**MRP Revisions to address the TWG Minority Report**
**GCMRC**
**June 12, 2007**

## AMWG Recommendation

**"AMWG approves the MRP as a working document to help guide preparation of the FY 08-09 work plan and budget; and recommends to the Secretary of the Interior the GCMRC be charged with (1) addressing the concerns listed in the TWG minority report in a final FY 07-11 document and (2) bringing that document to the AMWG for further consideration in the summer of 2007."** AMWG Meeting, December 5, 2007

The TWG minority report (Appendix A) was authored by NPS, Colorado and WAPA.

## NPS Issues Related to the MRP

The NPS and GCMRC met on 1/11/2007 regarding NPS concerns over the draft MRP that had been specified in the minority report presented to the AMWG on 12/6/06. The discussion boiled down to a concern that the draft MRP (11/14) lacked a comprehensive list of critical science questions that would be addressed over the next 5 years. To address this NPS concern, GCMRC and NPS agreed that GCMRC would develop a crosswalk table showing how the 250 +/- Research Information Needs in the AMP Strategic Plan relate to the Strategic Science Questions in the draft MRP. Through a review of this table, GCMRC and NPS would identify new science questions to be included in the MRP. GCMRC would bring the revised list to the TWG for review. The crosswalk table and additional science questions would be included in the revised draft MRP and brought to the AMWG for approval at its summer meeting.

Table 1 (attached) provides a crosswalk between Research Information Needs identified in the AMP Strategic Plan and strategic science questions in the FY07-FY11 Monitoring and Research Plan. Table 1 also identifies five new Strategic Science Questions that will be added to the MRP. These include:

1. What habitats and habitat characteristics, if any, will enhance survival, growth, and reproduction of native Grand Canyon fishes, especially humpback chub, in the mainstem Colorado River?
2. What are the most effective strategies and control methods to limit nonnative fish predation on, and competition with, native fishes?
3. What life stage(s) of rainbow trout pose the greatest threat to humpback chub and other native fishes? Are the rainbow trout that threaten humpback chub resident fish, produced in the Little Colorado River reach of the Colorado River, or are these rainbow trout immigrants that were spawned in the Lees Ferry reach?
4. What are the effects of ramping rates on sediment transport and sandbar stability?
5. What is the rate of change in eddy storage (erosion) during time intervals between BHBFs? [both 4 and 5 were derived from the 2006 Knowledge Assessment report]

The criteria used to determine whether a new SSQ should be added to the MRP included:

1. The RIN has not been met or resolved, *and*
2. The RIN is not addressed by an existing SSQ or other aspect of the MRP, *and*
3. The RIN is a priority for the next 5 years based on whether it was (a) relevant to an AMWG priority questions, and (b) feasible to accomplish, *and*
4. the RIN is a science related question

All criteria needed to be met before a new question was proposed.

## WAPA and State of Colorado Issues Related to the MRP

John Hamill (GCMRC) met with Rod Kuharich (CO), Randy Seaholm (CO), Mary Barger, (WAPA), and Clayton Palmer (WAPA) on December 6, 2006, in Las Vegas, NV, to discuss issues identified in the TWG minority report on the MRP. Three major issues were identified:

1. **Humpback Chub monitoring**: There is a concern that FWS has not accepted the protocols/models used by GCMRC to determine the humpback chub population status in the Grand Canyon. GCMRC has been working with FWS to ensure that the monitoring protocols and models for humpback chub in the Grand Canyon are consistent with the requirements of the Humpback Chub Recovery Plan. **Language will be included in the MRP that clarifies that the humpback chub monitoring being conducted under the auspices of the AMP will be designed to meet the standards or requirements specified in the Humpback Chub Recovery Plan.**

2. **Sediment:** The primary sediment issues were that
   - Policy guidance needs to be provided on the geographic scope of sediment work in the Grand Canyon, i.e., is the focus on the entire Colorado River from Glen Canyon Dam to Lake Mead or just to the Marble Canyon reach? **USGS supports the definition of this and other Desired Future Resource Conditions and will update the MRP when they are developed and agreed to by the managers**.
   - WAPA and Colorado would like the MRP to reflect that other options for sediment conservation will be addressed. **USGS is unaware of any other feasible options for sediment conservation over the next five years.**
   - Colorado expressed concern that use of sand bars by recreational users significantly threatens the persistence of sand bars. **This issue has not been identified by the AMP as a high priority research issue for the next 5 years**

   WAPA/Colorado were invited to draft proposed revisions to the MRP to reflect the points above; however none were provided

3. **Food Base**
   - The MRP currently specifies that effects of stable vs. fluctuating flows on food base would be addressed through the Long Term Experimental Plan which is still a work in progress. There is currently a place holder in the MRP to address the effects of

alternative flow regimes on food base. The intent is to update the MRP to be consistent with the LTEP once it is finalized. **Accordingly, USGS does not believe that the MRP should be modified to address this need at this time.**

- Palmer supports implementation of Argonne National Lab's proposal for doing short term experiments to evaluate the effects of fluctuating flows on drift and food base in FY 2008. **If WAPA believes that the Argonne proposal needs to be considered before the Long Term Experimental Plan is completed, USGS recommends that this proposal be brought to the TWG for consideration during the preparation of the FY 2008 work plan.**

**Next Steps**

1. GCMRC will revise the MRP based on consideration of comments/recommendations from the primary authors of the Minority Report (Colorado, NPS and WAPA)
2. GCMRC will send out proposed MRP revisions for review and concurrence by the TWG
3. GCMRC will send out proposed MRP revisions for review and approval by the AMWG (August 1, 2007)

Table 1. Crosswalk between Research Information Needs identified in the AMP Strategic Plan and strategic science questions in the FY07-FY11 Monitoring and Research Plan.

