	earlier data (pre-1950) is of questionable accuracy	aircraft GPS since 1998; earlier data unknown	Minimal
Springs Seeps	GIS	Springs and Seeps in	GRCA Hydrology	updated	GRCA and	Potential as water	Point locations only;	Rec GPS; USGS	Unknown to link to

GRCA Bighorn Sheep GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
	(Vector)	GRCA and vicinity		12/19/2012	vicinity	sources or habitat for wildlife	most have not been inventoried	1:24K quad maps	Inventory data
National Hydrography Dataset	GIS (Vector)	Hydrography	USGS NHD	downloaded 10/6/2012	GGCLA Analysis Area sub-basins	Potential as water sources or habitat for wildlife	1:24K	USGS 1:24K topo maps; USGS PBS maps	None
National Elevation Dataset	GIS (Raster)	Digital Elevation Data; derivatives Aspect, Slope	USGS; Mosaic and Derivatives by GRCA GIS	downloaded 1/1/2009	most of GGCLA Analysis Area; remainder available from USGS	Potential habitat modeling	modeled at 10m cell size	Diverse source data	Moderate to download and mosaic additional data to completely cover the Analysis Area; potentially High if other derivations or models are needed
Transportation	GIS (Vector)	Road and Trails	GRCA GIS; BLS; USFS	updated 3/13/2013	most of GGCLA Analysis Area	Potential habitat fragmentation, human access	Data outside GRCA is incomplete and from different sources, with different attributes	Varied, but with feature-level metadata	Significant to compile from various sources to a single standard over entire Analysis Area
Vegetation Map	GIS (Vector)	Vegetation (Associations)	GRCA	9/12/2012	GRCA and GC-Parashant NM	Potential habitat modeling	1-hectare minimum mapping unit size; Does not cover entire GGCLA Analysis Area; only a small fraction of polygons field-verified	NAIP imagery (2007 and 2010) segmentation, CART analysis, and field editing	None
Vegetation Plots	GIS (Vector)	Vegetation Classification Plots	GRCA	2007-2008	GRCA and GC-Parashant NM	Potential habitat modeling	Plot data is in a separate SQL Server database, but easily linked; only 76 (3.4%) of Plots are in Riparian Lifeform types	Rec GPS (+/- 5 meters)	Minimal
Biotic Communities Of The Southwest	GIS (Vector)	Biotic Communities	Brown and Lowe; Nature Conservancy; ALRIS;	2004	Arizona	Potential habitat modeling	1:1 million scale; very broad units	Scan and digitize paper map	None

GRCA Bighorn Sheep GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
			IMADSES; NMCFWRU						
Colorado River Vegetation USGS 2002	GIS (Vector)	Riparian Vegetation along the CO River Corridor	GCMRC	2002	CO River Corridor	Potential habitat modeling	CO River Corridor only; there is an outlier in southern AZ that suggests entire dataset should be re-checked	Ground surveys and image processing	Minimal to Moderate, depending on review of the data outlier
Natural Vegetation AGFD 1976	GIS (Vector)	Natural Vegetation	AZ Game and Fish	1976	Arizona	Potential habitat modeling	Large data gaps in GGCLA Analysis Area	Digitized from drawn maps?	Unknown
Vegetation Warren 1982	GIS (Vector)	Vegetation types	UA and NPS (Warren, Recihhardt, and Mouat)	1982	GRCA	Potential habitat modeling	GRCA extent only; Doesn't appear to have Riparian Veg types; Newest GRCA Veg mapping (2012) is judged better	Unknown	None
Veg 2000	GIS (Vector)	Vegetation for FARSITE modeling	GRCA	2000	Parts of GRCA N and S Rims	Potential habitat modeling	Only covers portions of GRCA; modified from Vegetation_Warren _1982 for FARSITE modeling	Unknown	Unknown
PAD-US	GIS (Vector)	US Protected Area Database; GAP Status, Protected Areas, Land Ownership	NPScape, USGS GAP	2/22/2011	GGCLS Analysis area and beyond	Potential measure of habitat quality	Not all areas within the GGCLA Analysis Area are attributed, or sources clearly identified	Multiple	Minimal, but data currently as Web Service; extraction could be Moderate
Roadless Areas	GIS (Vector)	Areas without Roads ("raw" and "Major Roads"	NPScape, ESRI	2005	GGCLS Analysis area and beyond	Potential habitat fragmentation, human access	The ESRI Roads data doesn't accurately reflect the current Road system in GRCA, and perhaps	Buffer of existing Roads layers	Moderate to High

GRCA Bighorn Sheep GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
							elsewhere		
Land Cover	GIS (Raster)	Land Cover, Land Cover Change	NPScape, NLCD, NOAA, NALC	2006	GGCLS Analysis area and beyond	Potential measure of habitat quality and threats		Multiple	Unknown
Overflights	GIS (Vector)	Flight Tour Routes and Flight Free Zones	GRCA, FAA	current	GRCA	Noise levels as a threat to habitat		None for current condition; draft NPS Modified Preferred Alternative is restricted	Low
Wilderness	GIS (Vector)	Proposed GRCA Wilderness	GRCA	proposed	GRCA	Measure of protected status and potential measure of habitat quality	Not yet finalized, as part of BCMP	None	Low

Bighorn Sheep Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Habimap - Mammal Distributions - Bighorn Sheep	GIS (raster)	Generalized habitat distributions for Desert and Rock Mountain Bighorn Sheep	AGFD	2011	AZ	Generalized mammal distributions for Species of Greatest Conservation Need	Information is available only in interactive map form	Species of Greatest Conservation Need based on list identified in Arizona State Wildlife Action Plan	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Desert Bighorn Sheep Habitat (bighorn)	GIS (vector)	Anticipated desert bighorn sheep habitat on the AZ Strip based on ground-truthed pre-1988 topographic maps that identified elevations over 3600 feet that had mountain ranges with sheep populations	BLM	2007	AZ Strip	Predicted bighorn sheep habitat for AZ Strip region	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

Bighorn Sheep Database and GIS Summary – External sources

Faunmap - Bighorn Sheep	non-spatial data (*.txt database files transferrable to GIS)	Generalized national spatial distributions of desert bighorn sheep for late Quaternary	Illinois State Museum	1995	Mojave Desert Network Parks	Historic mammal distributions	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

GRCA Permitted Research Studies – Bighorn Sheep

PI Last Name	***PI First Name***	***Study #***	***Affiliations***	***Study Length***	***Title***	***Data Availability***
Blaisdell	James	GC-16	GRCA	1960 - 1964	Bighorn-Burro Competition Study	NRInfo Ref Code 120097
Ghiglieri	Michael	n/a	University of California – Davis	11/1/84 - 12/31/86	The Ecology and Population Dynamics of Desert Bighorn Sheep in Grand Canyon National Park	Final report not received
Heins	David	n/a	Millsaps College, Mississippi	1979	Ecologic and systemic investigations of mammals and fishes	Final report not received
Hoffmeister	Donald	GC-7	University of Illinois	c. 1954 - 1964	The Mammals of Grand Canyon National Park	NRINfo Ref Code 164886. GRCA Library Call # QL719 .A6 H58 1971 c.1-4.
Stockwell	Craig	n/a	NAU	1984 - 1987	The Effect of Helicopter Overflights on the foraging behavior of desert bighorn sheep (*Ovis Canadensis nelsoni*) at Grand Canyon National Park	NRInfo Ref Code 37105. GRCA Library Call # QL737.U53 S75 1985, QL737.U53 S76 1987, QL737.U53 S75 1989.
Vaughan	Michael	GRCA-00040	Virginia Polytechnic Institute and State University	6/1/01 - 12/31/03	Population estimation and development of a land-based classification protocol for bighorn sheep in Grand Canyon National Park, as amended by supplements and other communications.	Final report not received

Raptors

Desired Condition: Raptors are present and well-distributed through all historically occupied habitats. Raptor nesting and production of fledglings is within the normal range of variation for the given habitats. Threatened and Endangered species population numbers, breeding activity, and presence of nesting and foraging habitat are aligned with recovery plan goals (USFWS 1996, 2012).

Indicator	***Reference Condition***	***Target***
Occupied territories	TBD	TBD
Production of young	TBD	10% of territories are monitored annually for production of young
Prey resources (species, abundance and distribution)	Determine reference conditions through mark-recapture methods	Maintain reference conditions
Wild condor population number	Most recent years data	100 by 2020; 150 for delisting
Successful condor nesting attempts	Average number since nesting first detected (2003)	An average of 5 annually by 2020
Mexican Spotted Owl occupancy rates	TBD	Owl occupancy rates stable or increasing trend after 10 years of monitoring (USFWS 2012)

GRCA Raptors Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Mexican Spotted Owl Surveys	Tabular	Surveys for MSO can occur for these purposes - inventory, compliance and monitoring. These survey types essentially record the same information - basic survey information, owl detection information and nest location information.	Janice Stroud-Settles Grand Canyon National Park	2001 - present	Primarily in eastern half of Park	Spatially locate where MSO surveys have been conducted. Spatially locate where MSOs have been detected. Spatially locate where MSO nests have been found. And possibly determine reproductive success.	Does not represent a systematic Park-wide survey.	Basic survey information is recorded including type of survey, date, observer(s), start/end time, coordinates, PAC name and result of survey. Any species of owl detected will include observation type (heard, visual, both), call type, age, sex and UTM coordinates. When a nest is located UTM coordinates are recorded.	Spatially locating surveys, owl detections and nests is simple.
Northern Goshawk Surveys	Tabular	NOGO surveys conducted for compliance. Information recorded includes basic survey information, Accipiter detection information and nest location information.	Janice Stroud-Settles Grand Canyon National Park	2004 - 2011	Eastern half of Park on North and South rims	Spatially locate where NOGO surveys have been conducted. Spatially locate where NOGOs have been detected. Spatially locate where NOGO nests have been found. And possibly determine reproductive success.	Does not represent a systematic Park-wide survey.	Basic survey information is recorded including date, start time, coordinates and result of survey. Any species of Accipiter detected will include observation type (heard, visual, both), call type, age, sex and UTM coordinates. Discovery of a nest is also noted.	Spatially locating surveys, NOGO detections and nests is simple.
California Condor Observations	Tabular	Contains Condor observation information including a textual description of location and Condor number.	Greg Holm Grand Canyon National Park	2009 - present	Park-wide	Identify areas where California Condors are seen in the Park. Possibly identify spatial patterns for individual Condors.	Observation locations are provided as common name place, rather than coordinates.	Observation information includes unique bird number, detection type, date, time, observer and common name place.	Simple to convert tabular data to spatial layer.

GRCA Raptors GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
MSO	GIS (Vector)	MSO Habitat, Home Range and Core Areas, Nests, Roosts, PACs, Telemetry, Critical Habitat, and Surveys	GRCA, USFWS	1992-2012	GRCA	MSO range, habitat, etc.	various stages of development	Multiple	Moderate to High
California Condor	GIS (Vector)	Condor Sightings, Nests, Distribution	GRCA	2008	GRCA	Range, habitat, etc.	Highly variable and incomplete data	Multiple	Moderate to High
Northern Goshawk	GIS (Vector)	Historic Nest Sites	GRCA	Unknown	GRCA	Potential habitat	unknown data quality	Unknown	Moderate to High
Peregrine Falcon	GIS (Vector)	Territories	Unknown	Unknown	GRCA	Potential habitat	spatially and temporally limited data	Unknown	Moderate to High
Stock Tanks	GIS (Vector)	Stock tank (pts and polys) within GRCA	GRCA GIS	updated 2/7/2013	GRCA	Potential as water sources or habitat for wildlife	Some features not field-verified	Digitized from NAIP or high-res imagery	
Burn Severity	GIS (Vector)	Burn Severity for GRCA Fires	GRCA Fire	2001-2011	GRCA	Potential effects on habitat	Only where fires have occurred; only data since 2011	MODIS satellite	Minimal
Fire History	GIS (Vector)	Perimeters of historic fires in GRCA	GRCA Fire	1910-2012	GRCA	Potential effects on habitat	earlier data (pre-1950) is of questionable accuracy	aircraft GPS since 1998; earlier data unknown	Minimal
Springs Seeps	GIS (Vector)	Springs and Seeps in GRCA and vicinity	GRCA Hydrology	updated 12/19/2012	GRCA and vicinity	Potential as water sources or habitat for wildlife	Point locations only; most have not been inventoried	Rec GPS; USGS 1:24K quad maps	Unknown to link to Inventory data
National Hydrography Dataset	GIS (Vector)	Hydrography	USGS NHD	downloaded 10/6/2012	GGCLA Analysis Area sub-basins	Potential as water sources or habitat for wildlife	1:24K	USGS 1:24K topo maps; USGS PBS maps	None
National Elevation Dataset	GIS (Raster)	Digital Elevation Data; derivatives Aspect, Slope	USGS; Mosaic and Derivatives by GRCA GIS	downloaded 1/1/2009	most of GGCLA Analysis Area; remainder available from USGS	Potential habitat modeling	modeled at 10m cell size	Diverse source data	Moderate to download and mosaic additional data to completely cover the Analysis Area; potentially High if other derivations or models are needed

GRCA Raptors GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Transportation	GIS (Vector)	Road and Trails	GRCA GIS; BLS; USFS	updated 3/13/2013	most of GGCLA Analysis Area	Potential habitat fragmentation, human access	Data outside GRCA is incomplete and from different sources, with different attributes	Varied, but with feature-level metadata	Significant to compile from various sources to a single standard over entire Analysis Area
Vegetation Map	GIS (Vector)	Vegetation (Associations)	GRCA	9/12/2012	GRCA and GC-Parashant NM	Potential habitat modeling	1-hectare minimum mapping unit size; Does not cover entire GGCLA Analysis Area; only a small fraction of polygons field-verified	NAIP imagery (2007 and 2010) segmentation, CART analysis, and field editing	None
Vegetation Plots	GIS (Vector)	Vegetation Classification Plots	GRCA	2007-2008	GRCA and GC-Parashant NM	Potential habitat modeling	Plot data is in a separate SQL Server database, but easily linked; only 76 (3.4%) of Plots are in Riparian Lifeform types	Rec GPS (+/- 5 meters)	Minimal
Biotic Communities Of The Southwest	GIS (Vector)	Biotic Communities	Brown and Lowe; Nature Conservancy; ALRIS; IMADSES; NMCFWRU	2004	Arizona	Potential habitat modeling	1:1 million scale; very broad units	Scan and digitize paper map	None
Colorado River Vegetation USGS 2002	GIS (Vector)	Riparian Vegetation along the CO River Corridor	GCMRC	2002	CO River Corridor	Potential habitat modeling	CO River Corridor only; there is an outlier in southern AZ that suggests entire dataset should be re-checked	Ground surveys and image processing	Minimal to Moderate, depending on review of the data outlier
Natural Vegetation AGFD 1976	GIS (Vector)	Natural Vegetation	AZ Game and Fish	1976	Arizona	Potential habitat modeling	Large data gaps in GGCLA Analysis Area	Digitized from drawn maps?	Unknown
Vegetation Warren 1982	GIS (Vector)	Vegetation types	UA and NPS (Warren, Recihhardt, and Mouat)	1982	GRCA	Potential habitat modeling	GRCA extent only; Doesn't appear to have Riparian Veg types; Newest GRCA Veg mapping (2012) is judged better	Unknown	None

GRCA Raptors GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Veg 2000	GIS (Vector)	Vegetation for FARSITE modeling	GRCA	2000	Parts of GRCA N and S Rims	Potential habitat modeling	Only covers portions of GRCA; modified from Vegetation_Warren_1982 for FARSITE modeling	Unknown	Unknown
PAD-US	GIS (Vector)	US Protected Area Database; GAP Status, Protected Areas, Land Ownership	NPScape, USGS GAP	2/22/2011	GGCLS Analysis area and beyond	Potential measure of habitat quality	Not all areas within the GGCLA Analysis Area are attributed, or sources clearly identified	Multiple	Minimal, but data currently as Web Service; extraction could be Moderate
Roadless Areas	GIS (Vector)	Areas without Roads ("raw" and "Major Roads"	NPScape, ESRI	2005	GGCLS Analysis area and beyond	Potential habitat fragmentation, human access	The ESRI Roads data doesn't accurately reflect the current Road system in GRCA, and perhaps elsewhere	Buffer of existing Roads layers	Moderate to High
Land Cover	GIS (Raster)	Land Cover, Land Cover Change	NPScape, NLCD, NOAA, NALC	2006	GGCLS Analysis area and beyond	Potential measure of habitat quality and threats		Multiple	Unknown
Overflights	GIS (Vector)	Flight Tour Routes and Flight Free Zones	GRCA, FAA	current	GRCA	Noise levels as a threat to habitat		None for current condition; draft NPS Modified Preferred Alternative is restricted	Low
Wilderness	GIS (Vector)	Proposed GRCA Wilderness	GRCA	proposed	GRCA	Measure of protected status and potential measure of habitat quality	Not yet finalized, as part of BCMP	None	Low

Raptors Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
California Condors Released in AZ	non-spatial data (tabular)	Current location and occurrence status of condors in AZ	The Peregrine Fund	2013	CA, AZ, MX	Identification of general condor population locations	Not spatial data	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
California Condor Recovery Population Size	non-spatial data (tabular)	Overview page with population size and distribution	The Peregrine Fund	2013	CA, AZ, MX	Identification of general condor population numbers at locations	Not spatial data	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Habimap - Arizona Important Bird Areas	GIS (vector)	Varied habitats important for all AZ native birds, including riparian habitat and Sky Island habitat	Arizona Game and Fish Department	2012	AZ	Identification of general important bird areas	Information is available only in interactive map form	Based on National Audubon Society information from United States Important Bird Area program	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Habimap - Bird Distributions	GIS (raster)	Generalized habitat distributions for American Peregrine Falcon, Bald Eagle, Cactus Ferruginous Pygmy-Owl, California Condor, Common Nighthawk, Ferruginous Hawk, Golden Eagle, Mexican Spotted Owl, Mountain Pygmy-Owl, Northern Goshawk, Western Burrowing Owl, and Whiskered Screech-Owl	Arizona Game and Fish Department	2011	AZ	Generalized bird distributions for Species of Greatest Conservation Need	Information is available only in interactive map form	Species of Greatest Conservation Need based on list identified in Arizona State Wildlife Action Plan	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Northern Goshawk Occupancy model	GIS(raster)	Habitat occupancy for northern goshawk	Lab of Landscape Ecology and Conservation Biology	1991-2007	AZ	Identify areas likely for NOGO presence	TBD	Dickson et al. publication in review (derived spatially-explicit statistical models based on NOGO expert knowledge)	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

GRCA Permitted Research Studies – Raptors

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Austin	William	GRCA-00133	USFWS	12/1/03 - 12/31/07	Management of Reintroduced California Condors in Northern Arizona	NRInfo Ref Code 648459.
Carothers	Steven	n/a	SWCA, Inc.	3/15/88 - 12/31/88	Peregrine Falcon Study	NRInfo Ref Code 36327. Brown BT, Hoffman SW. 1988. Ecology and Management of the Peregrine Falcon in the Southwest, with Special Reference to the Impact of Human Disturbance: An Annotated Bibliography. SWCA, Inc. Flagstaff, AZ. Published Report-36327.
Emslie	Steven	n/a	University of Florida	1984 - 1985	Excavation of Caves in Grand Canyon, Arizona: A Preliminary Report	NRInfo Ref Code 42778, 133471. GRCA MC # GRCA 59002, GRCA 68511, GRCA 68510, Accession Folder GRCA 4597.
Glinski	Richard	n/a	AGFD	6/26/97 - 12/31/00	Peregrine Falcon Survey and Monitoring Protocol	Birds of prey in the American West by Tom Vezo/Richard Glinski [Special Collections of Cline Library QL677.78 .V49 2002]
Hunt	Grainger	GRCA-00212	The Peregrine Fund	4/15/10 - 4/15/11 2/1/04 - 12/31/07 9/23/03 - 9/23/07	The Peregrine Fund – California condor Restoration Project	NRInfo Ref Code 20083, 165116, 20400, 544283. GRCA Library Call # QL696 .C53 R48 2002, QL696 .C53 R48 2007, QL696 .C53 C355 2010. Might be final product: Condors in canyon country: the return of the California condor to the Grand Canyon region / Sophie A. H. Osborn [QL696 .C53 O83 2007 c.1-3].
Mannan	R.W.	n/a	UA	3/28/91 - 12/31/92	Goshawk Diets in Logged and Unlogged Ponderosa Forests in Northern Arizona	Final report not received.
Reynolds	Richard	GRCA-00608	USFS	9/6/12 - 9/30/12	Acquisition of LiDAR data: effects of forest structure on the long-term demographic performance of northern goshawks	Current study. No report received.
Salafsky	Susan	GRCA-00158	Rocky Mountain Research Station	5/28/02 - 12/31/05	Factors Affecting Northern Goshawk Diets and Fecundity in Northern Arizona	NRInfo Ref Code 2170318. GRCA Library Call # QL696 .F32 R49 2006; QL696 .F32 S25 2004. Thesis in file, but not complete copy. “Covariation between Prey Abundance and Northern Goshawk Fecundity on the Kaibab Plateau, Arizona” by Susan Salafsky from CSU-Fort Collins.
Ward	Laurie	n/a	AGFD	6/20/90 - 9/30/92 6/23/92 - 9/30/93	Northern Goshawk Breeding Survey in Northwestern Arizona	Final report received. NRInfo Ref Code 558191, 3797. GRCA Library Call # QL696 .F32 W37 1992.
Willey	David	GRCA-00023	USGS - Colorado Plateau Field Station	5/10/00 - 12/31/02	Habitat modeling using surveys for Spotted Owls in Grand Canyon National Park.	GRCA Library Call # QL696 .S83 W55 2001; QL696.S83 W554 2000.
Willey	David	GRCA-00229	Montana State University	8/5/08 - 8/5/09 3/1/04 - 7/1/08	Surveys for Mexican Spotted Owls in Grand Canyon National Park	NRInfo Ref Code 558333. GRCA Library Call # QL696 .S83 W554 2000. Final report received.
Willey	David	n/a	NAU	6/24/92 - 12/31/92	Mexican Spotted Owl Inventory on the North and South Rims of Grand Canyon National Park	NRInfo Ref Code 77584, 558263. GRCA Library Call # QL696.S83 .W55 1998, QL696 .S83 W55 1991 c.1-2. “Inventory for threatened Mexican spotted owls (Strix occidentalis lucida) in Grand Canyon National Park” submitted by David W. Willey.
Willey	David	n/a	n/a	3/6/98 - 12/31/99	Field Test of Landscape Habitat Model for Mexican Spotted Owl Habitat in GRCA	NRInfo Ref Code 558333. GRCA Library Call # QL696 .S83 W55 2001, QL696 .S83 W554 2000. “Mexican Spotted Owl Distribution and Habitat within Grand Canyon NP” 2001.

Herpetofauna

Desired Condition: Habitat conditions are such that population numbers and species diversity of herptofauna is maintained within the historic range of natural variability.

Indicator	***Reference Condition***	***Target***
Herptofauna diversity	TBD	Maintain species diversity at reference levels
Herptofauna density	TBD	Maintain population density at reference levels
Number and distribution of water sources other than Colorado River	Seeps and Springs Map (GRCA 2011)	Water flow in seeps and springs remains within historic range of natural variability and are not impacted by non-native burros, back-country users, or modifications to groundwater tapping

Herpetofauna Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Critical Desert Tortoise Habitat	spatial data (raster)	Northern Arizona areas of critical desert tortoise habitat	BLM	1994	AZ Strip	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Desert Tortoise Habitat Categories	spatial data (raster)	Desert tortoise habitat categories as defined by 1988 range-wide Desert Tortoise Plan	BLM	1988	AZ Strip	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Desert Tortoise Recovery Data Explorer	non-spatial data (map only)	Spatial data explorer for threat layers, recovery action layers, and relevant base layers for desert tortoise revised recovery plan	University of Redlands	2009	Mojave Desert Network Parks	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Desert Tortoise Recovery Model Explorer	non-spatial data (map only)	Model explorer including threats, stresses, population effects, and recovery actions for threat layers for desert tortoise revised recovery plan	University of Redlands	2010	Mojave Desert Network Parks	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Desert Tortoise Survey data for GRCA and PARA	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Parashant National Monument Resource Condition Geodatabase	spatial data (vector)	Threatened and endangered habitat as designated by USFWS, namely Desert Tortoise (polygon)	NPS	2011	Grand Canyon Parashant National Monument	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Suitable Desert Tortoise Habitat	spatial data (vector)	Desert tortoise suitable habitat in Arizona based on a BLM-generated model incorporating elevation, terrain, climate and vegetation	BLM	1992	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

Herpetofauna Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
USFWS Critical Habitat for Desert Tortoise	spatial (vector)	Spatial polygon data on where final critical habitat for desert tortoise occurs based on description provided in Federal Register	USFWS	2010	Mojave Desert Network Parks	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USFWS Desert Tortoise Recovery Office Annual Monitoring Data 2001-2010	spatial (raster, vector), and non-spatial data (data must be requested)	Sampling data including spatial and non-spatial data attributes of monitoring areas, spatial and non-spatial attributes of walked transects, spatial and non-spatial data collected on live and dead desert tortoises, and characterization of focal tortoises with radio transmitters used to describe the proportion of tortoises visible for detection on transects (data must be requested)	USFWS Desert Tortoise Recovery Office	2001-2010	Mojave Desert Network Parks	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

Herpetofauna Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Habimap - Reptile Distributions	GIS (raster)	Generalized habitat distributions for Arizona Black Rattlesnake, Arizona Mud Turtle, Arizona Night Lizard, Arizona Skink, Arizona Striped Whiptail, Bezy's Night Lizard, Brown Vinesnake, Canyon Spotted Whiptail, Chihuahuan Black-headed Snake, Flat-tailed Horned Lizard, Gila Monster, Gila Spotted Whiptail, Goode's Horned Lizard, Green Ratsnake, Hooded Nightsnake, Massasauga, Mexican Rosy Boa, Milksnake (Cochise County), Mojave Desert Tortoise, Mojave Fringe-toed Lizard, Narrow-headed Gartersnake, New Mexico Ridge-nosed Rattlesnake, Northern Mexican Gartersnake, Ormate Box Turtle, Pai Striped Whiptail, Painted Turtle, Red-backed Whiptail, Regal Horned Lizard, Ridge-nosed Rattlesnake, Rock Rattlesnake, Saddled Leaf-nosed Snake, Slevin's Bunchgrass Lizard, Sonora Mud Turtle, Sonoran Collared Lizard, Sonoran Coralsnake, Sonoran Desert Tortoise, Sonoran Shovel-nosed Snake, Sonoran Whipsnake, Sonoyta Mud Tutle, Thornscrub Hook-nosed Snake, Tiger Rattlesnake, Tucson Shovel-nosed Snake, Twin-spotted Rattlesnake, Variable Sandsnake, Western Black Kingsnake, Western Yellow-bellied Racer, Yaqui Black-headed Snake, Yellow Mud Turtle, and Yuman Desert Fringe-toed Lizard	Arizona Game and Fish Department	2011	AZ	Generalized reptile distributions for Species of Greatest Conservation Need	Information is available only in interactive map form	Species of Greatest Conservation Need based on list identified in Arizona State Wildlife Action Plan	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI

Herpetofauna Database and GIS Summary – External sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Habimap - Amphibian Distributions	GIS (raster)	Generalized habitat distributions for Arizona Toad, Chiricahua Leopard Frog, Desert Pacific Treefrog, Lowland Burrowing Treefrog, Lowland Leopard Frog, Northern Leopard Frog, Plains Leopard Frog, Relict Leopard Frog, Sonoran Tiger Salamander, Tarahumara Frog, and Western Barking Frog	Arizona Game and Fish Department	2011	AZ	Generalized amphibian distributions for Species of Greatest Conservation Need	Information is available only in interactive map form	Species of Greatest Conservation Need based on list identified in Arizona State Wildlife Action Plan	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI

GRCA Permitted Research Studies – Herpetofauna

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Bartlett	Rickey	GRCA-00564	NAU	11/18/10 - 5/1/11	Mapping of Permian Trackways in Grand Canyon	Final report not received.
Brown	Nikolle	n/a	n/a	7/1/99 - 12/31/00	An unsolicited proposal to synthesize the biogeography of the snakes within the Grand Canyon.	Final report not received.
Brown	Nikolle	n/a	n/a	7/1/99 - 12/31/00	An unsolicited proposal to synthesize the biogeography of the snakes within the Grand Canyon.	Final report not received.
Christensen	Kerry	GRCA-00093, GRCA-00230, GRCA-00231	Hualapai Tribe	5/1/06 - 9/14/08 4/15/04 - 12/31/07 3/13/97 - 12/31/97	Southwestern Willow Flycatcher Surveys on Upper Lake Mead by the Hualapai Tribe/Hualapai Terrestrial Resource Monitoring in lower Grand Canyon	GRCA Library Call # QK147 .C47 T73 1998, QL696 .P289 C47 2007, QL677.4.C47 H83 1998.
Clemmer	Glenn	n/a	US Fish and Wildlife	8/11/81 - 10/1/81 1970 - 1985	Studies on the fishes of the Colorado River in Grand Canyon National Park	NRInfo Ref Code 47682. GRCA MC # GRCA 56977. "Suvey of Fishes, Mammals and Herpetofauna of the Colorado River in Grand Canyon" by Royal Suttkus and Glenn Clemmer; June 1976 GRCA Colorado River Research Series Contribution Number 34.
Davis	Alison	GRCA-00548	University of California - Berkeley	5/9/10 - 5/9/11	The role of color polymorphism in the evolutionary dynamics of mimetic species: A statistical phylogeographic approach	Final report not received.
Douglas	Michael	GRCA-00160	Colorado State University	1/1/02 - 12/31/07	Comparative Phylogeography of Grand Canyon and the Colorado Plateau	NRInfo Ref Code 2169814.
Douglas	Michael	GRCA 000012	ASU, Department of Zoology	4/17/96 - 12/31/01	Evolutionary Relationships among Populations of Amphibians, Reptiles, and Fish in the Grand Canyon of Arizona	NRInfo Ref Code 165086, 558256.
Garrigues	Roy	GC-9	UA/GRCA	1959 - 1965	Reptile and Amphibian Survey	Final report not received. Previous P.I.: Charles Lowe; Permit suspended in 1962, Garrigues took over.
Gerhardt	H. Carl	GRCA-00514, GRCA-00265	University of Missouri - Columbia	3/1/10 - 3/1/11 3/30/09 - 6/16/09 4/1/05 - 12/30/08 4/1/05 - 4/30/06 3/28/00 - 12/31/04	Evolution of Vocal Communication in the Canyon Treefrog	Final report not received.
Glenn	James	n/a	VA Medical Center	1/1/81 - 12/31/81 5/80 - 10/80	Venom:Crotalus viridus abyssus	Venom characteristics as an indicator of hybridization between Crotalus viridis viridis and Crotalus scutulatus scutulatus in New Mexico by James Glenn and Richard Straight [1990].
Kimberling	Diana	n/a	GRCA	1/1/94 - 12/31/95	Genetic Comparisons among Isolated Populations of *Rana Pipiens* in Arizona	Re-Analysis of Genetic Structure among Populations of Rana pipiens in Arizona and Utah Mark P. Miller, Diana N. Kimberling and Paul Keim The Southwestern Naturalist, Vol. 44, No. 4 (Dec., 1999), pp. 527-530
Miller	Donald	n/a	Southern Illinois	5/15/80 - 8/15/80	Reptiles and Amphibians of the Grand Canyon Park	NRInfo Ref Code 7892. GRCA Library Call # QL653 .A75

GRCA Permitted Research Studies – Herpetofauna

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
			University	8/6/79 - 8/20/79 6/30/78 - 12/31/78		C44 1981. QL653.A6 A47 1982 c. 1-2 in the Grand Canyon Main Library.
Perez	John	GRCA-00036	Texas A&M University-Kingsville	8/23/96 - 12/31/02	Geographical variation of snake venom in the United States	NRInfo Ref Code 558262. Final report received. 18 pgs. GRCA Library Call # QP632 .V46 P47 2001.
Persons	Trevor	GRCA-00116	USGS/Biological Resources Division	5/1/01 - 12/31/04	Supplemental inventory of herpetofauna of Grand Canyon National Park.	NRInfo Ref Code 599076.
Persons	Trevor	GRCA-00116	USGS/Biological Resources Division	5/1/01 - 12/31/04	Supplemental inventory of herpetofauna fauna of Grand Canyon National Park.	NRInfo Ref Code 599076.
Prival	Dave	GRCA-00282	University of Arizona	6/1/06 - 7/30/08	Herpetological Inventory of the Arizona Strip	Final report not received.
Schwalbe	Cecil	n/a	Arizona Game and Fish	6/14/84 - 9/1/85	Effects of Increased Fluctuations of Flow from Glen Canyon Dam on the Reptiles and Amphibians of the Grand Canyon	NRInfo Ref Code 60502, 72681. QL 666.L2 W345 1986 in Special Collections and Archives at Cline Library.
Shoop	C. Robert	n/a	University of Rhode Island	1975 - 1983	Amphibians and Reptiles of Grand Canyon National Park	Final report not received.
Spence	John	n/a	NPS, GLCA	9/12/96 - 1/31/98	Monitoring Northern leopard frogs and vegetation	NRInfo Ref Code 558173. GRCA Library Call # TC530 .S74 1996 (1996 report).
Starrett	Bryan	n/a	Phoenix Zoo	4/90 - 6/93	Collecting rattlesnakes *(Crotalus viridis abyssus)* for the Phoenix Zoo	This is not a research permit, it is a collecting permit. All three files are in one folder now named the Gila Taxonomy Project.
Steinman	Michael	GRCA-00240	University of Colorado at Colorado Springs	6/1/04 - 12/31/05	Geographical variation of the morphological characteristics and venom protein content, particular to taxonomic classification, of the Western Rattlesnake (Crotalus viridis) complex in South Eastern Utah and North Eastern Arizona.	Final report not received.
Summerville	William	n/a	Staten Island Zoological Society	1981 - 1982	Collection of *Crotalus viridis abyssus*	Final report not received.
Whiting	John	n/a	Brigham Young University	1986	An isoenzymatic electrophoretic study of *sceloporus magister* or *Uta stasburiana* in the Grand Canyon: A look at the barrier effect	Final report not received.
Zerba	Kim	n/a	ASU	1982 - 1987	Individual variability in tiger salamander (*Ambystoma Tigrinum*) predation and consequences for zooplankton community structure	Genetica, Spring Netherlands Vol. 89 Numbers 1-3, February 1993, 167-183.

Greater Grand Canyon Landscape Assessment

Landscape TWG Meeting Summary

June 12, 2013

The first meeting of the GGCLA Landscape Technical Work Group (TWG) was held on June 12, 2013, to begin refining the scope and approach to assessing landscape condition.

In attendance: Bill Austin (USFWS); Peter Bungart (Dept. of Cultural Resources, Hualapai Tribe); Todd Chaudhry (GRCA); Will Flatley (NAU); Valerie Stein Foster (Kaibab NF); Pete Fulé (NAU); Santiago Garcia (GRCA); Brian Gatlin (GRCA); Cerissa Hoglander (NAU/LCI); Mike Kearsley (GRCA); Catherine Lentz (GRCA); Ariel Leonard (Kaibab NF); Jay Lusher (GRCA); Mark Nebel (lciGRCA); Jodi Norris (SCPN); Chris Marks (GRCA); Jean Palumbo (NAU/LCI); Jill Rundall (NAU); Erik Schiefer (NAU); Tom Sisk (LCI); Amanda Stan (NAU); Larissa Yocom (NAU).

Acronyms and symbols

GCT: Grand Canyon Trust

GGCLA: Greater Grand Canyon Landscape Assessment

GRCA: Grand Canyon National Park

LCI: Landscape Conservation Initiative (NAU)

LLECB: Lab of Landscape Ecology and Conservation Biology (NAU)

MNA: Museum of Northern Arizona

NAU: Northern Arizona University

SCPN: Southern Colorado Plateau Network

Meeting summary

Part 1: Biodiversity and Ecosystem Intactness

I. Biodiversity - Native floral and faunal diversity was identified as a value at Workshop I (Oct. 11, 2012).

- Criteria for assessing biodiversity
  - Endemic plants
  - Microsite/habitat assessment
  - Ecosystem structural attributes; e.g. old growth forest structure
  - Habitat diversity vs species diversity
  - Culturally significant species; e.g. medicinal plants
- Specific, measurable indicators for biodiversity
  - Endemics (particularly plants)
  - Passerines, goshawk (reference breeding bird atlas)
  - Forest density, age class, cavities, woody debris
  - Invertebrates
  - Native/non-native components of biota
  - System altering species (exotic annual grasses, tamarisk, beaver)
- Threats to biodiversity
  - Climate change
  - Understanding the changing likelihood of "extreme events"
  - Urban influence and intensive management effects
- Analytical approach to assessing biodiversity
  - Historical data: trend/time series analysis
  - Identify possible refugia in light of climate changes
  - Model disturbances across landscape

  - Historical photo analysis (could provide cultural insight)
  - Multi-scale approach to biodiversity assessment
  - For cultural approach: interviews; information in place names
- Definitions/approaches to biodiversity as a concept – the group did not come up with points for this topic.

II. Ecosystem intactness

- Criteria for assessing ecosystem intactness
  - Composition and analysis
  - Connectivity vis a vis "barriers"
  - Viewsheds and aesthetic values
  - Soundscape/natural quiet
  - "Wilderness characteristics" – visitor experiences
- Measurable indicators for ecosystem intactness
  - For grasslands – pronghorn movement
  - Connectivity/carry of fire at a landscape scale may differ among habitat/veg types
  - Disturbance- distribution of patch sizes
  - Development patterns and influences
  - Road network
- Major threats to ecosystem intactness
  - Increasing human footprint (development, increasing visitation, energy development, roads)
  - Movement barriers
- Appropriate analytical approach to assessing ecosystem intactness
  - Connectivity analysis
  - Compositional analysis
  - Genetic structure and gene flow
  - Acoustic analysis/assessment
- Definitions/approaches to ecosystem intactness as a concept
  - System components present and functioning
  - Cultural perception and aesthetic resources

III. Data

- Vegetation data:
  - GRCA has the recently completed vegetation map data for the entire park, as well as mainstem river monitoring veg plots; veg plots in the side canyons associated with tamarisk treatments; fire effects veg plots; fire effects /rapid assessment plots, and work the I&M network has done in some of the forested communities. Historic data includes the Warren Map from the 1970s, the Wagner map from the 1930s (plots for this map were resampled in the last 5 years by John Vankat). Also a Bryophyte inventory completed by Theresa Clark.
  - Kaibab NF has forest structural data, historical range plot monitoring data, existing stand dataset, mid-scale dataset, and data on riparian vegetation around springs for half the known springs on the KNF.

