# Priority Questions w- Strategic Science Questions

## Found in the Strategic Science Plan:

The strategic science questions will be addressed through the following general categories of activities:

1. Core-monitoring activities are scientifically validated protocols or methods to assess the condition and trend of priority GCDAMP resources (humpback chub, sediment, food base, etc.).

2. Research and development activities include research projects aimed at (1) addressing hypotheses or information needs related to a priority GCDAMP resources or (1) developing and testing new technologies or monitoring procedures.

3. Long-term experimental activities include a suite of flow and nonflow treatments, monitoring and research, and management actions (1) to improve the condition of target resources (humpback chub, cultural sites, sediment, etc.) and (2) to understand the relationship between treatments and management actions and target resources.

Five priority questions, each with their own Key Strategic Science Questions, to help guide the GCDAMP science program:

1. **Why are the humpback chub not thriving, and what can we do about it? How many humpback chub are there and how are they doing?**

SSQ 1.1 - To what extent are adult populations of native fish controlled by production of young fish from tributaries, spawning and incubation in the mainstem, survival of young-of-year (YoY) and juvenile stages in the mainstem, or by changes in growth and maturation in the adult population as influenced by mainstem conditions? [FY2006–11]

SSQ 1.2 - Does a decrease in the abundance of rainbow trout and other coldwater and warmwater nonnatives in Marble and eastern Grand Canyons result in an improvement in the recruitment rate of juvenile humpback chub to the adult population? [FY2006–11]

SSQ 1.3 - Do rainbow trout immigrate from Glen to Marble and eastern Grand Canyons, and, if so, during what life stages? To what extent do Glen Canyon immigrants support the population in Marble and eastern Grand Canyons? [FY2007–11]

SSQ 1.4 - Can long-term decreases in the abundance of rainbow trout in Marble and eastern Grand Canyons be sustained with a reduced level of effort of mechanical removal or will recolonization from tributaries and from downstream and upstream of the removal reach require that mechanical removal be an ongoing management action? This question also applies to future removal programs targeting other nonnative species. [FY2007–11]

SSQ 1.5 - What are the important pathways, and the rate of flux among them, that link lower trophic levels with fish and how will they link to dam operations? [FY2006–09]

SSQ 1.6 - Are trends in the abundance of fish populations, or indicators from fish such as growth, condition, and body composition (e.g., lipids), correlated with patterns in invertebrate flux? [FY2006–09]

SSQ 1.7 - Which tributary and mainstem habitats are most important to native fishes and how can these habitats best be made usable and maintained? [FY2008–09]

SSQ 1.8 - How can native and nonnative fishes best be monitored while minimizing impacts from capture and handling or sampling? [FY2007–11]

1. **Which cultural resources, including traditional cultural properties, are within the area of potential effect, which should we treat, and how do we best protect them? What is the status and trends of cultural resources and what are the agents of deterioration?**

SSQ 2.1 - Do dam-controlled flows affect (increase or decrease) rates of erosion and vegetation growth at archaeological sites and TCP sites, and if so, how? [FY2007–11]

SSQ 2.2 - How do flows impact old high water zone terraces in the CRE (where the majority of archaeological sites occur), and what kinds of important information about the historical ecology and human history of the CRE are being lost due to ongoing erosion of the Holocene sedimentary deposits? [FY2004–11]

SSQ 2.3 - If dam-controlled flows are contributing to (influencing rates of) archaeological site/TCP erosion, what are the optimal flows for minimizing future impacts to historic properties? [FY2009–11]

SSQ 2.4 - How effective are various treatments (e.g., check dams, vegetation management, etc.) in slowing rates of erosion at archaeological sites over the long term? [FY2006–11]

SSQ 2.5 - What are the TCPs in the CRE, and where are they located? [FY2006–11]

SSQ 2.6 - How can tribal values/data/analyses be appropriately incorporated into a science-driven adaptive management process in order to evaluate the effects of flow operations and management actions on TCPs? [FY2006–08]

SSQ 2.7 - Are dam-controlled flows affecting TCPs and other tribally valued resources in the CRE, and, if so, in what respects are they being affected, and are those effects considered positive or negative by the tribes who value these resources? [FY2006–11]

1. **What is the best flow regime?**

SSQ 3.1 - Is there a “flow-only” operation (i.e., a strategy for dam releases, including managing tributary inputs with BHBFs, without sediment augmentation) that will restore and maintain sandbar habitats over decadal time scales? [FY2008–11]