| No. | AMWG Sequence No. and Category | AMWG Priority | RIN no. | RIN text | SSQs and relevant CMINs<br>Questions listed below are from the MRP. | Comments |
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| 1 | 1, A | 1 | 2.1.2 | Quantify sources of mortality for humpback chub < 51 mm in rearing habitats in the LCR and mainstem and how these sources of mortality are related to dam operations. | **New SSQ**: What habitats and habitat characteristics, if any, will enhance survival, growth, and reproduction of native Grand Canyon fishes, especially humpback chub, in the mainstem Colorado River? | The current draft of the HBC management plan calls for a contract to investigate fate of YOY HBC. GCMRC is initiating work to address this RIN in FY 07. A new research and development activity will be added to the MRP to further address this RIN. |
| 2 | 1.5, A | 1 | 2.1.3 | What is the relationship between size of HBC and mortality in the LCR and the mainstem? What are the sources of mortality (i.e., predation, cannibalism, other) in the LCR and the mainstem? | **New SSQ**: What habitats and habitat characteristics, if any, will enhance survival, growth, and reproduction of native Grand Canyon fishes, especially humpback chub, in the mainstem Colorado River? | The current draft of the HBC management plan calls for a contract to investigate fate of YOY HBC. GCMRC is initiating work to address this RIN in FY 07. A new research and development activity will be added to the MRP to further address this RIN. |
| 3 | 2, A | 1 | 2.1.4 | What habitats enhance recruitment of native fish in the LCR and mainstem? What are the physical and biological characteristics of those habitats? | **New SSQ**: What habitats and habitat characteristics, if any, will enhance survival, growth, and reproduction of native Grand Canyon fishes, especially humpback chub, in the mainstem Colorado River?<br>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 YoY and juvenile stages in the mainstem, or by changes in growth and maturation in the adult population as influenced by mainstem conditions?<br>SSQ 1-7. Which tributary and mainstem habitats are most important to native fishes and how can these habitats best be made useable and maintained?<br>SA 1. What are the most limiting factors to successful HBC adult recruitment in the mainstem: spawning | GCMRC is initiating work to address this RIN in FY 07. |

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| | | | | | success, predation on YoY and juveniles, habitat (water, temperature), pathogens, adult maturation, food availability, competition? | |
| 4 | 2, A | 1 | 2.1.5 | Determine the timing and quantity of young-of-year humpback chub dispersal (passive and active) from the LCR. | 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 YoY and juvenile stages in the mainstem, or by changes in growth and maturation in the adult population as influenced by mainstem conditions? | This is informally documented by the consistent observation that catch of young HBC in the mainstem follow spates of monsoonal flows from the LCR. Timing and relative abundance can be addressed quantitatively by relating the catches in the current GCMRC database to LCR flow data; GCMRC is pursuing this question in FY 07 and later years. Determining absolute abundances would require good survivorship of captured and tagged young fish and high likelihood of capturing tagged young fish, both of which are tenuous assumptions. |
| 5 | 2, C | 1 | 2.2.3 | What are the measurable criteria that need to be met in order to remove jeopardy for humpback chub in the Colorado River ecosystem? | None proposed | Policy question. The existing (currently set aside) recovery goals (USFWS 2002) set measurable criteria that we would assume would be more stringent than those necessary to remove jeopardy. The GC population may already meet the 2002 recovery goal targets, being revised in 2007. |
| 6 | 2, A | 1 | 2.2.5 | What are the appropriate habitat conditions for HBC spawning? Where are these found? Can they be created in the mainstem? | 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 YoY and juvenile stages in the mainstem, or by changes in growth and maturation in the adult population as influenced by mainstem conditions?<br>SSQ 1-7. Which tributary and mainstem habitats are most important to native fishes and how can these habitats best be made useable and maintained?<br>**New SSQ:** What habitats and habitat characteristics, if any, will enhance survival, growth, and reproduction of | Existing data show that humpback chub are reproducing in the Little Colorado River, with its attendant physical conditions. Recommendations of the April 2007 science workshop were forwarded to USBOR for their consideration in the upcoming EIS. These recommendations attempted, among other things, to describe optimization of mainstem |

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| | | | | | native Grand Canyon fishes, especially humpback chub, in the mainstem Colorado River? | conditions for humpback chub, and may be tested beginning in water year 2009. |
| 7 | 2, A | 1 | 2.2.8 | What combination of dam release patterns and non-native fish control facilitates successful spawning and recruitment of humpback chub in the Colorado River ecosystem? | 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 YoY and juvenile stages in the mainstem, or by changes in growth and maturation in the adult population as influenced by mainstem conditions?<br>SSQ 1-4. Can long-term decreases in 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?<br>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?<br>**New SSQ**: What habitats and habitat characteristics, if any, will enhance survival, growth, and reproduction of native Grand Canyon fishes, especially humpback chub, in the mainstem Colorado River? | Limiting variables will be important to a timely answer to this question. It is reasonable to think that warmer temperatures (TCD) may be more important that either of the two parameters suggested in this question. Recommendations of the April 2007 science workshop were forwarded to USBOR for their consideration in the upcoming EIS. These recommendations attempted, among other things, to describe optimization of mainstem conditions for humpback chub, and may be tested beginning in water year 2009. |
| 8 | 2, A | 1 | 2.2.9 | What is the appropriate role of humpback chub augmentation as a management strategy to establish mainstem spawning aggregations? | None proposed | Policy and management question. The HBC genetics management plan will address the technical/management aspects of this question. Policy aspects will have to be taken up by the Secretary, AMP committees, and managers, especially USFWS and AZGFD. |
| 9 | 2, A | 5 | 2.3.2 | How will warming mainstem temperatures affect the abundance and distribution of parasites/disease? | 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?<br>SA 1. What are the most limiting factors to successful HBC adult recruitment in the mainstem: spawning success, predation on YoY and juveniles, habitat (water, | A report on investigations of the effects of parasites on humpback chub is expected by the end of fiscal year 2007. This report should shed additional light on this RIN. |

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| | | | | | temperature), pathogens, adult maturation, food availability, competition? | |
| 10 | 2, A | 1 | 2.4.1 | What are the most effective strategies and control methods to limit non-native fish predation and competition on native fish? | **New SSQ**: What are the most effective strategies and control methods to limit nonnative fish predation on, and competition with, native fishes? | This RIN is being specifically addressed in the MRP through the nonnative control project. Project manager was hired for this purpose in FY06. |
| 11 | 2, A | 1 | 2.4.3 | To what degree, which species, and where in the system are exotic fish a detriment to the existence of native fish through predation or competition? | SA 1. What are the most limiting factors to successful HBC adult recruitment in the mainstem: spawning success, predation on YoY and juveniles, habitat (water, temperature), pathogens, adult maturation, food availability, competition?<br>**New SSQ**: What life stage(s) of rainbow trout pose the greatest threat to humpback chub and other native fishes? Are the rainbow trout that threaten humpback chub resident fish, produced in the Little Colorado River reach of the Colorado River, or are these rainbow trout immigrants that were spawned in the Lees Ferry reach? | This RIN is being specifically addressed in the MRP through the nonnative control project. A project manager was hired for this purpose in FY06. |
| 12 | 2, A | 1 | 2.6.1 | What is a viable population? | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations? | M.O. 2.6 refers to FMS, BHS, and SD. Policy and management question. There is a textbook answer to this question associated with system carrying capacity, demographics, and genetics, but to develop a GC-specific answer requires an understanding of the productivity of the system and how fish utilize that productivity. System productivity is being investigated by the current aquatic food base program. |
| 13 | 2, A | 1 | 2.6.2 | What are the significant threats to these species? | 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 YoY and juvenile stages in the mainstem, or by changes in growth and maturation in the adult population as influenced by mainstem conditions? | This RIN is also addressed by the HBC Comprehensive Plan |
| 14 | 2, A | 1 | 4.2.6 | To what extent are RBT below the Paria River | SSQ 1-4. Can long-term decreases in abundance of rainbow trout in Marble and eastern Grand Canyons be | The listed SSQ most directly addresses the first part of this RIN. |