  - SEINet datasets
- Bird species composition
  - Arizona Breeding Bird Atlas
  - Rocky Mountain Bird Observatory (bird data for GRCA and KNF)
  - SCPN bird monitoring data for mixed conifer and pinyon-juniper habitat
- Invertebrate species composition
  - Larry Stevens/Museum of Northern Arizona data.
  - KNF Terrestrial Ecosystem Survey monitoring data.
  - GCMRC aquatic macroinvertebrate data for main stem of Colorado River.
  - Southwest Colorado Plateau Network (NPS I&M) has data on aquatic macroinvertebrates.

Part 2: Forests and Fire

I. Introduction and background

- Fire is a resource as well as a potential threat for communities
- We look at fires in terms of fire regimes—as a series of events—and are interested in metrics that include time since fire, frequency, extent, seasonality, patchiness, and intensity.
- The GRCA Fire Management Plan (FMP) EIS identified reference conditions, existing conditions, and desired conditions for four communities: Spruce-Fir, Mixed Conifer, Ponderosa and Pinyon-Juniper.

2. The LLECB Approach – has been developed over the last 10 years from the first Western Mogollon Plateau Landscape Assessment to the Four Forests Restoration Intiative. Based on foundational layers that can be used in models to predict fire behavior, fire risk and the effects of fire on other resource values such as wildlife habitat. Incorporates the social dimension of forest health issues and uses a collaborative, participatory approach.

3. Fire management in GRCA involves using fire as a resource and letting it burn in areas where it will be beneficial. The park has a ten-year plan that identifies these areas. This includes prescribed burns. Secondly, it involves suppression of fire, so those areas where suppression is a default action must also be identified. Fire is a topic that will be central to a lot of management decisions in the park, both in regards to the management of active fire, and also because of its potential to affect almost every other resource in the park. There has been no park-wide fire modeling since the completion of the FMP EIS.

4. Indicators for fire as a focal resource (process) and for associated vegetation communities

- Cover of native and non-native species – ties into discussions about biodiversity and associated threats
- Richness of native species
- Tree density
- Fire type
- Fire frequency
- Basal area
- Snag density
- Tree regeneration
- Total herb and shrub cover
- Canopy closure

5. Potential sources of data and other information

- Pete Fulé is looking at even-aged patches of trees as indicators of past high severity fires and using that information to discover how often they occurred and how large they were.
- The FMP EIS has a lot of information that can be used in the assessment
- TC suggested looking for tamarisk in high resolution imagery of the river corridor (park has this)
- Will Flatley will be modeling future vegetation response to climate change and fire on the North
- PF suggested applying circuit theory to fire spread in the GGCLA analysis area. Referred to Mirand Gray's modeling of fire spread in grasslands and shrublands.
- TC suggested using LANDFIRE to determine ecological departure.
- Burn severity mapping was suggested.
- SPOTS (Strategic Placement of Treatments techniques to maximize the effectiveness of fuel treatments in reducing problem fire behavior, adverse fire effects, and suppression costs) was brought up but not endorsed as a technique to use.

6 . Value of GGCLA to GRCA fire management planning

- Identifies new factors affecting fire, e.g. dead tamarisk in river corridor
- Will provide a framework to assess current conditions against desired conditions
- Can synthesize existing information and develop novel tools to aid decision-making (e.g. prioritize areas for management based on condition and risk)

Action Items

1. Determine how to integrate information in an appropriate way to allow inference across the whole area.

2. Pete Fulé to send Todd a copy of John Vankat's analysis to develop state and transition models for North Rim forests.

Meeting detail

Morning, Part 1: Biodiversity

1. Introduction and background – Todd Chaudhry (TC)

Todd Chaudhry presented background information on the GGCLA, explained the process for selecting the focal resources, which started with a stakeholder workshop in October 2012, the collaborative nature of the assessment, and the purpose of the TWGs. Work groups are tasked with refining the scope of the assessment, identifying the best condition indicators and reference/desired conditions, identifying potential or known threats, identifying information and data needs that exists, and synthesizing the information to assess current conditions and trends. For complete details, see http://lci.nau.edu/ggcla.aspx.

2. Update on TWGs

- Vegetation TWG: identified exotics as a threat on a landscape scale. Still working on identifying focal resources for this topic. Identified thus far are: riparian vegetation, desert scrub, rim habitats (a unique

habitat that helps to define this landscape), and rare and special status species (may be nested within broader vegetation communities.

- Physical resources: Focusing on springs and cave ecosystems. Working on determining how to assess the condition of these resources and how to report this.
- Cultural resources: Recognizing that there is potentially a cultural element in all the resource categories, we hope to take an integrated approach. Some cultural resources can be represented spatially (on a map), and other broader resources might be more difficult to represent in this manner.
- Wildlife: focal wildlife species identified thus far include mountain lion and pry species (as a system); raptors, particularly forest raptors (northern goshawk), and prey species; herpetofauna (but not much information on herps in grand canyon region – could be identified as future research need)
- Visitor experience: on hold to wait for some of the products being developed for the back country management plan (to avoid duplication of effort)

3. Landscape Values identified in Workshop #1

For the landscape TWG, the broad resources that were identified are fire, biodiversity, ecosystem intactness, a lumping of relatively big concepts. Some of the things that people valued were:

- Natural patterns and processes
- A healthy, resilient, large and intact ecosystem,
- Connectivity for wildlife
- Refugia...

Native floral and faunal diversity (biodiversity) was another thing identified at the workshop as a value.

- Considering non-natives as a threat as opposed to adding to diversity.
- T&E and endemic species, rare species

The challenge is to determine at what level to identify diversity. Most common metric is at the species level, but you can go down to the genetic level, or up to the ecosystem level. We have an opportunity to mix and match these for this assessment.

Another important process in this landscape, particularly in forested areas. Can be considered both a value and a threat, depending on the community, on the conditions under which certain events take place, (13:33) depending on the nature of those fire regimes in relation to historical fire regimes.

4. Objectives for Part I of today's meeting

- Define the focal resource; e.g. what is biodiversity? How do you define it?
- Identify the indicators and measures to assess biodiversity
- Identify reference conditions
- Determine current conditions
- Identify data resources
- Determine the level of confidence in the data resources.

5. Desired condition in GRCA

Park has identified desired conditions for a suite of resources, both natural and cultural. Under the landscape category, identified natural processes, high levels of biodiversity and community resilience.

6. Some initial indicators of focal resources in the landscape category

- SCPN has identified vital signs (resource indicators) for parks in the network (table 1). Some may be available for our landscapes and some may not. Data may be readily available for some, and not for others.

Table 1. Vital signs, or resource indicators, for parks in the Southern Colorado Plateau Network of the National Park Service.

Indicator	*Reference Condition*	*Target*
Roadless areas (%)	TBD	TBD
Habitat connectivity with adjacent lands	TBD	TBD
Acres managed under historical fire regimes (%)	TBD	TBD
Start of growing season*	TBD	TBD
Date of maximum greenness*	TBD	TBD
Total seasonal production*	TBD	TBD
Snow cover duration*	TBD	TBD
Park area affected by disturbance*	TBD	TBD
Disturbance patch size*	TBD	TBD

- We also see that this landscape assessment process will help us to iteratively develop these desired conditions and to hone in on those indicators which make the most sense for assessing their condition. Through time, we can take a look at our monitoring data within the park and adjacent areas and really see how those conditions are tracking in terms of our desired conditions

7. Definining the scope: Tom Sisk (TS)

Tom presented a couple of ideas to set the stage for creative thinking about how to tackle the point of integration – where we reassemble those resource categories that we have broken down in a way that is useful for management.

- The reductionist tradition that we generally operate under fragments the landscape – we tend to isolte areas and resources of interest. This is appropriate approach for the other TWGs, but not for what we are trying to do in the Landscape TWG.
- Real landscapes are complicated – composed of a lot of complex and interrelated conditions that influence each other. Now we want to think about that resource or those indicators imbedded in a continuous landscape with lots of different influences.
- When we talk about the landscape piece, we're really trying to think about this as a **process-driven approach**. So we're thinking about what actually occurs and unfolds, and at what scale does it unfold. So we want to conduct our analysis at the scale at which those ecosystem processes unfold or operate.
- The minimum dynamic landscape (Pickett and White, *The Ecology of Natural Disturbance and Patch Dynamics)* – the smallest area that captures the full dynamic of how key processes undold, the area area in which multiple, individual events can transpire from beginning to end.

- Keep in mind that we are working with existing data, but we have pretty considerable analytical (39:54) resources that we can draw on. So it's really an interplay between the technical/analytical side and the collaborative side. How can we represent complex things with data that maybe were collected for other purposes.

8. Terminology

- Foundational data – core data that underlie our analysis; this corresponds, to some extent, with the focal resources and the indicators that underlie that. These are what we would draw on to map the folcal resources or the processes that really affect the condition of the focal resources.
- Derived data – to get at these things requires some form of spatial modeling or analysis. Example: in some of LLECB's earlier work, we developed a weries of foundational data on forests in the southwest that involve independent derivation of vegetative composition. These include forest structural measures: basal area, stand density and canopy cover—the big three that drive a lot of fire and wildlife modeling.

SOME EXAMPLES OF OTHER ASSESSMENTS CONDUCTED BY THE LLECB

Here are some examples that show how when we have a clear idea of the resources we want to assess and work with at the landscape scale, and we have the available data that are out there amongst our community of collaborators, we can apply spatial analysis and modeling techniques to the data to get at the information we are wanting to focus on.

9. Capturing biodiversity on a landscape scale: two approaches in the White Mountain Landscape Assessment

Tom mentioned the White Mountain Landscape Assessment (WMLA) in the Apache-Sitgreaves NF and the Western Mogollon Plateau Landscape Assessment and the Four Forest Restoration Initiative.

In the WMLA process the group grappled a lot with the idea of "biodiversity", and kicked around a lot of ideas. They came up with two different indices:

- Species richness: We had good data on bear habitat, passerine species richness, a lot of data on MSO, Northern Goshawks, tassle-eared squirrel density, red squirrel habitat, pronghorn habitat all played into this idea of wildlife richness. So we were able to aggregate those data, through a participatory process, select the datasets, weight them and basically use fairly straightforward spatial analytical processes to then scale the whole landscape, from high to low in a relative measure of wildlife richness as one indicator of biodiversity. So this is a species-centric approach that leverages a lot of occurrence and abundance data. So you or I could probably pick at this and find issues or problems. The point is that through this iterative process, we arrived at a representation that that group of people very engaged in this landscape, felt was a pretty good representation of this rather fuzzy concept of biodiversity.
- Habitat diversity: The group looked at areas that were high or low with respect to the diversity of the vegetation type at that scale. Looked at riparian habitats, old growth management areas, a measure of topographic roughness, which is the physical analog, if you will, of the vegetative diversity. And then we looked at forest structural diversity in a similar way. But that was one area where in the end the group felt that the data didn't really support the analysis in a robust and defensible way, so we backed away from that. But the others were integrated in a similar way to take a habitat-based approach to this concept of biodiversity.
- Then the group combined those two into a composite species richness and habitat layers. The composite evaluation was then subsequently used in concert with other issues of interest, like fire hazard, for example, and a range of values associated with the White Mountains to prioritize an area.
- An interesting observation—areas that were top priorities for management attention in the WMLA process lined up with the cross-hatched area representing the burn perimeter of the Wallow fire, which occurred 5 years later.

10. Exotic Species Analysis – Kane and Two Mile Ranches

Exotic species/invasive species issues, have been brought up in the vegetation and other Technical Work Groups. The LLECB has been working on modeling the probability of cheat grass occurrence at Kane and Two Mile Ranches with the GCT, USFS, BLM and others. Kane and Two Mile Ranches cover 50,000 acres and are nested within the GGCLA analysis area. The modeling, based on field data and using an occupancy modeling framework, was subsequently usesd to influence livestock management and other activities across the ranches, for example, steering clear of the areas where you would expect cheat grass to be likely to move in following disturbance, or targeting control efforts in those areas where we think intervention might make a difference, in terms of arresting cheat grass spread following, for example, fire. This sort of approach could be extended across our study area, with certain caveats and complications. But it's an illustration of where there are data, there are means of modeling those data across large areas. For certain select species, this might be the type of effort we might want to undertake for the GGCLA, particularly with invasive species.

Also at Kane and Two Mile Ranches, we've looked at **fire risk**—I talked a little bit about fire hazard that is the propensity of a fire to burn in a certain condition, and that hazard often underlies our estimates of fire behavior. But another issue is occurrence—where are large fires most likely to occur. So we can look at historic ignitions and the history of burns and the landscape correlates that are associated with large fires and generate predictions where large fires are more or less likely to occur, another thing that might drive some of our prioritization in management planning.

Another example in that same area, is the **northern goshawk,** which we undertook with Richard Reynolds, who most of you know as the goshawk guru on the Kaibab Plateau. We used the AZGFD and USFS datasets on northern goshawk, to do an occupancy assessment of goshawk occurrence across the region. And so for the first time we have estimates of the probability of site occupancy by goshawk. This may or may not be something that we want to wrap intothe GGCLA work. But again on a wildlife perspective, it gives you a sense of how we can extend from a particular study area to certain questions that are manifested in a much broader scale.

11. Wildlife habitat connectivity

This is an ongoing project covering a broader area in the Four Corners region that encompassess the GGCLA analysis area. WE are using a modeling approach to look at wildlife habitat connectivity based on principles of current flow. This approach was developed by Brad McRae when he was a graduate student at NAU. So, if wildife habitat connectivity emerges as something we want to look at at the landscape scale, we have tools to do that.

12….injecting a little bit of reality

- This will not be fast and easy.
- We really have to be incisive about what we believe is important and what are those issues that we can tackle at the landscape scale that will help us to maintain that big picture perspective as we work through the resource condition assessment.
- We're going to have to be judicious and identify things that are particularly valuable. Because, after breaking it down, assessing and evaluating, we'll want to pull some really key issues back together at the landscape scale to give us this comprehensive landscape perspective on the whole resource condition assessment.

13. Questions?

- Do we want to be thinking of long-term monitoring of these resources?
  - TC: What I would say from a management point of view, the park perspective, is that those indicators which we identify through this process should have the same qualities and may very well be the same indicators that we would want to include in a long-term monitoring program. Those measures

are good indicators of the condition of a given resource. They include those characteristics that define a good indicator in that they are measurable, you can define them, you can collect data on them, you can analyze them.

My hope for this process is that for these focal resources that we've included in this assessment, we will narrow down the field of appropriate indicators, and those would be the first candidates we would consider for future long-term monitoring.

- TS: Another way to think about it: if there are overarching issues that describe process at the landscape scale, and we're able to capture those in some way, then they're going to be certain indicators or variables that are driving those processes—these drivers, or influential correlates, may be the appropriate things to monitor. So I think it's not necessarily the highest level process at the landscape scale we can monitor, but some of the indicators or drivers of that process might be extracted as things that can be efficiently and effectively monitored through time. They shed light on the larger process that is of interest at the landscape scale.

- Question from P. Bungart: I just came off a GC river trip…and this was a trip with multiple agencies, land managers, scientists, tribal representatives, and we talked about some of the actions that are going on down there. We're talking about complexity here, and one of the things that I took away from that trip, and many people are aware of the sediment restoration issues down there, trying, you know, with the high flow experiments and trying to restore some of the beaches and the sandwall on the beaches, and we saw presentations about how, in some cases, if the conditions are just right, with sediments being deposit along the riverbank, if the wind conditions are good, that sand will, through Aeolian processes, then blow further up on the beach, and in some cases, help to bury and preserve archeological sites.

  And then, in several places on these newer active dunes there were also these native perennial grasses that were being re-established. I don't think that in particular was anticipated at all as part of the scope for that kind of a study. But that was a very positive outcome because it's restoring ecological health; it's helping to restore biodiversity. You look further up the slope where the sand hadn't reached yet and it tended to be cheat grass.

  So I'm trying to think about how, once we have these unanticipated effects, good or bad, how that fits into the decision-making

  - TS: Putting that into the context of what I was just discussing, I would say that, given what you've just said and what you experienced, that someone who was really focusing on landscape-scale process in the river corridor would identify those processes of sand deposition as a driving, a very important overarching landscape-scale process. And so, if we were focusing on the river corridor, for example, we might end up in that same place and want to look at how that process is manifested and what are the issues that are really driving the availability of sediment and how it's dispersed. And then from that, we would have an insight or an overarching perspective on things like the dynamic between native and exotic grasses, or herbaceous vegetation in the river corridor, and it might tell us a whole lot of other things, too.

- (P. Bungart continued) To add to that, it's an example of how you can't really separate natural and cultural resources, preservation of archeological resources and restoration of native plant communities, which, in the case of these perennial grasses, were, in the past, a food resource. So there's a cultural outcome to that as well, as well as for biodiversity

  - TS: Yes, I think that's important…I think one of the experiments that we're taking on here, is really trying to keep those tightly coupled and appreciate the linkages (1:07:32) between natural and cultural resources that have been, at least in my opinion, sort of artificially separated, maybe for good reasons administratively, but when we're trying to integrate and think broadly across the landscape, we have the blessing to proceed cautiously and thoughtfully in addressing natural/cultural resources as an interconnected perspective. It also makes it very obvious that the participatory part of this is key, and we really want to corral understanding broadly about the whole landscape, and you

obviously can't do that if the cultural knowledge base is dealt with in a different process than the natural resource knowledge base.

- (Question from Jodi Norris) Are there many fundamental datasets that let you look through time? At any time scale, say, is goshawk habitat increasing? Is mixed conifer habitat, as far as for condition assessment, if we know that it's shrunk by whatever percent over the last set of years…It seems like that would be useful.
    - TS: I think we can, but I don't know how, right now. And so what those resources are, and drawing on all of you, in terms of what would be a fair way to approach that and represent it, and what data do exist, and what data are available for undertaking that, is something that I can only get at as a group. And that kind of anticipates what the next thing on our agenda is. Really starting to talk about these focal resources that are dealt with at the landscape scale, and then try to get a crisper definition of what they are, the focus, and what the intent of assessing them is, and that's where I think you all can really start steering this whole process in a good direction.
- (comment from Ariel Leonard) In working on the forest plan revision, didn't have any places where they had widelspread data, but had trend data from the early 1900s for some places. Looked at changes in the mixed conifer density and species composition. Also had grassland data. So, though it wasn't landscape scale, they did have some information for certain areas "to at least indicate those trends and give us some ideas about what types of pressures are acting on those systems and what we might need to do…"
    - TS: So that is one way –leverage historical data – reconstruct things based on those data. We also can make some assumptions and simulate what the structure would have been like under different hypothetical conditions (modeling) and then look at the differences there. Or do both. That's where really getting grounded is why we need this participatory approach.
    - And if there are particular things that are of interest to the group, or high interest to individuals in the group, that's where things really happen, when we get this new matching up of people and ideas and we can work closely to produce something of value to the whole group. . It's getting the people who are most plugged in to conditions on the ground, and what's important in terms of setting policy and management approaches. That's where this stuff can mean something. Otherwise, we can do a lot of academic work and it may or may not have an impact on what the landscape looks like ten or fifty years from now. That's really what our objective is.
- Mike Kearsley talked about the GRCA vegetation map
    - Different levels portrayed – association, class, macrogroup or formation level. Allows you to look at diversity across the landscape at different scales.
    - 1500 classification plots – an exhaustive survey of all species present
    - Information about physical setting: soils, geology, etc.
    - 700 observation plots for calibration where they collected information on a half dozen dominant species in a short period of time

14. Vegetation and other data

- Jill Rundall suggested that from the conversation, GGCLA could use vegetation species richness and composition as an indicator of biodiversity. Ariel concurred. Todd also concurred saying that we have a lot of vegetation datasets: ranging from mainstem river monitoring veg plots; veg plots in the side canyons associated with tamarisk treatments; fire effects veg plots; fire monitoring (unintelligible) plots; rapid assessment plots, and work the I&M network has done in some of the forested communities.
- Ariel listed veg datasets that the Kaibab NF has: more forest structural data than understory data; GCT has data for the Kane Ranch areas; historical range plot monitoring data; a dataset that they've been using for the forest health study, a mid-scale dataset which is consistent across the region… existing stand exam dataset. And then… veg data around springs, for more than half of our known springs.

- TC: Working with Larry Stevens and MNA to compile datasets within and outside the park and put it into the statewide springs database. This springs data will be an important component for biodiversity, because obviously those are biodiversity hotspots across the landscape. But it's going to depend on how muchdata we pull together for that effort, we could roll into these landscape- level biodiversity metrics… So we could have different data sources at different scales that we can try to combine…So there's the challenge of do you focus to have a broader array of indicators for fewer resources, or do you have a select few number of indicators that you have data on across the larger landscape?

15. Metrics for assessing biodiversity values

- TC: Coming out of that first workshop, there were these issues of biodiversity and intactness that we weren't able to imbed in the other working groups…so they got moved into the landscape group. Assessing their conditions is part of the NRCA standard template for the NPS. ..But we're also interested in these landscape metrics and characterizing things at the broader scale for two main purposes:
  - In order to look across the park and prioritize areas for management, we really need to take a comprehensive look, so that we can compare places A&C with places B&D, for example, and try to take multiple factors into account and be able to direct resources to the highest priorities and also to allocate resources more efficiently.
  - to start looking at those cross-boundary management issues—what are those landscape processes that actually need to be represented at broad spatial scale in order to be able to make intelligent decisions and characterize those across the analysis area. This then allows that integration of values and threats and the incorporation of threats that might be external to the park.

  And so, what are your thoughts in this landscape, in terms of the incisive way that we might be able to characterize as biodiversity values across this largest area?
- AL: this is where historical information about baseline composition would be very good because … increased species richness is not necessarily always good for the ecosystem. If you have species that might be native to the general area, but are now starting to occupy areas that they didn't previously, they could displace native species that are adapted to microsites.
  - TS: I'm going to partition these out under the categories that are on the agenda. So, I hear that endemic plants as one criterion that might be incorporated into some index or aggregate measure of biodiversity, and an appropriate analytical approach for assessing biodiversity might be to mobilize historical data in some sort of trend or time-series analysis. Was that right? (AL: yes)

16. Climate change

- AL: My question is related to climate change and how we account for species movement, reaction to changing conditions related to climate change?
  - TS: my initial response to that is I think that I'd start out by asking, 'is climate change a major threat to biodiversity at the landscape scale in our region? And I'd think most of us would probably say, 'obviously, yes. And then, we could ask 'well, how to we get at characterizing…maybe 'threat' is a little too narrow of a definition, but certainly 'major driver change and some things are gonna be threatened by that change and others won't. But if we understand something about the occurrence of different microsites or microhabitats across the area, that puts us in a position of anticipating how conditions will change, whether it gets hotter and drier, or some other anticipated changes, and see how that'll affect the microsites for certain endemic plants. In this case there may be better ways of articulating that.
  - However, at this point, we're not explicitly doing a downscaling of regional climate models to assess the threats to the park. But that doesn't mean we can't anticipate the influence of climate change as a general threat. We might a few months down the road be integrating that climate change assessment into this process, but for now we're not explicitly undertaking climate change analysis efforts.

- TC: Tying the microsite comment with climate change and pulling in the concept of refugia that was elicited in the first workshop, we could potentially look at some of our physical layers, in terms of topography and slope, aspect and elevation, and identify areas that could potentially be refugia for certain guilds of species. That might be one approach, where we're pulling in multiple concepts and looking at landscape level diversity of refugia and that pulls into the potential for certain suites of species to persist in the landscape.
- TS: So, I think that's one possible analytical approach—to look at endemic plants and characterize their microsites and simply say, under warmer or elevationally shifted conditions, where might refugia for those species occur in the park. And then if we were able to do that in a fairly simple way for any one species, we might not have a lot of confidence in it, but if we did it for a lot of species, and we saw where those things overlapped, then we might find a propensity of north facing areas of given elevations that we might expect to be important for retaining those biodiversity elements under a warmer climate. So that could be done in various ways, working with experts and other people who want to plug in and find a way that makes sense in the context of this, then I think analytically we could support that process. That'd be one approach.
- TS (cont): But I think that's the Godzilla in the room, what's going to happen ten to fifty years from now with the inevitable shifts that we're going to see. I think if we can pluck out of the full range of possibilities some practical ways to try to get at very specific conditions or situations, of which this might be one, we could really anticipate a lot of the management questions that will be emerging, and have some go-to datasets, and would have thought about the idea a bit.

Other things we might do?

- AL: In recent planning for KNF, we acknowledged climate change in a general sense, but then broke out those threats to specific things that affect resources. We talked about drought, increased heat, more extreme weather events, uncharacteristic fire—the short term stuff that we're seeing every day and that affects our resources and potentially our management. So our focus on addressing climate change threats is how do we increase resiliency in these systems and retain these microsites, moisture climates. So we focused on specifics, not just climate change in general.
- TS: I think Ariel what you're saying, is one way of dealing with the effects of climate change is to see how that might affect the likelihood of what we consider to be extreme events directly impacting the resource. And so, rather than try to model climate change, we can look at the disturbances that shape the system and see how their frequency or their intensity is likely to change due to climate change, and sort of indirectly get at climate change itself.
- TS: So I put under analytical approaches, to model disturbances across landscape. Might be climate driven in part, or it might not be. So, are there other ideas in terms of what are the appropriate criteria for assessing biodiversity? And related to that, what might be specific measureable indicators that we'd actually develop datasets and work with in order to get at those criteria?

17. Habitat

- AL: One of the things that we have as monitoring indicators are snags, downed logs, etc., which provide specific habitat for specific species, and in some places are maybe not at the levels that they were historically.
  - TC: one of the fire-related data layers that's available is LandFire, and from it we have coverage for the entire analysis area, and vegetation condition class and ecological departure, so it's not only looking at departure from historical fire regimes, but includes data on exotics and structure and floristics, and so , in that sense, you're starting to distinguish these larger vegetation communities and differentiate them based on those current vs. historical conditions. I know some people have issues with LandFire in the sense that if you start to drill down to too fine of a scale, it starts to unravel very quickly, and there are issues with accuracy at that finer scale. But at the broader scale, across the 5 million acre analysis area, using some of those products would make sense, and we could

also utilize some of those same concepts, and utilize some better datasets, like our current Veg Map to have finer scale data that is of a higher accuracy, and maybe more appropriate for drilling down and looking at those.

- TS: One of the things that I think is obvious is that we have in the last decade or two, collectively focused a lot of attention on forests, arid forests. So for this morning, thinking about the whole region of consideration, and that the majority of it is not forested, are there ways of getting at some of these issues for grassland and shrub communities and woodland communities? What would be the criteria for assessing biodiversity in those areas?

  A point that may be obvious is the distinction between species data and occurrence… and then there's the habitat-based approach for looking at diversity—where we have habitat diversity, we'll have species diversity. This represents a fundamental debate, I guess, within biodiversity studies in general, and many of the different land management agencies are struggling with where to put their focus and resources—on the species side, or on the habitat side? So I think we will have to play both sides of that in the assessment and understand that both approaches are going to be utilized into the future, and we don't want to put all of our eggs in one basket...So, keeping that in mind, and trying to visualize these non-forested habitats across our very large study area, how might we characterize the relative importance of biodiversity of that landscape?

  - JN: it is a given that we're going to use as much as we can of those 1500 plots (in the veg map), and create all the kinds of diversity things from all the different kinds of associations…
  - MK: But at the same time, I think you're going to have to think in a larger scale, and when I think about biodiversity…the desert scrub parts, the inner parts of the canyon…you're going to have to think in terms of habitat and modeling to get habitat identification for places outside of where the veg map was done. I mean 1500 was a lot of plots and this is a million and a half acres, because we also included parts of Lake Mead and parts of Grand Canyon Parashant. So the plot density wasn't that great, but they were fairly successful in actually getting things right. So it is possible to model some level, whether it's life form or …as far as what kind of habitat you're in.

- PB (1:55:50): So I think just speaking of western Grand Canyon, when I look at historic photographs, there was a lot more biodiversity and a lot more vegetation, period, in western Grand Canyon and many parts of the Colorado River than there was pre-dam, 10 years ago. So is that a desirable outcome that we have this **artificially created biodiversity**? A lot of people would say yes. I mean there's habitat enrichment for many species. I mean, we don't like to see the tamarisk, but the willow fly catcher occupies the tamarisk groves, so if we get rid of the tamarisk, how does that impact willow flycatcher?
  - TC: : It is a challenge from a management point of view and we don't have any answers… Our goal for this process is to identify what that condition is and then, in some ways as managers, we're going to have to determine whether we give that condition a green light, a yellow light or a red light. And different people may assign different colors to that same condition.
  - PB: Which reflects our values. And thinking about values in a lot of this… to a large part, because of water and power interests, that river system will pretty much always be taken care of, regardless of climate change, because so much depends on that, there's a lot of value ascribed to that. In terms of the forests that we were talking about, we have more fire management, more forest thinning, most of it in urban interface areas, which I think reflects values—we don't want our houses to burn down. At the same time, the way that forest is used in other ways, different activities, both intensity and different types of activities near cities is different than those near Blue Ridge or Clints Well, or other places that are more isolated. I wonder if there's a way to stratify the way that these different areas are analyzed.

TC: Another component of biodiversity that we often forget about, but it's really important, is **the invertebrate component,** which, from a faunal perspective, represents the greatest proportion of biodiversity by far. Through the work of Larry Stevens and others we do have some extensive datasets available…

TS: …I'm just wondering what the sense is here. I think we've had more discussion under what I would consider habitat diversity, over the last 15 minutes or so, and I do think that there are advantages and there are datasets we can leverage to do that, and I'm wondering, in our concept, biodiversity, and how we want to represent it across the greater grand canyon landscape, are we talking about developing indices that approach biodiversity from a habitat standpoint. Do we also want to leverage existing species level data to develop an index that's more based on that side of the equation?

- JN: I'm curious, Grand Canyon is just so in your face diverse. Plants migrate; they can go up and down, it's so unusual. So, what's your perspective on how… the white Mountains habitat is an interesting case because you have a lot of flat forest and swales and maybe some deep soils and shallow soils. Would that same thing be as useful in a place like Grand Canyon? Or would the differences focus mostly on differences in soil depths in the flat area because everything else is really vertical. Seems like it's so diverse over short distances, with microhabitats and everything else. Would it work the same?
  - TS: That's a good question. I think your point's a really good one. I think we may see the sort of biophysical conditions vary over such short distances that it's a real challenge to represent them. I'd be curious about what others might say, and whether there are taxa that might lend themselves to that kind of species level assessment. Another way to look at this', if it is inherently complicated and less tractable to develop say a species richness index, which then could be characterized across the whole landscape is to move toward a more habitat-driven approach to biodiversity, but then augment that with a few individual species about which we know a lot, and then ask the question, 'do these, what might be candidate umbrella species, do those patterns correspond in any way to the way that we are able to characterize habitat diversity across the landscape. Then, if so, or if not, then that influences the way we interpret those landscape-scale data layers. But, this is kind of the nut, where we are right now, is trying to surface people's best ideas so that we can sort of explore those in greater depth right now.

    And I guess my sense is, we have a number of tractable ways of dealing with forested stuff and the river corridor, and this really topographically variable portion—below the rim portion—I'm not sure we have a lot of stuff to sink or teeth into right now, in terms of how we'd characterize biodiversity. So I just throw that door open.

18. Defining "biodiversity"

TS: I haven't written anything here in terms of what are definitions or approaches to biodiversity as a concept.… Maybe we need to take one more step back and just say, if we're interested in biodiversity as a concept, how do we define that such that we can actually uncover the important elements of the term as they affect the future management of the Grand Canyon region?

- AL: I think a scalar approach is necessary. The microsites will be fine-scale type habitat diversity and then landscape level stuff and whether or not we're talking about more wide-ranging species vs. species that don't move very much. Whether or not you pick up fine, mid, and landscape or some other scale…
- Valerie: …just being mindful about nonnatives, there's that distinction between those that can alter ecosystems vs. other more benign.
  - TC: …we've identified within our vegetation program those nonnatives that are of highest management priority, and that is one of the criteria that we use—the potential impacts that a given species has on ecosystem patterns and processes.
  - PB: I think in general, we value native species, but I think in some cases they become invasive themselves. I'm thinking prickly pear and cholla… and arrow weed in some places. Even along the river we say the

sediments being restored, but then there are native plants that are repopulating, but it's basically a monoculture in those microsites.

- TS: So what I put down here is "system altering invasive spp" and these could be native or nonnative.

- TS: One thing I wanted to ask of those of you who spend a lot of time thinking about cultural resources. Are there ways of characterizing this fuzzy concept of biodiversity drawing on cultural histories and understandings. You know, biodiversity tends to be kind of a techno jargon word, but the idea behind it is old, it's people, in terms of those resources and how they're utilized. Do you think there might be a way to look at that across the landscape in terms of those biological resources that are really critical, either interms of their utility or in terms of the way they represent the state of the system?
  - TC: Would tribal members view, I mean if they're trying to place value on one condition or another, let's say the historical vs current, would the concept of biodiversity be part of that judgment, or would they be more looking at the pieces, and are there culturally significant species that maybe were present then, that aren't present now, or vice versa.
  - PB: … I think they would look at culturally significant species, whether it's for food, materials, and generally would like to see the restoration of that. There's sort of this idea that maybe the past was a better place, but at the same time, I think there have been certain changes, like let's say, even arrow weed—they might be using that to make cradle boards. And if there's more of that around and it's easier to get to, then they might think, 'that's a good thing, we like that. Or, if there are culturally significant plants that are more prevalent because of adapting or changing conditions, they'd probably give that a thumbs up, speaking somewhat speculatively...
  - TS: …I think it would be really…very helpful if some of that information could be represented spatially—these are key resources that the people go into this region for, or they identify a particular canyon as being important because these biological resources traditionally have been available there...
  - PB: …thinking about the broader landscape, I think we'd actually find a broad range of responses to those kinds of questions. Some tribal members are ranchers, and they may think that chaining is a good thing, if they believe that it resulted in better rangeland for their livestock. And then other people would say, 'well, we value the mesquite because of the mesquite beans, or agave for the food value.
  - TS: I think the range of opinions is where it gets really interesting because if we could characterize that in an acceptable helpful way, then you could start seeing where things overlap and don't overlap, and that's where we start getting a clear idea of what the resource management challenges are; how what happens inside and outside of the park influences the other side of the boundary; where common interests are. That's the sort of thing that can empower people to make decisions that work for everybody and get ahead of those issues… It might be that it's too complicated or too sensitive, or just not a high enough priority for tribal people and others who have this cultural-based idea of biodiversity. But I think it'd be worth looking into that possibility because if it were possible it would revolutionize the way we think about biodiversity and be more inclusive of different values.
  - AL: …the places in the forest that tribes have shown the most interest in tend to be those areas that have high biodiversity, for example,traditional medicinal plant collection areas, springs, areas with elevational changes…
  - TC: I think what's interesting about that nuanced concept of biodiversity through a cultural perspective, whether that's Native American or otherwise, is there's an accessibility issue. In the spatial context, it provides some unique opportunities to do a spatial analysis where we are looking at accessibility and how different people, depending on their different interests and uses, use the landscape.
  - TS: …WE still are threats, humanity, but there are different scales of threat, and sometimes the sustainable harvest and use of resources actually becomes a motivator for conservation. And exploring that a little bit in this landscape, which has some of the highest biological and cultural diversity of anywhere in the country, presents an opportunity for us…

- AL: …and it can also be a tool. This is where you look at…if we're facing external development threats, for example, it might take this range, including interests from tribal groups, to preserve certain areas to help maintain habitat. So it really is a collaborative effort.
- TC: Part of our motivation for this effort to begin with was to compile this information in a collaborative way where we're engaging stakeholders and subject matter experts so that when faced with emerging issues, we've already done the homework, we've already identified what the current condition is, what the threats are, and we're not scrambling at the last minute to pull together a lot of information. We already have a defensible, peer-reviewed product that we can take to the Superintendent, or to Tribal leaders and say "look, this is what we already know, this is a threat, this is what could happen. So we can start to work together to confront some of these shared issues in a more proactive, instead of reactive way.

- …are there textbook classic definitions of biodiversity that you've discussed merits of…?
  - TS: Well, there definitely are, and I've kind of studiously avoided the professor mode. And I think … what we need to do is figure out what the operational definitions are for this landscape. So we could talk about the … lotus-shaped diagram that's in most of the textbooks, but I think that may or may not be useful here. I think your first point is the key one: are we talking about biodiversity, thus far in a way that's (allowing us) to adopt a landscape perspective to capture those values in the landscape that are broadly appreciated in such a way that we can bring data and modern science to basically provide insight when these difficult, multiple resource, complex issues emerge…So, maybe we need to work through this and say, given all the things that we're proposing to do, our operational definition of biodiversity is this…
  - PB: Seems like sustainability is a component of how we would define biodiversity. Biodiversity in some ways is self explanatory, you know, diverse biosphere, but one of our concerns is having it also be sustainable...
  - TS: If we take that diversity of life literal translation of the word, and I think we are hitting on the major forms of diversity, which is composition, which is associated with the species level, typically. Structure is how are those elements arranged on a landscape and Pete made a point about that with regards to the forest characteristic, and structural and age class and how are those species-level components of biodiversity actually distributed across the landscape, and then there's the functional part—what role do they play in the ecosystem. And I think the things we've been talking about are hitting on all three of those. And the point, I think it was Ariel's point about the scaling—how those things scale from the microsite to the greater landscape is a big challenge. So we need to be able to move among scales. I'd say that those elements that are part of our discussion frame the classical definition of biodiversity…

Morning, Part 2: Ecosystem Intactness

19. How will the landscape assessment be used?

- The assessment will explicitly identify what we don't know and what type of research and monitoring will help to shift us from having low confidence in our assessment of ethnographic resources to a medium confidence.
- NPS has been working on creating a framework for cultural resource assessments. The project had a conference call with them a few months ago, to find out where they were at and what the framework was looking like. The park service is leaning towards a symbology that distills the information down into a management-friendly format. From our data we can see that we don't know much.
- Also, if our assessment indicates that ethnographic resources are of significant concern, and maybe trending

downward, then that's a red flag for management. Using this symbology, a manager should be able to flip through the assessment and easily pick out the red flags, which can alert them to significant threats for which we will need to engage others to help deal with.