SSQ 3.2 - To what extent could predation impacts by nonnative fish be mitigated by higher turbidity or dam-controlled high-flow releases? [FY2007–08]

SSQ 3.3 - What are the hydropower replacement costs of the modified low fluctuating flow (annually, since 1996)? [FY2007–08]

SSQ 3.4 - What are the projected hydropower costs associated with the various alternative flow regimes being discussed for future experimental science (as defined in the next phase experimental design)? [FY2006–07]

SSQ 3.5 - How is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? [FY2006–09]

SSQ 3.6 - What Glen Canyon Dam operations (ramping rates, daily flow range, etc.) maximize trout fishing opportunities and catchability? [FY2007–08]

SSQ 3.7 - How do dam-controlled flows affect visitors’ recreational experiences, and what is/are the optimal flows for maintaining a high-quality recreational experience in the CRE? [FY2007–08]

SSQ 3.8 - What are the drivers for recreational experiences in the CRE, and how important are flows relative to other drivers in shaping recreational experience outcomes? [FY2007–09]

SSQ 3.9 - How do varying flows positively or negatively affect campsite attributes that are important to visitor experience? [FY2009–11]

SSQ 3.10 - How can safety and navigability be reliably measured relative to flows? [FY2007–08]

SSQ 3.11 - How do varying flows positively or negatively affect visitor safety, health, and navigability of the rapids? [FY2007–09]

SSQ 3.12 - How do varying flows regimes positively or negatively affect group encounter rates, campsite competition, and other social parameters that are known to be important variables of visitor experience? [FY2007–09]

1. **What is the impact of sediment loss and what should we do about it?**

SSQ 4.1 - Is there a “flow-only” operation (i.e., a strategy for dam releases, including managing tributary inputs with BHBFs, without sediment augmentation) that will restore and maintain sandbar habitats over decadal timescales? [FY2008–11]

SSQ 4.2 - How important are backwaters and vegetated shoreline habitats to the overall growth and survival of YoY and juvenile native fish? Does the long-term benefit of increasing these habitats outweigh short-term potential costs (displacement and possibly mortality of young humpback chub) associated with high flows? [FY2007–11]

1. **What will happen when a temperature control device is tested or implemented? How should it be operated? Are safeguards needed for management?**

SSQ 5.1 - How do dam release temperatures, flows (average and fluctuating component), meteorology, canyon orientation and geometry, and reach morphology interact to determine mainstem and nearshore water temperatures throughout the CRE? [FY2006–08]

SSQ 5.2 - How is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? [FY2006–08]

SSQ 5.3 - To what extent do temperature and fluctuations in flow limit spawning and incubation success for native fish? [FY2003–08]

SSQ 5.4 - What is the relative importance of increased water temperature, shoreline stability, and food availability on the survival and growth of YoY and juvenile native fish? [FY2003–08]

SSQ 5.5 - Will increased water temperatures increase the incidence of Asian tapeworm in humpback chub or the magnitude of infestation, and if so, what is the impact on survival and growth rates? [FY2003–08]

SSQ 5.6 - Do the potential benefits of improved rearing habitat (warmer, more stable, more backwater and vegetated shorelines, more food) outweigh negative impacts due to increases in nonnative fish abundance? [FY2007–11]

SSQ 5.7 - How do warmer releases affect viability and productivity of native/nonnative vegetation? [FY2007–11]

# Information Needs

SSQs and information needs specified in the SSP (2007) are being used to drive monitoring and research activities for the next 5 years. In addition, GCMRC developed a crosswalk table (appendix A) showing how the RINs in the GCDAMP Strategic Plan relate to the SSQs in the SSP. Through a review of this table, GCMRC identified five new SSQs to be added to the MRP. These include:

SSQ RIN 1: What habitats and habitat characteristics, if any, will enhance survival, growth, and reproduction of native Grand Canyon fishes, especially HBC, in the mainstem Colorado River?

SSQ RIN 2: What are the most effective strategies and control methods to limit nonnative fish predation on, and competition with, native fishes?

SSQ RIN 3: What life stage(s) of RBT pose the greatest threat to HBC and other native fishes in Grand Canyon? Are the RBT that threaten native fishes in Grand Canyon produced above or below the mouth of the Paria River?

SSQ RIN 4: What are the effects of ramping rates on sediment transport and sandbar stability?

SSQ RIN 5: What is the rate of change in eddy storage (erosion) during time intervals between BHBFs?