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| | | | | predators of native fish, primarily HBC? At what size do they become predators of native fish, especially HBC, i.e. how do the trophic interactions between RBT and native fish change with size of fish? | 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? | The second part of the RIN largely has to do with ontogenetic feeding shift and gape size available from the extensive RBT literature. A project will be added to the MRP to address this RIN. |
| 15 | 2, A | 6+ | 5.2.2 | How does the size and quality of the habitat used by Kanab ambersnail change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? | None proposed | Annual monitoring is tracking changes in KAS habitat consistent with CMINs for this resource. |
| 16 | 2, A | 3 | 12.9.2 | What is the best combination of dam operations and other management actions to achieve the vision, mission, goals, and objectives of the GCDAMP? | None proposed | Policy question. Conservation of natural resources is a general goal for many of the AMP/GCMRC projects, but determining whether objectives have been met will require that objectives are established. |
| 17 | 2, A | 3 | 12.9.3 | What are the relationships between dam operations and other management actions in their effects on resources addressed by GCDAMP management objectives? | None proposed | Ongoing monitoring of natural and cultural resources provides some of the data needed to answer this RIN. Recommendations of the April 2007 science workshop were forwarded to USBOR for their consideration in the upcoming EIS. These recommendations, among other things, proposed dam operation to benefit humpback chub, and may be tested beginning in water year 2009. |
| 18 | 2.5, Done | 1 | 2.1.1 | What is the minimum population size of HBC | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to | This RIN has policy and science elements. There is a textbook |

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| | | | | that should be sustained in the LCR, to ensure a viable spawning population of HBC in the LCR? | dam operations? | answer to this question associated with system carrying capacity, demographics, and genetics but to develop a GC-specific answer requires an understanding of the productivity of the system and how fish utilize that productivity. The AMP, through GCMRC, is currently investigating the transfer of biologic energy among organisms in GC. The ultimate legal answer to this RIN is expected to be contained in the revision of the Recovery Goals re-initiated in 2007. |
| 19 | 2.5, A | 1 | 2.2.4 | What is the relationship between the "aggregations" in the mainstem and LCR? Are mainstem aggregations "sinks" of the LCR? Are aggregations real or due to sampling bias? | None proposed | 2006 paper by Paukert and others answers much of this RIN. Aggregations don't appear to be sinks, although additional data are needed. There is a relatively high level of site fidelity exhibited by HBC, and recent sampling of both aggregations and random sites (addresses bias) suggests that aggregations are maintained over time. |
| 20 | 2.5, A | 1 | 2.4.2 | Determine if suppression of non-native predators and competitors increases native fish populations? | 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 YoY and juvenile stages in the mainstem, or by changes in growth and maturation in the adult population as influenced by mainstem conditions?<br>SA 1. What are the most limiting factors to successful HBC adult recruitment in the mainstem: spawning success, predation on YoY and juveniles, habitat (water, temperature), pathogens, adult maturation, food availability, competition? | This RIN is being specifically addressed in the MRP through the nonnative control project. A project manager was hired for this purpose in FY06. This RIN is also addressed by continuing the long-term monitoring of humpback chub. |
| 21 | 2.5, A | 1 | 2.4.6 | What are the population dynamics of those non-native fish that are the | SSQ 5-6. Do the potential benefits of improved rearing habitat (warmer, more stable, more backwater and vegetated shorelines, more food) outweigh negative | This RIN is being specifically addressed in the MRP through the nonnative control project. A |

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| | | | | major predators and competitors of native fish? | impacts due to increases in nonnative fish abundance? | project manager was hired for this purpose in FY06. Monitoring of these species is carried out as described in a CMIN. |
| 22 | 2.5, A | 6+ | 4.2.1 | What is the rate of emigration of rainbow trout from the Lees Ferry reach? | **New SSQ**: What life stage(s) of rainbow trout pose the greatest threat to humpback chub and other native fishes? Are the rainbow trout that threaten humpback chub resident fish, produced in the Little Colorado River reach of the Colorado River, or are these rainbow trout immigrants that were spawned in the Lees Ferry reach? | An additional research project to address rainbow trout threats to native fishes will be added to the MRP. Current monitoring, along with ongoing investigations (described in a CMIN) of alternative monitoring methods using tags (FY07 and beyond), will provide much needed information. |
| 23 | 2.5, A | 6+ | 4.2.2 | What is the most effective method to detect emigration of rainbow trout from the Lees Ferry reach? | **New SSQ**: What life stage(s) of rainbow trout pose the greatest threat to humpback chub and other native fishes? Are the rainbow trout that threaten humpback chub resident fish, produced in the Little Colorado River reach of the Colorado River, or are these rainbow trout immigrants that were spawned in the Lees Ferry reach? | This issue is being explored in FY07 and beyond through exploration of sonic tags and other possible monitoring methods. Monitoring carried out consistent with CMIN. |
| 24 | 2.5, C | 6+ | 5.1.5 | What is the taxonomic identity of the Oxyloma snails at Vasey's Paradise? Is a change to the existing taxonomic status warranted? | (No additional SSQ because of relatively low AMWG priority) | AMP-funded research has recently been compiled by U of AZ and should be available in 2007. Taxonomic change appears warranted but any regulatory change is a USFWS policy decision. |
| 25 | 2.5, C | 6+ | 5.1.6 | What is the range of occurrence of the ambersnail taxon found at Vasey's Paradise? [NOTE: Intended to address the issue of whether this is an endemic population or a relict population or part of a metapopulation.] | (No additional SSQ because of relatively low AMWG priority) | Taxonomic review by U of AZ will also report on geographic ranges of taxa. |
| 26 | 3, A | 1 | 1.5.3 | How has the value and availability of drift as a food source for Humpback chub changed | SA 1. What are the most limiting factors to successful HBC adult recruitment in the mainstem: spawning success, predation on YoY and juveniles, habitat (water, temperature), pathogens, adult maturation, food | Current foodbase research is using available historic data, but some aspects of this question can never be addressed because certain data |