- A benefit of taking a collaborative approach is that we're not going to be able to tackle big issues like uranium mining and wind power development that threatening visual landscapes and other resources alone, as an individual park. With a collaborative approach, we can engage and seek help from stakeholders outside of the park.
- Todd provided an example from the Saugus Ironworks which conducted a cultural resource condition assessment. The approach that they have taken has focused more on the state of the knowledge of those resources, as opposed to the condition of those resources. He made the point that the archeological resources condition assessment framework developed at the national level is the level we need to get to for the resources we are including in this assessment. For ethnographic resources, we need to get there some way or another. These overall assessments are going to direct what we may or may not need to do as park managers.

20. Some final process points.

- Those people who are heavily involved in the overall project will be responsible for identifying the tasks and following up on what has been discussed here. Will come up with a preliminary framework that will fit into the larger framework.
- In the fall we will have another stakeholder workshop where we will roll out what has come out of the Technical Work groups, and maybe some preliminary products, and an opportunity for the broader stakeholder group to have additional input.
- Still figuring out what types of spatial analyses will be done, but one example is The Nature Conservancy's Ecoregional Assessment, looking at areas of high priority and high opportunity. But, has been cautioned about trying to do an analysis across resources.
- A final point was made to the effect that areas that are sacred to a number of tribes can also be high in biodiversity. Suggested the term "hot spot" to describe them.

Meeting adjourned at about 12:00 pm.

Afternoon Session: Forests and Fire

1. Introduction and background

Fire is both a resource and a threat across the landscape. Resources can be affected by fire, both positively and negatively. The goal of this assessment is to come up with an overall determination about the state of fire across the landscape.

- Are we concerned about the status of fire, or is it in relatively good condition?
- What is the trend in that resource, and what is our confidence level in that determination, based on the quality of the data we have, based on the methods that we used to make that assessment?

Some history: For the GRCA fire management plan EIS, reference conditions, existing conditions and desired conditions were identified for each of the fire-adapted communities: Spruce-Fir, Mixed Conifer, and Ponderosa

Forests, and Pinyon-Juniper Woodlands (see GRCA_FMP_EIS_Fire Conditions_june2009.pdf). Keep in mind that the role of fire and its importance will vary by community. For the communities for which we know less about the role of fire, these are more qualitative descriptions, although they do draw upon existing data. For those for which we know a lot about how fire functions and about historical conditions, like ponderosa forests, desired conditions can be very specific.

We talk about fires in terms of fire regimes—not individual events, but a series of events. Some of the metrics include frequency, extent, and seasonality. We want to look at current conditions and how they compare to "historical conditions"; what are likely future conditions, and what are sustainable conditions, given things like climate changes. But we don't always equate historical conditions with desired conditions. Getting back to historical conditions may not be possible or desirable.

The park has identified specific management objective for fire in different forested communities. Adheres to the NPS national fire monitoring framework and has installed fire monitoring handboodk (FMH) plots and rapid assessment plots to monitor prescribed burns. Assesses whether or not they have met fire management goals annually.

2. The LLECB Approach –

TS: looked at fire in the context of forest restoration and management in a collaborative framework. Involves data that describes the conditions of forest or woodlands/shrublands and allows us to infer a lot about the potential for fire, and the nature of the fire that might occur under different circumstances. We need a framework to consider multiple resources and multiple points of interest simultaneously.

- Foundational data layers- vegetation composition, basal area, stand density, canopy cover, etc. LLECB has been developing these datasets using data from a variety of sources and can now model these foundational data across very large areas.
- Western Mogollon Plateau study was the first project to apply this landscape level approach to looking at fire and other factors that people consider in tandem with fire. This approach was refined and later used in the Wood Supply Study, and then the Four Forests Restoration Initiative (4FRI).
- An important tool is FlamMap, a fire behavior mapping program that computes potential fire behavior characteristics (spread rate, flame length, fireline intensity, etc.) over an entire FARSITE landscape for constant weather and fuel moisture conditions.
- Fire risk modeling using landscape conditions and historical burn information. Helps to prioritize areas across the landscape for mgmt. intervention.
- The power of this approach is that the same foundational data layers can be leveraged to look at other things that are important in terms of how we manage fire, for example, wildlife values. Can look at the value of forested habitats for wildlife species and begin to balance the priorities that we might set in terms of fire with other social priorities. Helps to move from science to management decisions.
- The social dimension of this scale of analysis necessitates us taking a more inclusive, participatory approach that involves of identifying public values, points of conflict, points of agreement, and taking all this into consideration, negotiating where on the landscape is that wood really available to be harvested
- Final example: the Kaibab Forest Health Focus – involved zooming in to focus on the project level. Used a collaborative process to come up with vegetation management approaches that are ecologically grounded and socially filtered.

3. GRCA Fire Management and GGCLA objectives for analysis of forests and fire

TC: The main objective is to utilize the existing data in new ways so we can extract more information from the data we currently have to help address some of our management questions and needs. Chief among these is the need to prioritize areas for management given shrinking budgets and the need to be more strategic.

- GRCA fire management structure. NPS has a Division of Fire and Aviation. However, on the north Kaibab Plateau, GRCA has a joint fire management operation with the USFS. This is more of a cross-boundary approach, but there are significant differences as to how fire is managed on both sides of the fence.

  On the South Rim district, GRCA coordinates with the USFS< but it is not a joint operation as on the north Kaibab.

- Fire management in GRCA encompasses several different things:
  - Fire for resource benefit involves letting fires burn in areas where we feel there may be resource benefits. Important to identify these areas in advance, which includes identifying areas for prescribed burns. The park has a ten-year plan that tentatively identifies these area, but things such as availability of resources and money can derail plans, so plans have to be shifted and reevaluated each year.
  - Suppresion is another fire management activity. Identifying areas where suppression is the default action (due to factors such as the proximity of fires to sensitive targets like cultural resources or developed areas) would also be valuable.

- Looking at the nexus between fire management and other resources, for example, cultural resources. A large portion of the park has not been surveyed for cultural resources – about 95%. We need prior clearance to do fire management around cultural resources. So, if we develop predictive models that identify where there is a high probability of cultural sites occurring, then we can incorporate this information in our prescribed burning planning units. This way we won't spend time and money clearing areas where there is a low probablility that cultural sites would be present.
- TS: Importance of fire – shapes the landscape. With climate change, will likely play an even more prominent role. Everything from the forest to the hydrology of the North Rim and how precipitation is captured and infiltrates could really be reshaped by fire. That's the reason why this topic is central to a lot of management decisions in the future… It's not just the management of active fire, but it's the potential to affect almost every resource during this period of rapid change.
- TC: described how the Warm Fire on the North Kaibab resulted in type changes that were not necessarily desired. Talked about how assumptions about effects of various severities of fire would probably not hold true under a climate change scenario, and that we could potentially lose a significant diversity component due to a large, stand-replacing fire.

4. Indicators for fire as a focal resource (process) and for associated vegetation communities

- Cover of native and non-native species – ties into discussions about biodiversity and associated threats.
- Richness of native species
- Tree density
- Fire type
- Fire frequency
- Basal area

- Snag density
- Tree regeneration
- Total herb and shrub cover
- Canopy closure

5. Reference conditions and other data sets

- Ponderosa pine – a lot of historical data available – ERI (NAU) has put together info on historical forest structure for the Colorado Plateau
- Reference conditions may not be what we define as desired conditions, but they may provide a baseline against which we can assess current conditions to see how much they depart from historical conditions.
- Data from fire behavior modeling done for the North and South Rims with FlamMap and FARSITE (from old vegetation map – 5 or 6 years old) for the fire management plan. But we would want to use the most recent veg map data.
- LandFire products which cover the entire analysis area and include vegetation, fuel, fire regimes and topography. Approach identifies ecological departure, in terms of fire regime, floristics, vegetation community structure provides a relative index of condition at the broader landscapes. Is this applicable for GGCLA? Can we incorporate information from the recent veg map, for a more accurate base layer, but utilize some of the same assessment frameworks?
- Maps: Fire history perimeters, repeat fires, fire severity data, fire progression with weather data that corresponds to each day of the fire progression, map of distribution of fire monitoring plots, new vegetation map.

6. Questions and comments on fire information presented?

- Pete Fulé is looking at high severity fire in mixed conifer on the Kaibab Plateau. Looking for even-aged patches of trees as indicators of high severity fires in the past, and trying to discover how often they occurred and how large they were.
- Chris: Did not assess the effects of fire below the rim. The river corridor has not been included in the GRCA fire management plan – for a couple of reasons – push back on doing management actions below the rim, and safety concerns about taking tactical actions on wildfires. We do get starts below the rim. They're often on bluffs, and they burn a single tree, or ten trees, then they run into rock. So if take action on fires it's because it's human caused on the river. Most wildfires in the canyon are not accessible to firefighters, so we monitor, and they often go out in a day or two because of the lack of fuels.
- TC: Suggested looking for tamarisk in high-resolution imagery of the corridor that the park has. Tamarisk leaf beetle is currently defoliating those tamarisk, resulting in significant mortality, and will probably result in heightened fire risk in those areas, similar to that in pine beetle kill areas, where you had dead needles on the trees and high accumulation of dead litter and that risk might be attenuated in the future.
- Will Flatley (Pete Fule's student): looking at vegetation response to climate change and fire, and modeling that into the future on the North Rim. I hope to identify threats to particular community types. **Could have some results by mid-2014.**
- Pete pointed out that Miranda Gray is applying circuit theory to fire spread in grasslands and shrublands in a probabilistic sense—where is fire likely to spread in SW Arizona? Can this approach be used for GGCLA?

  - TC: Do you think that might be more applicable outside of the forested system since it relies on NDVI?
  - PF: the use of the NDVI to calculate the fuels is more applicable to the Grand Staircase area. Sam Cushman at the Rocky Mountain Research Station does a lot of work with that.
- PF: in the modeling system that Will's using the idea the changes are a state and transition kind of change. John Van Kat worked on an analysis for GRCA to develop state and transition models for North Rim Forests (2005). *Pete has a copy of what he did and can send it to Todd.
- TC: Trying to keep the GRCA Veg Map updated with fire disturbance, but have not come up with a solution for that using the burn severity maps, because you have the challenge of having veg polygons that are intersected by the fire event and then you have differential fire severity within those polygons, then you need to have the out year data to determine what happens. Perhaps the VanKat models might provide us with insights to different approaches we might take to keep the veg map updated because, as with any veg map, it's already outdated, particularly in forested landscapes in some areas.
- Chris: The fire program has taken a couple stabs at making a crosswalk post-fire using fuel models. So we've done a crosswalk and split that by severity, e.g. if we take mixed conifer, we would have four crosswalks: high severity, high moderate, moderate(?) low and low, and we would track that out through the fuel models, not through vegetation.
- TC: talked about using LANDFIRE to determine ecological departure. Thinks this would be useful in the assessment because it shows the relative departure of vegetation communities from historical conditions, not just in terms of fire regimes, but in terms of exotics and other measures. It can be used to look at fire across both fire sensitive and fire dependent communities and give the condition of those communities relative to fire and other threats or values.
- Can burn severity mapping be used in the GGCLA? Jodi Norris responded by saying soil burn severity is the most common, but it doesn't apply very well across ecosystems. For example, in BAND, fires completely toasted P-J, but the severity rating was low—there's a disconnect between vegetation and soil burn severity…
- Fire modeling in GRCA? Only project-specific modelling since the Fire Management Plan EIS.
- TC: anyone familiar with SPOTS – Strategic Placement of Treatments (techniques to maximize the effectiveness of fuel treatments in reducing problem fire behavior, adverse fire effects, and suppression costs)?
  - Jill R: It's a collaborative and iterative process, but we found it to be a big time and resource commitment—a fairly intensive experience.
- TC: Could some of the approaches used in the Kaibab Forest Health Focus be expanded for the GGCLA analysis area? JR: possibly, but the Tipover project might be better…
- Chris: GRCA is planning to use the Tipover project to improve timber stands on approximately 9,123 acres of National Forest Land, through prescribed fire and understory thinning on the border of the Kaibab NF and GRCA to bring fire back into the park.
- Chris: Described previous collaborative modeling through Colorado State University called STARFIRE, but has not been adopted by park for decision-making.
- TC: Big challenge—there has been so much work done on fire and fire-adapted vegetation communities in this area that it's hard to figure out the most sensible way to synthesize that information in a way that is useful for park managers and for our neighboring landscapes. Some suggestions that came up during the break:
  - identify the criteria that we use for prioritizing areas for management. Problem is that management

within the fire context can mean a lot of different things. It can mean thinning, where you suppress fires, where you let fires go, do you ignite prescribed fire…But a lot of folks, particular fire managers and those in operations have their own internal model about where they prioritize and why. Perhaps we can take those and translate into spatial layers based on existing data. This could provide a framework on which to refine some of the prioritization work already done in the park…

- We could brainstorm those factors that would be considered in prioritizing actions and then think about how to translate them into a spatial analysis. This would be based on current conditions, and we have a lot of data we can use to quantify current conditions…

7. Key criteria for fire suppression at GRCA:

- Public safety – around developed areas, locations with human interactions
- seasonality and potential effects
- a key thing for GRCA is to make decisions for areas that are further departed (from historical conditions) than normal as a result of 100+ years of fire suppression.
- adjacent values at risk (Chris)
- consider possibilities for management opportunities – are there opportunities to create a planning area and actually manage a fire for resource benefit. If not, sometimes will suppress
- smoke impacts to our partners, both internal and external
- available resources
- Management support component driven by socio-political factors that are hard to quantify, e.g. fight a fire because the first lady was on the river and didn't want to have smoke around her
- long-term effects on cultural resources
- other values at risk, which include buildings, habitat for T&E species…there are many of them
- prevailing wind – long-term weather patterns
- access
- time since last fire
- suppress all fires in the WUI (but will do prescribed burns)

Jill R. said most of these could have a geographic component and a spatial extent. Asked for a confirmation that there are areas that have been identified that management will always let burn—yes, some such areas have been identified—(TC: tend to be sky islands, like Powell Plateau).

8. Fire as a resource vs. threat – how to rate the trade-off

- Can the resource values and threat posed by fire be weighted to help guide management decisions?
- Occurrence of previous fires can affect fire regime upon subsequent burnings. It's possible that you may shift one area outside of its natural range as you try to shift another area back into its natural range of variability. How to weigh the trade-off?

9. Value of GGCLA to GRCA fire management planning

- TC: if we can develop a repeatable assessment framework, we can update the assessment periodically and see how those current conditions stack up against our desired conditions. We want to be able to take the information we have and utilize it in a real-time framework.

- Chris: One thing that was not considered in the FMP was that we had a change agent in tamarisk. – Does fire have the potential to be part of that ecosystem now, either beneficial or detrimental? We hope that the GGCLA will provide some information and guidance for the next iteration…
- TC: We can draw on information outside of our analysis area, where there is ongoing research on tamarisk beetle impacts. My understanding is they have already had increased fire activity in some of those large stands of dying and dead tamarisk.
- TC: We recently started working in mixed conifer and spruce-fir communities, but there are questions because of the high level of uncertainty about what those historic fire regimes were and the higher potential level of risk for allowing natural starts to burn in some of those areas, or even prescribed burning. What information about those forest types would help inform our assessment of the current condition of those areas?

TC wrapped up the meeting by explaining what the process would be moving forward…

Greater Grand Canyon Landscape Assessment (GGCLA)
Landscape Resources Technical Workgroup Initial Meeting Outline
Wednesday, June 12, 2013
Session 1: Landscape Metrics 8:00am – 12:00pm
Session 2: Fire Ecology 1:00pm – 5:00pm

Objectives and expectations

This technical workgroup will help to identify appropriate condition indicators, compile and evaluate data/information sources, develop assessment criteria and methods, and assess the conditions and trends of focal resources within its respective discipline. The workgroup will be facilitated by GRCA/NAU staff and will include other subject matter experts (SMEs) and stakeholder representatives, depending upon interest and availability. Participants will be expected to actively engage in the workgroup, including providing sound technical guidance, doing 'homework' in preparation for meetings, and helping to develop work products (e.g. literature reviews, spatial layers, condition assessments, etc.). Subsequent meetings (incl. conference calls/webinars) will be determined on an as needed basis. Specific objectives for the initial meeting include the following:

- Refine scope of assessment for focal resources (e.g. fine-/coarse-filter, ecosystemic-/taxonomic-level).
- Identify and assess preliminary condition indicators and reference/desired conditions.
- Identify and assess known/potential threats.
- Identify appropriate spatiotemporal scale(s) of analysis.
- Develop condition assessment criteria (e.g. indicator ranges/thresholds) and analytical approach (e.g. quantitative/qualitative score, spatial modeling).
- Identify and assess information/data needs, sources, and gaps.
- Identify specific tasks, products, roles, responsibilities, and timelines.

Focal resource(s)

Focal resources were identified based on input from participants during the GGCLA Workshop on October, 11th, 2012 and subsequent discussions amongst GRCA and NAU staff. Desired condition statements, indicators, reference conditions, and targets are from the 'Draft Grand Canyon National Park Desired Conditions' (2012) and references therein. *Denotes NPS Southern Colorado Plateau Network Vital Signs and Measures in the following tables as outlined in Thomas et al. 2006. TBD - To be determined based on GRCA and/or other relevant data sources (incl. workgroup products). Spatial and tabular datasets include those developed or acquired by GRCA.

Data table color codes are as follows:

Documented	In Development	Not Documented	Not Evaluated	To be Developed

Research studies listed include relevant permitted research conducted in GRCA since 1958. Research results (e.g. reports, publications, datasets) are not necessarily readily available for all those listed.

Landscape Metrics

Desired Condition: Grand Canyon National Park's 1.2 million acres are dominated by natural processes that support high levels of biodiversity, community resilience, and facilitate adaptation in the face of climate change. Assessment includes biodiversity, connectivity, ecosystem intactness, and exotic species.

Indicator	*Reference Condition*	*Target*
Roadless areas (%)	TBD	TBD
Habitat connectivity with adjacent lands	TBD	TBD
Acres managed under historical fire regimes (%)	TBD	TBD
Start of growing season*	TBD	TBD
Date of maximum greenness*	TBD	TBD
Total seasonal production*	TBD	TBD
Snow cover duration*	TBD	TBD
Park area affected by disturbance*	TBD	TBD
Disturbance patch size*	TBD	TBD

Fire Ecology

Desired Condition: This section is covered in attached 8 page document - *"GRCA FMP EIS.AEF June 2009.pdf."*

GRCA Landscape/Biodiversity/Connectivity/Ecosystem Intactness/Exotics Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Exotic Plants	Tabular	Contains information about the presence and management of exotic plant species in Park. The data set is not a systematic survey of exotics plants. The main goal of project is to control exotic plant populations in targeted areas of the Park.	Lori Makarick GRCA	2002 - present	Developed areas on rim, inner canyon and river corridor	- Identify areas where exotic plant species are found and treated including frequency and extent of control. - Possibly look at effectiveness of control in sites with enough data.	- Does not represent valid presence / absence of exotic plants within the Park. - Does not represent complete distribution of exotic plants within the Park. - Data have not been thoroughly vetted.	Entries contain site specific information including slope, aspect, elevation, light exposure, surface water and associated plant species. Entries include identification of exotic plant species, the areal extent of the exotic plant population and the percent cover of the species, along with the geographic location (UTM center point) of the population. If control actions are taken, information about the number of plants controlled, aerial cover removed, area treated, treatment type, plant phenology, and specific information about control actions that might be useful to determine future management action needs. If herbicide is used, the type, mixture and amount are recorded.	Moderate to high effort extracting data from complex data structure and vetting data thoroughly.
Vegetation Transects	Tabular	Contains information about ground cover, vegetation cover and vegetation structure measurements taken along 50m transects. The intent is to monitor changes in these measurements. Most transects are placed in river camps. 448 transects have been created, 202 of which have been sampled at least 5 times. Transects are commonly used to measure changes after exotic plant removal or vegetation restoration.	Lori Makarick GRCA	2000 - present	Majority of sites in river corridor; some on rim and inner canyon	Quantify and describe vegetation characteristics for river campsites primarily.	- Great majority of data is in river campsites. - Data collection methods have changed limiting use of some data. - Data have not been thoroughly vetted.	Entries contain site specific information including slope, aspect, elevation, bearing, light exposure, geologic layer and UTM data for the start and end point of the transect, along with a verbal description. Entries include measurements that were taken along a 50m transect at 5,15,25,35,45m: Daubenmire ground and plant cover (2005-present), vegetation structure method 1 (2004 - 2008), vegetation structure method 2 (2006 - present), soil measurements (2005 - present), and point intercept method for ground and plant species	Moderate to high effort extracting data from complex data structure and vetting data thoroughly.

GRCA Landscape/Biodiversity/Connectivity/Ecosystem Intactness/Exotics Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
								(2000-present). Along with other ancillary data including dominant and associated plant species and photos of transect start and end.	
Rare Plants	Tabular	Describes rare plant populations, identifies locations where rare plants are found and characterizes the immediate site.	Lori Makarick GRCA	2004 - 2012	Majority of sites are in eastern half of Park	- Identify rare plant locations in the Park. - Help create predictive model of rare species.	- Does not represent a systematic Park-wide survey for rare plants. -Small number of records.	The number of individuals and number of subpopulations is estimated, size of area occupied is estimated, phenology of population is estimated, evidence of reproductive success, evidence of symbiotic relationships, evidence of disease, predation or injury are all noted. The site is characterized by measuring ground cover, noting animal use evidence, and noting natural and anthropogenic disturbances.	Simple to convert tabular data to spatial layer.
Bryophytes	Tabular	Update the bryophyte floristics in Park including expanding the known bryoflora by collecting bryophytes and incorporating modern collections since the 1940s, report the local distribution and microhabitat specificity of each species, and report regions and substratum types supporting high regional diversity. The study sought to determine if bryophyte communities differed significantly within three forest types - pinyon-juniper, ponderosa pine, and mixed confier forests. Sampling occurred along trail corridors.	Southern Colorado Plateau Network	2008 - 2009 (field work) 2007 - 2010 (specimen collection)	Eastern half of Park	- Identify hot spots of bryophyte diversity in Park. - Identify the locations of rare species. Regionally or locally rare species may warrant special attention. - Bryophyte communities can be described generally using the 3 forest types sampled.	- Field sampling limited to trail corridors. - Results indicate microhabitat and microclimatic variation are more important drivers of distribution and abundance of rock bryophytes.	Compiled and reviewed existing collections and contributed new specimens collected from 2007 to 2010. Over 1,310 new specimens were collected. Collections were summarized spatially into 6 collection regions - North Rim, South Rim, Inner Canyon, Colorado River, Lake Mead and Marble Canyon. At each of 104 sites, 3 rocks were randomly selected to sample. Rocks had to be at least 1m from trail and be large enough to fill a 100cm x 1cm quadrant. Species cover was estimated to the nearest 1 cm^2.	

GRCA Landscape/Biodiversity/Connectivity/Ecosystem Intactness/Exotics Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Vegetation Mapping	Tabular	The Vegetation Mapping Project was intended to sample, classify, describe and accurately map the plant communities comprising the Park. The tabular data contains classification plot and observation point data collected during project fieldwork. Classification plot data was used to create a classification of vegetation alliances and plant associations for GRCA. Observation points are used to inform the photo-interpretation/image processing phase of the project.	Mike Kearsley GRCA	2007 - 2009	Park-wide	- Describe vegetation characteristics across a wide variety of vegetation communities park-wide. - Describe fire fuels information across a wide variety of vegetation communities park-wide.	Snapshot in time data.	Classification plot and observation point tables contain basic information on plot or point location, visit specific information, overall vegetation characteristics, species and strata-specific data related to a plot or point, details on stems, height, crown width, and other tree attributes, environmental features and conditions (including ground cover) of plot or point, details on photos taken of plot or point, and final determination of plot vegetation association as determined by NatureServe.	Simple to convert tabular data to spatial layer.
Cave Resources	Tabular	Data set includes cave descriptions, inventory assessments, description of any human impacts and evaluation of resource values. Inventory assessment includes: biological, hydrologic, terrestrial substrate, paleontologic/geologic/mineralogic, cultural resources, and recreational.	Steve Rice GRCA	1930 - present	Park-wide	- Rate importance of caves based on evaluation of resource values. - Resources of special concern can be linked to specific caves. - Identify caves subject to human impact.	Represents a small sample of caves that likely exist in the Park.	Caves are described and inventoried using protocol specific to the Park. The protocol is likely to be used as a Park-wide protocol. Protocol collects: detailed cave location information; detailed accessibility information; inventory of biological resources; physical resources including hydrology, lithology, speleothem details and speleogens; paleontological resources; cultural resources; evidence of human impact; evaluation of resource values (1-5); hazard rating to access cave.	Simple to convert tabular data to spatial layer.

GRCA Landscape/Biodiversity/Connectivity/Ecosystem Intactness/Exotics Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Springs and Seeps	Tabular	9 springs in Park were sampled to Level 2 Inventory protocol. These GRCA springs were sampled: Dripping Springs, Buck Farm Canyon Spring, Upper Butte Fault Spring, Lower Butte Fault Spring, 70 Mile Spring, Stone Creek Spring, Thunder River Spring, Nettle Spring, Warm Springs.	Southern Colorado Plateau Network	spring of 2005	Park-wide	- Identify potential or observed natural or anthropogenic disturbances. - Examine patterns in geomorphology characteristics. - Examine patterns in vegetation community composition, diversity, exotic species presence and sensitive species occurrences. - Examine patterns in invertebrate community composition and diversity.	Very limited number of springs sampled and single visit to each spring.	Level 2 protocol includes the following: spring location information; detailed site description; photograph(s); sample riparian and aquatic plant communities; sample terrestrial and aquatic invertebrate communities; conduct geologic/geomorphic and hydrogeochemical analyses; discharge rates; and conduct wildlife observations.	Simple to convert tabular data to spatial layer.
Mountain Lion Cluster Investigation	Tabular	Limited movement of collared mountain lions was investigated to determine activity type(s), habitat characteristics of area, and weather measurements during cluster period.	Brandon Holton GRCA	2005 - 2009	Eastern half of Park	Explore possible spatial and temporal patterns in activity of mountain lions.	Limited number of records.	Spatial information about the cluster includes cluster centroid coordinates and elevation. Three activity types can be recorded along with confidence in the diagnosis of activity. Aspect, slope and topography are recorded. Recorded vegetation characteristics include percent cover, habitat type, dominant cover type.	Simple to convert tabular data to spatial layer.

GRCA Landscape/Biodiversity/Connectivity/Ecosystem Intactness/Exotics Database Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
								Latrines, scat, tracks and beds are noted.	
Bighorn River Observations	Tabular	Bighorn observations made in the Colorado River corridor, usually during a river trip. Age and sex are recorded as well as activity. Approximate distance from the river is also recorded.	Greg Holm GRCA	2005 - present	Colorado River corridor	Identify areas where bighorn are seen in the Colorado River corridor.	- Limited number of records. - Expertise of observers varies widely.	When a bighorn is viewed the following is recorded - river mile and/or coordinates, river side, date, time, total group size, number of each age class, vertical and horizontal distance from the river, activity, weather, river trip information and comments.	Simple to convert tabular data to spatial layer.
Mexican Spotted Owl Surveys	Tabular	Surveys for MSO can occur for these purposes - inventory, compliance and monitoring. These survey types essentially record the same information - basic survey information, owl detection information and nest location information.	Janice Stroud-Settles GRCA	2001 - present	Primarily in eastern half of Park	- Spatially locate where MSO surveys have been conducted. - Spatially locate where MSOs have been detected. - Spatially locate where MSO nests have been found. And possibly determine reproductive success.	Does not represent a systematic Park-wide survey.	Basic survey information is recorded including type of survey, date, observer(s), start/end time, coordinates, PAC name and result of survey. Any species of owl detected will include observation type (heard, visual, both), call type, age, sex and UTM coordinates. When a nest is located UTM coordinates are recorded.	Spatially locating surveys, owl detections and nests is simple.

GRCA Landscape/Biodiversity/Connectivity/Ecosystem Intactness/Exotics Database Summary

Data Theme	***Data Type***	***Content Description***	***Source***	***Time Period***	***Spatial Extent***	***Appropriate Uses***	***Limitations***	***Data Methods***	***Use Cost***
Northern Goshawk Surveys	Tabular	NOGO surveys conducted for compliance. Information recorded includes basic survey information, Accipiter detection information and nest location information.	Janice Stroud-Settles GRCA	2004 - 2011	Eastern half of Park on North and South rims	- Spatially locate where NOGO surveys have been conducted. - Spatially locate where NOGOs have been detected. - Spatially locate where NOGO nests have been found. And possibly determine reproductive success.	Does not represent a systematic Park-wide survey.	Basic survey information is recorded including date, start time, coordinates and result of survey. Any species of Accipiter detected will include observation type (heard, visual, both), call type, age, sex and UTM coordinates. Discovery of a nest is also noted.	Spatially locating surveys, NOGO detections and nests is simple.
California Condor Observations	Tabular	Contains Condor observation information including a textual description of location and Condor number.	Greg Holm GRCA	2009 - present	Park-wide	- Identify areas where California Condors are see in the Park. - Possibly identify spatial patterns for individual Condors.	Observation locations are provided as common name place, rather than coordinates.	Observation information includes unique bird number, detection type, date, time, observer and common name place.	Simple to convert tabular data to spatial layer.

GRCA Biodiversity GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Fire	GIS (Vector)	Fire History, Fire Severity, Fire Effects, Fire Treatments	GRCA	March 2013	GRCA	Effects on Biodiversity	GRCA only	Multiple	None
Forest Insect And Disease	GIS (Vector)	Insect Infestations and Forest Disease	USFS	2000-2011	GGCLA Analysis Area	Effects on Biodiversity	Surveys limited to forested areas only	Aerial Surveys	None
National Hydrography Dataset	GIS (Vector)	Waterways	USGS	January 2011	GGCLA Analysis Area	Effects on Biodiversity		Multiple	None
Seeps and Springs	GIS (Vector)	Seeps and Springs	GRCA, MNA	December 2012	GGCLA Analysis Area	Biodiversity hotspots		Multiple	None
Public Land Ownership	GIS (Vector)	Land Ownership	ALRIS, GRCA	May 2013	GGCLA Analysis Area	Land Management policies dependent on ownership			Unknown
National Elevation Dataset	GIS (Raster)	Elevation, Aspect, Slope	USGS	April 2012	GGCLA Analysis Area	Effects on Biodiversity			Depends on application
Transportation	GIS (Vector)	Roads, Trails, Routes	GRCA, USBLM, USFS, other	March 2013	GGCLA Analysis Area	Effects on Biodiversity	not standardized across ownerships	GPS, NAIP, USGS 24K DRG, other	potentially high, to update and standardize, especially outside GRCA
Vegetation Map	GIS (Vector)	Vegetation	GRCA, others	January 2013	GRCA	Effects on Biodiversity	GRCA only	NAIP interpretation + field validation	Unknown
Arizona Wilderness Areas	GIS (Vector)	Wilderness areas in AZ	ALRIS	October 2010	GGCLA Analysis Area	Protected status as promoter of Biodiversity		Compilation	None
Wildlife	GIS (Vector)	Wildlife Occurrences, Habitat	GRCA		GRCA	Potential indicators of Biodiversity	GRCA only		Varies, but significant
PAD-US	GIS (Vector)	US Protected Area Database; GAP Status, Protected Areas, Land Ownership	USGS GAP	February 2011	GGCLA Analysis Area	Protected status as promoter of Biodiversity	Not all areas within the GGCLA Analysis Area are attributed, or sources clearly identified	Multiple	Minimal, but data currently as Web Service; extraction could be Moderate
Land Cover	GIS (Raster)	Land Cover, Land Cover Change	NPScape, NLCD, NOAA, NALC	2006	GGCLA Analysis Area	Effects on Biodiversity		Multiple	Unknown
Exotic Plants	GIS (Vector)	Invasive Species	GRCA		GRCA	displacement of native species	GRCA only	GPS, NAIP, USGS 24K DRG	Moderate

Biodiversity Database Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Arizona Flora Dynamic Map (by coordinates) and Lists (by region)	GIS (vector), non-spatial data	Research checklists of Arizona flora species by region, including Grand Canyon National Park and dynamically populated lists based on coordinates input on an interactive map	Southwest Environmental Information Network (SEINET)	depends on region	Southwest US	Could provide species lists as an indicator of flora biodiversity	spatial data only by coordinate point rather than by polygon	depends on region, collections updated and maintained by NPS staff for GRCA	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Sagemap Database Sagebrush Distribution	GIS (raster)	Current distribution of 10 sagebrush vegetation types and associated vegetation in the western US	The Nature Conservancy, Natural Heritage Program, NatureServe	1980-2001?	Great Basin region in intermountain West, excluding AZ and NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Sagemap Database Cheatgrass Invasion Risk	GIS (raster)	Risk model of invasive cheatgrass threats (low to high risk) to sagebrush habitats in shrubland ecosystems	US Geological Survey, US Forest Service, Oregon State University (Knick et al.)	1980-2002?	Great Basin region in intermountain West, excluding AZ and NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Sagemap Database Pinyon-Juniper Expansion Risk	GIS (raster)	Risk model of invasion of native shrublands (primarily sagebrush ecosystems) by juniper and pinyon pine	US Geological Survey (Wisdom et al.)	2004	Great Basin region in intermountain West, excluding AZ and NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Vegetation Drought Response Index (VegDRI)	GIS (raster), other data products in development	Vegetation drought response index (eMODIS or AVHRR VegDRI), weekly geospatial model that depicts drought stress on vegetation within coterminous US (can be eMODIS or AVHRR based)	US Geological Survey - EROS, High Plains Regional Climate Center, US Department of Agriculture	2008-2013	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI

Biodiversity Database Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Desert Botanical Garden List of Arizona Endemic Taxa	non-spatial data (*.pdf)	List of Arizona endemic plant taxa with federally listed species noted	Desert Botanical Garden GIS-based Analysis of Endemic Plant Distributions in Arizona	TBD	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Desert Botanical Garden Arizona Endemic Taxa by Region	non-spatial data (*.pdf maps)	Maps of AZ endemic taxa by region	Desert Botanical Garden GIS-based Analysis of Endemic Plant Distributions in Arizona	TBD	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Desert Botanical Garden Arizona Endemic Taxa Distributions	non-spatial data (*.pdf maps)	Maps of individual AZ taxon distributions	Desert Botanical Garden GIS-based Analysis of Endemic Plant Distributions in Arizona	TBD	AZ	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
The Nature Conservancy Southwest Biotic Communities	GIS (vector)	TNC developed a digital version for the whole of David E. Brown and Charles H. Lowe's 1981 map	The Nature Conservancy (TNC)	1981	Southwest US	Defines boitic communities	TBD	TNC developed a digital version for the whole of David E. Brown and Charles H. Lowe's 1981 map	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
The Nature Conservancy Arizona Grasslands	GIS (vector)	Extent, condition, and distribution of grassland types in Arizona	The Nature Conservancy (TNC)	TBD	AZ, portions of Mexico and NM	Habitat type and quality	TBD	Quality of grasslands define by expert interviews and field verification, classifications detailed in metadata	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

Biodiversity Database Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
AGFD Research Branch (via AZ State Land Department Riparian) Riparian Vegetation	GIS (raster)	Riparian vegetation associated with perennial waters	AGFD Research Branch via AZ State Land Department	1993-1994	AZ	Riparian vegetation	TBD	LANDSAT TM digital satellite data and Multiple Resolution Videography used to generate maps in 1993-1994	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
USGS-NPS Vegetation Inventory USGS-NPS Vegetation Characterization Program/Vegetation Inventory	data products in development	Classification, description, and mapping of vegetation communities in national park units to be available online when completed for relevant national park units.	USGS-NPS	data products in development	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
LANDFIRE Existing Vegetation Type	GIS (raster)	Complexes of plant communities	Landscape Fire and Resource Management Planning Tools	2008	National	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
LANDFIRE Existing Vegetation Cover	GIS (raster)	Vertically projected percent cover of the live canopy layer for a specific area	Landscape Fire and Resource Management Planning Tools	2008	National	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
LANDFIRE Existing Vegetation Height	GIS (raster)	Average height of the dominant vegetation	Landscape Fire and Resource Management Planning Tools	2008	National	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
GAP Species Richness Coverages (Amphibians, Birds, Mammals, Reptiles)	GIS (vector)	Common species and plant communities from GAP Analysis Program	Southern Arizona Data Services Program	TBD	Southwest US	Identifies species richness spatially	*e00 format (coverage)	Data derived from GAP Analysis Program	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

Biodiversity Database Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Southwest Regional Gap Analysis Project (SW ReGAP) Vertebrate Habitat Distribution Models	GIS (raster)	Digital habitat models searchable by common or scientific name	Southwest Regional Gap Analysis Project	TBD	Southwest US	Provides generalized animal habitat models	*IMG format	Data derived from SW ReGAP Analysis Program	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Southwest Regional Gap Analysis Project (SW ReGAP) Species Richness Maps by HUCs	non-spatial data (map only)	Amphibian, mammal, reptile, bird, breeding birds, and all species richness maps for AZ	Southwest Regional Gap Analysis Project	TBD	Southwest US	Provides generalized species richness maps	non-spatial data	Data derived from SW ReGAP Analysis Program	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Arizona Forest Resource Assessment	non-spatial data	Arizona Forest Resource Asssessment Report including identification of forest conditions and trends	Arizona State Forestry Division	2010	AZ	Could provide support for NRCA portion of GGCLA	non-spatial data (*.pdf)	Collaborative analysis of forest-related conditions, trends, threats, and opportunities	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Integrated Land Assessment Project (ILAP) R3_CurrentVeg_AridWoodland_2012020	GIS (raster)	Random Forest-derived estimates of arid and woodland current veg structure and cover for initial modeling conditions (yr 2000)	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI

Biodiversity Database Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Integrated Land Assessment Project (ILAP) R3_CurrentVeg_Forest _20110817	GIS (raster)	Random Forest-derived estimates of forest current veg structure and cover for initial modeling conditions (yr 2000)	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Integrated Land Assessment Project (ILAP) R3_PotentialVegType_ 20120213	GIS (raster)	Potential vegetation types used to correspond each veg model to an area of the landscape	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Integrated Land Assessment Project (ILAP) R3_States_ModeledWo odland_20120525	GIS (raster)	Post-rollup, modeled states (crosswalked from current veg) for woodland models	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI

Biodiversity Database Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Integrated Land Assessment Project (ILAP) R3_ModeledStates_Forest_20120604	GIS (raster)	Post-rollup, modeled states (crosswalked from current veg) for forest models	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Integrated Land Assessment Project (ILAP) VDDT models database and template Path models database (3 files)	database (*.mdb)	Database files for VDDT and template Path models for AZ Colorado Plateau (files prefaced by ACP*)	Halofsy et al. 2012 Integrating Social, Economic, and Ecological Values across Large Landscapes DRAFT Report, USDA, USFS Pacific Northwest Research Station Portland, Oregon, General Technical Report PNW-GTR-xxxx	2012	AZ, NM	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
BLM Rapid Ecoregional Assessment (REA) Mojave Basin and Range	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
BLM Rapid Ecoregional Assessment (REA) Colorado Plateau	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

GRCA Permitted Research Studies – Biodiversity

PI Last Name	*PI First Name*	*Study #*	*Permit #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Chambers	Carol		GRCA-9805-13-001	NAU	7/9/98 - 12/31/03	Response of small mammal communities and Sin Nombre virus to ecological restoration of ponderosa pine in Northern Arizona.	No final report received.
Covington	William		9702-24-001	NAU, School of Forestry	5/23/97 - 12/31/06	Grand Canyon Forest Ecosystem Restoration	GRCA Library Call # SD144 .A6 R43 2000.
Kearsley	Michael	GRCA-00057	GRCA-2006-SCI-0041, GRCA-2004-SCI-0028	NAU	12/1/06 - 12/31/08 7/16/04 - 12/31/06	A Reassessment of Kaibab Squirrel Activity and Habitat Quality on the Walhalla Plateau, Grand Canyon National Park	No final report received.
Kotliar	Natasha	GRCA-00119	GRCA-2001-SCI-0027	USGS	5/15/01 - 12/31/05	The Effects of Burn Severity and Heterogeneity on Early Post-fire Avian and Plant Communities in Coniferous Forests of the Rocky Mountains	GRCA Library Call # QH545 .F5 K68 2002. GRCA MC # GRCA 79712.
Mecham	Nancy Mulready		GRCA-2000-SCI-0087	NAU	11/11/00 - 12/31/01	The Natural History of Fire in America's National Parks: A Biological and Educational Perspective	226 pgs. GRCA Library Call # SD421 .M854 2003.
Rambo	Jennie	GRCA-00167	GRCA-2002-SCI-0024	ASU	8/2/02 - 11/1/02	The response of understory plant diversity to different fire histories in Ponderosa pine grasslands across northern Arizona	No final report received.
Rubin	Spencer	GRCA-00581	GRCA-2011-SCI-0038	NAU	6/6/11 - 8/1/12	Wetland Plant Communities and Historic Settlement Disturbance on the Colorado Plateau: Baseline Data for Conservation	No final report received.
Schlossberg	Scott	GRCA-00104	GRCA-2001-SCI-0007	University of Illinois at Urbana-Champaign	5/1/01 - 12/31/01	Effects of Cattle Grazing and Fire on the Birds of Pinyon-Juniper Woodlands	No final report received.
Short	Karen	GRCA-00077	GRCA-2000-SCI-0072, 9905-17-001	University of Montana, Missoula	6/7/99 - 12/31/01	The Effects of Surface Fires on Birds and Arthropods in Southwestern Ponderosa Pine Forests.	GRCA Library Call # SF85.6.F57 S56 2002.
Sisk	Tom	GRCA-00506	GRCA-2008-SCI-0018	NAU/Grand Canyon Trust	6/6/08 - 6/6/09	Implications of North Rim anthropogenic ecological boundaries- conservation and restoration of NR forests	No final report received.
Thode	Andrea	GRCA-00558	GRCA-2010-SCI-0046	NAU	6/01/10 - 12/31/10	Regeneration in mixed conifer forests following fires of different severities in GRCA	No final report received.
Vandygriff	Jim	GRCA-00303	GRCA-2007-SCI-0008; 9606-27-001	Rocky Mountain Research Station	3/1/07 - 12/30/08	Mountain pine beetle susceptibility/risk rating in southwestern Ponderosa Pine.	No final report received.

