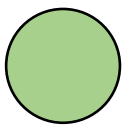
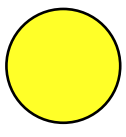
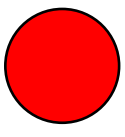
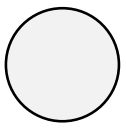
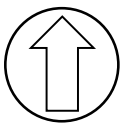
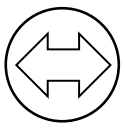
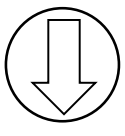
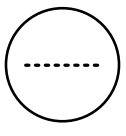
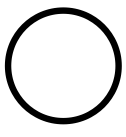
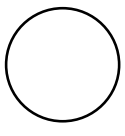
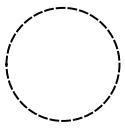
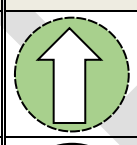
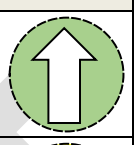
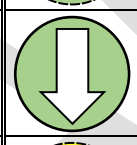
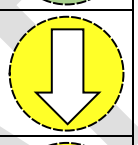
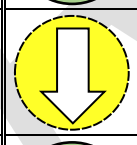
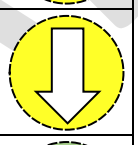
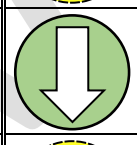
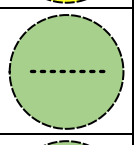
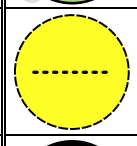
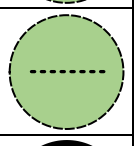
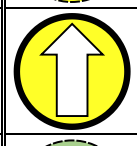
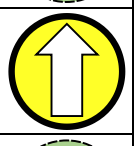
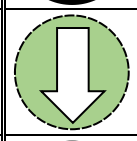
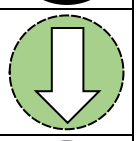
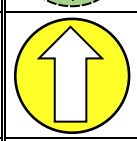
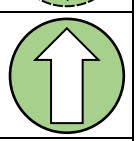
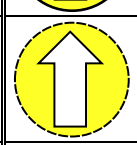
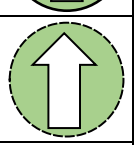
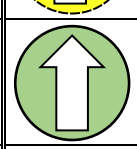
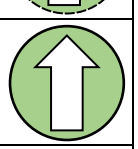
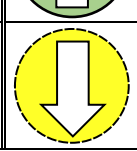
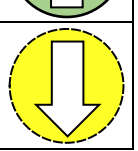
GCDAMP FY2017 Knowledge Assessment Summary: Drivers & Constraints

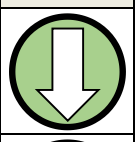
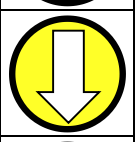
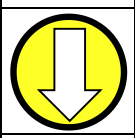
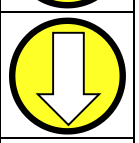
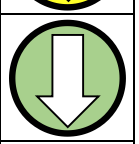
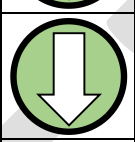
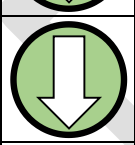
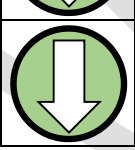
April 7, 2017

Symbol Key										
Strength of Effect				Direction of Effect				Confidence		
Strong	Moderate	Weak	Unknown	Positive	Neither	Negative	Unknown	High	Medium	Low
										

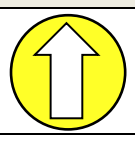
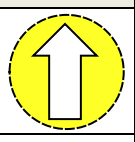
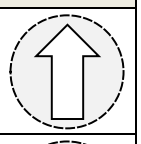
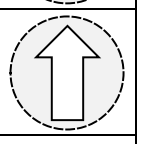
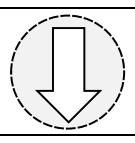
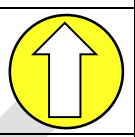
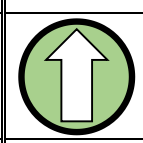
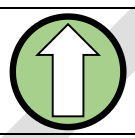
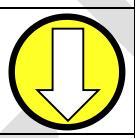
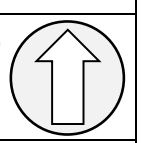
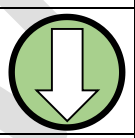
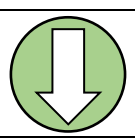
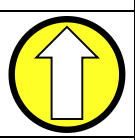
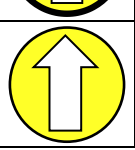
AQUATIC FOOD BASE