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| | | | | with the implementation of Record of Decision operations? | availability, competition? | were not collected historically. |
| 27 | 3, A | 5 | 2.2.7 | Determine if implementation and operation of the TCD and/or steady flows represent a technically feasible, ecologically sustainable, and practical option for establishing mainstem spawning. | None proposed | Testing of TCD will require construction and operation. Recent GCMRC flows analysis with temperature modeling suggests two-unit TCD could elevate mainstem flow temperatures to levels that would encourage spawning, but not steady flows alone; however, HBC may always depend primarily on tributary spawning. Recommendations of the April 2007 science workshop were forwarded to USBOR for their consideration in the upcoming EIS. These recommendations attempted, among other things, to describes a dam operation to improve mainstem conditions for humpback chub, and may be tested beginning in water year 2009. |
| 28 | 3, A | 1? | 2.2.10 | What techniques are available to determine natal stream of fishes in the Colorado River ecosystem? | None proposed | Isotopes of carbon, nitrogen, and hydrogen appear to have excellent promise for addressing this question. Carbon and nitrogen isotopes are part of existing foodbase program; GCMRC is seeking additional funding to include hydrogen isotopes. |
| 29 | 3, A | 1 | 2.2.12 | What are the impacts of research activities on mortality, recruitment and the population size of humpback chub? | None proposed | GCMRC initiate a study in FY 07 to evaluate the impacts of trammel nets on native fishes. In addition, GCMRC will ask humpback chub PEP to address this question, including effective testing methods that may be pursued. |
| 30 | 3, A | 1 | 2.3.1 | How do parasite/disease loads affect population | SSQ 1-1. To what extent are adult populations of native fish controlled by production of young fish from | |

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| | | | | viability? | tributaries, spawning and incubation in the mainstem, survival of YoY and juvenile stages in the mainstem, or by changes in growth and maturation in the adult population as influenced by mainstem conditions?<br>SA 1. What are the most limiting factors to successful HBC adult recruitment in the mainstem: spawning success, predation on YoY and juveniles, habitat (water temperature) pathogens, adult maturation, food availability, competition? | |
| 31 | 3, A | 1 | 2.4.4 | What are the target population levels, body size and age structure for non-native fish in the Colorado River ecosystem that limit their levels to those commensurate with the viability of native fish populations? | None proposed | This RIN is being specifically addressed in the MRP through the nonnative control project. A project manager was hired for this purpose in FY06. The biological energy modeling is expected to provide insights to help answer this RIN. |
| 32 | 3, A | 1 | 2.4.5 | What are the sources (natal stream) of nonnative predators and competitors? | None proposed | Nonnative control planning (FY07) seeks to determine relative biological importance of this question. The answer to this question may go outside the current scope of the AMP |
| 33 | 3, A | 6+ | 5.1.9 | How can incidental take for Kanab ambersnail at Vasey's Paradise be minimized? | None proposed | NPS limiting recreation access addresses this concern on a regular basis, and moving vegetation mats in burlap appears to be effective mitigation measure during experimental high flow events. |
| 34 | 3, A | 5 | 7.1.3 | What are the potential ecological effects of increasing mainstem water temperatures? | 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 YoY and juvenile stages in the mainstem, or by changes in growth and maturation in the adult population as influenced by mainstem conditions?<br>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? | This question is likely to be addressed through the LTEP |

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| 35 | 3, A | 3 | 7.4.4 | How does flow rate and fluctuation affect habitat availability and utilization by fish and other organisms? | 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 YoY and juvenile stages in the mainstem, or by changes in growth and maturation in the adult population as influenced by mainstem conditions?<br>SSQ 1-7. Which tributary and mainstem habitats are most important to native fishes and how can these habitats best be made useable and maintained?<br>SA 1. What are the most limiting factors to successful HBC adult recruitment in the mainstem: spawning success, predation on YoY and juveniles, habitat (water temperature) pathogens, adult maturation, food availability, competition? | This question is likely to be addressed through the LTEP |
| 36 | 3, A | 2 | 11.1.3 | What are the thresholds triggering management actions? | SSQ 2-1. Do dam controlled flows increase or decrease rates of erosion and vegetation growth at arch sites and TCPs, and if so, how?<br>SSQ 2-2. How do flows impact OHWZ terraces in the CRE, 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 terraces?<br>SSQ 2-3. If flows contribute to arch site/TCP erosion, what are the optimal flows for minimizing impacts to these cultural resources?<br>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?<br>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?<br>CMIN 11.1.1 (SPG revised) Determine the condition and integrity of prehistoric and historic sites in the Colorado River ecosystem through tracking rates of erosion, visitor impacts, and other relevant variables. Determine the condition and integrity of TCPs in the Colorado River ecosystem. | This RIN is ultimately a management/ policy decision related to desired future conditions, but ongoing research on relationship between flows, climate, and subaerial sediment transport, and data collected through monitoring efforts, can help determine the best answer. Recommendations of the April 2007 science workshop were forwarded to USBOR for their consideration in the upcoming EIS. These recommendations attempted, among other things, to describe optimization of mainstem conditions for humpback chub, including action triggers, and may be tested beginning in water year 2009. |

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| 37 | 3, A | | * IN 12.1 | Develop information that can be used by the TWG, in collaboration with GCMRC, to establish current and target levels for all resources within the AMP as called for in the AMP strategic plan. | None proposed | Policy and management question. GCMRC can assist, but ultimately managers need to decide what target conditions the AMP is trying to attain. |
| 38 | 3, A | 3 | 12.9.1 | What is the impact on downstream resources of short-term increases to maximum flow, daily fluctuations, and downramp limits? | **New SSQ.** What are the effects of ramping rates on sediment transport and sandbar stability?<br>**New SSQ**. What is the rate of change in eddy storage (erosion) during time intervals between BHBFs? | To be determined through the LTEP. Several reports have been published since 1998 by sediment scientists that provide information addressing this question. However, ramping rate studies were still identified as being needed during the 2005 Knowledge Assessment workshop. Ramping rates research is best undertaken initially through flume experiments and modeling and then through field verification below Glen Canyon Dam. The new SSQs included here were derived from the 2006 Knowledge Assessment Report and admittedly pertain to only one of several downstream resources of interest. |
| 39 | 3.5, Done | 1 | 2.2.1 | What is a viable population and what is the appropriate method to assess population viability of native fish in the Colorado River ecosystem? What is an acceptable probability of extinction over what management time period for humpback chub throughout the Colorado River ecosystem? | None proposed | Policy and management questions. Determination of viable population and acceptable extinction probability up to management agencies. Recent publications on ASMR model provide strong support for this method to assess population size/trend. |
| 40 | 3.5, A | 1 | 2.3.3 | How does non-native fish | SA 1. What are the most limiting factors to successful | |