GRCA Permitted Research Studies – Biodiversity

PI Last Name	*PI First Name*	*Study #*	*Permit #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Vankat	John	GRCA-00241; GRCA-00241	GRCA-2007-SCI-0012; GRCA-2004-SCI-0020	GRCA	6/1/04 - 12/31/09	Re-measurement and measurement of vegetation plots in Grand Canyon National Park	No final report received.
Waltz	Amy	GRCA-00084	GRCA-2000-SCI-0079, 9903-19-001	NAU	4/19/99 - 12/31/00 4/19/99 - 12/31/00	Butterfly community structure in Grand Canyon National Park ponderosa pine forests: remnant forest patches	No final report received.
Willey	David	GRCA-00023	GRCA-2000-SCI-0021	USGS- Colorado Plateau Field Station	5/10/00 - 12/31/02	Habitat modeling using surveys for Spotted Owls in Grand Canyon National Park	GRCA Library Call # QL696 .S83 W55 2001; QL696.S83 W554 2000.
Willey	David	GRCA-00229	GRCA-2008-SCI-0022, GRCA-2004-SCI-0011	Montana State University	8/5/08 - 8/5/09 3/1/04 - 7/1/08	Surveys for Mexican Spotted Owls in Grand Canyon National Park	GRCA Library Call # QL696 .S83 W554 2000.
Allan	Gery	GRCA-00253	GRCA-2008-SCI-0023, GRCA-2006-SCI-0030, GRCA-2004-SCI-0037	NAU	8/5/08 - 9/30/08 7/1/06 - 7/30/07 10/1/04 - 6/1/05	Using Biotechnology to Restore Riparian Habitats in the West: Genetic and Genomic Studies of Biodiversity and Drought Tolerance	No final report received.
Bamforth	Stuart	GRCA-000024	GRCA-2000-SCI-0022, 0004-06-001	Tulane University	5/18/00 - 12/31/00	Cyanobacterial-lichen crusts from Grand Canyon	No final report received.
Clark	Theresa	GRCA-00310	GRCA-2008-SCI-0013, GRCA-2007-SCI-0013	NAU	5/1/08 - 5/1/09 5/1/07 - 5/1/08 5/1/07 - 5/1/08	Bryophyte Flora of Grand Canyon National Park	No final report received.
Cobb	Neil	GRCA-00400	GRCA-2007-SCI-0019	NAU	6/15/07 - 12/30/10	Conducting an All Taxa Biodiversity Inventory (ATBI) program for Grand Canyon National Park	No final report received.
Crawford	Julie	GRCA-00271	GRCA-2006-SCI-0005	Transition Zone Horticultural Institute - The Arboretum at Flagstaff	2/1/06 - 3/30/07	Ex situ conservation of populations of vulnerable plants on National Park Service lands	No final report received.
Douglas	Michael	GRCA-00160	GRCA-2002-SCI-0020	Colorado State University	1/1/02 - 12/31/07	Comparative Phylogeography of Grand Canyon and the Colorado Plateau	No final report received.
Haire	Sandra	GRCA-00273	GRCA-2005-SCI-0021	USGS Biological Resource Division, Fort Collins Science Center	6/1/05 - 12/30/06	Disturbance Ecology of Rocky Mountain Pine Forests: Conservation Implications	GRCA Library Call # QH545 .F5 K68 2002.

GRCA Permitted Research Studies – Biodiversity

PI Last Name	*PI First Name*	*Study #*	*Permit #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Super	Paul	GRCA-00290	GRCA-2006-SCI-0021	NPS	5/20/06 - 7/30/06	Inventory of Eumycetozoa in North America using National Park Service Units	No final report received.
Wynne	J. Judson	GRCA-00328	GRCA-2008-SCI-0001	Merriam-Powell Center for Environmental Research- Northern Arizona University	3/15/08 - 12/31/10	Ecological Inventory of Caves at Grand Canyon National Park	No final report received.
Barger	Nichole	GRCA-00250	GRCA-2005-SCI-0018	University of Colorado - Boulder	6/1/05 - 12/31/06	Regional Carbon Storage Responses to Woody Encroachment in Western Pinyon-Juniper Systems.	No final report received.
Belnap	Jayne	GRCA-00237	GRCA-2004-SCI-0026	USGS	9/1/04 - 7/31/05	Recovery Rates of Biological Soil Crusts	No final report received.
Bly	Darren	GRCA-00513	GRCA-2009-SCI-0001	Shenandoah University	3/11/09 - 3/14/09	Modeling the Impact of Environmental Discontinuities on Plant Populations	No final report received.
Bowker	Matthew	GRCA-00247	GRCA-2004-SCI-0032	NAU	8/1/04 - 12/31/05	Predicting the Occurrence and Species Composition of Biological soil Crusts in the Flagstaff Area National Parks and Monuments.	55 pgs. GRCA Library Call #s S593.25 .B69 2006, S593.25 .B69 2007.
Cole	Kenneth	GRCA-00515, GRCA-00258	GRCA-2009-SCI-0004, GRCA-2005-SCI-0003, 9810-22-001	USGS/NAU/Forest and Rangeland Ecosystem Science Center	3/29/09 - 3/29/10 2/1/05 - 2/28/06 2/16/99 - 12/31/04	Past, Recent, and Twenty-First Century vegetation change in the arid southwest.	GRCA Library Call #s QK21 .A75 C65 2004, QK63 .C65 2004.
Fule	Peter	GRCA-000052	GRCA-2000-SCI-0047, 9907-01-001, 9702-24-001	NAU	9/3/99 - 12/31/04 5/23/97 - 12/31/99	Multi-Century Fire Modeling Over Landscape Gradients	GRCA Library Call #s SD421.32 .A75 F85 2002 c.1-2; QH104.5 .G73 F85 2005.
Gloss	Steven	GRCA-00147	GRCA-2002-SCI-0007	USGS/GCMRC	5/1/02 - 12/31/03	Benthic Sampling for Monitoring in Glen and Grand Canyon for 2002	GRCA Library Call #QH105 .A65 S73 2005 c.1-2.
Hall	Robert	GRCA-00273	GRCA-2010-SCI-0019, GRCA-2009-SCI-0046, GRCA-2007-SCI-0032, GRCA-2006-SCI-0010	University of Wyoming	5/1/10 - 5/1/11 10/1/09 - 12/31/09 5/1/08 - 5/1/09 3/1/06 - 12/30/07	Linking whole-system carbon cycling to quantitative food webs in the Colorado River	No final report received.

GRCA Permitted Research Studies – Biodiversity

PI Last Name	*PI First Name*	*Study #*	*Permit #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Holmes	Jennifer	GRCA-00311	GRCA-2011-SCI-0017	USGS Colorado Plateau Research Station	4/11/11 - 4/11/12	SCPN bird monitoring in pinyon-juniper and mixed conifer habitats in GRCA	No final report received.
Holmes	Jennifer	GRCA-00311	GRCA-2007-SCI-0015	USGS Colorado Plateau Research Station	5/1/07 - 12/30/08	Pilot Monitoring Surveys to Support of Long-Term Monitoring of Bird Communities in National Park Service Units of the Southern Colorado Plateau Network	No final report received.
Jamison	Levi	GRCA-00575	GRCA-2011-SCI-0029	UA	5/16/11 - 5/16/12	Colonization of GRCA by the Northern tamarisk beetle (Diorhabda carinulata)	No final report received.
Kennedy	Robert	GRCA-00536	GRCA-2009-SCI-0041	Oregon State University	8/17/09 - 9/17/09	Assessing satellite maps of landscape dynamics in national parks of western U.S.	No final report received.
Kennedy	Theodore	GRCA-00207	GRCA-2003-SCI-0099	GCMRC	10/1/03 - 12/31/05	Terrestrial-Aquatic linkages in the Colorado River Ecosystem: is leaf litter from riparian vegetation a significant source of carbon to the aquatic food web?	GRCA MC # GRCA 87632.
Fogel	Robert	GRCA-00274	GRCA-2005-SCI-0022	University of Michigan	6/1/05 - 7/31/06	Tethered fairy ring demography along a ponderosa pine chronosequence	No final report received.
Keener	Paul	GC-5		UA	1959 - 1964	Study of Park Fungi	GRCA MC #s GRCA 52848, GRCA 52842.
Stevens	Larry			NAU	9/1/90 - 9/30/92	The Ecology of Aquatic Diptera in the Colorado River below Glen Canyon Dam	GRCA Library Call # TC557 .A7 G52 B55 1992. GRCA MC # 68582.
Waltz	Amy	GRCA-00084	GRCA-2000-SCI-0079, 9903-19-001	NAU	4/19/99 - 12/31/00 4/19/99 - 12/31/00	Butterfly community structure in Grand Canyon National Park ponderosa pine forests: remnant forest patches.	No final report received.

GRCA Connectivity GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Restrictions*	*Use Cost*
National Hydrography Dataset	GIS (Vector)	Waterways	USGS	January 2011	GGCLA Analysis Area	potential Corridors or impediments		Multiple	None	None
Utilities	GIS (Vector)	GRCA Utilities Infrastructure	GRCA	December 2012	GRCA	potential impediments to habitat Connectivity	GRCA only	GPS, CAD, NAIP	None	None
Public Land Ownership	GIS (Vector)	Land Ownership	ALRIS, GRCA	May 2013	GGCLA Analysis Area	Land Management policies dependent on ownership			None	Unknown
National Elevation Dataset	GIS (Raster)	Elevation, Aspect, Slope	USGS	April 2012	GGCLA Analysis Area	potential modeling of Connectivity			None	Depends on application
Overflights	GIS (Vector)	Overflights corridors	GRCA	January 2011	GRCA	potential disruption of Connectivity	GRCA only	Digitized from USGS 24K Topo DRGs	None	None
Transportation	GIS (Vector)	Roads, Trails, Routes	GRCA, USBLM, USFS, other	March 2013	GGCLA Analysis Area	disruption of Connectivity	not standardized across ownerships	GPS, NAIP, USGS 24K DRG, other	None	potentially high, to update and standardize, especially outside GRCA
Vegetation Map	GIS (Vector)	Vegetation	GRCA, others	January 2013	GRCA	potential modeling of Connectivity	GRCA only	NAIP interpretation + field validation	None	Unknown
Arizona Wilderness Areas	GIS (Vector)	Wilderness areas in AZ	ALRIS	October 2010	GGCLA Analysis Area	Protected status as promoter of Connectivity		Compilation	None	None
PAD-US	GIS (Vector)	US Protected Area Database; GAP Status, Protected Areas, Land Ownership	USGS GAP	February 2011	GGCLA Analysis Area	Protected status as promoter of Connectivity	Not all areas within the GGCLA Analysis Area are attributed, or sources clearly identified	Multiple	None	Minimal, but data currently as Web Service; extraction could be Moderate
Land Cover	GIS (Raster)	Land Cover, Land Cover Change	NPScape, NLCD, NOAA, NALC	2006	GGCLA Analysis Area	potential modeling of Connectivity		Multiple	None	Unknown

Landscape and Connectivity Database Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Restrictions*	*Use Cost*
Habimap Arizona Wildlife Linkages - AZ Missing Linkages	non-spatial data (map only)	Linkage Design from Arizona Missing Linkages 2007 and 2008 reports to AGFD	AGFD	2007	AZ	TBD	Information is available only in interactive map form	TBD	Publicly available via associated website: http://habimap.org/habimap/	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Habimap Arizona Wildlife Linkages - Habitat Blocks	non-spatial data (map only)	Habitat Blocks Version 1 derived from The Arizona Wildlife Linkages Workgroup, 2006	AGFD	2006	AZ	TBD	Information is available only in interactive map form	TBD	Publicly available via associated website: http://habimap.org/habimap/	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Habimap Arizona Wildlife Linkages - Linkage Zones	non-spatial data (map only)	Potential Linkage Zones Version 1 derived from the Arizona Wildlife Linkages Workgroup, 2006.	AGFD	2006	AZ	TBD	Information is available only in interactive map form	TBD	Publicly available via associated website: http://habimap.org/habimap/	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Habimap Arizona Wildlife Linkages - Linkage Zones across Habitat	non-spatial data (map only)	Potential Linkage Zones Across Habitat Blocks Version 1 derived from the Arizona Wildlife Linkages Workgroup, 2006	AGFD	2006	AZ	TBD	Information is available only in interactive map form	TBD	Publicly available via associated website: http://habimap.org/habimap/	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

GRCA Permitted Research Studies – Landscape and Connectivity

PI Last Name	*PI First Name*	*Study #*	*Permit #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Hufford	Larry	GRCA-00599	GRCA-2012-SCI-0024	Washington State University	5/15/12 - 5/15/13	Phylogeography and Evolution of Mentzelia cronquistii (Loasaceae) and the Mentzelia marginata Complex	No final report received.
Kearsley	Michael	GRCA-00304	GRCA-2009-SCI-0035, GRCA-2008-SCI-0028; GRCA-2006-SCI-0043	Engineering-Environmental Management, Inc; USGS; NPS	8/1/09 - 12/31/12 8/1/08 - 8/1/09 1/1/07 - 7/30/08	Vegetation Data Collection: Supporting the NPS-USGS Vegetation Classification and Mapping Program at GRCA	GRCA Library Call # QK147 .G73 2010b v.1-2, QK147 .G73 G74 2010.
Ralston	Barbara	GRCA-00611	GRCA-2012-SCI-0042	USGS	10/1/12 - 12/31/12	Pilot study: Monitoring vegetation response to dam operations using a response guild approach	No final report received.
Vankat	John	GRCA-00241	GRCA-2010-SCI-0040	Vankat Consulting, LLC	8/5/10 - 12/31/12	Resample Historical Vegetation Study Plots in GRCA	No final report received.
Cohen	Warren	GRCA-00298	GRCA-2006-SCI-0037	USDA Forest Service-Pacific Northwest Research Station	9/1/06 - 12/30/07	Determining Viable Methods to Monitor Landscape Patterns in National Park Service Units of the Northern and Southern Colorado Plateau Networks: Project to Support Monitoring Protocol Development	No final report received.
Covington	William		9702-24-001	NAU, School of Forestry	5/23/97 - 12/31/06	Grand Canyon Forest Ecosystem Restoration	GRCA Library Call # SD144 .A6 R43 2000.
Fule	Peter	GRCA-000052	GRCA-2000-SCI-0047, 9907-01-001, 9702-24-001	NAU	9/3/99 - 12/31/04 5/23/97 - 12/31/99	Multi-Century Fire Modeling Over Landscape Gradients	GRCA Library Call # SD421.32 .A75 F85 2002 c.1-2; QH104.5 .G73 F85 2005.
Haire	Sandra	GRCA-00273	GRCA-2005-SCI-0021	USGS Biological Resource Division, Fort Collins Science Center	6/1/05 - 12/30/06	Disturbance Ecology of Rocky Mountain Pine Forests: Conservation Implications	GRCA Library Call # QH545 .F5 K68 2002.
Holmes	Jennifer	GRCA-00311	GRCA-2007-SCI-0015	USGS Colorado Plateau Research Station	5/1/07 - 12/30/08	Pilot Monitoring Surveys to Support of Long-Term Monitoring of Bird Communities in National Park Service Units of the Southern Colorado Plateau Network	No final report received.
Kennedy	Robert	GRCA-00536	GRCA-2009-SCI-0041	Oregon State University	8/17/09 - 9/17/09	Assessing satellite maps of landscape dynamics in national parks of western U.S.	No final report received.
Kotliar	Natasha	GRCA-00119	GRCA-2001-SCI-0027	USGS	5/15/01 - 12/31/05	The Effects of Burn Severity and Heterogeneity on Early Post-fire Avian and Plant Communities in Coniferous Forests of the Rocky Mountains	Status report : the effects of burn severity and heterogeneity on post-fire avian and plant communities of the Rocky Mountains and Colorado Plateau / Natasha B. Kotliar, Sandra L. Haire. GRCA Library Call # QH545 .F5 K68 2002. GRCA MC # GRCA 79712.

GRCA Permitted Research Studies – Landscape and Connectivity

PI Last Name	*PI First Name*	*Study #*	*Permit #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Sisk	Tom	GRCA-00506	GRCA-2008-SCI-0018	NAU/Grand Canyon Trust	6/6/08 - 6/6/09	Implications of North Rim anthropogenic ecological boundaries-conservation and restoration of NR forests	No final report received.
Vandygriff	Jim	GRCA-00303	GRCA-2007-SCI-0008; 9606-27-001	Rocky Mountain Research Station	3/1/07 - 12/30/08	Mountain pine beetle susceptibility/risk rating in southwestern Ponderosa Pine.	PI changed from previous permit # in 1998 from Jill Wilson; contact info: #435-755-3574/ email: jvandygriff@fs.fed.us Final Report might be 2000 Forest Service document “Mountain pine beetle attack in ponderosa pine: comparing methods for rating susceptibility”
Weisberg	Peter	GRCA-00283	GRCA-2006-SCI-0035, GRCA-2006-SCI-0012	University of Nevada-Reno	8/31/06 - 12/31/07, 4/01/06 - 8/31/06	Non-native Tamarix ramossisima recruitment along the Colorado River: Interactions among flow regimes and geomorphology	The influence of floods and precipitation on Tamarix establishment in Grand Canyon, Arizona: consequences for flow regime restoration, 2011.
Willey	David	GRCA-00023	GRCA-2000-SCI-0021	USGS- Colorado Plateau Field Station	5/10/00 - 12/31/02	Habitat modeling using surveys for Spotted Owls in Grand Canyon National Park.	GRCA Library Call # QL696 .S83 W55 2001; QL696.S83 W554 2000.

GRCA Ecosystem Intactness GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Restrictions*	*Use Cost*
Fire	GIS (Vector)	Fire History, Fire Severity, Fire Effects, Fire Treatments	GRCA	March 2013	GRCA	potential effects on Ecosystem Intactness	GRCA only	Multiple	None	None
Forest Insect And Disease	GIS (Vector)	Insect Infestations and Forest Disease	USFS	2000-2011	GGCLA Analysis Area	potential effects on Ecosystem Intactness	Surveys limited to forested areas only	Aerial Surveys	None	None
National Hydrography Dataset	GIS (Vector)	Waterways	USGS	January 2011	GGCLA Analysis Area	potential effects on Ecosystem Intactness		Multiple	None	None
Utilities	GIS (Vector)	GRCA Utilities Infrastructure	GRCA	December 2012	GRCA	disruptions to Ecosystem Intactness	GRCA only	GPS, CAD, NAIP	None	None
Public Land Ownership	GIS (Vector)	Land Ownership	ALRIS, GRCA	May 2013	GGCLA Analysis Area	Land Management policies dependent on ownership			None	Unknown
National Elevation Dataset	GIS (Raster)	Elevation, Aspect, Slope	USGS	April 2012	GGCLA Analysis Area	potential modeling of Ecosystem Intactness			None	Depends on application
Overflights	GIS (Vector)	Overflights corridors	GRCA	January 2011	GRCA	potential disruption of Ecosystem Intactness	GRCA only	Digitized from USGS 24K Topo DRGs	None	None
Transportation	GIS (Vector)	Roads, Trails, Routes	GRCA, USBLM, USFS, other	March 2013	GGCLA Analysis Area	disruption of Ecosystem Intactness	not standardized across ownerships	GPS, NAIP, USGS 24K DRG, other	None	potentially high, to update and standardize, especially outside GRCA
Vegetation Map	GIS (Vector)	Vegetation	GRCA, others	January 2013	GRCA	potential modeling of Ecosystem Intactness	GRCA only	NAIP interpretation + field validation	None	Unknown
Arizona Wilderness Areas	GIS (Vector)	Wilderness areas in AZ	ALRIS	October 2010	GGCLA Analysis Area	Protected status as promoter of Ecosystem Intactness		Compilation	None	None

GRCA Ecosystem Intactness GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Restrictions*	*Use Cost*
PAD-US	GIS (Vector)	US Protected Area Database; GAP Status, Protected Areas, Land Ownership	USGS GAP	February 2011	GGCLA Analysis Area	Protected status as promoter of Ecosystem Intactness	Not all areas within the GGCLA Analysis Area are attributed, or sources clearly identified	Multiple	None	Minimal, but data currently as Web Service; extraction could be Moderate
Land Cover	GIS (Raster)	Land Cover, Land Cover Change	NPScape, NLCD, NOAA, NALC	2006	GGCLA Analysis Area	potential modeling of Ecosystem Intactness		Multiple	None	Unknown
Exotic Plants	GIS (Vector)	Invasive Species	GRCA		GRCA	disruption of Ecosystem Intactness	GRCA only	GPS, NAIP, USGS 24K DRG	None	Moderate

Ecosystem Intactness Database Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Restrictions*	*Use Cost*
Habimap - Unfragmented Areas Model	non-spatial data (map only)	Interactive map of large, contiguous land masses not fragmented by barriers	AGFD	2011	AZ	Identification of intact landscapes	Information is available only in interactive map form	Based on the existence of large, contiguous land masses that aren't fragmented by barriers, the diversity of vegetation types within those land masses, and the importance of those areas to the overall availability of any particular vegetation type within the state	Publicly available via associated website: http://habimap.org/habimap/	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

Disturbance Threats to Ecosystem Database Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Restrictions*	*Use Cost*
Abandoned Mined Lands Inventory System (AMLIS) - Points	GIS (vector)	Digital database containing Abandoned Mine Lands Inventory information (2 abandoned mines are listed within AOI, several sites occur just outside AOI boundary)	Abandoned Mine Lands	TBD	National	Identification of possible threat locations for water quality, cultural resources, etc.	Not able to be downloaded or manipulated	Based on AML Inventory	Available only through ArcGIS Resources Online	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
BLM Northern Arizona Mineral Withdrawal	GIS (vector)	Spatial data (polygons) of mineral withdrawl areas	BLM	2012	AZ Strip	Polygons of areas for mineral extraction around AOI	generalized polygons only	Based on BLM and National Forest lands (and potentially some AZ state and private lands) affected by mineral withdrawal.	Publicly available via associated website: http://www.blm.gov/az/st/en/prog/maps/gis_files.html	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
BLM Grazing Allotments	GIS (vector)	Spatial data (polygons) of grazing allotments managed by BLM	BLM	TBD	National	Identification of areas affected by livestock grazing	TBD	Based on BLM grazing allotments	Publicly available via associated website: http://www.geocommunicator.gov/GeoComm/services.ht	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

Disturbance Threats to Ecosystem Database Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Restrictions*	*Use Cost*
									m#Download	
Recreational Access Arizona	GIS (vector)	Interactive map of recreational access points, routes, and access projects	AGFD	2013	AZ	Identification of access to and through public lands for recreational purposes	Information is available only in interactive map form	TBD	Publicly available via associated website: http://www.azaccessmap.com/	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Habimap - Arizona Allotments/Pastures	GIS (vector)	Interactive map of Arizona State Land Department Allotments, Bureau of Land Management Allotments, USFS Allotments, and USFS Pastures	AGFD	2010, 2011	AZ	Identification of potential livestock grazing threats	Information is available only in interactive map form	Based on AZ State Land, BLM, and USFS grazing allotments	Publicly available via associated website: http://habimap.org/habimap/	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USFS Fire Record Database Fires	non-spatial data	Fire records for state of Arizona by land management agency including fire name, code, type, and location (based on individual DI-1202 fire reports completed for every fire occurring on US public lands).	USFS	1972-2011, varies by region	AZ	TBD	TBD	TBD	Publicly available via associated website: http://fam.nwcg.gov/fam-web/weatherfirecd/state_data.htm	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USFS Fire Record Database Weather	non-spatial data	Fire records for state of Arizona by land management agency and related weather by weather station.	USFS	1950-2012, varies by weather station	AZ	TBD	TBD	TBD	Publicly available via associated website: http://fam.nwcg.gov/fam-web/weatherfirecd/state_data.htm	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
USGS Dynamically Downscaled Regional Climate	GIS (raster)	Dynamical downscaled regional climate for Pacific Southwest and Southern Rockies	USGS	1968-2099	TBD	TBD	TBD	TBD	Publicly available via associated website: http://regclim.coas.oregonstate.edu/visualization/rcd/regional-climate-downloader/index.html#project=regcm	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI

Disturbance Threats to Ecosystem Database Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Restrictions*	*Use Cost*
NARCCAP North American Regional Climate Change Assessment Program	GIS (raster)	50-km resolution climate change scenario simulation output from multiple regional climate models nested within multiple atmosphere-ocean general circulation models for 30-year current and future periods	North American Regional Climate Change Assessment Program	free registration needed for data access	TBD	TBD	TBD	TBD	Publicly available via associated website: http://www.earthsystemgrid.org/project/NARCCAP.html	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
Applied Climate-Change Analysis: The Climate Wizard Tool Future Climate (2050s and 2080s)	GIS (raster)	statistically downscaled regional climate model based on one of the following scenarios: High A2, Medium A1B, Low B1; output based on one of 16 model options, an ensemble mean, or ensemble percentiles and can be map of averages or map of change for precipitation or average temperature	TNC	projection to 2050s or to 2080s	Global, National, State	Regional climate predictions up to 2089	TBD	statistically downscaled regional climate models based on one of 16 model options, an ensemble mean, or ensemble percentiles	On LLECB Server; publicly available via associated website: www.climatewizard.org	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI
UCAR MAGICC/SCENGEN Regional Climate Models	GIS (raster)	Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC) carries through calculations at the global-mean level using the same upwelling-diffusion, energy-balance climate model that has been and is employed by IPCC while a regional climate scenario generator (SCENGEN) uses these results, together with spatially detailed results from the CMIP3/AR4 archive of AOGCMs, to produce spatially detailed information on future changes in temperature, precipitation and MSLP, changes in their variability, and a range of other statistics	UCAR	free registration needed for data access	TBD	TBD	TBD	TBD	Publicly available via associated website: http://www.cgd.ucar.edu/cas/wigley/magicc/	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: Clip raster to GGCLA AOI

GRCA Permitted Research – Ecosystem Intactness

PI Last Name	PI First Name	Study #	Permit #	Affiliations	Study Length	Title	Data Availability
Jacobi	William	GRCA-00516	GRCA-2009-SCI-0006	Columbus State University	5/1/09 - 10/1/09	Firewood movement across state lines by national park visitors	No final report received.
Kotliar	Natasha	GRCA-00119	GRCA-2001-SCI-0027	USGS	5/15/01 - 12/31/05	The Effects of Burn Severity and Heterogeneity on Early Post-fire Avian and Plant Communities in Coniferous Forests of the Rocky Mountains	Status report : the effects of burn severity and heterogeneity on post-fire avian and plant communities of the Rocky Mountains and Colorado Plateau / Natasha B. Kotliar, Sandra L. Haire. GRCA Library Call # QH545 .F5 K68 2002. GRCA MC # GRCA 79712.
Mecham	Nancy Muleady		GRCA-2000-SCI-0087	NAU	11/11/00 - 12/31/01	The Natural History of Fire in America's National Parks: A Biological and Educational Perspective	"The Natural History of Fire in Grand Canyon National Park" NAU; 2003. 226 pgs. GRCA Library Call # SD421 .M854 2003.
Rambo	Jennie	GRCA-00167	GRCA-2002-SCI-0024	ASU	8/2/02 - 11/1/02	The response of understory plant diversity to different fire histories in Ponderosa pine grasslands across northern Arizona	No final report received. ASU Library Call # LD179.15 2006 .R365.
Rubin	Spencer	GRCA-00581	GRCA-2011-SCI-0038	NAU	6/6/11 - 8/1/12	Wetland Plant Communities and Historic Settlement Disturbance on the Colorado Plateau: Baseline Data for Conservation	No final report received.
Schlossberg	Scott	GRCA-00104	GRCA-2001-SCI-0007	University of Illinois at Urbana-Champaign	5/1/01 - 12/31/01	Effects of Cattle Grazing and Fire on the Birds of Pinyon-Juniper Woodlands	No final report received.
Short	Karen	GRCA-00077	GRCA-2000-SCI-0072, 9905-17-001	University of Montana – Missoula	6/7/99 - 12/31/01	The Effects of Surface Fires on Birds and Arthopods in Southwestern Ponderosa Pine Forests.	GRCA Library Call # SF85.6.F57 S56 2002.
Sisk	Tom	GRCA-00506	GRCA-2008-SCI-0018	NAU/Grand Canyon Trust	6/6/08 - 6/6/09	Implications of North Rim anthropogenic ecological boundaries- conservation and restoration of NR forests	No final report received.
Thode	Andrea	GRCA-00558	GRCA-2010-SCI-0046	NAU	6/01/10 - 12/31/10	Regeneration in mixed conifer forests following fires of different severities in GRCA	No final report received.
Vandygriff	Jim	GRCA-00303	GRCA-2007-SCI-0008; 9606-27-001	Rocky Mountain Research Station	3/1/07 - 12/30/08	Mountain pine beetle susceptibility/risk rating in southwestern Ponderosa Pine.	PI changed from previous permit # in 1998 from Jill Wilson; contact info: #435-755-3574/ email: jvandygriff@fs.fed.us Final Report might be 2000 Forest Service document "Mountain pine beetle attack in ponderosa pine: comparing methods for rating susceptibility".

GRCA Permitted Research – Ecosystem Intactness

PI Last Name	PI First Name	Study #	Permit #	Affiliations	Study Length	Title	Data Availability
Vankat	John	GRCA-00241; GRCA-00241	GRCA-2007-SCI-0012; GRCA-2004-SCI-0020	GRCA	6/1/04 - 12/31/09	Re-measurement and measurement of vegetation plots in Grand Canyon National Park.	No final report received.
Willey	David	GRCA-00023	GRCA-2000-SCI-0021	USGS- Colorado Plateau Field Station	5/10/00 - 12/31/02	Habitat modeling using surveys for Spotted Owls in Grand Canyon National Park.	GRCA Library Call # QL696 .S83 W55 2001; QL696.S83 W554 2000.
Haire	Sandra	GRCA-00273	GRCA-2005-SCI-0021	USGS Biological Resource Division, Fort Collins Science Center	6/1/05 - 12/30/06	Disturbance Ecology of Rocky Mountain Pine Forests: Conservation Implications	Report location - http://www.umass.edu/landeco/research/swfire/swfire.html, shaire@nrc.umass.edu. GRCA Library Call # QH545 .F5 K68 2002.
Barger	Nichole	GRCA-00250	GRCA-2005-SCI-0018	University of Colorado - Boulder	6/1/05 - 12/31/06	Regional Carbon Storage Responses to Woody Encroachment in Western Pinyon-Juniper Systems.	Cho-ying Huang, Gregory P. Asner, Roberta E. Martin, Nichole N. Barger, Jason C. Neff (2009) Multiscale analysis of tree cover and aboveground carbon stocks in pinyon–juniper woodlands. Ecological Applications: Vol. 19, No. 3, pp. 668-681.
Belnap	Jayne	GRCA-00237	GRCA-2004-SCI-0026	USGS	9/1/04 - 7/31/05	Recovery Rates of Biological Soil Crusts	jayne_belnap@usgs.gov, 435-719-2333; www.pnas.org/cgi/doi/10.1073/pnas.0505734102.
Bly	Darren	GRCA-00513	GRCA-2009-SCI-0001	Shenandoah University	3/11/09 - 3/14/09	Modeling the Impact of Environmental Discontinuities on Plant Populations	No final report received.
Bowker	Matthew	GRCA-00247	GRCA-2004-SCI-0032	NAU	8/1/04 - 12/31/05	Predicting the Occurrence and Species Composition of Biological soil Crusts in the Flagstaff Area National Parks and Monuments.	55 pgs. Cline Library Call # S593.25 .B695 2004. GRCA Library Call # S593.25 .B69 2006, S593.25 .B69 2007.
Cole	Kenneth	GRCA-00515, GRCA-00258	GRCA-2009-SCI-0004, GRCA-2005-SCI-0003, 9810-22-001	USGS/NAU/Forest and Rangeland Ecosystem Science Center	3/29/09 - 3/29/10 2/1/05 - 2/28/06 2/16/99 - 12/31/04	Past, Recent, and Twenty-First Century vegetation change in the arid southwest.	GRCA Library Call # QK21 .A75 C65 2004, QK63 .C65 2004.
Covington	William		9702-24-001	NAU, School of Forestry	5/23/97 - 12/31/06	Grand Canyon Forest Ecosystem Restoration	GRCA Library Call # SD144 .A6 R43 2000.
Gaither	Marlene	GRCA-00194	GRCA-2003-SCI-0088	University of Arizona, Coconino County	7/1/03 - 7/31/05 1995 - 1997?	Occurrence and Control of Emerging Water Borne Pathogens in the State of Arizona	Wilderness & Environmental Medicine 20(1):6-13. 2009 doi: 10.1580/06-WEME-OR-43.1.
Gloss	Steven	GRCA-	GRCA-2002-SCI-0007	USGS/GCMRC	5/1/02 - 12/31/03	Benthic Sampling for Monitoring in Glen and	The state of the Colorado River ecosystem in Grand

GRCA Permitted Research – Ecosystem Intactness

PI Last Name	PI First Name	Study #	Permit #	Affiliations	Study Length	Title	Data Availability
		00147				Grand Canyon for 2002	Canyon : a report of the Grand Canyon Monitoring and Research Center, 1991-2004 / edited by Steven P. Gloss, Jeffrey E. Lovich, and Theodore S. Melis. GRCA Library Call # QH105 .A65 S73 2005 c.1-2.
Hall	Robert	GRCA-00273	GRCA-2010-SCI-0019, GRCA-2009-SCI-0046, GRCA-2007-SCI-0032, GRCA-2006-SCI-0010	University of Wyoming	5/1/10 - 5/1/11 10/1/09 - 12/31/09 5/1/08 - 5/1/09 3/1/06 - 12/30/07	Linking whole-system carbon cycling to quantitative food webs in the Colorado River	No final report received. Final deliverable may be in GCMRC library.
Hornewer	Nancy	GRCA-00089	GRCA-2003-SCI-0096, GRCA-2002-SCI-0016, GRCA-2000-SCI-0084, 9911-02-001, 9801-22-004	USGS – Water Resources Division	9/1/03 - 12/31/07 7/8/02 - 9/30/05 2/1/00 - 12/31/03 3/9/98 - 12/31/99	Monitoring and research of streamflow, sediment transport, and water quality in the Colorado River Ecosystem between Glen Canyon Dam and Lake Mead: Part 2	Might be in GCMRC library // Also see GRCA-00218 PI David Topping [Part 1], Also see Fisk, Gregory/Graf, Julia.
Kearsley	Michael	GRCA-00057	GRCA-2006-SCI-0041, GRCA-2004-SCI-0028	NAU	12/1/06 - 12/31/08 7/16/04 - 12/31/06	A Reassessment of Kaibab Squirrel Activity and Habitat Quality on the Walhalla Palteau, Grand Canyon National Park	No final report received.
Kennedy	Robert	GRCA-00536	GRCA-2009-SCI-0041	Oregon State University	8/17/09 - 9/17/09	Assessing satellite maps of landscape dynamics in national parks of western U.S.	No final report received.
Fule	Peter	GRCA-00227	GRCA-2004-SCI-0009	Northern Arizona University	4/1/04 - 12/31/06	Fire Use over a Southwestern Elevational Gradient: Effects of 2003 Fires	11 pgs. GRCA Library Call # SD421.32 .G73 F85 2007.
Fule	Peter	GRCA-000052	GRCA-2000-SCI-0047, 9907-01-001, 9702-24-001	NAU	9/3/99 - 12/31/04 5/23/97 - 12/31/99	Multi-Century Fire Modeling Over Landscape Gradients	GRCA Library Call # SD421.32 .A75 F85 2002 c.1-2; QH104.5 .G73 F85 2005.
Fule	Peter	GRCA-00309	GRCA-2007-SCI-0018	NAU	5/1/07 - 12/30/09	Post-wildfire dynamics of woody debris: mechanisms and management implications	No final report received.
Holmes	Jennifer	GRCA-00311	GRCA-2011-SCI-0017	USGS Colorado Plateau Research Station	4/11/11 - 4/11/12	SCPN bird monitoring in pinyon-juniper and mixed conifer habitats in GRCA	No final report received.
Holmes	Jennifer	GRCA-00311	GRCA-2007-SCI-0015	USGS Colorado Plateau Research Station	5/1/07 - 12/30/08	Pilot Monitoring Surveys to Support of Long-Term Monitoring of Bird Communities in National Park Service Units of the Southern Colorado Plateau Network	No final report received.
Jamison	Levi	GRCA-00575	GRCA-2011-SCI-0029	UA	5/16/11 - 5/16/12	Colonization of GRCA by the Northern tamarisk beetle (Diorhabda carinulata)	No final report received.