Resource Characteristic➔ / Driver or Constraint ➔	Food base diversity	Secondary production
Algae and aquatic macrophyte quantity and quality		
Cool water temperatures		
Fall flood disturbance (HFEs)		
Flow fluctuation		
High sustained discharges (e.g., equalization)		
Leaf litter and similar inputs (allochthonous input)		
Low dissolved oxygen (<5mg/L) in water column and/or substrate		
Nutrients		
Spring flood disturbance (HFEs)		
Substrate quality		
Turbidity and suspended sediment		

ARCHAEOLOGICAL & CULTURAL RESOURCES

Driver or Constraint ↓ / Resource Characteristic →	Depositional Integrity (Arch site stability)	National Register Integrity
Destruction of feature		
Displacement of feature/artifact		
Human visitation		
Loss of matrix		
Sand bar erosion (versus deposition)		
Vegetation encroachment		
Water erosion		
Wind erosion		

HUMPBACK CHUB

Driver or Constraint ↓ / Resource Characteristic →	Adult population in western Grand Canyon	Adult population that spawns in the LCR	Juvenile chub population in CR near the LCR	Juvenile chub population in LCR and CR near the LCR	Juvenile chub population in western Grand Canyon
Aquatic food base					
HFE frequency					
High-sediment floods in LCR					
Humpback chub recruitment from LCR					
Humpback chub recruitment from smaller size classes					
Predation and displacement by rainbow trout					
Temperature in CR in western Grand Canyon					
Temperature in CR near the LCR regularly < 12°C					
Temperature in CR near the LCR regularly > 15°C					
Temperature in CR near the LCR regularly 12-15°C					
Turbidity					

HYDROPOWER & ENERGY

Resource Characteristic➔ / Driver or Constraint ⬇	Electric generation (capacity)	Electric generation (energy production)	Electric generation (energy value)	Emissions	Hydro-mechanical equipment	Load following capability	Net firming purchases
Daily fluctuation limits	↓	↔	↓	--------		↓	↓
Declining reservoir elevation	↓	↓	↓	↓		↔	↓
Equalization events	↑	↓	↑	--------		--------	↑
Experimentation (HFEs, LSFs, etc.)	↓	↓	↓	--------	↓	↓	↓
Maintenance constraints	↓	↓	↓	--------		↓	--------
Minimum and maximum release caps	↓	↔	↓	--------		↓	↓
Monthly volume distribution	↓	↓	↓	--------		--------	--------
Ramp rate limits	↓	↔	↓	--------		↓	↓
Transmission constraints	↓	--------	↓	--------		↓	↓

INVASIVE FISH SPECIES

Resource Characteristic➔ / Driver or Constraint ⬇	All non-native coldwater fish	All non-native coolwater fish	All non-native warmwater fish	Brown Trout at Lees Ferry Reach	Brown Trout below Lees Ferry Reach	Green Sunfish	Smallmouth Bass	Walleye
Brown trout recruitment in Lees Ferry Reach				⬇				
Brown trout spawning habitat and recruitment below Lees Ferry Reach					⬇			
High flow event(s)			⬆					
Increasing temperature						⬇		⬇
Increasing temperature 1-3 degrees	⬆							
Increasing temperature 3-5 degrees		⬇						
Increasing temperature 5-10 degrees			⬇					
Smallmouth bass numbers in Lake Powell							⬇	
Walleye numbers in Lake Powell								⬇

RAINBOW TROUT

Resource Characteristic➔ / Driver or Constraint ⬇	LCR Inflow Area & Marble Canyon Rainbow Trout Fishery - Movement	LCR Inflow Area & Marble Canyon Rainbow Trout Fishery - Recruitment	Lees Ferry Rainbow Trout Sport Fishery - Age0 Growth	Lees Ferry Rainbow Trout Sport Fishery - Age0 Survival	Lees Ferry Rainbow Trout Sport Fishery - Growth and condition	Lees Ferry Rainbow Trout Sport Fishery - Recruitment	Lees Ferry Rainbow Trout Sport Fishery - RTELSS Age0 recruitment	Lees Ferry Rainbow Trout Sport Fishery - Spawning magnitude/hatch success	Rainbow Trout Maximum Size
Algae and invertebrate production					↑				
Controlled high and/or steady flows (incl. equalization)	↔	↔					↑	↑	
High annual, summer, and spring flow						↓			
High winter flow and/or low spring flow						↑			
Invertebrate drift availability									↑
Invertebrate drift size distribution									↑
Prey-size and abundance									↑
Rainbow trout density (# fish/km, >150mm)									↓
Spring 2008 HFE			↑	↑					
Temperature in CR									↓