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| | | | | control affect disease/parasite loads? [Note: The concept is if there are fewer hosts, there will be a lower incidence of parasites.] | HBC adult recruitment in the mainstem: spawning success, predation on YoY and juveniles, habitat (water temperature) pathogens, adult maturation, food availability, competition? | |
| 41 | 3.5, A | 6+ | 4.2.7 | What dam release patterns most effectively maintain the Lees Ferry RBT trophy fishery while limiting RBT survival below the Paria River? | SSQ 3-6. What Glen Canyon Dam operations (ramping rates, daily flow range, etc.) maximize trout fishing opportunities and catchability? | This question would be most appropriately addressed as a LTEP study. |
| 42 | 3.5, A | 2 | 11.1.2 | What are the historic properties within the area of potential effects? | SSQ 2-1. Do dam controlled flows increase or decrease rates of erosion and vegetation growth at arch sites and TCPs, and if so, how?<br>SSQ 2-2. How do flows impact Old High Water Zone (OHWZ) terraces in the CRE, 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 terraces?<br>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 those resources?<br>CMIN 11.1.1 (SPG revised) Determine the condition and integrity of prehistoric and historic sites in the Colorado River ecosystem through tracking rates of erosion, visitor impacts, and other relevant variables. Determine the condition and integrity of TCPs in the Colorado River ecosystem. | The RIN question was answered in the 1995 EIS: 336 archaeological sites. There are still uncertainties regarding which sites are affected by which specific aspects of dam operations, and how dam processes interact with other elements of the environment to effect those changes; these uncertainties are being addressed through R&D studies in FY07-FY09. There are also continuing uncertainties about the numbers and locations of traditional cultural properties (see comment below.) BOR, as lead agency for Section 106 compliance, has the responsibility for completing TCP identification. |
| 43 | 3.5, A | 2 | 11.1.2 .a | For each tribe and living community, what are the register eligible traditional cultural properties? | 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 those resources? | This info need remains unresolved. BOR is supposed to address this RIN in the context of NHPA compliance, although it is unclear how much progress has been made in recent years towards answering this question. |
| 44 | 4, A | 6+ | 1.1 | What are the fundamental trophic interactions in the | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to | |

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| | | | | aquatic ecosystem? | dam operations? | |
| 45 | 4, A | 6+ | 1.4 | What is the current carbon budget for the Colorado River ecosystem? | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations? | |
| 46 | 4, A | 1 | 2.2.2 | Determine if a population dynamics model can effectively predict response of native fish under different flow regimes and environmental conditions. | None proposed | No models with appropriate data are available to address this RIN. However such a model is a long term goal. Coggins continues to refine GC model for both natives and nonnatives. |
| 47 | 4, A[1] | 1 | 2.2.6 | What are the criteria for establishment of spawning aggregations (i.e., how does one determine if it is "established")?<br><br>[1] Normally, this RIN would be placed in Category C. However, pursuant to the 2001 Department of the Interior Appropriations Bill that established the power revenue cap, this RIN is placed in Category A. | 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 YoY and juvenile stages in the mainstem, or by changes in growth and maturation in the adult population as influenced by mainstem conditions?<br>SSQ 1-7. Which tributary and mainstem habitats are most important to native fishes and how can these habitats best be made useable and maintained?<br>SA 1. What are the most limiting factors to successful HBC adult recruitment in the mainstem: spawning success, predation on YoY and juveniles, habitat (water temperature) pathogens, adult maturation, food availability, competition? | This is primarily a policy determination. However, a "Population Viability Analysis" could be conducted to shed light on this question. |
| 48 | 4, A | 6+ | 2.6.5 | How are movement patterns for flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem affected by age, natal stream, and dam operations? | 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 YoY and juvenile stages in the mainstem, or by changes in growth and maturation in the adult population as influenced by mainstem conditions? | Studies focused specifically on FMS, BHS or SD are not high priority for next 5 years |
| 49 | 4, A | 6+ | 2.6.6 | How is the rate of mortality for flannelmouth sucker, bluehead sucker, and | 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 YoY and juvenile stages in the mainstem, or | Studies focused specifically on FMS, BHS or SD are not high priority for next 5 years |

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| | | | | speckled dace in the Colorado River ecosystem related to individual body size? What are the sources of mortality for flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem? | by changes in growth and maturation in the adult population as influenced by mainstem conditions? | |
| 50 | 4, A | 6+ | 5.1.4 | Identify and evaluate alternative Management Actions to ensure viability of Kanab ambersnail at Vasey's Paradise where (1) the population dynamic model predicts loss of population viability, or (2) monitoring discovers substantial habitat or Kanab ambersnail population declines. | (No additional SSQ because of relatively low AMWG priority) | USFWS conducting species status review in 2006-07 that will help prioritize this information need |
| 51 | 4, A | 6+ | 5.1.8 | What are the measurable criteria that need to be met to remove jeopardy for Kanab ambersnail at Vasey's Paradise? | (No additional SSQ because of relatively low AMWG priority) | USFWS conducting species status review in 2006-07 that will help prioritize this information need |
| 52 | 4, A | 6+ | 6.4.1 | How have the abundance, composition, and distribution of the sand beach community changed since dam closure (1963), high flows (1984), interim flows (1991), and the implementation of Record of Decision operations (1996)? | (No additional SSQ because of relatively low AMWG priority) | This will be a focus of the vegetation synthesis project initiated in FY 07. Current work being conducted consistent with CMINs. |
| 53 | 4, A | 6+ | 6.5.3 | How has the abundance | (No additional SSQ because of relatively low AMWG | This will be a focus of the |

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| | | | | and distribution of non-native species changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)? | priority) | vegetation synthesis project initiated in FY 07. Current work being conducted consistent with CMINs. |
| 54 | 4, A | 5 | 7.1.2 | What are the most likely downstream temperature responses to a variety of scenarios involving a TCD on Glen Canyon Dam? | 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 near shore water temperatures throughout the CRE? | This information need for the mainstem has been largely addressed through the temperature modeling conducted for the experimental flow analysis. Additional modeling is being initiated in 2007 to increase accuracy and to include near shore habitats. |
| 55 | 4, A | 6+ | 7.2.3 | Which metals should be measured? Where and how often? | (No additional SSQ because of relatively low AMWG priority) | Please refer to the PEP review report on quality of water from 1999. |
| 56 | 4, A | 3 | 7.4.3 | How do changes in flow volume and rate of change affect food base and energy productivity in the Colorado River ecosystem? | SSQ 3-5. How is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |
| 57 | 4, A | 4 | 8.5.1 | What elements of Record of Decision operations (upramp, downramp, maximum and minimum flow, MLFF, HMF, and BHBF) are most/least critical to conserving new fine-sediment inputs, and stabilizing sediment deposits above the 25,000 cfs stage? | **New SSQ**. What are the effects of ramping rates on sediment transport and sandbar stability?<br>**New SSQ.** What is the rate of change in eddy storage (erosion) during time intervals between BHBFs? | Several reports have been published since 1998 by sediment scientists that provide information addressing this question. However, ramping rate studies were still identified as being needed during the 2005 Knowledge Assessment workshop. These new SSQs were derived from those discussions among sediment scientists and are taken from the 2006 Knowledge Assessment report. Ramping rates research is best undertaken initially |