GRCA Permitted Research – Ecosystem Intactness

PI Last Name	PI First Name	Study #	Permit #	Affiliations	Study Length	Title	Data Availability
Kennedy	Theodore	GRCA-00207	GRCA-2003-SCI-0099	GCMRC	10/1/03 - 12/31/05	Terrestrial-Aquatic linkages in the Colorado River Ecosystem: is leaf litter from riparian vegetation a significant source of carbon to the aquatic food web?	GRCA MC # GRCA 87632.
Kobor	Jeremiah	GRCA-00172	GRCA-2002-SCI-0030	NAU	10/3/02 - 9/1/04	Coupling of a numerical groundwater/surface water flow model with an ecosystem response model for the Redwall-Muav aquifer and associated springs and channels of the South Rim, Grand Canyon, Arizona	Cline Library Call # QE86.G73 K636 2004. GRCA Library Call # QE86 .G73 K63 2004.
Melis	Theodore	GRCA-00217	GRCA-2003-SCI-0105	USGS, GCMRC	11/1/03 - 12/31/05	Remotely Sensed Data Collection in the Grand Canyon	No final report received.
Melis	Theodore	GRCA-00329	GRCA-2008-SCI-0003	GCMRC	2/1/08 - 6/30/08	Science Activities for Potential 2008 Experimental High Flow at Glen Canyon Dam	GRCA MC #s GRCA 106089, 106090,106091, 106092, 106093, 106094, 106095, 106096, 106097, 106098, 106099, 106100, 106276, 106277, 106278, 106280, 106281, 106282, 106283, 106284, 106288.
Miller	Mark	GRCA-00268	GRCA-2005-SCI-0015	USGS	4/14/05 - 12/31/06	Field-Based Evaluations of Measures and Measurement Techniques to Support Long-Term Monitoring of Terrestrial Ecosystems in Colorado Plateau National Park Service Units	223 pgs. GRCA Library Call # QH104.5 .G73 M55 2006.
Monroe	Stephen	GRCA-00557	GRCA-2010-SCI-0043	NPS	7/27/10 - 12/31/11	Inventory of Spring Ecosystems in the Grand Canyon Region, Arizona	No final report received.
O'Brien	Gary		9905-03-001	Grand Canyon River Guides, Inc.	5/13/99 - 12/31/00	Adopt-A-Beach Program	GRCA Library Call # TC175.2.O27 E44 2000, TC175.2 .O27 E44 1999 c.1-2.
Parnell	Rod	GRCA-000003	GRCA-2000-SCI-0003, 9801-22-003	NAU	2/16/00 - 12/31/00 3/9/98 - 12/31/99	A Proposal to Monitor Changes in Fine-Grained Sediment Deposits throughout the Colorado River Ecosystem in Glen, Marble, and Grand Canyons During Fiscal Years 1998 and 1999	"Sand deposition in the Colorado River Ecosystem from flooding of the Paria River and the effects of the November 1997, Glen Canyon Dam test flow" 2000. 40 pgs. GRCA Library Call # TC557 .A62 S36 2000 c.1-2.
Persons	William		9803-20-001	Arizona Game and Fish Department	5/15/98 - 12/31/99	Monitoring the Rainbow Trout Fishery of the Colorado River Ecosystem from Glen Canyon to Lees Ferry.	“Rainbow Trout and Lower Trophic Levels in the Lee’s Ferry Tailwater Below Glen Canyon Dam, Arizona: A Review.”. 53 pgs. GRCA Library Call # SH167 .R34 M35 1999.
Persons	William		9602-07-001	Arizona Game and Fish	3/14/96 - 1/1/97	A proposal to determine effects of a controlled flood on the aquatic ecosystem of	GRCA MC # GRCA 66183, GRCA 66180.

GRCA Permitted Research – Ecosystem Intactness

PI Last Name	PI First Name	Study #	Permit #	Affiliations	Study Length	Title	Data Availability
				Department		the Colorado River downstream from Glen Canyon Dam, Arizona	
Ralston	Barbara	GRCA-00028	GRCA-2000-SCI-0021	GCMRC	4/16/00 - 12/31/05	Interim Fish Monitoring Plan FY2000-2001	Might be at GCMRC library or in SCRE Report.
Ralston	Barbara	GRCA-00182	GRCA-2003-SCI-0074	GCMRC	4/1/03 - 7/31/05	Alliance-level Vegetation Inventory Map of the Colorado River Ecosystem	Maybe in SCRE report: GRCA 87632 or might be QH541.5 .R52 R35 2007 (Vegetation Database) or might be GCMRC library. GRCA MC # GRCA 87632.
Ralston	Barbara	GRCA-00319	GRCA-2007-SCI-0028	USGS	5/1/08 - 6/15/09	Vegetation Inventory Map of the Colorado River Ecosystem for Change Detection	GRCA Library Call # QH541.5 .R52 R35 2007.
Sabo	John	GRCA-00281	GRCA-2006-SCI-0016	ASU	2/7/06 - 2/7/07	Aquatic and terrestrial contributions of organic carbon to the Colorado River Ecosystem using stable hydrogen isotopes	No final report received.
Salafsky	Susan	GRCA-00158	GRCA-2002-SCI-0017	Rocky Mountain Research Station	5/28/02 - 12/31/05	Factors Affecting Northern Goshawk Diets and Fecundity in Northern Arizona	Thesis in file, but not complete copy. “Covariation between Prey Abundance and Northern Goshawk Fecundity on the Kaibab Plateau, Arizona” by Susan Salafsky from CSU-Fort Collins. GRCA Library Call # QL696 .F32 R49 2006; QL696 .F32 S25 2004.
Schmidt	John		9807-27-001	Utah State University	9/25/98 - 12/31/00	An Integrated Historical Analysis of Flow, Sediment Transport, and Channel-Side Sediment Storage between Lees Ferry and Middle Granite Gorge in Grand Canyon	No final report received.
Springer	Abe	GRCA-00267	GRCA-2005-SCI-0026	NAU/GCWC	8/01/05 - 2/28/06	Northern and southern Colorado Plateau NPS springs ecosystem inventory	GRCA Library Call # SB615 .T25 N66 2006. GRCA MC #s GRCA 79709, GRCA 83655, GRCA83656, GRCA 83671, GRCA 84372, GRCA 84378.
Springer	Abe	GRCA-000029	GRCA-2000-SCI-0026, 0005-04-002	NAU	5/18/00 - 12/31/01	Rates and amounts of discharge from seeps and springs of the Redwall-Muav Aquifer, Grand Canyon, Arizona	Some of this study’s data was used in a 2006 presentation at the Rocky Mountain Section- 58th Annual Meeting. GRCA Library Call # QE86.G73 K477 2002 (PI- James A. Kessler).
Stevens	Lawrence		9803-10-001	GCMRC, Shippensburg University	5/15/98 - 12/31/02	A proposal to quantify potential mean monthly shortwave solar radiation in the Colorado River ecosystem downstream from Glen Canyon Dam	GRCA Library Call # RC963.5 .H4 S43 2000.
Stevens	Lawrence	GRCA-00130	GRCA-2001-SCI-0031	Grand Canyon Wildlands Council	8/1/01 - 12/31/02	Inventory, Assess and Recommend Recovery Priorities for Arizona Strip Springs, Seeps, and	Report Title: Biological inventory and assessment of ten South Rims springs in Grand Canyon National Park:

GRCA Permitted Research – Ecosystem Intactness

PI Last Name	PI First Name	Study #	Permit #	Affiliations	Study Length	Title	Data Availability
						Natural Ponds	draft final report, 2003. GRCA MC # GRCA 83656.
Stevens	Lawrence	GRCA-00083	GRCA-2000-SCI-0078, 9703-27-001	ATA, GCMRC, NAU	1/1/98 - 12/31/99 5/12/97 - 12/31/98	Investigate genetic relatedness between ambersnail populations (Succineidae: Oxyloma spp.) in the U.S. and Canada // A preliminary draft feasibility study for research on endangered kanab ambersnail use of native and non-native host plants in Grand Canyon National Park, Arizona.	GRCA Library Call # QL430.5 .S87 K36 1999c.
Waltz	Amy	GRCA-00084	GRCA-2000-SCI-0079, 9903-19-001	NAU	4/19/99 - 12/31/00 4/19/99 - 12/31/00	Butterfly community structure in Grand Canyon National Park ponderosa pine forests: remnant forest patches.	No final report received.
Webb	Robert	GRCA-00111	GRCA-2001-SCI-0032	USGS Water Resources Division	8/1/01 - 12/31/06	Long-term monitoring of coarse-grained sediment input, storage, and impacts to physical habitats throughout the main channel of the Colorado River Ecosystem.	No final report received.
Wiele	Stephen	GRCA-00164	GRCA-2002-SCI-0023	USGS Water Resources Division	2/1/02 - 1/31/05	Development of a management tool for predicting multi-dimensional and 1-dimensional sand transport in the Colorado River ecosystem.	Report location- Water Resources Research, vol., 43, W02425, doi: 10.1029/2005WR004824, 2007. 16 pgs. GRCA Library Call # QE571 .W5 2007.
Young	Susan		9803-04-001	University of Vermont	4/22/98 - 12/31/02	Relationship of substrate grain size to surface-active arthropod communities on alluvial deposits: Colorado River, Grand Canyon, Arizona	Relationship of Surface-Active Arthropod Assemblages to Sediment Texture and Vegetation on Alluvial Deposits along the Colorado River, Grand Canyon, Arizona, Susan M. Young, Uuniversity of Vermont master's thesis, 1999. 40 pgs. GRCA MC # GRCA 79057.
Willey	David	GRCA-00229	GRCA-2008-SCI-0022, GRCA-2004-SCI-0011	Montana State University	8/5/08 - 8/5/09 3/1/04 - 7/1/08	Surveys for Mexican Spotted Owls in Grand Canyon National Park	GRCA Library Call # QL696 .S83 W554 2000.
Fogel	Robert	GRCA-00274	GRCA-2005-SCI-0022	University of Michigan	6/1/05 - 7/31/06	Tethered fairy ring demography along a ponderosa pine chronosequence	No final report received. Study may have been unsuccessful.
Keener	Paul	GC-5		UA	1959 - 1964	Study of Park Fungi	GRCA MC # GRCA 52848, GRCA 52842.
Stevens	Larry			NAU	9/1/90 - 9/30/92	The Ecology of Aquatic Diptera in the Colorado River below Glen Canyon Dam	“The Effects of Glen Canyon Dam on the Aquatic Food Base in the CO River Corridor in GC, AZ”. GRCA Library Call # TC557 .A7 G52 B55 1992. GRCA MC # 68582.
Cohen	Warren	GRCA-00298	GRCA-2006-SCI-0037	USDA Forest Service-Pacific	9/1/06 - 12/30/07	Determining Viable Methods to Monitor Landscape Patterns in National Park Service	No final report received.

GRCA Permitted Research – Ecosystem Intactness

PI Last Name	PI First Name	Study #	Permit #	Affiliations	Study Length	Title	Data Availability
				Northwest Research Station		Units of the Northern and Southern Colorado Plateau Networks: Project to Support Monitoring Protocol Development	
Haire	Sandra	GRCA-00273	GRCA-2005-SCI-0021	USGS Biological Resource Division, Fort Collins Science Center	6/1/05 - 12/30/06	Disturbance Ecology of Rocky Mountain Pine Forests: Conservation Implications	Report location - http://www.umass.edu/landeco/research/swfire/swfire.html, shaire@nrc.umass.edu. GRCA Library Call # QH545 .F5 K68 2002.
Karlstrom	Karl	GRCA-00203	GRCA-2010-SCI-0017, GRCA-2009-SCI-0005, GRCA-2004-SCI-0012	University of New Mexico	4/1/10 - 4/1/11 4/3/09 - 12/31/09 5/1/04 - 12/31/08	The Trail of Time at Grand Canyon: synthesis of Proterozoic research and studies of Quaternary geology of Grand Canyon	"Informal Geoscience Education on a Grand Scale: The Trail of Time Exhibition at Grand Canyon" Journal of Geoscience Education, v. 56, n. 4, September, 2008, p. 354-361. [not sure if final report]. 8 pgs.
Kotliar	Natasha	GRCA-00119	GRCA-2001-SCI-0027	USGS	5/15/01 - 12/31/05	The Effects of Burn Severity and Heterogeneity on Early Post-fire Avian and Plant Communities in Coniferous Forests of the Rocky Mountains	Status report : the effects of burn severity and heterogeneity on post-fire avian and plant communities of the Rocky Mountains and Colorado Plateau / Natasha B. Kotliar, Sandra L. Haire. GRCA Library Call # QH545 .F5 K68 2002. GRCA MC # GRCA 79712.
Weisberg	Peter	GRCA-00283	GRCA-2006-SCI-0035, GRCA-2006-SCI-0012	University of Nevada-Reno	8/31/06 - 12/31/07, 4/01/06 - 8/31/06	Non-native Tamarix ramossisima recruitment along the Colorado River: Interactions among flow regimes and geomorphology	No final report received. The influence of floods and precipitation on Tamarix establishment in Grand Canyon, Arizona: consequences for flow regime restoration, 2011.

GRCA Exotics GIS Summary

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Restrictions*	*Use Cost*
Stock Tanks	GIS (Vector)	Stocktanks	GRCA	February 2013	GRCA	potential sites for Exotics		GPS, NAIP, NHD	None	None
Fire	GIS (Vector)	Fire History, Fire Severity, Fire Effects, Fire Treatments	GRCA	March 2013	GRCA	potential sites for Exotics	GRCA only	Multiple	None	None
Forest Insect And Disease	GIS (Vector)	Insect Infestations and Forest Disease	USFS	2000-2011	GGCLA Analysis Area	potential sites for Exotics	Surveys limited to forested areas only	Aerial Surveys	None	None
Utilities	GIS (Vector)	GRCA Utilities Infrastructure	GRCA	December 2012	GRCA	potential introduction and dispersal corridors for Exotics	GRCA only	GPS, CAD, NAIP	None	None
Designated Campsites	GIS (Vector)	Backcountry Campsites	GRCA	May 2012	GRCA	potential introduction sites for Exotics	GRCA only	GPS, NAIP	None	None
Transportation	GIS (Vector)	Roads, Trails, Routes	GRCA, USBLM, USFS, other	March 2013	GGCLA Analysis Area	potential introduction and dispersal corridors for Exotics	not standardized across ownerships	GPS, NAIP, USGS 24K DRG, other	None	potentially high, to update and standardize, especially outside GRCA
Exotic Plants	GIS (Vector)	Invasive Species	GRCA		GRCA	displacement of native species	GRCA only	GPS, NAIP, USGS 24K DRG	None	Moderate

Exotics Database Summary – External Sources

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Restrictions*	*Use Cost*
Southwest Exotic Mappings Program (SWEMP) 2007 Regional Database	non-spatial data	Database of invasive, non-native species by county and land management agency	USGS SWBSC	2007	AZ	Database of invasive species with general locations in AOI	non-spatial data (*.mdb)	Semi-annual compilation of non-native, invasive plant species database by USGS Southwest Biological Science Center	Publicly available via associated website: http://sbsc.wr.usgs.gov/research/projects/swepic/swemp/swempA.asp	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Kane and Two-Mile Ranches Cheatgrass Predictive Model	spatial data (raster)	Predictive model of invasive cheatgrass spread for Kane and Two Mile Ranches (MOU required)	LLECB/Grand Canyon Trust	2008	Kane and Two Mile Ranches	Could potentially apply predictive model to full AOI	MOU required	Predictive model determined using model selection via a set of candidate models incorporating combinations of environmental variables	MOU required	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Arizona Wildlands Invasive Plants (AZ-WIP) Assessments Database	non-spatial data	Database of invasive, non-native species that threaten Arizona's wildlands	USGS SWBSC	2005	AZ	Database of invasive species threatening AZ wildlands	non-spatial data in difficult to navigate (*.mdb)	Developed by Arizona Wildland Invasive Plant Working Group beginning in 2003	Publicly available via associated website: http://sbsc.wr.usgs.gov/research/projects/swepic/SWVMA/2E_Documents.asp	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD
Alien Plants Ranking System (APRS) Database and Software	non-spatial data	Database and computer program that helps managers prioritize decisions concerning invasive non-native plants as well as databases with scores for many alien species across the US	USGS Southwest Biological Science Center	TBD	Southwest US	Database ranking management priorities for invasive plant species management	non-spatial data (*.mdb)	Database compilation of APRS records from locations around the US through a cooperative effort among the National Park Service, Northern Arizona University, Ripon College, University of Minnesota, and the U.S. Geological Survey	Publicly available via associated website: http://sbsc.wr.usgs.gov/research/projects/swepic/aprs/downloads.asp	TASK 1: ACQUIRE DATA TASK 2: ASSESS DATA QUALITY TASK 3: TBD

GRCA Permitted Research Studies – Exotics

PI Last Name	*PI First Name*	*Study #*	*Permit #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Brian	Nancy	GRCA-000046	GRCA-2000-SCI-0041, 9702-19-001	Grand Canyon National Park Science Center	2/2/97 - 12/31/01	Augmenting the vascular plant specimen collection of the Grand Canyon Herbarium.	GRCA Library Call # QK86.A75 B75 2001.
Foust	Richard	GRCA-00144	GRCA-2002-SCI-0008	NAU	4/1/02 - 12/31/03	Correlation of Spring-discharge to Groundwater Source Using 234U/238U Isotope Ratios	No final report received.
Hart	Robert		9910-29-001	USGS	3/22/00 - 12/31/03	Detailed Hydrogeologic Assessment of South Rim Area, Grand Canyon National Park	Might be: “Assessment of Spring Chemistry along the South Rim of Grand Canyon in Grand Canyon National Park, Arizona” or “Chemical Characteristics of Ground-Water Discharge at Selected Springs, South Rim Grand Canyon National Park, Arizona”. GRCA MC # GRCA 80840.
Jacobi	William	GRCA-00516	GRCA-2009-SCI-0006	Columbus State University	5/1/09 - 10/1/09	Firewood movement across state lines by national park visitors	No final report received.
Jamison	Levi	GRCA-00575	GRCA-2011-SCI-0029	UA	5/16/11 - 5/16/12	Colonization of GRCA by the Northern tamarisk beetle (Diorhabda carinulata)	No final report received.
Makarick	Lori	GRCA-00168	GRCA-2002-SCI-0022	NPS	10/11/02 - 12/31/06	Tamarisk Management and Tributary Restoration	Ongoing project. See Lori for data.
Rink	Glenn	GRCA-00226	GRCA-2009-SCI-0002, GRCA-2007-SCI-0011, GRCA-2004-SCI-0010	NAU	4/1/09 - 4/1/10 2/1/04 - 12/30/08 2/20/04 - 12/31/06	Increasing the Grand Canyon Herbarium holdings	No final report received.
Weisberg	Peter	GRCA-00283	GRCA-2006-SCI-0035, GRCA-2006-SCI-0012	University of Nevada-Reno	8/31/06 - 12/31/07, 4/01/06 - 8/31/06	Non-native Tamarix ramossisima recruitment along the Colorado River: Interactions among flow regimes and geomorphology	The influence of floods and precipitation on Tamarix establishment in Grand Canyon, Arizona: consequences for flow regime restoration, 2011.
Ayers	Tina			NAU	6/92 - 1/95 1/1/95 -12/31/95	(Continue) Monitor the Effects of Interim Flows from Glen Canyon Dam on Riparian Vegetation in the Colorado River corridor, Grand Canyon, Arizona	Kearsley MJ, Ayers TJ. 1996. The effects of interim flows from Glen Canyon Dam on riparian vegetation in the Colorado River corridor, Grand Canyon National Park, Arizona Final report. Northern Arizona University, Dept of Biological Sciences. Flagstaff, AZ. 8041-8-0002. Published Report-558176. [At Cline Library Gov Docs].
Friedman	Jonathan		9606-18-01, 9704-25-001	National Biological Service, Midcontinent	9/3/96 - 9/30/97	Influence of floods on exotic saltcedar along the Little Colorado River in Grand Canyon National Park	No final report received.

GRCA Permitted Research Studies – Exotics

PI Last Name	*PI First Name*	*Study #*	*Permit #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
				Ecological Science Center			
Kearsley	Michael		9610-09-001	NAU, GCMRC	5/27/97 - 12/31/97	Second Year Transition Monitoring of Riparian Plant Habitats in Grand Canyon National Park, Arizona	Terrestrial Vegetation Work for 1997 Steady Low and High Flows, Draft Final Report, Michael Kearsley and Tina Ayers [NAU, 1998]; Second year transition monitoring of riparian vegetation from Glen Canyon Dam to Pearce Ferry : draft 1997 final report / Michael J.C. Kearsley and Tina J. Ayers ; John R. Spence. GRCA Library Call # TC557 .A62 K43 1998; QK147 .K43 S43 1999.
Kearsley	Michael		9802-05-001	NAU	3/9/98 - 12/31/98	Recovery and losses in riparian soil seed banks of the Colorado River Corridor in Grand Canyon	No final report received.
Stevens	Lawrence			NAU	1985	Invertebrate Herbivore Community Dynamics on *Tamarix chinensis* Loueiro and *Salix exigua* Nuttall in the Grand Canyon, Arizona	Cline Library Call # QH541.5.S7S7. GRCA MC # GRCA 84395.
Spence	John		9601-19-04	NPS, GLCA	9/12/96 - 1/31/98	Monitoring Northern leopard frogs and vegetation	GRCA Library Call # TC530 .S74 1996 (1996 report).
Sisk	Thomas	GRCA-00551	GRCA-2010-SCI-0030	NAU	5/20/10 - 12/20/11	Ecological Impacts of Bison and Implications for Cross-Jurisdictional Management in the Grand Canyon Region	Thesis saved in Sisk file. 92 pgs. GRCA Library Call # QL737.U53 R45 2012. GRCA MC # GRCA 108902.
Makarick	Lori	GRCA-00088	GRCA-2011-SCI-0006, GRCA-2008-SCI-0004, GRCA-2006-SCI-0026, GRCA-2001-SCI-0045, 9611-14-001	NPS	1/1/11 - 12/31/12 3/20/08 - 12/29/10 6/5/06 - 12/31/09 2/1/05 - 12/31/07 11/1/01 - 12/31/06	Collection of Plant Specimens for Grand Canyon National Park's Vegetation Program	No final report received.
Stevens	Lawrence	GRCA-00225	GRCA-2012-SCI-0038, GRCA-2009-SCI-0045, GRCA-2009-SCI-0015, GRCA-2006-SCI-0013, GRCA-2004-SCI-0004, 0002-29-001	MNA	9/1/12 - 9/1/13 9/17/09 - 9/17/10 4/9/09 - 7/9/09 3/1/06 - 7/30/07 3/1/04 - 7/1/05 5/9/00 - 12/31/01	Development of an annotated checklist of the arthropods of Grand Canyon National Park	Biological collections in Grand Canyon National Park in 2000 : final report / Lawrence E. Stevens.; Macroinvertebrate inventory of Grand Canyon National Park, Arizona : Final report. GRCA Library Call # QH541 .S748 2001, QL362.7 .S74 2008.

GRCA Fire Science Research Studies

Primary author	*Secondary Authors*	*Title*	*Year*	*Publication Type*	*Publication Place*	*Files*	*Study Related to:*
Abella, S. R.	Covington, W. W.; Fule, P. Z.; Lentile, L. B.; Meador, A. J. S.; Morgan, P.	Past, present, and future old growth in frequent-fire conifer forests of the Western United States	2007	Journal	Ecology and Society 12(2): 16	pdf	Wally Covington
Baas, J. M.	Haas, G. E.; Ross, D. M.; Loomis, R. J.	A pilot study of visitor knowledge and support for prescribed burning at Grand Canyon National Park	1985	Proceedings	Proceedings--Symposium and Workshop on Wilderness Fire. USDA Forest Service, Intermountain Forest and Range Experiment Station, General Technical Report INT-182, Ogden, UT. Pages 310-314		N/A
Baker, W. L.		Fire history in ponderosa pine landscapes of Grand Canyon National Park: is it reliable enough for management and restoration?	2006	Journal	International Journal of Wildland Fire 15:433-437.		Bill Baker
Bennett, P. S.		The ecological role of fire in north rim forests, Grand Canyon National Park	1974	Journal	Plateau 46:168-181		N/A
Bennett, P. S.		The fire ecology of the ponderosa pine ecosystems of the North Rim forests, Grand Canyon National Park	1976	Unpublished report	GRCA	hardcopy	N/A
Bertolette, D. R.	Spotskey, D. B.	Fuel model and forest type mapping for FARSITE TM input.	1999	Proceedings	Joint Fire Science Conference and Workshop Proceedings: "Crossing the Millennium: Integrating Spatial Technologies and Ecological Principles for a New Age in Fire Management". University of Idaho and the International Association of Wildland Fire, Moscow, ID and Fairfield, WA. Pages 234-241.http://jfsp.nifc.gov/conferenceproc/Ma-11Bertoletteetal.pdf>	pdf	N/A
Binkley, D.	Sisk, T.; Chambers, C.; Springer, J.; Block, W.	The role of old-growth forests in frequent-fire landscapes	2007	Journal	Ecology and Society 12(2):18	pdf	Wally Covington
Boatman, J.	Henderson, D.	Grand Canyon wind study aids in smoke management				hardcopy	N/A
Brown, R. T.	Agee, J. K.; Franklin, J. F.	Forest restoration and fire: Principles in the context of place	2004	Journal	Conservation Biology 18: 903-912.	pdf	N/A
Covington, W.W.	Moore, M. M.; Fule, P.Z.; Smith, H.B.	Grand Canyon Forest Ecosystem Restoration: Research objective 1: Landscape studies of fire regimes and	2000	Unpublished report	GRCA	hardcopy	Wally Covington

GRCA Fire Science Research Studies

Primary author	*Secondary Authors*	*Title*	*Year*	*Publication Type*	*Publication Place*	*Files*	*Study Related to:*
		forest structure					
Crawford, J.	Whitchurch, G.	Four years of vegetation change following the Outlet Fire, North Rim Grand Canyon National Park: Effects of fire and firefighting activities	2003	Unpublished report	GRCA	Word doc	N/A
Crawford, J.	Straka, K.	The Outlet Fire of 2000: Results from five years of vegetation monitoring, North Rim, Grand Canyon National Park	2004	Unpublished report	GRCA	Word doc	N/A
Crawford, J.		2004 Outlet Fire releve vegetation survey	2005	Unpublished report	GRCA	Word doc	N/A
Crocker-Bedford, D.C.	Vankat, J.L.; Bertolette, D.R.; Jurgensen, C.L.; Leatherbury, P.; McKinnon, T.	Reduction in mid- and large-diameter conifers since at least 1935 in Ponderosa Pine Forest of Grand Canyon National Park	2004	Unpublished manuscript	GRCA	Word doc	John Vankat
Crocker-Bedford, D.C.	Vankat, J.L.; Bertolette, D.R.; Jurgensen, C.L.; Leatherbury, P.; McKinnon, T.	Increase in mixed conifer characteristics since at least 1935 in Ponderosa Pine - Mixed Conifer Transition Forest of Grand Canyon National Park	2004	Unpublished manuscript	GRCA	Word doc	John Vankat
Duhnkrack, J.A.		Fire Regime Analysis of Ponderosa Pine Forest at the Grandview Monocline on the South Rim of Grand Canyon National Park, Arizona	1982	Report	Problem Series, Huxley College of Environmental Studies, 34 pages, Western Washington University, Bellingham, Washington		Jesse Duhnkrack
Fergusen, C. W.	Black, D. M	Tree-Ring Chronologies on the North Rim of the Grand Canyon	1952	Journal	Tree Ring Bulletin 19(2)		N/A
Fule, P. Z.	Crouse, J. E.; Heinlein, T. A.; Covington, W. W.	Fire, forest change, and restoration at Grand Canyon	2003	Abstract	Second International Wildland Fire Ecology and Fire Management Congress and Fifth Symposium on Fire and Forest Meteorology, 16-20 November 2003, Orlando, FL <http://ams.confex.com/ams/FIRE2003/techprogram/paper_65751.htm	pdf	Pete Fule
Fule, P.Z.	Covington, W.W.; Smith, H.B.; Springer, J.D.; Heinlein, T.A.; Huisinga, K.D.; Moore, M.M.	Comparing ecological restoration alternatives: Grand Canyon, Arizona	2002	Journal	Forest Ecology and Management 170: 19–41	pdf	Pete Fule
Fule, P.Z.	Covington, W.W.; Moore, M.M.; Heinlein, T.A.; Waltz, A.E.M.	Natural variability in forests of the Grand Canyon, USA	2002	Journal	Journal of Biogeography 29: 31-47	pdf	Pete Fule
Fule, P.Z.	Heinlein, T.A.; Covington, W.W.;	Assessing fire regimes on Grand Canyon	2003	Journal	International Journal of Wildland Fire 12:	pdf	Pete Fule

GRCA Fire Science Research Studies

Primary author	*Secondary Authors*	*Title*	*Year*	*Publication Type*	*Publication Place*	*Files*	*Study Related to:*
	Moore, M.M.	landscapes with fire-scar and fire-record data			129–145		
Fule, P.Z.	Crouse, J.E.; Heinlein, T.A.; Moore, M.M.; Covington, W.W.; Verkamp, G.	Mixed-severity fire regime in a high-elevation forest of Grand Canyon, Arizona, USA	2003	Journal	Landscape Ecology 18: 465–486	pdf	Pete Fule
Fule, P.Z.	Crouse, J.E.; Cocke, A.E.; Moore, M.M.; Covington, W.W.	Changes in canopy fuels and potential fire behavior 1880-2040: Grand Canyon, Arizona	2004	Journal	Ecological Modelling 175: 231–248	pdf	Pete Fule
Fule, P.Z.	Cocke, A.E.; Heinlein, T.A.; Covington, W.W.	Effects of an intense prescribed forest fire: is it ecological restoration?	2004	Journal	Restoration Ecology 12(2): 220-230	pdf	Pete Fule
Fule, P.Z.	Covington, W.W.; Stoddard, M.T.; Bertolette, D.	Minimal-Impact Restoration Treatments Have Limited Effects on Forest Structure and Fuels at Grand Canyon, USA.	2006	Journal	Restoration Ecology 14(3): 357–368	pdf	Pete Fule
Fule, P.Z.	Heinlein, T.A.; Covington, W.W.	Fire histories in ponderosa pine forests of Grand Canyon are well supported: reply to Baker	2006	Journal	International Journal of Wildland Fire 15: 439–445	pdf	Pete Fule
Fule, P.Z.	Laughlin, D.C.	Wildland fire effects on forest structure over an altitudinal gradient, Grand Canyon National Park, USA	2007	Journal	Journal of Applied Ecology 44: 136-146	pdf	Pete Fule
Fule, P.Z.	Heinlein, T.A.; Covington, W.W.; Moore, M.M.	Continuing Fire Regimes in Remote Forest of Grand Canyon National Park	2000	Proceedings	USDA Forest Service Proceedings RMRS-P-15-VOL-5	pdf	Pete Fule
Fule, P.Z.		Wildfire Ecology and Management at Grand Canyon, USA: Tree-Ring Applications in Forest Fire History and Modeling	2010	Book chapter	in M. Stoffel et al. (eds.), Tree Rings and Natural Hazards: A State-of-the-Art, Advances in Global Change Research 41	pdf	Pete Fule
Gildar, C.N.	Fule, P.Z.; Covington, W.W.	Plant Community Variability in Ponderosa Pine Forest Has Implications for Reference Conditions	2004	Journal	Natural Areas Journal 24:101–111	pdf	Cara Gildar
Haire, S.L.	McGarigal, K.	Inhabitants of landscape scars: succession of woody plants after large, severe forest fires in Arizona and New Mexico	2008	Journal	The Soutwestern Naturalist 53: 146-161	pdf	Sandra Haire
Haire, S.L.	McGarigal, K.	Changes in fire severity across gradients of climate, fire size, and topography: a landscape ecological perspective	2009	Journal	Fire Ecology 5: 86-103	pdf	Sandra Haire
Haire, S.L.	McGarigal, K.	Effects of landscape patterns of fire	2010	Journal	Landscape Ecology 25: 1055-1069	pdf	Sandra Haire

GRCA Fire Science Research Studies

Primary author	*Secondary Authors*	*Title*	*Year*	*Publication Type*	*Publication Place*	*Files*	*Study Related to:*
		severity on regenerating ponderosa pine forests (Pinus ponderosa) in New Mexico and Arizona, USA					
Harrington, M. G.	Hawksworth, F. G.	Interactions of fire and dwarf mistletoe and mortality of southwestern ponderosa pine	1988	Proceedings	Effects of Fire Management of Southwestern Natural Resources: Proceedings of the Symposium. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. Pages 234-240	hardcopy	N/A
Heinlein, T.A.	Covington, W.W.; Fule, P.Z.; Moore, M.M.; Smith, H.B.	Development of Ecological Restoration Experiments in Fire Adapted Forests at Grand Canyon National Park	2000	Proceedings	USDA Forest Service Proceedings RMRS-P-15-VOL-5.	pdf	Wally Covington
Higgins, A.		The effects of burn entry and burn severity on stand structure and composition in Grand Canyon National Park	2011	Thesis	Northern Arizona University, MS Thesis	pdf	N/A
Huisinga, K.D.	Laughlin, D.C.; Fule, P.Z.; Springer, J.D.; McGlone, C.M.	Effects of an intense prescribed fire on understory vegetation in a mixed conifer forest	2005	Journal	Journal of the Torrey Botanical Society 132(4): 590–601	pdf	Pete Fule
Kaufmann, G.A.	Covington, W.W.	Effect of Prescribed Burning on Mortality of Presettlement Ponderosa Pines in Grand Canyon National Park	2001	Proceedings	USDA Forest Service Proceedings RMRS-P-22	pdf	Wally Covington
Kaufmann, G.A.		Effects of prescribed burning on mortality of presettlement ponderosa pines in Grand Canyon National Park	2000	Thesis	Northern Arizona University, MS Thesis	hardcopy	Wally Covington
Kaufmann, M. R.	Binkley, D.; Fule, P. Z.; Johnson, M.; Stephens, S. L.; Swetnam, T. W.	Defining old growth for fire-adapted forests of the Western United States	2007	Journal	Ecology and Society 12(2):15	pdf	
Kim, Y.	Yang, Z.; Cohen, W.B.; Pflugmacher, D.; Lauver, C.L.; Vankat, J.L.	Distinguishing between live and dead standing tree biomass on the North Rim of Grand Canyon National Park, USA using small-footprint lidar data	2009	Journal	Remote Sensing of Environment 113: 2499-2510	pdf	
Kim, Y.		Distinguishing between live and dead standing tree biomass on the North Rim of Grand Canyon National Park, USA using small-footprint lidar data	2009	Thesis	Oregon State University	pdf	
Laughlin, D. C.	Fule, P.Z.	Wildland fire effects on understory plant	2008	Journal	Canadian Journal of Forest Research 38:	pdf	