RECREATIONAL EXPERIENCE

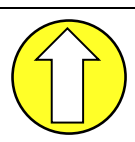
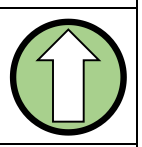
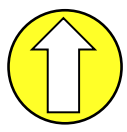
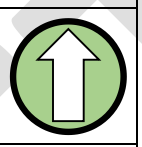
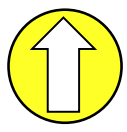
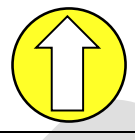
Resource Characteristic➔ / Driver or Constraint ⬇	Backpacking/day-use shore access	Backpacking/day-use shore availability	Backpacking/day-use usable campsite area	Flatwater floating in Glen Canyon NRA	Glen Canyon walk-in angling access and safety	Glen Canyon walk-in angling trout abundance	Glen Canyon walk-in angling trout condition	Glen Canyon watercraft angling access and safety	Glen Canyon watercraft angling trout abundance	Glen Canyon watercraft angling trout condition	Whitewater boat mooring (i.e., reduced beaching risk)	Whitewater navigational risk	Whitewater navigational risk Diamond down	Whitewater river crowding (i.e., rapids, beaches)	Whitewater river running experience (i.e., rapids)	Whitewater time on river	Whitewater usable campsite area	Wilderness experience
Annual whitewater and aircraft launches for recreational visitors																		⬇
Annual whitewater & aircraft launches for resource mgt., research, and transport																		⬌
Flow fluctuation	⬇	⬇	⬇		⬇			⬇			⬇	⬆	⬆	⬇	⬇	⬇	⬆	
Flow magnitude	⬇	⬇	⬇								⬆	⬆	⬆	⬆	⬆	⬆	⬇	
Past HFEs				⬇														
Rainbow trout abundance						⬆			⬆									
Rainbow trout condition							⬆			⬆								
Riparian vegetation expansion																	⬇	

RIPARIAN VEGETATION

Resource Characteristic➔ / Driver or Constraint ➘	Area of herbaceous marsh habitats	Area of woody vegetation	Community heterogeneity	Functional group cover	Native to non-native ratio	Species richness	Total vegetation cover	Vegetation structure (vertical layering)
Base flows		↑		↑			↑	↑
Harvesting by beaver					↑			
Inundation disturbance interval and timing			↑			↑		
Magnitude and duration of floods	↑	↑		↑			↑	↑
Past vegetation restoration	↑	↑	↑	↑	↑	↑	↑	↑
Proportion of silt in substrate	↑							
Sediment erosion/deposition disturbance interval and timing			↑			↑		
Tamarisk beetle					↑			

The expert team also states, “We are confident that very large floods (>90,000 cfs) are capable of removing vegetation and that the current HFE's are not large enough or long enough to remove vegetation. We know that vegetation management has a large impact on vegetation immediately following treatment, but we do not know how long those management actions will remain intact without maintenance (e.g., vegetation regrowth after removal). We also don't have good data on how fall versus spring HFE's differ in their impacts on vegetation, but expect there would be significant differences. Please see the spreadsheet for more detailed information on what is known, unknown, and what work is in progress.”

SEDIMENT

Resource Characteristic➔ / Driver or Constraint ➔	Availability of sand for aoelian transport in support of archeological site preservation	Campsite area	Sand storage	Sandbar volume
Annual release volume				
Short duration high flows				
Sustained high flows				
Sustained low flows				
Vegetation expansion				
Vegetation loss				

WATER QUALITY

Resource Characteristic➔ / Driver or Constraint ➘	GCD outflow concentrations of dissolved oxygen	GCD outflow concentrations of metals (e.g., selenium, mercury, uranium, etc.)	GCD outflow concentrations of nutrients (e.g., phosphorous, nitrogen)	GCD outflow concentrations of phytoplankton, zooplankton, chlorophyll a	GCD outflow salinity, TDS, specific conductance	GCD outflow temperature	GCD outflow turbidity/sediment load
Lake Powell biological oxygen demand	↑						
Lake Powell chemical oxygen demand	↑						
Lake Powell inflow dynamics	↑	↑	↑				↑
Lake Powell inflow: spring runoff or baseflow					↑	↑	
Lake Powell nutrient concentrations (e.g., phosphorous, nitrogen)				↑			
Lake Powell thermal stratification regime	↑	↑	↑	↑	↑	↑	↑
Lake Powell water clarity/turbidity				↑			
Lake Powell water surface elevation (high versus low)	↑	↑	↑	↑	↑	↑	↑