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| | | | | | | through flume experiments and modeling and then through field verification below Glen Canyon Dam. The second question is best addressed through future BHBF testing and long-term monitoring of sand storage between such tests. |
| 58 | 4, A | 4 | ** SIN 8.5.3 | What is the relationship between turbidity and biological processes? | SSQ 3-5. How is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |
| 59 | 4, A | 4 | ** SIN 8.5.6 | What are the grain-size characteristics of sand bars associated with designated riparian vegetation zones? | (No additional SSQ because of relatively low AMWG priority) | This SIN is a legitimate science question and should be pursued as support becomes available. Grain size data from terrestrial beach environments was collected within FIST study reaches using innovative "beach ball" digital cameras (Rubin and others, personal communication) and verified with standard sieving methods. These methods can be further developed and used in conjunction with terrestrial vegetation monitoring to resolve this question further, if the existing data are not adequate. |
| 60 | 4, A | 2 | 11.1.1 | What are the sources of impacts to historic properties? | SSQ 2-1. Do dam controlled flows increase or decrease rates of erosion and vegetation growth at arch sites and TCPs, and if so, how?<br>SSQ 2-2. How do flows impact OHWZ terraces in the CRE, 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 terraces?<br>CMIN 11.1.1 (SPG revised) Determine the condition and integrity of prehistoric and historic sites in the Colorado River ecosystem through tracking rates of erosion, visitor impacts, and other relevant variables. Determine the condition and integrity of TCPs in the Colorado River ecosystem. | |

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| 61 | 4, A | 2 | 11.1.3.b | How should adverse effects to historic properties be mitigated? | SSQ 2-3. If flows contribute to arch site/TCP erosion, what are the optimal flows for minimizing impacts to these cultural resources?<br>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?<br>CMIN 11.1.1 (SPG revised) Determine the condition and integrity of prehistoric and historic sites in the Colorado River ecosystem through tracking rates of erosion, visitor impacts, and other relevant variables. Determine the condition and integrity of TCPs in the Colorado River ecosystem.<br>CMIN 11.2.1 (SPG revised) Determine the condition of traditionally important resources and locations using tribal perspectives and values. | The RIN is primarily a management decision, not a science question, although ongoing research for core monitoring (e.g. study of check dam effectiveness and erosion rates) can provide data helpful to making a scientifically-sound management decision. |
| 62 | 4, A | 2 | 11.2.3 | Determine acceptable methods to preserve or treat traditionally important resources within the Colorado River ecosystem. | SSQ 2-3. If flows contribute to arch site/TCP erosion, what are the optimal flows for minimizing impacts to these cultural resources?<br>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?<br>CMIN 11.1.1 (SPG revised) Determine the condition and integrity of prehistoric and historic sites in the Colorado River ecosystem through tracking rates of erosion, visitor impacts, and other relevant variables. Determine the condition and integrity of TCPs in the Colorado River ecosystem.<br>CMIN 11.2.1 (SPG revised) Determine the condition of traditionally important resources and locations using tribal perspectives and values. | The issue of acceptability is largely a management decision for BOR, NPS, tribes and other AMP stakeholders to discuss and resolve. Ongoing research and development for core monitoring (e.g., the study of check dam effectiveness) will provide data helpful to informing this management decision. |
| 63 | 4.5, A | 6+ | 2.5.3 | What characteristics define suitable habitat for razorback sucker? Does suitable habitat for razorback sucker occur in the Colorado River ecosystem? | (No additional SSQ because of relatively low AMWG priority) | Not a current AMP high priority. |
| 64 | 4.5, A | 6+ | 2.6.4 | What is the age structure, | (No additional SSQ because of relatively low AMWG | Not a current AMP high priority. |

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| | | | | including relationship between age and size of flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem? | priority) | |
| 65 | 4.5, A | 1 | 4.1.3 | To what extent is there overlap in the Lees Ferry reach of RBT habitat and native fish habitat? | 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 YoY and juvenile stages in the mainstem, or by changes in growth and maturation in the adult population as influenced by mainstem conditions?<br>SSQ 1-7. Which tributary and mainstem habitats are most important to native fishes and how can these habitats best be made useable and maintained?<br>SA 1. What are the most limiting factors to successful HBC adult recruitment in the mainstem: spawning success, predation on YoY and juveniles, habitat (water temperature) pathogens, adult maturation, food availability, competition? | |
| 66 | 4.5, A | 6+ | 4.2.3 | How is the rate of emigration of RBT from the Lees Ferry reach to below the Paria River affected by abundance, hydrology, temperature, and other ecosystem processes? | 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 YoY and juvenile stages in the mainstem, or by changes in growth and maturation in the adult population as influenced by mainstem conditions?<br>SSQ 1-7. Which tributary and mainstem habitats are most important to native fishes and how can these habitats best be made useable and maintained?<br>SA 1. What are the most limiting factors to successful HBC adult recruitment in the mainstem: spawning success, predation on YoY and juveniles, habitat (water temperature) pathogens, adult maturation, food availability, competition? | Habitat work by Korman and evaluation of tagging methods by GCMRC and AZGFD are addressing this need in FY07 and beyond. |
| 67 | 4.5, A | | 4.2.5 | To what extent is there overlap in the Colorado River ecosystem below the Paria River of RBT habitat and native fish | 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 YoY and juvenile stages in the mainstem, or by changes in growth and maturation in the adult | |