GRCA Fire Science Research Studies

Primary author	*Secondary Authors*	*Title*	*Year*	*Publication Type*	*Publication Place*	*Files*	*Study Related to:*
		communities in two fire-prone forests			133-142.		
Laughlin, D.C.	Bakker, J.D.; Stoddard, M.T.; Daniels, M.L.; Springer, J.D.; Gildar, C.N.; Green, A.M.; Covington, W.W.	Toward reference conditions: wildfire effects on flora in an old-growth ponderosa pine forest	2004	Journal	Forest Ecology and Management 199: 137–152	pdf	
Laughlin, D.C.	Bakker, J.D.; Fule, P.Z.	Understorey plant community structure in lower montane and subalpine forests, Grand Canyon National Park, USA	2005	Journal	Journal of Biogeography 32: 2083–2102	pdf	
Laughlin, D.C.	Fule, P.Z.	Meeting Forest Ecosystem Objectives with Wildland Fire Use	2006	Journal	Fire Management Today 66 (4): 21-24.	pdf	
Laughlin, D.C.	Grace, J.B.	A multivariate model of plant species richness in forested systems: old-growth montane forests with a long history of fire	2006	Journal	OIKOS 114: 60-70	pdf	
Laughlin, D.C.	Roccaforte, J.P.; Fule, P.Z	Effects of a second entry prescribed fire in a mixed conifer forest	2011	Journal	Western North American Naturalist 71(4): 557–562	pdf	
Makarick, L.	Eisenberg, B.; White, J.; Salter, B.; Fawcett, K.	2001 revegetation and exotic species surveys in the the Outlet Fire	2001	Unpublished report	GRCA	hardcopy	
Makarick, L.	Eisenberg, B.; Watters, K.	2002 revegetation and exotic species surveys in the Outlet Fire	2002	Unpublished report	GRCA	hardcopy	
Mast, J.N.	Wolf, J.J.	Ecotonal changes and altered tree spatial patterns in lower mixed-conifer forests, Grand Canyon National Park, Arizona, U.S.A.	2004	Journal	Landscape Ecology 19: 167–180	pdf	
Mast, J.N.	Wolf, J.J.	Spatial patch patterns and altered forest structure in middle elevation versus upper ecotonal mixed-conifer forests, Grand Canyon National Park, Arizona, USA	2006	Journal	Forest Ecology and Management 236: 241-250	pdf	
Meigs, G.W.		Recent patterns of large fire events on Kaibab Plateau, Arizona, USA	2004	Thesis	Cornell University, Undergraduate Honors Thesis	hardcopy	
Moore, M. M.	Covington, W. W.; Fule, P. Z.	Reference conditions and ecological restoration: A southwestern ponderosa pine perspective	1999	Journal	Ecological Applications 9: 1266-1277.	pdf	
Moore, M.M.	Huffman, D.W.	Tree Encroachment on Meadows of the North Rim, Grand Canyon National Park, Arizona, U.S.A.	2004	Journal	Arctic, Antarctic, and Alpine Research 36(4): 474-483	pdf	
Muleady-Mecham,		The natural history of fire in Grand Canyon	2003	Thesis	Northern Arizona University, PhD	hardcopy	

GRCA Fire Science Research Studies

Primary author	*Secondary Authors*	*Title*	*Year*	*Publication Type*	*Publication Place*	*Files*	*Study Related to:*
N.E.		National Park			Dissertation		
Muleady-Mecham, N.E.		Fire in Grand Canyon National Park and the Greater Grand Canyon Ecosystem: A review of the primary literature	2002	Unpublished report	Northern Arizona University	hardcopy	
Opperman, T.	Leonard, K.	Effects of spring v. fall prescribed burning on vegetation in a ponderosa pine (Pinus ponderosa) forest at Grand Canyon National Park, Arizona	2000	Abstract	Proceedings of Fire Conference 2000: The First National Congress on Fire Ecology, Prevention and Management, 27 November-December 1, 2000, San Diego, CA. University Extension, University of California Davis, Davis, CA.		
Opperman, T. S.	Leonard, K. W.; Galley, K. E. M.; Klinger, R. C.; Sugihara, N. G.	Effects of burning without thinning on ponderosa pine in Grand Canyon National Park	2000	Proceedings	Proceedings of Fire Conference 2000: The First National Congress on Fire Ecology, Prevention and Management. Tall Timbers Research Station, Tallahassee, FL. Pages 88-90		
Pabst, K.L.		Quantifying burn severity in a heterogeneous landscape: a comparison of the differenced Normalized Burn Ratio and the Relative differenced Normalized Burn Ratio in the Grand Canyon National Park, Arizona	2010	Thesis	South Dakota State University	pdf	
Palmer, K.		Modeling long-term changes to the ponderosa pine forests of Grand Canyon National Park	2012	Thesis	Northern Arizona University, MS Thesis	pdf	
Pyne, S. J.		Fire in America: a cultural history of wildland and rural fire	1982	Book	Princeton University Press, Princeton, NJ.		
Roccaforte, J.P.	Fule, P.Z, Covington, W.W., Laughlin, D.C.	Woody debris and tree regeneration dynamics following severe wildfires in Arizona ponderosa pine forests	2012	Journal	Canadian Journal of Forest Research 42: 593-604	pdf	
Rowlands, P.G.	Brian, N.J.	Fishtail Mesa: A vegetation resurvey of a relict area in Grand Canyon National Park, Arizona	2001	Journal	Western North American Naturalist 61(2): 159–181	pdf	
Sackett, S.S.		Natural fuel loadings in ponderosa pine and mixed conifer forests of the SW	1979	USFS Research Paper	RM-213 Rocky Mt. For. and Range Exp. Stn.		
Schmutz, E. M.	Michaels, C. C.; Judd, B. I.	Boysag Point: A relict area on the North	1967	Journal	Journal of Range Management 20: 363-369.	pdf	

GRCA Fire Science Research Studies

Primary author	*Secondary Authors*	*Title*	*Year*	*Publication Type*	*Publication Place*	*Files*	*Study Related to:*
		Rim of Grand Canyon in Arizona					
Spotskey, D. B.	Bertolette, D. R.	Fuel model and forest type mapping for FARSITE input [poster abstract]	1999	Abstract	Joint Fire Science Conference and Workshop Proceedings: "Crossing the Millennium: Integrating Spatial Technologies and Ecological Principles for a New Age in Fire Management". University of Idaho and the International Association of Wildland Fire, Moscow, ID and Fairfield, WA. Pages 287-287		
Stearns, L.P.		Meterological studies for smoke management in Grand Canyon National Park	1988	Unpublished report	USDOI, NPS, Air Quality Division. Interagency Agreement 492-082-03	hardcopy	
Stephens, S. L.	Fule, P. Z.	Western pine forests with continuing frequent fire regimes: Possible reference sites for management	2005	Journal	Journal of Forestry 103: 357-362.	pdf	
Vankat, J.L.	Crocker-Bedford, D.C.; Bertolette, D.R.; Jurgensen, C.L.; Leatherbury, P.; McKinnon, T.	Indications of large changes in Mixed Conifer Forest of Grand Canyon National Park	2004	Unpublished manuscript	GRCA	Word doc	John Vankat
Vankat, J.L.		Forest Changes in Grand Canyon National Park and Implications for Management	2010	Unpublished	GRCA	Word doc	John Vankat
Vankat, J.L.		Post-1935 changes in forest vegetation of Grand Canyon National Park, Arizona, USA: Part 1 – ponderosa pine forest	2011	Journal	Forest Ecology and Management 261: 309-325	pdf	John Vankat
Vankat, J.L.		Post-1935 changes in forest vegetation of Grand Canyon National Park, Arizona, USA: Part 2—Mixed conifer, spruce-fir, and quaking aspen forests	2011	Journal	Forest Ecology and Management 261: 326-341	pdf	John Vankat
White, M. A.	Vankat, J. L.	Middle and high elevation coniferous forest communities of the North Rim region of Grand Canyon National Park, Arizona, USA	1993	Journal	Vegetatio 109:161-174.	pdf	John Vankat
Wolf, J. J.	Mast, J. N.	Fire history of mixed-conifer forests on the North Rim, GRCA	1998	Journal	Physical Geography 19:1-14.		

GRCA Permitted Fire Science Studies

PI Last Name	*PI First Name*	*Study #*	*Permit #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Baisan	Christopher	GRCA-00206	GRCA-2004-SCI-0025	UA	7/1/04 - 12/31/05	Fire and Pandora Moth History in Northern Arizona	No final report received.
Baker	William	GRCA-00562	GRCA-2010-SCI-0053	University of Wyoming	10/27/10 - 12/31/11	Development and calibration of a new method of reconstructing fire history in low-severity fire regimes	No final report received.
Covington	William		9702-24-001	NAU, School of Forestry	5/23/97 - 12/31/06	Grand Canyon Forest Ecosystem Restoration	GRCA Library Call # SD144 .A6 R43 2000.
Fule	Peter	GRCA-00227	GRCA-2004-SCI-0009	NAU	4/1/04 - 12/31/06	Fire Use over a Southwestern Elevational Gradient: Effects of 2003 Fires	11 pgs. GRCA Library Call # SD421.32 .G73 F85 2007.
Fule	Peter	GRCA-000052	GRCA-2000-SCI-0047, 9907-01-001, 9702-24-001	NAU	9/3/99 - 12/31/04 5/23/97 - 12/31/99	Multi-Century Fire Modeling Over Landscape Gradients	GRCA Library Call # SD421.32 .A75 F85 2002 c.1-2; QH104.5 .G73 F85 2005.
Fule	Peter	GRCA-00309	GRCA-2007-SCI-0018	NAU	5/1/07 - 12/30/09	Post-wildfire dynamics of woody debris: mechanisms and management implications	No final report received.
Gildar	Cara		0004-13-001	NAU	6/5/00 - 12/31/01	Determining Understory Reference Conditions in Southwestern Ponderosa Pine Forests	"Plant Community and Arbuscular Mycorrhizal Dynamics Have Implications for Determining Ponderosa Pine Reference Conditions." GRCA Library Call # SD397.P6115 G553 2002. GRCA MC # GRCA 82396. Cline Library Call # SD397.P6115 G553 2002.
Haire	Sandra	GRCA-00273	GRCA-2005-SCI-0021	USGS Biological Resource Division, Fort Collins Science Center	6/1/05 - 12/30/06	Disturbance Ecology of Rocky Mountain Pine Forests: Conservation Implications	GRCA Library Call # QH545 .F5 K68 2002. http://www.umass.edu/landeco/research/swfire/swfire.html, shaire@nrc.umass.edu.
Hardy	Colin	GRCA-00276	GRCA-2005-SCI-0025	USDA Forest Service, Rocky Mountain Research Station	7/1/05 - 6/30/06	Demonstration and integration of systems for fire remote sensing, ground-based fire measurement, and fire modeling.	No final report received.
Jacobs	Brian	GRCA-00248	GRCA-2004-SCI-0033	NPS	1/1/04 - 5/31/06	Characterize Southwestern U.S. Woodland Systems: Soils and associated site factors as indicators of stand age-structure	No final report received.
Kotliar	Natasha	GRCA-00119	GRCA-2001-SCI-0027	USGS	5/15/01 - 12/31/05	The Effects of Burn Severity and	Status report : the effects of burn severity and

GRCA Permitted Fire Science Studies

PI Last Name	*PI First Name*	*Study #*	*Permit #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
						Heterogeneity on Early Post-fire Avian and Plant Communities in Coniferous Forests of the Rocky Mountains	heterogeneity on post-fire avian and plant communities of the Rocky Mountains and Colorado Plateau / Natasha B. Kotliar, Sandra L. Haire. GRCA Library Call # QH545 .F5 K68 2002. GRCA MC # GRCA 79712.
Mecham	Nancy Muleady		GRCA-2000-SCI-0087	NAU	11/11/00 - 12/31/01	The Natural History of Fire in America's National Parks: A Biological and Educational Perspective	"The Natural History of Fire in Grand Canyon National Park" NAU; 2003. 226 pgs. GRCA Library Call # SD421 .M854 2003.
Rambo	Jennie	GRCA-00167	GRCA-2002-SCI-0024	ASU	8/2/02 - 11/1/02	The response of understory plant diversity to different fire histories in Ponderosa pine grasslands across northern Arizona	ASU Library Call # LD179.15 2006 .R365.
Rubin	Spencer	GRCA-00581	GRCA-2011-SCI-0038	NAU	6/6/11 - 8/1/12	Wetland Plant Communities and Historic Settlement Disturbance on the Colorado Plateau: Baseline Data for Conservation	No final report received.
Schlossberg	Scott	GRCA-00104	GRCA-2001-SCI-0007	University of Illinois at Urbana-Champaign	5/1/01 - 12/31/01	Effects of Cattle Grazing and Fire on the Birds of Pinyon-Juniper Woodlands	No final report received.
Short	Karen	GRCA-00077	GRCA-2000-SCI-0072, 9905-17-001	University of Montana, Missoula	6/7/99 - 12/31/01	The Effects of Surface Fires on Birds and Arthopods in Southwestern Ponderosa Pine Forests.	GRCA Library Call # SF85.6.F57 S56 2002.
Sisk	Tom	GRCA-00506	GRCA-2008-SCI-0018	NAU/Grand Canyon Trust	6/6/08 - 6/6/09	Implications of North Rim anthropogenic ecological boundaries-conservation and restoration of NR forests	No final report received.
Thode	Andrea	GRCA-00558	GRCA-2010-SCI-0046	NAU	6/01/10 - 12/31/10	Regeneration in mixed conifer forests following fires of different severities in GRCA	No final report received.

Greater Grand Canyon Landscape Assessment

Visitor Experience TWG Meeting Summary
March 5, 2014, 1:00-4:00 pm

The first meeting of the GGCLA Visitor Experience Technical Work Group (TWG) was held on March 5, 2014 to begin refining the scope and approach to assessing visitor experience.

In attendance: Todd Chaudhry, GRCA; Sasha Stortz, Northern Arizona University; Alicyn Gitlin, Sierra Club; Dick Hingson, Sierra Club; Julie Rowe, Kaibab National Forest; Bill Austin, USFWS, John Dillon, Grand Canyon River Outfitters Association; Pam Foti, NAU; Laura Williams, Grand Canyon Association; Timothy C. Begay, Navajo Nation; Doug Nering, Grand Canyon Hikers and Backpackers Association; Damon Joyce, NPS Natural Resource Stewardship and Science Directorate; Jane Rogers, GRCA; Tom Sisk, NAU; Peter Pettengill, GRCA; Linda Jalbert, GRCA; Mark Nebel, GRCA; Kevin Dahl, National Parks Conservation Association (phone); Peter Bungart, Hualapai Tribe (phone); Santiago Garcia, GRCA; Mike Kearsley, GRCA; Helen Fairley, USGS- GCMRC

Acronyms and symbols

GGCLA: Greater Grand Canyon Landscape Assessment

GRCA: Grand Canyon National Park

LLECB: Lab of Landscape Ecology and Conservation Biology (NAU)

NAU: Northern Arizona University

TWG: Technical Work Group

Meeting summary

I. Background and purpose

Todd Chaudhry presented background information on the GGCLA, explained the process for selecting the focal resources, which started with a stakeholder workshop in October 2012, the collaborative nature of the assessment, and the purpose of the Technical Work Groups (TWG). Work groups are tasked with refining the scope of the assessment, identifying the best condition indicators and reference/desired conditions, identifying potential or known threats, identifying information and data needs that exists, and synthesizing the information to assess current conditions and trends. For complete details, see http://lci.nau.edu/ggcla.aspx.

Technical Work Group activities to date:

- Vegetation: Identified exotics as a threat on a landscape scale. Still working on identifying focal resources for this topic. Identified thus far are: riparian vegetation, desert scrub, rim habitats (a unique habitat that helps to define this landscape), and rare and special status species (may be nested within broader vegetation communities).
- Physical resources: Focusing on springs and cave ecosystems. Working on determining how to assess the condition of these resources and how to report this.
- Cultural resources: Recognizing that there is potentially a cultural element in all the resource categories, we hope to take an integrated approach. Some cultural resources can be represented spatially (on a map), and other broader resources might be more difficult to represent in this manner.
- Wildlife: Focal wildlife species identified thus far include mountain lion and prey species (as a system); raptors, particularly forest raptors (northern goshawk), and prey species; herpetofauna (but not much information on herps in Grand Canyon region – could be identified as future research need).

Objectives of today's meeting are:

- Discuss the scope of and approach to assessing visitor experience, specifically through recreational resources and wilderness experience
- Determine indicators and criteria for assessing each resource's conditions

- Identify the information that is available or needed in order to complete the assessment
- Discuss roles, responsibilities, timelines, and how to move forward working together

Resources to be addressed in today's meeting are based on values identified by stakeholders in the first workshop and include:

- Recreational resources: access, recreational opportunities, recreational amenities
- Wilderness: solitude, natural landscapes
- Viewscapes: natural scenery, air quality
- Dark night skies: natural lightscape
- Soundscape: natural sound/quiet

These resources connect and can be addressed in different ways. Recreation, for example, was identified as both a value and a risk to the landscape.

II. Backcountry Management Plan (BMP) status and relationship to the GGCLA

Linda Jalbert and Todd Chaudhry provided a status update on the BMP and its relationship to the GGCLA effort:

> There is a nexus between the BMP and the GGCLA but they are different efforts and this meeting isn't about the EIS. BMP is the process of revising the 1988 plan. We are in the final stages of completing a draft EIS and hope to have it out for comment this summer.
>
> Much information gathered to prepare for the BMP EIS is being used to inform the GGCLA as well, such as the visitor use data. The goal is to be coordinated, in order to avoid duplicating efforts. For example, through the BMP, data on visitor experience is being complied. Meanwhile the GGCLA is identifying sensitive resources, and use patterns. In the future, we can use these two approaches to develop monitoring and adaptive management for backcountry use and across the broader landscape.

Q: When will the data being developed become publicly accessible and how?

A: Most data represent current conditions and you'll see some of that today. Some data is sensitive, but use data is publicly available now. Steve Sullivan is the park contact for that information. Our intention is to make data available, but won't reveal sensitive location information such as archeology sites. We can instead represent, for example, densities of archeological sites by watersheds.

Q: Traditional cultural properties such as sacred sites. How will they be integrated?

A: Cultural resources TWG talked about that. Focused on archeological sites and ethnographic resources, encompassing a broad range of things. Valuable opportunity to proactively discuss issues.

Q: Once assessment is done, will there be government-to-government consultation

A: Because it's not an action, it's not subject to section 106 consultation requirements, but the information developed for GGCLA will be utilized to address future proposed actions. Have been in contact with tribes through outreach and presentations.

78 miles of Navajo nation is neighboring the park. Water and wildlife departments might have some data that can be used in the GGCLA.

Q: How will what's being done here be used? Is this a broad planning platform that compiles a lot of information that can then feed in to individual planning efforts?

A: Yes, well said. Natural Resource Condition Assessments are standardized nationally for the NPS. Under the program, we've added stakeholder engagement, integrate cultural and natural, and extend beyond the boundaries to

be more inclusive. This provides the opportunity to expand upon regional databases. For example, we've worked to add Grand Canyon springs data to Museum of Northern Arizona database, and then are getting permission to use neighboring data in analysis.

III. Recreational Resources

Todd Chaudhry introduced the idea of recreational resources in the GGCLA: The Park has identified desired conditions and some indicators in the past. Here we need to narrow down to the best indicators to determine condition both currently and over time

Some potential indicators have already been identified:

- Use levels: we have information, but it has caveats such as the difference between actual and permitted use
- Numbers and types of recreational activities: focus of BMP EIS activities
- Impacts to natural and cultural resources: Riparian communities is one of the focal vegetation communities, can be very sensitive to use impacts in desert landscapes
- Number of encounters with overnight users
- Visitor satisfaction with management actions

Are there ones missing, particularly ones that there are data for?

Q: What about campsite beaches, trails. Are they being monitored or accounted for?

A: A base layer has been developed for trails. It is importance as a resource and as a source of potential stressors. Helps inform risk assessment.

A: Those include canyoneering routes from the latest canyoneering books

Q: How is access integrated into the assessment?

A: Access across neighboring lands is being addressed in BMP. But access to amenities could be addressed in a lot of ways.

Vandalism, graffiti, collection piles are examples of user impacts. Are impacts occurring in more or less accessible areas? Campsites for example, previous campsite assessments measured impacted but non-designated areas. Looking back this seemed a valuable indicator for reflecting use intensity. To me that makes a lot of sense because it has direct linkage to plant establishment, etc.

Recreation impact assessments have been done by the park. They include density of campsites, intensity of use. Report on the Grand Canyon website; data has been used a lot.

Q: Are people aware of other data sets that would be more recent or outside of the park?

A: USFS does monitoring, some every year, some less frequently, in Kanab Creek wilderness area. Limited data but we could provide.

Q: Are there trailhead counts on the North side?

A: Don't have the people to count, don't think voluntary registers have been used in a while but I can check. Just happy if we can monitor camp and spring sites. Now have a national protocol for solitude monitoring. Not yet implemented.

Q: Any information on permits being issued versus actual use? Concerns about people not being able to recreate

A: It depends. Corridor trails have ranger presence and they are documenting how many people are out there. The information is available but probably hasn't been compiled and analyzed. Elsewhere with less ranger presence and use intensity, it is not as well known.

A: Speaking for the hiking community, we know the rangers aren't not usually out there, and we are often permitted in areas where we'd expect to see another party but don't always see them. -Operationally, and to what end, assessing that is a challenge.

- People are competing for access; it doesn't always lead to trust in the system.
- Could have a box at the trailhead to put in a slip they received with their permit or something to document they actually went on the trip.
- The permitted versus actual use is an interesting question and probably some methods exist to get at this. Permit data outside the corridor, one way we have to engage our folks in the backcountry is via questionnaire; pre- and post-trip. Following up post-trip, Q1- did you go on this trip? Question I would have with backpackers is, would they be open to having a pre/post-assessment?

In response to this question:

- I feel confident that many of us would, not everyone
- Generally find our response rates are pretty high
- That's my experience. We enjoy being asked.

Q: How would you assess condition of trail and backcountry accesses? Are there clear areas where you would say the condition is not desirable? We need more or more limited access?

A: What metric for access would be the objective part, and then is it a good thing or a bad thing? The principle issue I'd raise with respect to access is transparency. Is information about access well described and readily available?

Q: Does the source of that information matter? The park puts out information versus what might be available in a canyoneering book.

A: I don't think the source is particularly important. The current source is now the rumor mill of the internet. How do I get there, what are the road conditions, etc.

The indicator then would be current condition of available information that is enabling access? The information in itself is a metric. Hiking community would be happy to contribute their subjective, qualitative perspective of access

Q: What types of access?

A: Number of useable access points is finite but probably not very well cataloged.

There's also access via reservation lands

Q: Other components from a recreational resources point of view? Campsites, trails, access. Are there other things we should be considering?

A: I know park handles this differently than forest, but do you look at balance between guided and non-commercial use, or areas where that could be leading to user conflicts or exceeding capacity? When I used to work in Sedona, that was all we did. That balance between different user groups that don't always go together.

A: We do have those data as part of the overall use datasets.

A: BMP EIS no-action condition is basically the current condition, but the idea is what pieces of that need to be brought to the assessment, and what else should we bring in?

- Commercial versus noncommercial use, or conflict areas could be an indicator. Especially as tourism and ecotourism are going to continue to increase. How you work it in, I don't know.

- It'd also be interesting to see seasonal usage along with annual. When the commercial season drops out, that's when private increases. It might be a way to reveal capacity issues, etc. We need to look at them on a finer time scale. Annual isn't very useful on the ground.

Jill Rundall and Mike Kearsley discussed a draft map showing the history of permitted use in the park:

- This is a map of use intensity over 13 year average.
- Recognize seasonal importance. In addition to user conflicts, species like MSO and mountain lion can be sensitive to human presence, but that's also tied to certain times of year, and maybe group sizes.

Q: Is that map available now?

A: It will be when the report comes out for this project. And use summary report mentioned later on has it reported but not spatially is already available.

The question relates to, what's the controlling factor related to the release of this data. Data is already available. Products for the EIS won't be available yet, but will be available when the draft EIS is released. As with anything, have conversations with us if there are specific interests and data needs.

Intermediate products are of great interest.

Other indicators?

Q: Is there information for water quality near campsites?

A: There is some existing data, not looking at it here but it is part of the Colorado River Management Plan data.

- Strikes me that in remote areas, camps are near water could be an important variable.
- Signs of that are present based on some existing data. Fecal coliform has been present. Might be a good to identify for future monitoring.

IV. Wilderness Resources

The conversation transitioned to wilderness resources.

One question is if soundscape, viewscape and dark night skies are indicators of wilderness or should be addressed as stand-alone resources.

Existing indicators of wilderness include:

- Authorized and unauthorized treatments or actions
- Natural/biophysical components of native/non-native species
- Number and types of non-recreational facilities
- How untrammelled or unconfined people feel

Todd Chaudhry shared an example of a wilderness assessment:

Death Valley modeled wilderness quality based on a variety of indicators. Would like to see what data can be readily developed during this assessment. Use a more simplistic approach of wilderness quality.

Other qualities of wilderness in the Death Valley assessment included soundscape, viewshed, nightskies as indicators within this broader framework. Is this a reasonable approach for our assessment? They're stand-alone resources whose condition is assessed, but we include them in an analysis of wilderness quality as well?

[Lots of heads nodding]

V. Dark Night Skies

Laura Williams gave a presentation and led discussion on assessment of Dark Night Skies.

Indicators of dark night skies include:

- Entire sky luminance; ratio of anthroprogenic to natural light
- Luminance from city light domes is represented visually but not a separate indicator/data set. It's the same when you're measuring luminance
- Visual observations in Bortel class
- Sky quality meter

Artificial night sky brightness due to light pollution is increasing steadily all over the world. Indicators tell us how our night skies are doing, and that overall can be fed into an assessment of wilderness experience.

One indicator is anthropogenic light ratio. This is the ratio of measurable artificial light and measurable star brightness. Not known if we'll be able to get that from the NPS Night Skies team, but that's outside of my control. Suspect it will be available.

Q: Is there one value for the park?

A: Yes, indicators have come from the night skies team. It will be an average representing the whole park. They do a 360 panorama. The numbers probably won't vary too much in the park because you're not going be that much closer to Las Vegas or Flagstaff.

Q: But where are they standing in the park?

A: You could drop into crazy amounts of data collection. Part of this question is what a reasonable amount is. This is the brightness over the whole sky. Most of it is not about the immediate stuff happening on the horizon, so it's a broader indicator

Q: What about local light?

A: That's coming:

Another indicator: Bortle class. The Bortle class is the visual limiting magnitude and sky quality meter data have been collected but there are plans to collect it more. Bortle class is a way of classifying skies: Can you see the Milky Way? Can you see other key features? If you can't see it, then you have class X– a way of visually observing what visitors see.

VLM is another way of doing the same thing. It's taking a sky square and counting the number of stars you can see. Subjective, visual ability varies.

Sky quality meter: Magnitude of sky brightness at a 20 degree angle above you. You can get this out to different locations in the park. This might start to reflect Las Vegas to the west, Phoenix sky glow from the South Rim

- Sky quality meter is $200 and could be a citizen science approach.
- iPhone app exists.

But the point is these are measures that we can do in the park; we're not waiting for the night skies team to come. How much will be ready for the GGCLA, unsure, but would like to choose a handful of points around the park. Night skies team previously took points from north and south rim. All will be spatially represented. A Grand Canyon Youth trip in June will collect sky quality data on second half of the river.

Lighting inventory wasn't included by the night skies team but we're doing it in the park. It addresses the issue of local light and glare. Light location is recorded in GIS.

This could be another indicator- what % of lights are fully shielded? It's an indicator of local experience. We could come up with percentage for guidelines to getting a dark skies park status.

Resource threats: Other cities! But the goal is to work first in the park.

Areas of high importance, and how lights impact those areas. We can, through viewshed modeling or other approaches, identify what lights are shining into different wilderness areas. Desert View Watchtower, for example.

Another metric could be how many lights conform to the lightscape management plan, but unsure if the timeline will work.

Comment: Areas impacted by light include, from north rim, airport beacon, bright headlamps, and the windfarm. These should be documented, at least.

Response: Outside the park, there is a CO Plateau Dark Skies Cooperative run by Nathan Ament to coordinate with communities outside the park. Headlamp issue could be addressed by a light-scape management plan. This hasn't been discussed or approved, so there are caveats, but there could be a lumen limit in the park.

Response: Something like the headlamp issue would be a great way to use education and outreach. People assume you can see better with bright light, but then you can't see anything out to the sides.

Comment- I think the viewshed analysis will be key, though. It would be good to know from what points can you see the lights, day and night

Q: What does SQM measure?

A: Sky brightness. A lens with a cone measuring magnitudes per arc square second. The number is the brightness of one magnitude per one arc second. It takes the average of that whole cone.

It seems you could also, going down to the use data, know where camps are in close proximity to each other, it might impact the local light (headlamps) to address how campsites are managed.

Definitely hear a lot of frustration about headlamps.

Concluding comments: Dark skies something where we don't need to reinvent the wheel. Clear assessment protocol and indicators in place. But it will be exciting to bring local light into the conversation in a different way.

VI. Soundscape

Todd Chaudhry addressed soundscape. Some different indicators and desired conditions exist. Conservation groups provided input into the desired conditions and indicators at the time.

There is a long history of overflight policy in the park. Lots of information is out there. Soundscape is a very important resource and we want to include it in the assessment. Cognizant that we could spend all time and money on soundscape. So I'd like to talk about what information we can reasonably synthesize to give a good overall representation of soundscape within and adjacent to the park

Jill Rundall shared some maps of overflights.

So, this could be a broad assessment. In what areas do you expect overflight related noise impacts? Spatial and temporal elements.

Q: Regardless of whether people like it or not, you have all the modeling done during the overflights process?

A: Yes. Hope and intention would be to synthesize a reasonable amount of that information to represent current conditions.

Q: LEQ daytime. The park service has moved Yellowstone to LEQ day audible, which is different than averaging when you hear it and when you don't. That came out of the Yellowstone winter use plan that just went into effect. It's not just LMax. And then NA35 was brought up at the acoustical society of America and it was used by Paul Schomer on Hermit Trail this summer. NA35 captures surges above a certain threshold. I think you're on the right track but be aware of new developments. The ORV plan at Glenn Canyon has some information about listening area/alerting distance. Alerting distance is a straight line (distance when an animal would be able to hear), listening area reduction is a log where if its loud background noise, you're not going to be able to hear natural sounds as much. It's a way of relating to an impact.

Q: So if you knew the ambient level and the difference when a plane flies over then you can calculate the change?

- Dick mentioned the work Paul Schomer did on the Hermit, but also on the Widforss trail. That data is still being processed. It will be published in Acoustical Society of America. Dick can provide the title and author. Schomer et al. 2014. Captured other sounds on the North Rim because of the trails proximity to other areas. Focused on GRCA

Two other data sets: Post doc at Colorado State University Daniel Mennitt did a GIS sound map with all sorts of values to model it. He can create a continental scale sound map, working on getting it published if it hasn't already. Not sure how it works in GRCA where the terrain is so extreme

Off the shelf products with caveat are still helpful. We are looking at a 5 million acre analysis area so coarse scale maps may be appropriate

Other parks have plans with targets. Are the targets consistent across parks?

Uranium mining EA did a soundscape assessment for the different locations. Don't know where that data came from and if it might be helpful. They did viewscape too.

USFS hasn't heard any talk about sound issues.

Damon: Survey on visitor experience re: sound. FAA and VOLPE Draft report is out. It notes the difference in perceived level and sources of sound. Includes backcountry perceptions. Includes annoyance level (minor, moderate and severe)

Visitation in the forest, the ORV noise is an issue. I don't know if it's being measured at all, but it's been an annoyance on the Rainbow Rim or other roads on the forest. Potential audibility would be interesting

A volunteer crew on sound data would be ideal.

Inner canyon; you can definitely hear motor vehicle travel on the South Rim, primarily an issue at night.

Soundscape monitoring equipment managed on the Parachaunt. Peter will get in touch with Todd.

VII. Daytime Viewshed

Jill Rundall showed some draft viewshed analysis maps: This represents what you can see on the North Rim and the South Rim. Viewshed analysis doesn't include height of trees and observation point. It's based on elevation. But we can refine it. Can also identify areas outside the park where future development is permitted and have some sense of what might be areas of future potential.

Q: Where are the high use areas/viewpoints? Are there places that are important for a variety of reasons that we want to make sure lines of view are preserved?

Q: Where do you want those observation points to be? You can have many and do different types of analysis. Ideas welcome now or down the line.

- You can do the reverse too. Here's something (like the light on the watchtower), where can it be seen from?

- Places where people watch the sunset
- Might be good to represent different management zones. Areas in Western Grand Canyon with low use but most wilderness-like part of the park. In terms of viewscape, it could be really important. Try to pick a variety of places.
- Visibility of airways as well as road ways. You have visibility of air traffic too

Q: What about air quality?

- We have some air quality data.
- It's a pretty broad brush to apply but we have it.
- Regional and local; managed wildfires/burns too

VIII. Wrap Up Conversation

Q: Are there any glaring omissions? Lots can be considered under visitor experience or wilderness.

- Not sure it's a glaring omission, but going back to use levels, we have really good data on overnight, but we have limited information on day use. Important to address the nodes of day use; Deer Creek, other places on the river and on the rim. You might be able to correlate impacts with use. Would need to make assumptions about places that are also popular overnight.
- It's sort of like a category of attraction sites. Are there other categories besides attractions along the river?
- People from the rim going down for the day, people from the river going to Horseshoe Mesa, we do have some limited data. It's an indicator.
- Through CRMP would like to develop an attraction site data layer

Q: Is there integration of info on backpacker vs. river users in attraction areas? There is some conflict but they are tracked and managed in different frameworks

A: For some places it's been tracked through monitoring. Looking at it seasonally might help. There are areas that are day hike for river users but overnight backpacker area. There are lines of people looking at granaries in Nankoweep or sitting around Thunder River.

- We wouldn't have that in those locations, but would in some other places.
- They're different uses but need to be integrated.
- Doing some analysis of CRMP monitoring. Sites that were backpacker accessible had higher levels of resource impacts. We're not constrained by management plans to represent these things, we could look at the overlaps even at attraction sites and ID zones of overlap where there are higher use levels than we recognize in our permitting system. Gives a better sense of the actual use.

Q: Are there additional stock use beyond the corridors?

A: Good point. This was identified as a stressor during first workshop. We know where they are and are not permitted, can be represented.

Is there internal park use too? Should be incorporated.

For use, it would be interesting to just overlay everything. What's accessible by all the different means; hiking, river, stock, runners. May not have the numbers to ID if they are conflicting, but IDing potential conflict areas would be valuable.

Also, where a lot of evacuations occur, where medical needs. That is something that affects other users.

99% of it is corridor, maps light up with use areas

Toilets are all sling loaded out now.

What about mountain bikes?

Amplified music sources? Phones. Way more annoying than headlamps at night.

Something that's gone under the radar that we're shocked at was Hualapai exempt air tours (250,000 per use). Not sure sound is being monitored. Sierra Club requested FAA and GRCA to share what they know, but 8 years with an explosion of noise out on the west end. What level has it reached?

- We have some on the ground survey data
- Would be good to at least get a trend

Closing

Thanks for participating, has been very helpful for those working closely on GGCLA.

Hope that participation will lead to ownership and confidence in end product.

From a management point of view, hope to have the information on hand to be able to manage proactively.

A lot of assessment work is ongoing. We have preliminary models done for some wildlife resources. Many moving pieces. Its hard to coordinate and keep things all moving forward at the pace consistent with expectations, but happy with how things are shaping up.

There will be a second full stakeholder workshop in the beginning of June and intention is to present preliminary products and assessment of resources, with participation. Idea that stakeholders identify priority areas.

Goal to have analyses completed by late fall and hold a final workshop in the fall, all the while putting together a report.

For anyone interested in engaging in more depth and lend your expertise, please follow- up, and we'll be following up with a number of you, too.

It's an open process, feel free to contact core folks if you want to provide ideas or get more information.

The meeting adjourned at 4:45PM.

Greater Grand Canyon Landscape Assessment (GGCLA)
Visitor Experience Resources Technical Workgroup Initial Meeting Outline
Wednesday, March 5, 2014

Objectives and expectations

The Technical Workgroup will help to identify appropriate condition indicators, compile and evaluate data/information sources, develop assessment criteria and methods, and assess the conditions and trends of focal resources within its respective discipline. The workgroup will be facilitated by GRCA/NAU staff and will include other subject matter experts (SMEs) and stakeholder representatives, depending upon interest and availability. Participants will be expected to actively engage in the workgroup, including providing sound technical guidance, doing 'homework' in preparation for meetings, and helping to develop work products (e.g. literature reviews, spatial layers, condition assessments, etc.). Subsequent meetings (incl. conference calls/webinars) will be determined on an as needed basis. Specific objectives for the initial meeting include the following:

- Refine scope of assessment for focal resources (e.g. fine-/coarse-filter, ecosystemic-/taxonomic-level).
- Identify and assess preliminary condition indicators and reference/desired conditions.
- Identify and assess known/potential threats.
- Identify appropriate spatiotemporal scale(s) of analysis.
- Develop condition assessment criteria (e.g. indicator ranges/thresholds) and analytical approach (e.g. quantitative/qualitative score, spatial modeling).
- Identify and assess information/data needs, sources, and gaps.
- Identify specific tasks, products, roles, responsibilities, and timelines.

Focal resource(s)

Focal resources were identified based on input from participants during the GGCLA Workshop on October, 11th, 2012 and subsequent discussions amongst GRCA and NAU staff. Desired condition statements, indicators, reference conditions, and targets are from the 'Draft Grand Canyon National Park Desired Conditions' (2012) and references therein. *Denotes NPS Southern Colorado Plateau Network Vital Signs and Measures in the following tables as outlined in Thomas et al. 2006. TBD- To be determined based on GRCA and/or other relevant data sources (incl. workgroup products). Spatial and tabular datasets include those developed or acquired by GRCA.

Data table color codes are as follows:

Documented	In Development	Not Documented	Not Evaluated	To be Developed

Research studies listed include relevant permitted research conducted in GRCA since 1958. Research results (e.g. reports, publications, datasets) are not necessarily readily available for all those listed.

Recreational Resources

Desired Condition: Provide a diverse range of quality recreation opportunities; establish levels of use that enhance visitor experience by minimizing crowding, conflicts, and resource impacts; determine appropriate types of us e that will not unacceptably impact visitor experience, biophysical, or cultural resources; preserve opportunities that are appropriate and consistent with the preservation of wilderness character.