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| | | | | habitat? | population as influenced by mainstem conditions?<br>SSQ 1-7. Which tributary and mainstem habitats are most important to native fishes and how can these habitats best be made useable and maintained?<br>SA 1. What are the most limiting factors to successful HBC adult recruitment in the mainstem: spawning success, predation on YoY and juveniles, habitat (water temperature) pathogens, adult maturation, food availability, competition? | |
| 68 | 4.5, A | 6+ | 6.2.1 | How has the patch number, patch distribution, composition and area of the NHWZ community changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)? | 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?<br>CMIN 6.1.1., 6.6.1., 6.2.1, 6.5.1. Determine and track the abundance, composition, distribution, and area of terrestrial native and nonnative vegetation species in the CRE. | Vegetation monitoring and synthesis projects in FY07 and beyond are addressing this information need. . Monitoring being conducted consistent with CMINs for this resource |
| 69 | 4.5, A | 6+ | 6.5.1 | Determine if non-native species are expanding or contracting at a local scale (patch or reach). | 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? | Vegetation monitoring and synthesis projects in FY07 and beyond are addressing this information need. Monitoring being conducted consistent with CMINs for this resource |
| 70 | 4.5, A | | ** SIN 7.2.2 | Which water quality variables influence food base and fisheries in the Colorado River ecosystem? | SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations?<br>SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations? | |
| 71 | 4.5, A | 4 | * IN 8.1 | If sediment cannot be preserved in the system using available management actions, what is the feasibility (including technical, legal, economic, and policy issues) of sediment | None proposed | Partly addressed through the FY05-06 sediment augmentation engineering feasibility study. . (See Randle and others, 2007). No additional SSQ can be justified until such time that the SSQ relating to the “flows only” sediment question is resolved |

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| | | | | augmentation as a means of achieving this goal? | | through further tests of the BHBF concept. |
| 72 | 4.5, A | 4 | ** SIN 8.5.4 | What is the role of turbidity and how can it be managed to achieve biological objectives? | SSQ 3-5. How is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | Aside form food base project, this is a relatively low priority at this time. |
| 73 | 4.5, A | | 8.6.2 | How do ongoing inputs of coarse-sediment from tributaries alter the distribution of main channel habitats needed by benthic organisms within pools, runs, and eddies throughout the Colorado River ecosystem? | SSQ 3-5. How is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | (No additional SSQs are offered at this time owing to the relatively low AMWG priority assigned to this topic) |
| 74 | 4.5, A | 2 | 11.2.1 | What are traditionally important resources and locations for each tribe and other groups? | 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 those resources?<br>CMIN 11.1.1 (SPG revised) Determine the condition and integrity of prehistoric and historic sites in the Colorado River ecosystem through tracking rates of erosion, visitor impacts, and other relevant variables. Determine the condition and integrity of TCPs in the Colorado River ecosystem.<br>CMIN 11.2.1 (SPG revised) Determine the condition of traditionally important resources and locations using tribal perspectives and values. | As previously noted for RIN No. 11.1.2a, this info need remains unresolved. BOR is supposed to answer this RIN in the context of NHPA compliance. Some of this information may be provided indirectly by tribes through completing their FY06 monitoring protocol development project. |
| 75 | 4.5, A | 2 | 11.2.2 | What is the baseline measure for resource integrity? | None proposed | The RIN specifically references tribally valued resources (MO 11.2) but this question really applies to all AMP monitored resources. Baseline conditions have been established at the start of the AMP (1996). This IN should be determined as part of the target |

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| | | | | | | setting process for all AMP resources. |
| 76 | 4.5, A | | 12.3.1 | As necessary, investigate the most effective methods to integrate and synthesize resource data. | None proposed | This is major focus of FY07-11 GCMRC strategic plan and MRP. |
| 77 | 4.5, A | | 12.5.5 | Identify the desired level of information, education, and outreach provided for Glen and Grand Canyon river users and the general public? | None proposed | A possible task for POAGH |
| 78 | 4.5, A | | 12.11.1 | What are the most effective methods to maintain or attain the participation of externally-funded investigators? | None proposed | A possible AMWG task |
| 79/80 | 5, A | 3 | 1.1.1/ 1.1.2 | How are the composition and biomass of primary producers between Glen Canyon Dam and the Paria River affected by flow and water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), and water borne diseases, or other factors. | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations?<br>SSQ 1-6. Are fish populations, trends, or indicators from fish, such as growth, condition, and body composition, correlated with patterns in invertebrate flux?<br>SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |
| 81 | 5, A | 3 | 1.1.4 | What are the habitat characteristics between Glen Canyon Dam and the Paria River that most affect primary productivity? How are these characteristics affected by Glen Canyon Dam operations? | SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |
| 82 | 5, A | | 1.2 | How are the production, composition, density, and | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to | |

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| | | | | biomass of the benthic invertebrate community affected by primary productivity vs. allochthonous inputs? | dam operations? | |
| 83 | 5, A | | 1.2.2 | What is the estimated productivity of benthic invertebrates for the reach between Glen Canyon Dam and the Paria River? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.] | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations?<br>SSQ 1-6. Are fish populations, trends, or indicators from fish, such as growth, condition, and body composition, correlated with patterns in invertebrate flux?<br>SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |
| 84 | 5, A | | 1.3 | What foodbase criteria do other agencies use to assess aquatic ecosystem health? | | GCMRC will research this one, as part of the food base project final report |
| 85 | 5, A | | 1.4.1 | How are the composition and biomass of benthic invertebrates in the Colorado River ecosystem below the Paria River affected by flow, water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), new invasive species, and water borne diseases, or other factors? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations?<br>SSQ 1-6. Are fish populations, trends, or indicators from fish, such as growth, condition, and body composition, correlated with patterns in invertebrate flux?<br>SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |

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| | | | | pursued.] | | |
| 86 | 5, A | | 1.5.2 | How do top-down effects (grazing and predation) affect the abundance and composition of drift? | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations?<br>SSQ 1-6. Are fish populations, trends, or indicators from fish, such as growth, condition, and body composition, correlated with patterns in invertebrate flux?<br>SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |
| 87 | 5, A | 5 | 2.6.7 | How does temperature modification in the mainstem affect recruitment and mortality for flannelmouth sucker, bluehead sucker, and speckled dace originating from tributary spawning efforts? | 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 and juvenile stages in the mainstem, or by changes in growth and maturation in the adult population as influenced by mainstem conditions? | May be tested as part of the LTEP if a TCD is constructed |
| 88 | 5, A | 6+ | 5.1.2 | What parameters have the greatest influence on population viability of Kanab ambersnail at Vasey's Paradise (e.g., parasites, predation, discharges, habitat size, quality, and human use/visitation)? | (No additional SSQ because of relatively low AMWG priority) | This is being addressed by USFWS species status review in 2006-07. |
| 89 | 5, A | 6+ | 5.1.3 | Develop a population dynamic model to predict Kanab ambersnail viability under different flows and environmental conditions. | None proposed | No additional SSQ because of relatively low AMWG priority) |
| 90 | 5, A | 6+ | 5.2.1 | How does the size, quality, and recovery time of Kanab ambersnail habitat change following natural scours, or other events? | (No additional SSQ because of relatively low AMWG priority) | Variable flows/events will be needed to address this RIN. It may be more appropriate to consider it as an EIN to be addressed as part of the LTEP. |