Indicator	*Reference Condition*	*Target*
Overnight use levels in backcountry and wilderness zones	Visitor Study (Underhill 1986) Backcountry MP (NPS 1988) Visitor Study (Backlund 2008)	Levels consistent with resource protection standards.
Day use levels in backcountry and wilderness zones	Visitor Study (Underhill 1986) Visitor Study (Backlund 2008)	Levels consistent with resource protection standards.
Numbers and types of recreational activities in backcountry & wilderness zones	Backcountry MP (NPS 1988) Final Wilderness Rec. (NPS 1980)	Maintain or enhance appropriate with wilderness values
Number and type of recreational facilities (toilets, etc.) in wilderness zones	Backcountry MP (NPS 1988) Final Wilderness Rec. (NPS 1980) BC Toilet Maint EA/FONSI (NPS 2003) Visitor Study (Backlund 2008)	Minimum required
Impacts to natural and cultural resources from visitor use (LAC for each management zone)	Backcountry MP (NPS 1988) Resource MP (NPS 1997) Rapid Site Assessment (Foti, 2006) Visitor Study (Backlund 2008)	Will vary by management zone: Overall, reduce impacts and preserve and maintain integrity of resources
Number of encounters with overnight users (at campsites & while hiking) – varies by zone	Visitor Study (Underhill 1986) Backcountry MP (NPS 1988) Visitor Study (Stewart 1997) Visitor Study (Backlund 2008)	Reduce encounters at campsites (designated vs. at-large) – Increase opportunities for solitude
Visitor satisfaction w/ management actions	Visitor Study (Underhill 1986) Visitor Study (Backlund 2008)	Maintain or enhance

Wilderness

Desired Condition: Grand Canyon National Park's proposed wilderness areas retain their wilderness characteristics and values. Visitors find ample opportunities for primitive recreation and opportunities for solitude. Wilderness areas are affected primarily by the forces of nature, and signs of people remain substantially unnoticeable. Backcountry visitors' valu e and support wilderness preservation.

Indicator	*Reference Condition*	*Target*
Number of authorized or unauthorized treatment or action that manipulates wilderness	Wilderness Rec. (NPS 1980) General Management Plan (NPS 1995) Resource Mgmt Plan (NPS 1997) Fire Management Plan (NPS 2009) Invasive Plant MP (NPS 2009)	Authorized treatments reduced by 50% annually Eliminate unauthorized treatments
See natural/physical indicators: Number of species of concern, non-native species, visibility, ozone, water quality, etc	See appropriate sections	See appropriate sections
Number & type of non-recreational facilities – repeaters, scientific equipment; Number/type of administrative mechanization (w/ MRA)	Final Wilderness Rec. (NPS 1980) Backcountry MP (NPS 1988) CRMP (NPS 2006)	No facilities or equipment in wilderness zones unless deemed the minimum requirement
See recreation + Visitor management restrictions Climbing hardware	Final Wilderness Rec. (NPS 1980) Backcountry MP (NPS 1988) CRMP (NPS 2006) 36CFR 2.12	Minimum required to retain wilderness character

Viewscape

Desired Condition: Natural visibility conditions are maintained or enhanced in the park and scenic views of the landscape are not impaired by human activities.

Indicator	*Reference Condition*	*Target*
Deciview Index	Deciview index average of 6 on the 20% most impaired days	Deciview index ≤ 12 on the 20% least impaired days

Dark Night Skies

Desired Condition: Dark sky resources are enhanced in the park and nighttime views of the night sky are not impaired the nocturnal phototopic environment is within the range of natural variability.

Indicator	*Reference Condition*	*Target*
Sky luminance, , ratio of anthropogenic to natural	TBD	TBD
Illuminance from city light domes	TBD	TBD
Illuminance of entire sky, ratio of anthropogenic to natural	TBD	TBD
Vertical illuminance from light trespass	TBD	TBD
Visual observations: Bortel Class	TBD	TBD
Sky quality meter	TBD	TBD

Soundscape

Desired Condition: Visitors have opportunities throughout Grand Canyon National Park to experience natural sounds. The sounds of civilization are generally confined to developed areas and noise from air tours and commercial overflights restricted to flight corridors. Soundscapes are maintained to allow tribal songscapes to persist. ^Denotes indicators as recommended by D. Hingson with the Sierra Club.

Indicator	*Reference Condition*	*Target*
% time audible (see Overflights)	GRCA Overflights EIS (NPS 2012)	By 20?? X% of the park is noise free for greater than X% of the day
Number of man-made noise disturbances by backcountry use area (does not include air tours)	As above	0 daily in 90% of Wild Use Areas ? daily in % of Primitive U A ? daily in % of Threshold U A ? daily in % of Corridor U A
Number of man-made noise disturbances by backcountry use area (does include air tours or all aircraft)^	As above	0 daily in 90% of Wild Use Areas ? daily in % of Primitive U A ? daily in % of Threshold U A ? daily in % of Corridor U A
Number of commercial air tours by flight corridor (or all aircraft)	As above	0 daily over Wild Use Areas ? daily over Primitive U A ? daily over Threshold U A ? daily over Corridor U A
Lmax^	As above	TBD
Leq (daytime)^	As above	TBD
Noise free interval (day)^	As above	TBD
Number of events above 35 dBA/hour^	As above	TBD

GRCA Visitor Experience GIS Summary: Recreation Resources, Wilderness, Viewscape, Dark Night Skies, Soundscape

Data Theme	*Data Type*	*Content Description*	*Source*	*Time Period*	*Spatial Extent*	*Status*	*Appropriate Uses*	*Limitations*	*Data Methods*	*Use Cost*
Backcountry Management Plan.gdb	GIS (Vector)	Backcountry Use Areas, Management Zones, Campgrounds, Campsites, Toilets, Rapid Site Inventory	GRCA	last updated November 2013	GRCA	Documented	Backcountry use patterns, statistics, impacts, management	Rapid Site Inventory covers only a selected subset of campsites	multiple	minimal for spatial data; potentially significant to cross-walk with use data
CRMP.gdb	GIS (Vector)	River Campsite Boundaries	GRCA	2007-2011	GRCA River Corridor	Documented			high-res orthoimagery (18-cm)	minimal
Cultural Resource Sites	GIS (Vector)	Cultural Resource Sites	GRCA	last updated January 2014	GRCA	Documented	identify potential "attraction sties", potential impacts from visitor use, restricted areas	only a small portion of GRCA lands have been surveyed	GPS, NAIP and high-res imagery	minimal
Transportation.gdb	GIS (Vector)	Roads, Trails, Routes, Historic Routes, 3rd party Routes	GRCA	last updated February 2014	GRCA and some adjacent lands	Documented	access, attractions	not all 3rd party routes are digital	multiple	moderate to digitize additional 3rd party route networks
Seeps Springs	GIS (Vector)	Seeps and Springs	GRCA, Southwest Springs Institute, USGS-NHD	last updated January 2014	GRCA and some adjacent lands	Documented	backcountry water sources, potential impacts, potential attractions	large areas of GRCA remain unsurveyed	multiple	minimal
National Hydrography Dataset	GIS (Vector)	Water features	USGS	last updated October 2013	GGCLA analysis area	Documented	potential "attractions", backcountry water sources, recreation		multiple	minimal
Overflights.gdb	GIS (Vector)	Flight Routes, Flight-Free Zones	GRCA	last updated January 2011	GRCA	Documented	access for some visitors, noise impacts		on-screen digitized from USGS 24K quad map DRG's	correlation with Sound monitoring data and/or sound models could be significant
Proposed Wilderness	GIS (Vector)	Proposed Wilderness	GRCA	2010	GRCA	Documented	visitor use depends on wilderness status		vertical integration	minimal
Caves.gdb	GIS (Vector)	Cave Entrances	GRCA	2014	GRCA	In development	restricted access	only a small portion of GRCA lands have been surveyed	multiple	minimal

GRCA Visitor Experience Resources Database Summary

Data Theme	Data Type	Content Description	Source	Time Period	Spatial Extent	Appropriate Uses	Limitations	Data Methods	Use Cost
FAA Operations Data Noise Modeling	Spatial	Noise model created from tabular FAA operations data. Operations data (tabular) is flight information reported to the FAA by aircraft operators.	NPS Natural Sounds Program	2010 - 2012	Greater Grand Canyon Area	Examine spatial patterns and relationships of aircraft noise.	Model based on self-reported data by aircraft operators.	Currently unknown to GRCA staff	Unknown
Sound data	Tabular	Sound recordings in the Fossil Canyon general aviation corridor were taken over a period of time. Data from November 2006 to October 2007 were converted into spectrograms to count aircraft fly overs.	Jane Rodgers GRCA	2007?	One location in Fossil Canyon general aviation corridor	Quantify noise pollution levels at this location. Examine temporal noise pollution patterns.	Only one location was used for recording. Data quantity is massive.	Sound Pressure Level data were converted to spectrograms. Spectrogram signatures were identified to indicate sound source (e.g., insects, propeller planes, jets…)	High cost. Very high data storage cost and data processing time.
Night Sky Light Inventory	Tabular	Contains inventory and descriptive information for lighting in the developed areas of Park.	Deanna Greco GRCA	2013 - present	Developed areas on rim and river corridor	Identify areas with/without potential human produced light pollution.	Inventory effort has only been recently initiated.	Entries contain detailed information on lighting including location inventoried, lighting purpose, fixture type, bulb type, bulb wattage, number of bulbs per fixture and number of fixtures. Light meter readings (lux) are also recorded at night when possible.	Simple to associate data with spatial data in cases where spatial data have been digitized.
Visitor Experience Survey	Tabular	The goals of the survey are to measure quality of current visitor's experience, visitor attitudes, visitor preference and visitor expectations.	Peter Pettengill GRCA	2013	Trailheads of Bright Angel, South Kaibab and North Kaibab trails	Measure quality of experience. Examine any possible locational patterns in data.	No trend analysis.	Visitors were approached at trailheads and asked if they would voluntarily complete the paper survey.	Moderate cost due to initial data entry in Excel.
Backcountry Permitting Data	Tabular	Permitting data recording number of people, date(s) and location(s).	Steve Sullivan GRCA	?	Park-wide	Examine spatial and temporal patterns of visitor use in the backcountry.	Visitors provide itinerary and only opportunistic verification via backcountry ranger encounters.	Permit applications provide itinerary information.	Unknown

GRCA Permitted Research – Visitor Experience: Recreation

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Albrecht	Don		Texas A&M University	12/01/1990 - 12/01/1991	A study of perceptions, expectations, and satisfaction levels of visitors to Grand Canyon National Park	GRCA Library # G155 .U6 A42 1992 c.1-2. IRMA Ref # 2167736. 83 pgs.
Andrews	Edmund		USGS	02/28/1996 - 06/01/1997	Deposition rate and topographic evolution of sand bars in lateral separation eddies during high flows.	Deliverable might be located at GCMRC Library. IRMA Ref # 165224.
Avery	Valeen		Center for Colorado Plateau Studies	01/01/1987 - 12/31/1995	The Effect of Fluctuating Flows from Glen Canyon Dam on Wintering Bald Eagles and Spawning Rainbow Trout at Nankoweap Creek in Grand Canyon National Park	IRMA Ref # 37075, 165026.
Begay	Tim	GRCA-00199	Navajo Nation	08/01/2012 - 08/01/2013	2012 Navajo Nation Annual Glen Canyon Adaptive Management Program Consultation River Trip	Ongoing project. No final report received.
Bennett	Jeffery		GCES/NAU	01/01/1993 - 12/31/1995	Investigation of the influence of biogeochemical processes occurring within the beaches on nutrient spiraling	IRMA Ref # 2167497.
Blinn	Dean	GRCA-00045	NAU	03/09/1998 - 12/31/2000	Factors influencing benthic standing biomass in the Colorado River: Light, drift and velocity.	No final report received.
Block	Kenneth		University of Idaho Cooperative Park Studies	07/29/1999 - 12/31/1999	1999 Visitor Survey Card	GRCA Library # F788 .V571 1998. IRMA Ref # 2167786. 4 pgs.
Brickler	Stanley		UA	01/01/1980 - 12/31/1984	Water Quality Monitoring and Assessment in the Colorado River Corridor, Grand Canyon National Park	“Recreational water quality analyses of the Colorado River corridor in Grand Canyon” by Brock Tunnicliff and Stanley K Brickler in Applied and Environmental Microbiology: 1984 November; 48(5): 909-917. IRMA Ref # 165105.
Brown	Mathieu	GRCA-00297	Prescott College	10/30/2011 - 11/20/2011	Repeat Study of Recreation Impacts to Campsites on the Colorado River in Grand Canyon National Park	Partial report submitted. See Ronda for details.
Brown	Bryan		UA	12/04/1987 - 12/03/1988	Monitoring the Ecology and Natural History of Wintering Bald Eagles at Nankoweap Creek, Grand Canyon	GRCA Library # QL696.F32 B76 1989; QL684 .A6 B6875 1988. IRMA Ref # 79504, 650763.
Carothers	Steven		MNA	01/01/1981 - 12/31/1981	Recreational Impacts on Riverine Habitats in Glen Canyon National Recreation Area, Arizona	Draft final report included. Carothers SW and Others. 1981. Recreational impacts on riverine habitats in Glen Canyon National Recreational Area, Arizona. [No Publisher]. Published Report-102344. IRMA Ref # 102344.

GRCA Permitted Research – Visitor Experience: Recreation

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Carothers	Steven		MNA	01/01/1977 - 12/31/1979	Colorado River Resource Monitoring Project	Final report, river resource monitoring project-vegetation studies, Grand Canyon National Park. Part 1 / prepared by L.T. Green, Arthur M. Phillips, Jill Mazzoni ; submitted by Steven W. Carothers ; submitted to R. Roy Johnson. GRCA Library # QK147 .C377 1979. IRMA Ref # 108175.
Cole	David		Systems for Environmental Management	01/01/1982 - 12/31/1984	Ecological Impacts on Backcountry Campsites in Grand Canyon National Park	Cole DN. 1985. Ecological impacts on backcountry campsites in Grand Canyon National Park. Systems for Environmental Management. Missoula, MT. Cooperative Agreement No. CA8000-4-0001. Published Report-35821. GRCA Library # QH105 .A75 C65 1990. GRCA MC # GRCA 68624. IRMA Ref # 35821. 105 pgs.
Daniel	Terry		UA	07/13/1998 - 12/31/1999	Intelligent Agent Model for Simulating and Evaluating River Raft Scheduling Scenarios for the Grand Canyon National Park	GRCA Library # F788 .G56 I58 2001.
Fairley	Helen	GRCA-00262	GCMRC	06/01/2005 - 12/31/2005	Protocol Evaluation Panel Review of the Grand Canyon Monitoring and Research Center's Recreation Monitoring Program	Check GCMRC library. 928-556-7285
Gaither	Marlene	GRCA-00194	UofA, Coconino County	07/01/2003 - 07/31/2005	Occurrence and Control of Emerging Water Borne Pathogens in the State of Arizona	Wilderness & Environmental Medicine 20(1):6-13. 2009 doi: 10.1580/06-WEME-OR-43.1.
Greco	Deanna	GRCA-00590	GRCA	10/01/2012 - 12/31/2014	Granite Camp-Monument Creek Pilot Stewardship Project	Current study.
Hall	Troy		Virginia Polytechnic Institute	05/15/1998 - 12/31/2000	Indicators and Standards of river Trip Experience Quality in the Grand Canyon: A Replication and Extension	GRCA Library # F788 .H355 2000 Oversize. 1998 Colorado River boater study, Grand Canyon National Park / Troy Hall. IRMA Ref # 2170007. 194 pgs.
Hallo	Jeffrey	GRCA-00605	Clemson University	07/18/2012 - 12/01/2012	Informing principles of good lighting practices and high quality outdoor night recreation in U.S. National Parks: Visitors' perceptions, management practices, and policies	No final report received.
Hjerpe	Evan	GRCA-00148	NAU	04/01/2002 - 12/31/2003	Regional Economic Impacts of Grand Canyon River Runners	Cline Library # GV780.52.A6 H547 2003. GRCA Library # GV780.52 .A6 H547 2003 c.1-2. IRMA Ref # 2170017. 52 pgs.
Jalbert	Linda		GRCA	06/27/2000 - 12/31/2001	The effects of the LSSF on Whitewater Boating Safety on the Colorado River through Grand Canyon National Park	No final report received.

GRCA Permitted Research – Visitor Experience: Recreation

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Jalbert	Linda		GRCA	01/01/1996 - 12/31/1996	The Effects of the 1996 Beach/Habitat Building Flows on Observed and Reported Boating Accidents on the Colorado River in GRCA	No final report received.
Jalbert	Linda		GRCA	01/01/1992 - 12/31/1992	The Influence of Discharge on Recreational Values Including Crowding and Congestion and Safety in GRCA	IRMA Ref # 627994.
Johnson	Rebecca		Oregon State University	08/04/1999 - 12/31/2000	The effect of Fee Demonstration Program on backcountry users in selected national parks.	No final report received.
Jonas	Lilian	GRCA-00126	Jonas Consulting	07/01/2001 - 12/31/2002	Capturing the Grand Canyon River Experience	Historic profile of Colorado River users : an overview and integration of existing data / submitted by Lilian M. Jonas. GRCA Library # F788 .J663 2002. IRMA Ref # 2170039. 31 pgs.
Kaplinski	Matthew	GRCA-00321, GRCA-00129	NAU	02/19/2012 - 03/31/2013	Long-Term Monitoring of High-Elevation Campsites and Sandbar Morphology throughout the Colorado River Ecosystem	Many interim reports. Current study.
Karls	William		University of New Mexico	01/01/1986 - 12/31/1986	Benefits of a wilderness experience on measured stress levels in humans	No final report received.
Kearsley	Lisa		GCES	01/01/1996 - 12/31/1997	Effects of a beach/habitat building flow on campsites in the Grand Canyon	Library stacks: Government Documents: Applied Technology Associates. Glen Canyon Environmental Studies. 2 copies. IRMA Ref # 558177.
Kimberling	Diana		GRCA	01/01/1994 - 12/31/1995	Genetic Comparisons among Isolated Populations of *Rana Pipiens* in Arizona	Re-Analysis of Genetic Structure among Populations of Rana pipiens in Arizona and Utah Mark P. Miller, Diana N. Kimberling and Paul Keim The Southwestern Naturalist, Vol. 44, No. 4 (Dec., 1999), pp. 527-530.
Larralde	Signa		BOR/PA	03/20/1996 - 01/01/1997	FY96 Experimental Flood Flow cultural resources monitoring proposal, FY96 experimental flow cultural resources mitigation proposal	Glen Canyon National Recreation Area : FY97 Grand Canyon Monitoring and Research Center (GCMRC) monitoring of archaeological sites from Glen Canyon Dam to the Paria River Riffle / Tim W. Burchett. GRCA Library # CC76.3 .B87 1997. 53 pgs.
Lime	David		Cooperative Park Studies Unit/University of Minnesota	06/22/1999 - 12/31/1999	Monitoring Public Relations to the Recreational Fee Demonstration Program in the National Park System.	Cline Library e-Resource: "Trends in outdoor recreation, leisure, and tourism"
Manning	Robert		University of Vermont	08/28/1996 - 12/31/1999	Characterize Day-Use Hikers in GRCA, Develop Indicators of Quality, Support Benefits-Based Management, and Study Attitudes.	GRCA Library # F788 .S74 2000 c.1-2. IRMA Ref # 558371.

GRCA Permitted Research – Visitor Experience: Recreation

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Manning	Robert		University of Vermont	01/01/1982 - 12/31/1984	Management and Monitoring River Recreation: A State-of-the-Art Review	"Studies in outdoor recreation: search and research for satisfaction" By Robert E. Manning. GRCA Library # GV191.6 .M314 1986. GRCA MC GRCA 58388. IRMA Ref # 114222.
McBride	Earle	GRCA-00099	University of Texas	06/01/2001 - 12/31/2002	Downstream Changes in Mineralogy of Sand Beaches (Bars) of the Colorado River in a Part of Grand Canyon National Park and Glen Canyon National Recreation Area	GRCA Library # GB566 .C65 M33 2003. IRMA Ref # 2170195.
Meretsky	Vicky	GRCA-00294, GRCA-00066	Indiana University	05/25/2006 - 07/30/2007	Short- and long-term variability in vegetation patterns at seeps and springs.	GRCA Library Call # QH102 .A75 2008 "Aridland springs in North America: ecology and conservation" edited by Lawrence E. Stevens and Vicky J. Meretsky ; with a foreword by Gary Paul Nabhan. IRMA Ref # 664016.
Mink	Philip	GRCA-00242	University of Kentucky	06/15/2004 - 12/31/2005	Testing the effectiveness of ground penetrating radar and non-site archaeology for reconstructing cultural landscapes in the Grand Canyon region, northern Arizona	Might be: "Identifying at-risk heritage resources with GIS: modelling the impact of recreational activities on the archaeological record" by Patrick M. Uphus, Alan P. Sullivan III, Philip B. Mink II in International journal of Risk Assessment and Management V. 6 Number 4-6/2006 p. 330-343. Contact Philip.mink@uky.edu.
Neal	Lynn		SWCA, Inc.	10/13/1998 - 12/31/1998	A cultural resource data synthesis	GRCA Library # F788 .C8588 2000. GRCA MC # GRCA 79059. IRMA Ref # 628105.
O'Brien	Gary		Grand Canyon River Guides, Inc.	05/13/1999 - 12/31/2000	Adopt-A-Beach Program	GRCA Library # TC175.2.O27 E44 2000, TC175.2 .O27 E44 1999 c.1-2. IRMA Ref # 2170241.
Parnell	Rod		NAU/GCES	01/25/1996 - 09/30/1997	A proposal to continue monitoring of sand bars along the Colorado River	GRCA Library # TC175.2 .K37 1998. IRMA Ref # 2168906.
Persons	William	GRCA-00520	GCMRC	04/02/2012 - 04/02/2013	Collaborative Fish Monitoring Plan	Many interim reports. Current study. IRMA Ref # 2170840.
Persons	William		Arizona Game and Fish Department	05/15/1998 - 12/31/1999	Monitoring the Rainbow Trout Fishery of the Colorado River Ecosystem from Glen Canyon to Lees Ferry	GRCA Library # SH167 .R34 M35 1999. "Rainbow Trout and Lower Trophic Levels in the Lee's Ferry Tailwater Below Glen Canyon Dam, Arizona: A Review." 53 pgs. IRMA Ref # 558163, 2170264, 558366.
Ralston	Barbara	GRCA-00182	GCMRC	04/01/2003 - 07/31/2005	Alliance-level Vegetation Inventory Map of the Colorado River Ecosystem	Maybe in SCRE report: GRCA 87632 or might be QH541.5 .R52 R35 2007 (Vegetation Database) or might be GCMRC library. GRCA MC # GRCA 87632.
Richards	Merton		NAU	05/01/1987 - 09/01/1988	Impact of Pandora Moth Defoliation on Recreation Values in Grand Canyon National Park, Arizona	No final report received.

GRCA Permitted Research – Visitor Experience: Recreation

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Roberts	Catherine	GRCA-00072	NAU	09/25/1998 - 12/31/2003	Intelligent agent model for simulating and evaluating river raft scheduling scenarios for the GRCA	Cline Library # F788.E8358 2000. “Evaluation of river beach carrying capacity information utilized by the Grand Canyon River Trip Simulator: analysis and recommendations for future study” by Gary O’Brien.
Schmidt	John		Middlebury College	01/01/1988 - 12/31/1989	Topographic Changes of Alluvial Sand Bars, Lees Ferry to Bright Angel Creek, Colorado River, GRCA	Cline Library # GB595.A6 S345 1988. IRMA Ref # 126320.
Stewart	William		University of Illinois, GCMRC	04/02/1998 - 12/31/1999	A recreational opportunity spectrum for the Colorado River ecosystem in Grand Canyon.	GRCA Library # F788 .S74 2000 c.1-2. IRMA Ref # 558371. 67 pgs.
Stewart	William		Texas A&M	01/01/1994 - 12/31/1994	Bright Angel Day-use Questionnaire	GRCA Library # GV199.42 .A72 G8 S749 1997.
Stewart	William		Texas A&M	11/26/1993 - 06/30/1995	On-site Wilderness Recreation Experience	GRCA Library # F788 .S74 2000 c.1-2.
Thomas	Kathryn		USGS	07/24/1997 - 12/31/1997	Arizona Gap Analysis Program: Accuracy Assessment of Vegetation Data	Cline Library # GA108.7 .J336 1999 [Sarah Jacobs Thesis]. GRCA Library # GA145 .T46 2000. IRMA Ref # 558372.
Tunnicliff	Brock		UA	01/01/1982 - 12/31/1984	Drinking Water Treatment and Procedures for the Colorado River Corridor	Appl Environ Microbiol. 1984 November; 48(5): 909-917. GRCA MC # GRCA 68638. IRMA Ref # 34721.
Warme	John	GRCA-00236	Colorado School of Mines	06/15/2004 - 12/30/2006	Newly Discovered Ancient and Unusual Catastrophic Lanslide- Deer Creek Area in Grand Canyon National Park	"Sand Source Rocks and Downstream Changes in Mineralogy of Sand Beaches (Bars) of the Colorado River in a Part of Grand Canyon National Park and Glen Canyon National Recreation Area" by Earle McBride and John Warme, 2007. 22 pg. IRMA Ref # 2170195.
Webb	Robert	GRCA-00111	USGS Water Resources Division	08/01/2001 - 12/31/2006	Long-term monitoring of coarse-grained sediment input, storage, and impacts to physical habitats throughout the main channel of the Colorado River Ecosystem.	IRMA Ref # 657488, 2170544.
Webb	Robert		USGS	01/01/1994 - 12/31/1994	Old Timers Trip	Observations of environmental change in Grand Canyon: a report on the old timers trip, September 1994 by Robert H. Webb and Theodore S. Melis. GRCA Library # GB701 .W375 1995.

GRCA Permitted Research – Visitor Experience: Wilderness

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Greco	Deanna	GRCA-00590	GRCA	10/01/2012 - 12/31/2014	Granite Camp-Monument Creek Pilot Stewardship Project	Current study.
Mathers	Alex	GRCA-00607	Cambridge	08/20/2012 - 12/01/2012	The construction and perception of the aesthetics of wilderness in American national parks	No final report received.
Brennan	Ellen	GRCA-00143	GRCA	02/23/2012 - 02/23/2014	Research and Collection of Cultural, Historical, Archaeological, and Related Physical Specimens within Grand Canyon National Park	Current study.
Gaither	Marlene	GRCA-00194	University of Arizona, Coconino County	07/01/2003 - 07/31/2005	Occurrence and Control of Emerging Water Borne Pathogens in the State of Arizona	No final report received.
Popp	Carl	GRCA-00125	New Mexico Institute of Mining and Technology	07/01/2001 - 12/31/2003	Western States Visibility Assessment Program: Visibility and Economic Impact Modeling Based on Source Identification of Energy-Related Pollution Affecting Visibility in Selected Protected Visual Environments	No final report received.
Pollock	Michael		10,000 Years Institute; SW Forest Alliance	11/10/1997 - 12/31/1998	Proposal to Assess the Spatial and Temporal Age Structure and Physical Characteristics of Old-Growth Ponderosa Pine Forests in the American Southwest	No final report received.
Manning	Robert		University of Vermont	08/28/1996 - 12/31/1999	Characterize Day-Use Hikers in GRCA, Develop Indicators of Quality, Support Benefits-Based Management, and Study Attitudes	GRCA Library Call # F788 .S74 2000 c.1-2. GRCA MC # 558371.
Stewart	WIlliam		Texas A&M	11/26/1993 - 06/30/1995	On-site Wilderness Recreation Experience	GRCA Library Call # F788 .S74 2000 c.1-2.
Glass	Stephen		Wilderness Studies Institute	03/01/1989 - 04/30/1989	Archaeological Surface Survey and Photographic Inventory of Lower Granite Gorge, Grand Canyon National Park	GRCA Library Call # CC95 .G53 1989.
Karls	William		University of New Mexico	01/01/1986 - 12/31/1986	Benefits of a wilderness experience on measured stress levels in humans	No final report received.
Dickman	Dan		NAU	01/01/1978 - 12/31/1978	The Wilderness Experience in Grand Canyon	No final report received.

GRCA Permitted Research – Visitor Experience: Dark Night Skies

PI Last Name	*PI First Name*	*Study #*	*Affiliation*	*Study Length*	*Title*	*Data Availability*
Henry	Ronald		University of Southern California	07/01/1988 - 08/19/1988	Quantification of Human Perception of Visibility	R. C. Henry, S. Mahadev, S. Urquijo, and D. Chitwood, "Color perception through atmospheric haze," J. Opt. Soc. Am. A 17, 831-835 (2000)
Hallo	Jeffrey	GRCA-00605	Clemson University	07/18/2012 - 12/01/2012	Informing principles of good lighting practices and high quality outdoor night recreation in U.S. National Parks: Visitors' perceptions, management practices, and policies	See Ronda for report.

GRCA Permitted Research – Visitor Experience: Dark Night Skies

PI Last Name	*PI First Name*	*Study #*	*Affiliation*	*Study Length*	*Title*	*Data Availability*
Aube	Martin				Evaluating Potential Spectral Impacts of Various Artificial Lights on Melatonin Suppression, Photosynthesis, and Star Visibility	Aube´ M, Roby J, Kocifaj M (2013) Evaluating Potential Spectral Impacts of Various Artificial Lights on Melatonin Suppression, Photosynthesis, and Star Visibility. PLoS ONE 8(7): e67798. doi:10.1371/journal.pone.0067798. See Ronda for report.
NPS	Night Sky Team		NPS	06/29/2008	NPS Night Sky North Rim Quality Monitoring Report	See Ronda for report.
NPS	Night Sky Team		NPS	10/01/2007	NPS Night Sky South Rim Quality Monitoring Report	See Ronda for report.
			International Dark Sky Association	05/04/2010	Visibility, Environmental, and Astronomical Issues Associated with Blue-Rich White Outdoor Lighting	See Ronda for report.
Mace	Britton		Southern Utah University	2013	Visitor Evaluation of Night Sky Interpretation in BRCA and CEBR	See Ronda for report.
Smith	Brandi		Clemson University	07/2011	2011 Survey on NPS Use and Status of Night Resources Final Report	See Ronda for report.

GRCA Permitted Research – Visitor Experience: Soundscape

PI Last Name	*PI First Name*	*Study #*	*Affiliations*	*Study Length*	*Title*	*Data Availability*
Rodgers	Jane	GRCA-00585	GRCA	07/10/2010 - 12/31/2012	Soundscape Monitoring	See Ronda for final report.
Lee	Cynthia	GRCA-00563	Volpe Center	04/01/2011 - 04/01/2012	Human Response to Aviation Noise: Source Recordings	Preliminary report is final report without other 3 parks (same study was conducted at 4 NPs). PI expects to have final report in by Jan 2014. GRCA Library Call # TD893.6.A57 R37 2012
McMullen	Ken	GRCA-00246	GRCA	08/01/2004 - 09/30/2008	Soundscape and Noise Monitoring in Grand Canyon National Park	"Characterizing Grand Canyon Sounds" by Sarah Falzarano (2006) Geospatial Solutions 16(1):46.
Hale	Thomas	GRCA-00054	GRCA	08/27/1999 - 12/31/2000	Aircraft Noise Validation Study	No final report received.
Plante	Jake		Federal Aviation Administration	07/06/1998 - 12/31/1999	Dose response study for commercial air tour overflights in the National Parks	No final report received.
Harris, Miller, Miller and Hansen			Harris, Miller, Miller and Hansen	05/15/1994 - 05/31/1999	Acoustical and sociological research regarding aircraft overflight impacts	GRCA Library Call # TL671.65 .R67 T43 2004; GRCA MC # 608506.
Stockwell	Craig		NAU	01/01/1984 - 12/31/1987	The Effect of Helicopter Overflights on the foraging behavior of desert bighorn sheep (*Ovis Canadensis nelsoni*) at Grand Canyon National Park	GRCA Library Call # QL737.U53 S75 1985, QL737.U53 S76 1987, QL737.U53 S75 1989; GRCA MC # 37105.

Greater Grand Canyon Landscape Assessment

Workshop 2

June 10 – 11, 2014

Acronyms and symbols

GGCLA: Greater Grand Canyon Landscape Assessment
GRCA: Grand Canyon NP
GCT: Grand Canyon Trust
KNF: Kaibab National Forest
LAME: Lake Mead NRA
LCI: NAU Landscape Conservation Initiative
NPCA: National Park Conservation Assn.
NPS: National Park Service
NPS-IMR – NPS Intermountain Region
NRCA: NPS Natural Resource Condition Assessment
NNHPD: Navajo Nation Historic Preservation Dept.
NAU: Northern Arizona University
SCPN: Southern Colorado Plateau Network
TWG: Technical Work Group
TNC: The Nature Conservancy

Workshop 2 of the Greater Grand Canyon Landscape Assessment was held at the Health and Learning Center on the NAU Campus on June 10 and 11, 2014. The purpose of the workshop was to review and explore the spatial data developed for the stakeholder prioritization process identified in Workshop 1, using stakeholder-identified values and threats.

Day 1

In attendance: William Austin, USFWS; Timothy Begay, NN-HPD;Rachel Bennet, NPS-GRCA; Ellen Brennan, NPS-GRCA; Charley Bullets, Kaibab Paiute Tribe, Southern Paiute Consortium; Peter Bungart, Hualapai Tribe; Windy Bunn, NPS-GRCA; Melinda Ciocco, NN-HPD; Roger Clark, GCT; Kevin Dahl, NPCA; Lance Diskan, Flagstaff Dark Sky org; Janna DuShey, KNF; William Flatley, NAU; Santiago Garcia, NPS-GRCA; Eric Gdula, NPS-GRCA; Alicyn Gitlin, Sierra Club; Martha Hahn, NPS-GRCA; Dick Hingson, Sierra Club; Greg Holm, NPS-GRCA; Linda Jalbert, NPS-GRCA; Mike Kearsley, NPS-GRCA; Marissa Kelly, NPS-GRCA; Holly Kleindienst, KNF; Drew Leiendecker, KNF; Lori Makarick, NPS-GRCA; Mark Nebel, NPS-GRCA; Doug Nering, GC Hikers and Backpackers Assn; Jodi Norris, NPS-SCPN; Mark Sappington, NPS-LAME; Donna Shorrock, NPS-IMR; Valerie Stein-Foster, KNF; Travis, Wooley, TNC; Kevin Wright, BLM-Vermillion Cliffs NM.

GGCLA Core Team:

Tom Sisk, PI, LCI; Todd Chaudhry, PI, GRCA; Clare Aslan, Brett Dickson, Cerissa Hoglander, Jean Palumbo, Jill Rundall, Sasha Stortz, Luke Zachman

Workshop Summary

1. **Welcome and introductions**

   1.1. Tom Sisk (TS), Director of the Landscape Conservation Initiative (LCI) of NAU and Co-PI of the GGCLA project, welcomed the participants to Workshop 2, thanked everyone for attending, and described the vision and purpose of the GGCLA project. Introduced Martha Hahn, Chief of Science and Resource Management for Grand Canyon NP (GRCA).

   1.2. Martha Hahn – Thanked all for attending on behalf of Dave Uberuaga, Superintendent for GRCA, who could not attend.

   - Described how the GGCLA project reflects the reality that GRCA is not an island, and that the park does influence areas outside of the park and vice versa. Therefore, it is

important to understand what is going on at a landscape scale, and to consider the values and needs of the park's neighbors.

- Described how the GGCLA fit into the NPS planning process.

1.3. TS summed up what we are doing and why it's important, and invited everyone to introduce themselves.

2. **Workshop objectives**

2.1. TS projected an image of the Grand Canyon region taken from the shuttle and invited the attendees to shift their perspective and look at the region as a large, integrated whole. He pointed out the transition at the boundary between GRCA and Kaibab NF (KNF), which is visible on the map and a product of the different types of management in the different agencies. The GGCLA strives for a more integrated approach.

2.2. TS presented **objectives** for Workshop 2:

- Provide updates on the GGCLA process including spatial model and data development
- Review and explore spatial data developed for stakeholder prioritization process, and discuss spatial data layers and their uses
- Develop and explore landscape prioritization based on stakeholder-identified values and threats
- Discuss appropriate weights, ranks and uses of spatial data in identifying priority areas for management actions
- Identify recommended refinements to the prioritization process and clarify expectations for a final spatial prioritization to be reviewed and explored at a third and final workshop

2.3. TS provided background on the GGCLA, beginning with Workshop 1 in October 2012, and including definition of the analysis area, the three regions for analysis, the Technical Work Group meetings and the September 2013 Open House.

2.4. TS described **the participatory analysis process**, which is happening in parallel with the NPS Natural Resource Condition Assessment (NRCA), and how both processes will feed into and inform the final products for the project.

- Todd Chaudhry (TC), senior ecologist for GRCA and Co-PI for the GGCLA project talked about how decisions are to be informed by values and data, which are complementary, even though they are different things. Also talked about how different types of data can be incorporated, for example, information from opportunistic observations – at

one end of the spectrum, and from research vetted through peer review at the other end can be weighted in terms of value and emphasis.

A reactive organization makes decisions in a conflict situation, which aren't always the best decisions. This participatory process will help to inform decisions down the road, so that we can make better informed decisions that better meet our collective goals.

TS: We are building consensus through this process. Values can be incorporated in an informed way, such that science supports a clarification of public values.

- Question: There are an abundant # of decisions by various stakeholder to be made in the next couple of years. Have you stated these upcoming questions in order to help inform this discussion? TS's response – we addressed this in Workshop 1where we asked stakeholders to identify values and risks. The list of prioritized data needs reflected the issues that stakeholders identified. However, there is an imperfect match between the wish list and what gets delivered. If there are major gaps – the job of this analysis is to identify those gaps and determine how they can be filled in the future.

2.5. TS compared the NRCA process to the GGCLA process, identifying the additional elements in the GGCLA and those elements that are outside of the scope of the project (Table 1)

Table 1. Comparison of GGCLA to NPS Natural Resource Condition Assessment

NRCA Standard Elements	**GGCLA Additional Elements**	**Outside of Scope of GGCLA**
Multidisciplinary approach	Collaborate with stakeholders	Assess condition of all park resources
Use existing data	Assess cultural resources	Conduct robust quantitative analysis for all focal resources
Assess current conditions and trends of natural resources re: reference conditions	Assess contiguous lands outside of park	Analyze alternative futures (e.g. climate change)
Assess threats to resources	Conduct integrated spatial analysis	Identify specific management strategies and actions
Describe methods, assumptions and level of confidence in results	Identify priority areas based on values and threats	
Identify data gaps	Identify future research and monitoring needs	
Produce written report and GIS products		

2.6. TS described examples of similar efforts conducted by LCI in the past

- Western Mogollon Rim Landscape Assessment – prioritization map overlaid with Wallow fire – coincided with the highest priority areas identified in this process –

demonstrated that this process created meaningful result. Had we had more time and resources to commit, we might have been able to mitigate those losses

- Northern New Mexico Landscape Assessment workshop in Taos, NM in 2006 focused on watersheds
- Small diameter wood supply project in northern Arizona
- Kaibab Forest Health Focus. Over time, these efforts can influence future projects.

2.7. TS described the purpose of today's breakouts (see below) and urged everyone to think hard and reach deep in exploring the spatial data in order to get at those values on the landscape. The role of the spatial analysts that will be working with them is to help do this.

- Explore spatial data
- Review prioritization approach and process
- Conduct initial prioritization

2.8. Question: How are we determining threats? – is it just urgency?

TS response: Threats were identified as having the potential to influence those values that have been identified by stakeholders. The goal is to try and protect the values and also to address the stressors by trying to manage them so they become less of a threat. The next question would be "what do we do?". If a value is not susceptible to management activity, it won't contribute to prioritization. He reminded participants that we are not moving to a prescriptive process, and acknowledged that could be a bit frustrating.

- Question: Will there be an attempt to map the stressors? Answer: Yes.

3. **Data Overview**

3.1. Jill Rundall (JR), LCI

- Study extent
- What we learned in Workshop 1 –values and stressors to values were identified deliberatively and prioritized with dot votes. This provided a list of priorities for developing spatial data. Some of this is in the data atlas, and some is not available.

3.2. TC addressed additional data development –through CESU funding for Conservation Science Partners to develop spatial products and models. He mentioned that at this stage, we want to present draft products, take feedback from participants, and use this to refine the spatial products. The GGCLA Workshop 2 Data Atlas represents only a subset of the layers we have to play with today and tomorrow.

3.3. JR: Review of draft data layers developed thus far from existing data gathered from various sources.

3.4. Brett Dickson (BD), president and chief scientist, Conservation Science Partners (CSP) presented data layers developed from models.

- Question – is there consideration of wildlife corridors? How are you dealing with the edge, beyond the analysis areas? BD's answer was yes, we have accommodated edge effects.
- Question: are your wildlife models based on landscape models? BD's response was that all the wildlife models were drawn on telemetry data —except for mule deer.

4. **Example prioritization**. TS walked the group through an example prioritization focused on Wildlife climate adaptation. The goal was to identify the most important areas for assisting wildlife in adapting to climate change.

4.1. In prioritizing areas through which animals can disperse and redistribute themselves through the landscape, high value habitat was represented by the biodiversity and ecological integrity layers. Distance to roads is a negative habitat factor.

4.2. Question about weighting: Why did you use 2's and 3's? (Weighting scheme built into the model is 1-4 highest). You could argue that different weights are different values. TC's response– if you don't assign weights – by default, you are weighting them all the same. TS added that we could change the weights and run the model again and see how sensitive it is to the weights with diff weights. Also, keep in mind that the weights are relative.

4.3. We looked at the top 10% of the prioritized landscape that resulted from the example model. Illustrates how you can start with a conception of what's important, but there are many ways to take that information and turn it into a picture.

5. TS provided a preview of the afternoon's work for the breakout groups. Each group should address Above the Rim, Below the Rim, and the River Corridor in that order. River corridor (RC) will present special challenges. While the first two are large areas, the RC is a ribbon, only a few pixels wide. How will we represent the relative priorities along the River? Also is an area where we have had challenges obtaining the data.

6. **The Aesthetics of Conservation**: Lunch program by artist Bruce Aiken, long associated with the Grand Canyon.

7. **Small Group Break Out Session 1**

7.1. Objective: to collaboratively prioritize areas for management attention

7.2. Strategy: identify key values and stressors, and the spatial data to represent them; assign relative weights to values and stressors. Do this for all three regions.

7.3. Summaries of the small group breakout sessions start on page 12.

8. Report back the results of each break out group to the combined group

8.1. There was a steep learning curve and it took all three groups a lot of time to get the hang of it and make progress. None of the groups tackled the River Corridor prioritization.

8.2. Observations: One group did not identify the spatial layers to represent the values they identified. One group did not weight the values or the stressors. Another group assigned weights and then voted and took the average of weights. One group separated experiential values from ecological values and then addressed only the ecological values above the rim and the experiential values below the rim.

9. TS: **Day 1 wrap up comments and reflections**

9.1. Acknowledged that this was a difficult exercise. Asked: How clear were each of you about how to establish priorities? What's the alternative? To just react?

9.2. Asked, how high was the level of agreement? People felt relatively comfortable, and yet it was hard to do.

9.3. Even though there were a lot of data gaps, we had been able to gather together more than had ever been available to the park previously. However, the available data are never enough.

9.4. Combining apples with oranges in this way is always challenging, but sometimes necessary.

9.5. Prioritization must be an iterative process.

Day 2

In attendance: Donna Shorock (NPS), Greg Holm (GRCA) , Drew Leiendecker (KNF), Holly Kleindienst (KNF), Marissa Kelly (GRCA), Jonna DuShey (KNF), Abe Springer (NAU), Craig McMullen, (AZGFD), Martha Hahn (GRCA), Mark Sappington (NPS-LAM), Jodi Norris (NPS-SCPN), Pete Bungart (Hualapai), Mark Nebel (GRCA), Alicyn Gitlyn (Sierra Club), Valerie Stein Foster (KNF), Bill Austin (USFWS), Dick Hingson (Sierra Club), Doug Nerring (Grand Canyon Backpacker's Association) Tim Begay (Navajo Nation), Terry Morgart (Hopi Cultural Preservation Office), Melinda Ciocco (Navajo Nation), Linda Jalbert (GRCA), Mike Kearsley (GRCA), Jane Rogers (GRCA), Todd Chaudhry (GRCA), Rachel Bennet (GRCA), Kevin Wright (BLM), Travis Wooley (TNC)

10. **Small Group Breakout Session 2**

10.1. In small groups, spatial analysts presented the initial prioritizations they produced overnight and reported on any substitutions or modification of spatial layers they made in order to capture the values and stressors as accurately as possible.

10.2. Groups evaluated the resulting prioritization maps—did they capture the intent of the group? Discussed how to refine them.

10.3. Summaries of break out groups and maps of each group's priority maps are attached starting on page 12 and 23, respectively.

11. **Report out: Comparison of Small Group Prioritizations –** all three groups reconvened to discuss their results and prepare presentations of results for large group.

11.1. **Yellow group**

- **Participant comments**:
    - Concern was voiced about dark night skies being relegated to below the rim. Response was that we are acknowledging that resources identified for below the rim are affected by stressors above the rim as well as below the rim. The same person also felt that night sky values should be "housed" with infrastructure rather than wilderness. However, infrastructure is a stressor for dark night skies, and dark night skies are a component of the wilderness value.

11.2. **Blue Group**

- **Participant comments**
    - (above rim) Focused on mule deer as a value, and fire severity and the inverse of ecological integrity as a stressor
    - (above rim) The group was concerned about the lack of population data for wildlife.
    - (below rim) Lack of data for hydrology and water use was a concern.

11.3. **Green Group**

- **Participant comments**
    - Suggested that it might be better to divide the area into east versus west. For example, trails could be a value or a threat, depending on what area you are looking at.
    - Some group participants commented that it was challenging to value different parts of the landscape from a cultural perspective. Some tribal representatives would be interested in taking a different approach.

11.4. **General comments**

- Regarding the river corridor and below the rim, these are <u>not</u> natural environments as a result of the dam. How do we address the effects of the dam?
- Two of the three groups felt that the results of the prioritization were as they expected.

12. **Implications of preliminary analysis and next steps**

12.1. TS: Three possible courses of action:

1. Average the three prioritization results
2. Pick one prioritization and go with it
3. Refine the concept and do it differently

12.2. **Participant comments**

- We're trying to cram in too much, too many values, missing data. I know we have a product I can't endorse. BUT, it's the process that is fascinating and important. My priorities may change because of this process. I don't have time to learn all of this. It is the responsibility of the park staff.
- Perhaps we are looking at suggestion #3. If we add all three together, the priorities will be everywhere. If we redefine, we can narrow it down.
- Question: Are there shared values across the multi-agency managers here today?
- I was struck by the fact that people with similar values came up with such different prioritization results.
- Do you think it would be more tractable to break up the areas?
- We should more closely tie the stressors selected to the values identified.
- I think the process was valid, but am uncomfortable with the underlying datasets.
- Averaging the three or picking one of the scenarios is not the way to move forward. We should refine and do it again.
- The way we assigned the exercise influenced the result.
- There was much more overlap among the three scenario results for below the rim.
- TS confirmed that the sense of the group was to refine the concept and do another prioritization. He committed to working with the core team and coming back with something that meets the group's intent.

12.3. How do we move forward on the River Corridor?

- It should have a high priority, but not in this process—there are many studies dealing with the River.
- We are missing some of the overall connections to the landscape. There are a number of discharges at the river level, which have always been missing from other assessments. 3,000-4,000cfs of discharge at the river level are never analyzed.
- We need to look at both the aquatic and riparian habitats. Just having a general understanding of the landscape is not enough. What's more important is figuring out what is not known.
- Night skies are an important aspect of the river corridor.
- We need to look at the ecological and user aspects of the river corridor, and in the other two areas. Tributaries should be included in the river corridor. The river is highly compromised and diversity is coming from the tributaries.
- TS: acknowledge that the river was both heavily studied and important to stakeholders, and that it might be addressed but through a different approach than the prioritization used above and below the rim.

12.4. TS: Asked two questions**:** First- Of the datasets that weren't available, what were the most important pieces that you felt were needed?

- Soundscape-related data layers, including noise maps (% time audible), which are a measure of motorized impact on visitor experience; and LEQ audible – which is the sound intensity of the sound during the times it can be heard.
- What about non-data information – things that define greater meaning – night sky has profound meaning and is difficult to quantify.
- (Blue Group) Water resources, including hydrology, wildlife population and diversity, endemic vegetation
- Visitor use data in other areas (e.g. Havasupai and Hualapai)
- Potential renew energy development locations
- Related to additional wildlife data – RMBO has data layers
- Other invasive types
- A mechanism to connect threats to water resources, tied in with hydrology,

12.5. Second question (TS): You've been introduced to the data that we've developed. Would any of these layers be useful for other purposes?

- For example, a prioritization process that can be implemented in a different setting for a more immediate use. We could work with you to transfer this process. We invite your further input and requests.
- Question: When will this be publically available? Answer: all non-sensitive data will eventually be publically available. However, before sharing, we want to be able to provide it in a form that recognizes its strengths and short comings with proper metadata and other details.

12.6. TS reviewed the GGCLA objectives and our progress and successes. He acknowledged that looking at so many factors in an integrated way is a new approach, as is including stakeholders at the front end.

12.7. TC added: A lot of the products that we have been working with on the Resource Condition Assessment side will plug into this and provide insight into the overall condition of these resources. A number of products are still to come, for example:

- tributary/riparian veg comp/structure/change over past years,
- Northern Leopard frog habitat suitability model
- river avifauna
- database of archeological sites, where we have condition analysis for each of sites, trends over time
- caves assessment
- night skies assessment
- wilderness character

13. **Timeline review**

13.1. Wrap up with Workshop 3 this winter, finish report in 2015

13.2. Will need peer review – if anyone is interested in providing this service, let TC know

13.3. Report will be publically available.

14. Final comments and questions

14.1. Question: Have you considered impact thresholds? Answer: that might be the next step after this process, to identify threshold as it relates to a particular resource, then identify management actions.

14.2. Participant comment: This is amazing, all the effort and caring that's gone into it is appreciated! Over the course of the project timeline, we can see that much progress has been made.

14.3. TS's takeaway--To see how diffuse and incomplete a lot of this information is, to try to assemble is not an easy task, but a necessary one.

15. Martha Hahn – Park currently has many research proposals. This effort will help us to target and focus research proposals in the park and increase our collaborative prospects. Keep in mind that a lack of data is not a failure, but helps us to determine how to move forward.
16. TS: There has been a lot of excellent work, but noteworthy that much of that does not directly answer difficult management questions we face now.
17. TS acknowledged that it was a challenging workshop in many ways and thanked everyone for their hard work and participation over the course of the workshop and project.

Attachments: Break out group summaries, prioritization maps

1. Blue Group Summary

Facilitation Team: Luke Zachmann and Sasha Stortz

Day 1

Scenario goal(s):

Conservation and protection of natural and cultural resources

Data representations for prioritization exercise

Above the rim: The group selected the following values-

- Mule deer connectivity (weight 0.05). This was to represent the importance of connectivity for multiple wildlife species; a desire for more integrated wildlife presence layer was expressed
- Biodiversity (weight 0.4) was selected as a representation of species richness, with the suggestion that water resources could also act as an important indicator of biodiversity
- Historic fire disturbance regimes (weight 0.1)
- Density of sensitive areas (caves, archeological sites and springs) (weight 0.4)
- Endemic plants (weight 0.05). This was considered very important to include in analysis, but it was felt that this data was insufficient, thus the low weight. A desire for endemic fauna, along with flora, was expressed.

The group selected the following threats-

- Climate departures from normal (weight 0.05). This was particularly of interest in terms of rim species that will be vulnerable to future climate change, with the idea that higher priority should be given to areas more likely to change
- Fire severity potential (weight 0.3). High fire severity potential and previously burned areas were considered a stressor
- Ecological pressure/human modification (0.3). The inverse of the ecological integrity layer was considered acceptable for purposes of the exercise. The primary interest in this representation was existing and proposed developments, and the presence of non-natives and disturbed areas
- Soundscapes (0.1). Noise impacts from overflights as well as noise from the presence of people (roads and trails as proxies)
- Grazing and forest management (0.25). Potential Landfire Disturbance layer: overgrazing, browsing, and trampling by native and non-native species (elk, bison, and cattle).

Below the rim: The group spent less time discussing below the rim. They selected sensitive resources (springs, caves and archeological sites) (weight 0.34), wilderness (weight 0.33) and biodiversity (weight 0.33) to be weighted essentially equally as values. For stressors, they selected sound impacts including local and overflights (weight 0.35) and discussed desire for a representation of visitor impacts, including over visitation, human waste, the impact of trails and developed areas. They thought that a map of back country use or the opposite of the ecological integrity layer, representing ecological pressures or human modification, would be an acceptable representation, with a weight of 0.65.

Key ideas and discussion:

- Ecological integrity- uncomfortable with definition used. This is a definition of "human use". Ecological integrity should use more information about ecological processes- a functional ecological departure
- Representing sensitive areas is challenging; frustration not to be able to see it in the meeting
- Language – invasive vs. non-natives needs to be clarified
- Wildlife habitat representations: consider capturing vegetation change over time as an indicator of wildlife condition
- Data desire: use of water/groundwater pumping
- Data desire: springs and water flow below the rim

Day 2

Data layers used in analysis performed overnight:

Above the rim:

Values- Habitat connectivity for mule deer (0.05), multi-scale biodiversity index (0.4), historic fire regime (Landfire vegetation departure) (0.1), density of sensitive resources (0.4), density of endemic plants known locations (0.05)

Stressors- Fire severity potential (Landfire) (0.4), human modification (0.4), climate change (0.066), overflights (0.133)

Below the rim:

Values- multi-scale biodiversity index (0.34), density of sensitive resources (0.33), wilderness areas (0.33)

Stressors- backcountry use (percent by backcountry zone over the past decade) (0.4), overflights (0.2), human modification (0.4)

Key ideas and discussion:

Above the Rim Reflections

Value layers

- Strong associations with the rim itself due to weighting of biodiversity
- North rim mixed conifer doesn't come out as high priority, but seems like an unusual habitat. Consequence of choice of biodiversity over large intact ecosystems
- Value to using top 10% AND to looking at the full priorities layer with its details and variability
- How do we think of sacrifice areas versus high priority areas?

Stressor layers

- Unable to provide grazing data overnight, generating new ideas: can the TNC Arizona grasslands most threatened be a proxy for areas highly impacted by grazing? Defining grazing correctly as a stressor is important; desire for data to be tied to outcome on landscape. Not all grazing is bad.
- Ecological integrity "inverse" – resonates for some but not for others; intent of a human modification layer
- Some more remote areas, less visited areas come out for high in stress; worth visiting and addressing

Compilation

- Hot spots on values and stressors line up particularly on north and south rim; did we over-represent?
- Values in larger cohesive blocks
- Stressors are more diffuse than values were
- Strong signal similar on north and south rims

Refinements

- Ecological integrity/human modification might not be representing what we want it to
- Wildlife representations: population data is desired
- Representative sampling of endemics is needed

Below the Rim Reflections

Values Layers

- Used currently designated and proposed wilderness as a proxy for wilderness character
- Sensitive resources; just the top 10% would be interesting, like distribution here more than above the rim
- Missed adding access as a value in the rush to finish the below the rim discussion on day 1

Stressors Layers

- Seeing strong response to back country use and overflights in East part of canyon

Compilation

- Less overlap of values and stressors than above the rim

Refinements

- Wilderness- could add road corridors, will have a wilderness character model in the future. Also, current layer doesn't show cross-canyon non-wilderness corridor
- Appropriate representations of access: type of access, vulnerability, representation of access on the river + inner canyon
- Ecological integrity/human modification can be better represented
- Hydrology/hydrologic process are needed below the rim

Discussion on how to address the River Corridor in Analysis

- Other processes analyzing it, should it even be addressed here?
- But, it's important to address too due to connectivity across the landscape; not an isolated dataset
- Existing river corridor definitions to drive on:
  - CRMP: river corridor and 2 miles up side streams (access points to/from river)
  - LTEMP: not sure how it will be defined yet
  - BMP: Various representations
  - Interactions between back country users and visitors from river
- There is lots of data, how do we get it, or what do we want?
  - Some issues are a spatial framework for existing data

Concluding thoughts: Representation of stakeholders at the workshop impacts the weights and selection of values and stressors. We are missing some voices and that is reflected in the maps produced

2. Green Group

Facilitation team: Jill Rundall/Clare Aslan

Overview

The Green group was charged with developing a prioritization scenario to identify areas for management attention in geographic areas of GGCLA of 'Above the rim', 'Below the rim' and the 'River corridor' by selecting values and stressors from the compiled list that were identified during GGCLA Workshop 1. The small break-out Green group met for several hours on each of two days. During that time it became apparent that the river corridor geographic area would need further refinement before a prioritization effort could be undertaken and it was set aside. With two remaining geographic areas to address, day 1 included the review and discussion of the list of values and stressors, what could be added to those and what they meant in the context of each of the geographic regions. The group focused on outlining identifying and describing what each value and stressor chosen represented within the context of the prioritization. Ultimately, the group identified specific values and stressors with relative weights for each layer (identified later) with

the total weight adding to 1 and explanations as to what they represent; however, the choice of which spatial data to use for representation of these were deferred to the facilitator and spatial analyst's discretion. Overall trends for values chosen included both ecological and cultural interests such as biodiversity, intact ecosystems, water, recreation and cultural landscapes, and archeological resources. Stressors identified included anthropogenic disturbances affecting ecological and cultural resources and visitor experience such as invasive species, threats to water resources, unnatural fire regimes, noise and light pollution, and industrialization. Several small group members had to leave before the small group session ended. During the morning of Day 2, the Green group had some time to see the output prioritization map, but perhaps less time than the other groups due to technical difficulties. In addition, not all members were able to return. Discussion and feedback from the Green group on Day 2 revealed some dissatisfaction with the areas prioritized based on pre-identified values, largely because no one person in the group felt that his or her priority areas were identified. Individuals in the group were concerned with, for example, fire, noise pollution, or cultural values, and the meld of multiple values reduced the focus on any particular set of such values. To improve the map results, the group felt that better base maps were needed to represent, in particular, healthy fire regimes, cultural values, and noise pollution, although they acknowledged that such maps were unavailable to the GGCLA team to bring into this Workshop. Another suggestion was that the Canyon be divided into three or more east-west segments, representing management areas that differ significantly in focus and goal (for example, the upper Canyon, main corridor, and lower Canyon), so that the values and resulting maps can be tailored to differing management needs.

Summary of group intentions

Above the Rim

There were six values and three stressors chosen for the Above the Rim prioritization scenario. Values included fire and natural disturbance regimes, large intact ecosystems, wilderness values, scenery and viewsheds, wetlands and water sources, and archeological resources and traditional cultural properties. Stressors included industrialization and associated anthropogenic impacts, invasive and nuisance species, and unnatural fire regimes.

Representation of each value and threat with spatial data are described in detail in the scenario worksheet table and are summarized here.

<u>Values</u>

1. Fire, natural disturbance regime was chosen to capture the idea of the ponderosa pine forest community above the rim as influential of communities below the rim. The group felt that crown fire in particular represents an unhealthy fire regime reflected in very intense fires. Addressing areas of high crown fire activity that past experience shows to occur in this system will help protect other areas from the inevitable downstream effects that result from unplanned catastrophic wildfire. This value was depicted by selecting concurrent areas of ponderosa pine

vegetation type from LANDFIRE existing vegetation data and those of active crown fire as modeled in FlamMap at 97th percentile weather conditions. This layer was given the highest weight of 0.19.

2. Large intact ecosystems, wilderness values were identified as individual values for inclusion. Based on the group's purpose of including these two values of identifying areas that support native biological diversity and wilderness character and the importance of experiencing wilderness as a human experience, we represented both of these with one spatial layer for the analysis. This value was depicted by the ecological integrity spatial layer and given a weight of 0.38, a sum of the two weights assigned to the two initial values by the group.

3. Scenery and viewsheds were identified as important to distinguish vistas as one-of-a-kind, capturing the visitor experience, wonder, mystery and grandeur that is central to the character of the region. The visitor use viewsheds analysis was used to represent this value and was given a weight of 0.16.

4. Archeological resources / Traditional cultural properties value was important to the group to include acknowledging that cultural significance goes beyond the archeological resources and incorporates areas of value and activity. Through discussion this idea expanded to include traditional cultural properties that are in use currently including significant peaks and sites, trail networks and traditional use lands. The group also felt this would incorporate aspects of the visitor experience. This value was represented by spatial data of all traditional landscapes identified within the region that were available for GGCLA through the GRCA GIS and cultural staff. It was assigned a weight of 0.15 in the prioritization.

5. Wetland and water resource value was identified to be included by the group due to its connection with biodiversity and wildlife. A new data layer was derived for this value, combining spatial data of streams, springs, lakes and reservoirs locations. It had an assigned weight of 0.11.

<u>Stressors</u>

1. Industrialization and associated anthropogenic impacts stressors has a broad scope relating to human modification and ecological integrity for the Group. This included pollution from development, noise and light, air and water quality and energy development. Considerations that it could include resource extraction, ground water withdrawal, road networks and threats to- or access to traditional cultural properties as well. This was represented by the inverse of the ecological integrity model, giving the areas of high human modification high values with the assigned weight of 0.5.

2. Invasive and nuisance species were included as concerns of their impacts on ecological systems. These were represented with a new layer derived by combining two predictive models, the draft Bromus spp. and the USDA National Insect and Disease Risk composite data of percent of total basal area of all pests (damage agents) and all hosts (tree species). This layer was assigned a weight of 0.25.

3. Unnatural fire regimes were also considered important to identify areas where fire regimes may have changed, mainly due to suppression, creating greater density forests and as a landscape scale process that effects multiple resources. This stressor was represented with LANDFIRE's index of Vegetation Departure (2008, refresh), this depicts the amount of current vegetation departed from simulated historical vegetation reference conditions. It was assigned a weight of 0.25.

Below the Rim

There were six values and four stressors chosen by the Green group for the Below the Rim prioritization scenario. Values included wilderness values, biodiversity, intact ecosystems, cultural landscapes, water resources, and recreational values. Stressors included overflight/noise pollution, light pollution, invasive species and threats to water resources

Representation of each value and threat with spatial data is described in detail in the scenario worksheet table and is summarized here.

Values

1. Wilderness values and intact ecosystems were identified as individual values for inclusion. The group's interpretation of these values was wilderness providing mysterious silence, deepest below the rim as one of the most special and fragile aspects of the region and in visitor experience and the idea of an intact landscape. The group described the latter as no roads signifying greater connectivity, less fragmentation except by natural processes, less development and degradation and not trammeled. The ecological integrity model is an index of naturalness. Higher values represent a higher degree of naturalness (e.g. wilderness, fewer roads, less anthropogenic impact), while low values indicate a high degree of human modification. We represented both of these values with this single ecological integrity spatial layer for the analysis. It was assign the summed weight of those two values of 0.41.

2. Biodiversity as a way to incorporate the microsite and topographic and habitat diversity, transitioning between different ecosystem types. The potential biodiversity spatial layer was used and assigned a weight of 0.15.

3. Water resources were chosen by the Group to represent a refinement to biodiversity. Where these point and line features representing locations of spring and stream resources, with buffers, can be central to wildlife habitats. Smaller features integrated into the mapping can impact the outcome, offering a fine scale to help point in one direction or another. A new data layer was developed including the spring and perennial locations buffered 100 meters and weighted 0.18. This buffer, identified by the Group, hoped to capture areas that may be influenced by the water resources (e.g. vegetation, arthropod, avian and mammal diversity, etc.).

4. Cultural landscapes were chosen to try to encompass the archeological landscapes, traditional cultural properties and the idea of The Canyon as a home to people. This value was

represented by spatial data of all traditional landscapes identified within the region that were available for GGCLA through the GRCA GIS and cultural staff. It was assigned a weight of 0.14.

5. Recreational values was identified by the group with the idea that it is a large part of the inner canyon visitor experience. This was represented by trail density. Higher trail density relating to higher recreation opportunity. It was assigned a weight of 0.12. The group discussed the fact that recreational value means different things to different people (i.e., high trail density may be a negative from some perspectives) and concluded that subdividing the Canyon in an east-west fashion might result in different weighting or perhaps the use of the inverse of this metric in some subdivisions.

Stressors

1. Overflight/noise pollution was considered by the group as the over-riding source of noise pollution with additions by motor boats. The inverse of a new data layer that was developed to represent calculating the distance from published air tour flight lines was assigned a weight of 0.36.

2. Light pollution: the group wanted to use light pollution as a proxy for development. They considered that small scale, focal, point stressors could increase in the future, such as the Escalade Project. Additional increases could come from the increasing light domes from communities such as Tusayan. This was represented with known existing and proposed development and weighted at 0.17.

3. Invasive species of plants in particular (cheatgrass) are of concern as well as river-associated species that move up into tributaries threatening unique vegetation community components such as hanging gardens. The potential cheatgrass model was used to represent this and weighted at 0.23.

4. Water resource threats capture the idea of the effects on seeps/springs related to development levels above the rim. There was interest in incorporating climate change, human attraction to water, wells, altered flow regimes and water availability (depth). Trail density spatial layer was used as a proxy to represent this stressor. Human attraction to water is facilitated and closely related to locations of trails. There are no well locations below the rim; altered flow regimes data is unavailable consistently for springs (e.g. Roaring Springs pumping to South Rim) and is more likely related to the Dam and main stem of the Colorado River. The group agreed that a better representative layer capturing water resources would be valuable to this process. Water resource threats were weighted at 0.24.

3. **Yellow Group**

Facilitation Team: Brett Dickson and Cerissa Hoglander

Day 1

Scenario goal(s):

Above the Rim: Restoring natural fire regime and/or forest structure and composition for purpose of maintaining habitat integrity and water quality/quantity; old growth forest health; maintaining a natural night sky; maintenance of intact and unpolluted ground water HRV; suitable habitat for T&E; protection of existing cultural resources and landscapes; protection of a range of (including quiet) recreation opportunities, maintaining soundscapes

Below the Rim: Opportunities for solitude, unconfined recreation, and enjoyment of cultural values; protection of existing cultural resources and experiences;

Desired data layers:

Above the rim: the group discussed using the following values in their scenario:

- The group discussed using dominant vegetation cover type (weight 0.3) in order to represent an indication of habitat, successional stage and condition class but ultimately decided against using this spatial data layer
- The group used biodiversity (weight 0.2), MSO recovery areas (0.3) and Northern Goshawk habitat (0.2) to indicate the areas of forest structure and composition they were most interested in
- Springs density (0.3) was discussed as an indicator of a functioning hydrological system

Above the rim: the group discussed using the following stressors in their scenario:

- Mining activity (0.1) as a representation of stressors on water quality
- Crown fire behavior or fire hazard (0.5) as a representation of uncharacteristic fire behavior
- Bromus probability (0.2) and bison locations (0.2) to represent how exotic species alter fire regimes, hydrological regimes and biodiversity

Below the rim: They discussed using the following values in their scenario, all weighted equally:

- Natural night skies
- Natural quiet; overflights and overall sound impacts

- Cultural values such as ethnographic and visitor use viewsheds
- Intact water sources, as an ecological and cultural value
- Sensitive resources (caves, springs and archeological sites)

Below the rim: They discussed using the following stressors in their scenario:

- Flight lines (weight 0.3)
- Development and infrastructure, with a focus on the things that impact water quality and quantity; viewshed/wilderness stressor (0.4)
- Visitation (back country use areas) (0.2); More control over visitation than some other stressors.
- Mines: The things that impact water quality and quantity, and the experience you might have in the vicinity of, e.g., a spring; above rim stressors (0.1).

Day 2

Data layers used in prioritization analysis conducted overnight:

Above the rim values: MSO recovery habitat (weight 0.3), Northern Goshawk habitat (0.2), multi-scale biodiversity index (0.20, density of known spring locations (0.3)

Above the rim stressors: Mining activity (0.1), crown fire behavior (0.5), cheatgrass occurrence (0.2), bison habitat (0.2)

Below the rim values: natural night skies (0.166), flight lines (0.166), ethnographic viewshed (0.166), visitor viewshed (0.166), ethnographic resources (0.166), intact waters (0.166).

Below the rim stressors: development and infrastructure (0.4), visitation (0.2), flight lines (0.3), mines (0.1)

Key ideas and discussion:

Above the Rim

There was a bias towards the Kaibab NF because Mt. Trumbull and GC Parashant NM were not represented – indicated as no data

(Crown fire behavior was heavily weighted in the yellow prioritization – did this result in over prediction of fire severity in some veg types and some areas?

The result of the prioritization for the areas within the park were what some of the group would expect.

Below the Rim

Changed from presence/absence of sensitive resources to a count of sensitive resources (cultural) by HUC 12 watershed. Drawback is that one really important ethnographic site would get overshadowed by other values.

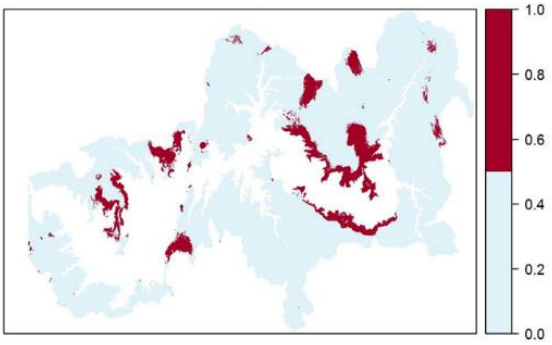
Lack of data for Hualapai and Havasupai visitor use, but might be able to get Supai daily use permit info and Hualapai overflight data.

The group was surprised at the high level of stressors in Marble Canyon because there is not a lot of visitor use there.

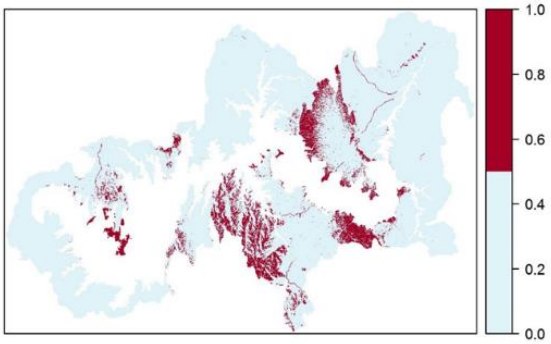
Stressors for springs were not represented. Perhaps a geologic fault layer, karst layer, pumping well layer?

Above the Rim Values Maps

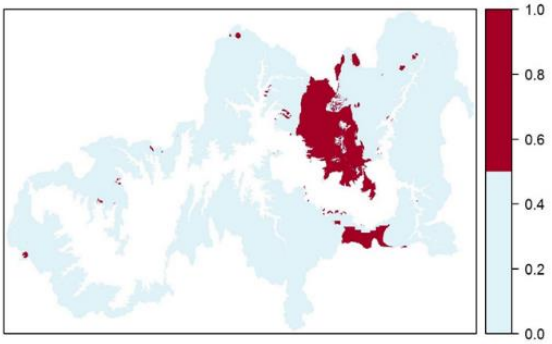
BLUE



GREEN

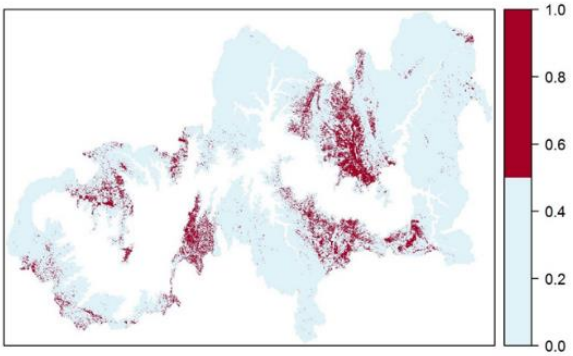


YELLOW

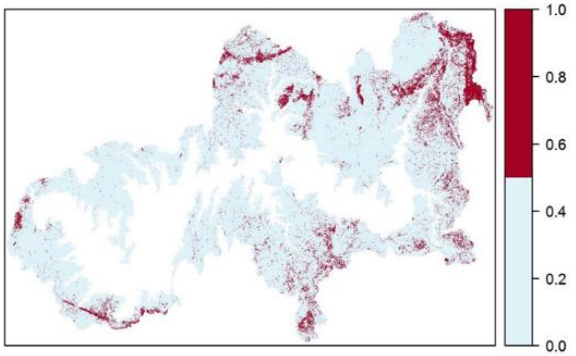


Above the Rim Stressors Maps

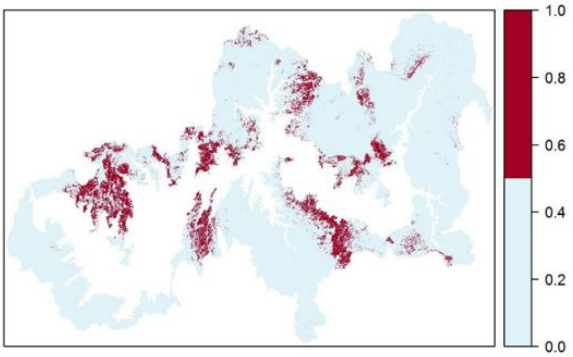
BLUE



GREEN

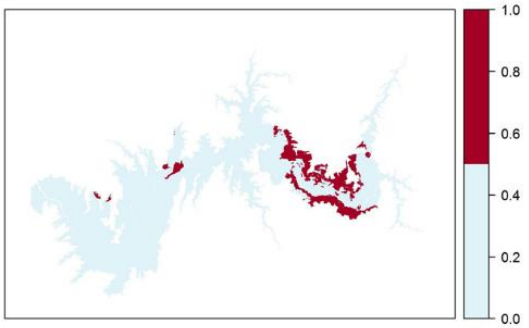


YELLOW

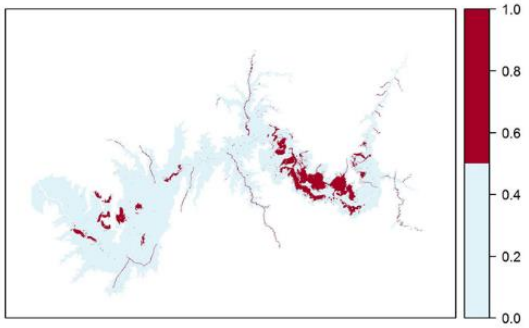


Below the Rim Values Maps

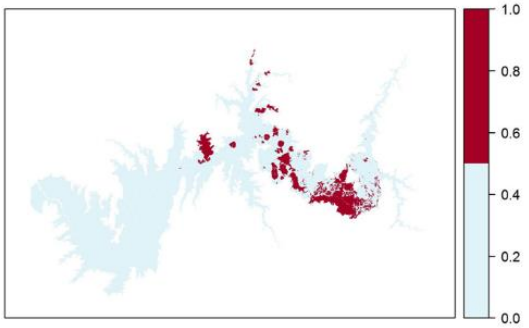
BLUE



GREEN

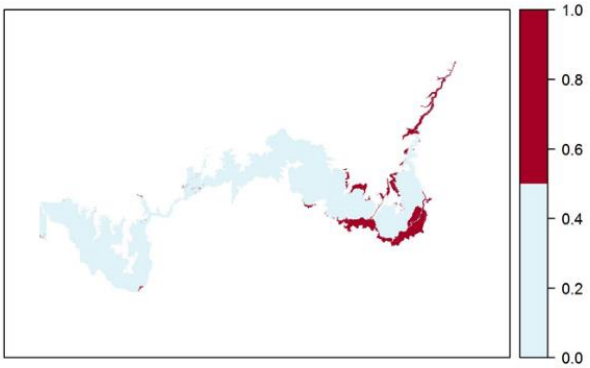


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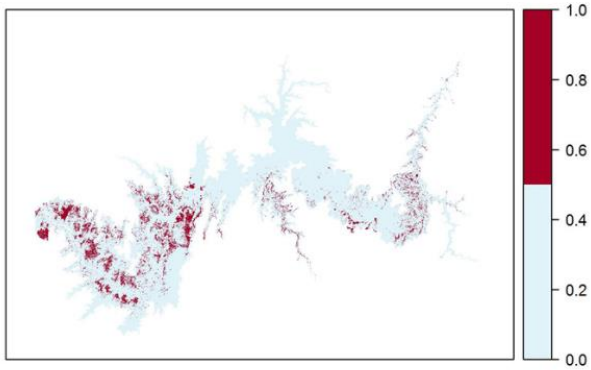


Below the Rim Stressors Maps

BLUE



GREEN



YELLOW