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| 91 | 5, A | 6+ | 6.1.1 | How has the abundance, composition, distribution, and area of the marsh community changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)? | 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? | Monitoring conducted consistent with CMINs. |
| 92 | 5, A or B | 6+ | 6.3.2 | What dam operations (Category A), or other management actions (Category B), have the potential to maintain the OHWZ community at the current stage elevation, or establish the community at a lower stage elevation? | 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? | Monitoring conducted consistent with CMINs. |
| 93 | 5, A | | * IN 6.4 | How much allochthonous material (e.g., leaf litter) is exchanged between the terrestrial and aquatic systems? | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations? | |
| 94 | 5, A or B | | 6.5.2 | What dam operations (Category A), or other management actions (Category B), have the potential to increase or decrease the distribution and abundance of non-native species? | 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? | Monitoring conducted consistent with CMINs. |
| 95 | 5, A | | 6.6.2 | Which seeps and springs are culturally important or occupied by rare and endemic species? | 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? CMIN 6.1.1., 6.6.1., 6.2.1, 6.5.1. Determine and track the abundance, composition, distribution, and area of terrestrial native and nonnative vegetation species in the CRE. | |
| 96 | 5, A | 5 | 7.1.1 | What are the desired | SSQ 3-5. How is invertebrate flux affected by water | |

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| | | | | ranges of spatial and temporal patterns of water temperatures for the Colorado River ecosystem? | quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations?<br>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 near shore water temperatures throughout the CRE?<br>SSQ 5-3. To what extent do temperature and fluctuations in flow limit spawning and incubation success for native fish? | |
| 97 | 5, A | | 7.2.1 | Which major ions should be measured? Where and how often? | SSQ 3-5. How is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations?<br>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 near shore water temperatures throughout the CRE?<br>SSQ 5-3. To what extent do temperature and fluctuations in flow limit spawning and incubation success for native fish? | |
| 98 | 5, A | | ** SIN 7.2.1 | How do the hydrodynamics and stratification of Lake Powell influence the food base or fisheries downstream? | SSQ 3-5. How is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations?<br>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 near shore water temperatures throughout the CRE?<br>SSQ 5-3. To what extent do temperature and fluctuations in flow limit spawning and incubation success for native fish?<br>SSQ #5.5 Will increased water temperatures increase the incidence of Asian Tapeworm in humpback chub or the magnitude of infestation, and if so, [*then*] what is the impact on survival and growth rates? | These are several related quality-of-water questions that require Lake Powell project to be linked with the Integrated Downstream Quality-of-Water project. This integrated synthesis topic should be approached as a new research and modeling initiative in the Lake Powell and downstream efforts and focused using advanced conceptual modeling (Phase II). |
| 99 | 5, A | | 7.2.2 | Which nutrients should be measured? Where and how often? | SSQ 3-5. How is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations?<br>SSQ 5-1. How do dam release temperatures, flows | Both this and RIN 7.2.1 should be combined and dealt with as one topic. |

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| | | | | | (average and fluctuating component), meteorology, canyon orientation and geometry, and reach morphology) interact to determine mainstem and near shore water temperatures throughout the CRE?<br>SSQ 5-3. To what extent do temperature and fluctuations in flow limit spawning and incubation success for native fish? | |
| 100 | 5, A | | 7.3.1 | Develop simulation models for Lake Powell and the Colorado River to predict water quality conditions under various operating scenarios, supplant monitoring efforts, and elucidate understanding of the effects of dam operations, climate, and basin hydrology on Colorado River water quality. | 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 near shore water temperatures throughout the CRE? | Temp model that has been developed for flow analysis and is currently being refined addresses one important component of this information need.<br>Physical scientists at the GCMRC do not concur with the idea of using a model to "supplant" monitoring. |
| 101 | 5, A | 3 | 7.4.2 | What is the desired pattern of seasonal and annual flow dynamics associated with powerplant operations, BHBFs, HMFs, or other flows to meet AMP Goals and Objectives? | All of the MRP Strategic Science Questions Under Priority #3, #4 and #5. | This is a case in which the SSQs contained in the MRP are actually more detailed than the RIN that preceded them. |
| 102 | 5, A | 4 | 8.1.1 | What is the longitudinal variability of fine-sediment inputs, by reach? | 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 time scales? | This is part of what is needed to answer SSQ #4.1 with respect to the system-wide sand mass flux (inputs). This is mostly known with respect to the major tributaries and fairly well known for the lesser tributaries with regard to coarse and fine sediment. |
| 103 | 5, A | 4 | 8.1.2 | What is the temporal variability of fine-sediment inputs, by reach? | 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 time | This is part of what is needed to answer SSQ #4.1 with respect to the system-wide sand mass flux (inputs). This is mostly known |

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| | | | | | scales? | from various publications with respect to both the seasonality and decadal-scale variability. |
| 104 | 5, A | 4 | 8.1.3<br>8.2.1<br>8.3.1<br>8.4.1<br>8.5.6 | What fine sediment abundance and distribution, by reach, is desirable to support GCDAMP ecosystem goals? [Note: Definition of "desirable" will be derived from targets for other resources and managers goals.] | 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 time scales?<br><br>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? | Managers need to define targets for sediment and other resources.<br><br>Physical scientists at GCMRC prefer to use the concept of spatial and temporal "evaluation criteria" rather than "targets" for addressing this RIN. |
| 108 | 5, A | 4 | **<br>SIN<br>8.5.2 | What is the relationship between the fine-sediment budget and turbidity? | SSQ #4.1e Can we develop a relationship between suspended sediment concentration and turbidity to support fisheries research? | This is sub-question "e" under SSQ #4.1 as reported in the 2005 Knowledge Assessment |
| 109 | 5, A | 4 | 8.5.4 | What is the significance of aeolian processes in terrestrial sandbar reworking? | 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 time scales? | This question was at least partially addressed by the work of Rubin and Draut in their 2003-2006 research, including the 2004 BHBF test. |
| 110 | 5, A | 4 | **<br>SIN<br>8.5.5 | How can the ongoing fine sediment supply be managed to achieve sustainable habitats? | 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 time scales? | This is partially answered within existing reports: Rubin and others, 2002; Wright and others, 2005; Topping and others, 2006, etc. |
| 112 | 5, A | | 9.3.1 | What is the desired target level of camping beaches by reach? | None proposed | Managers need to define targets for camping beaches and other AMP resources. GIS atlas project (FY07-08) may provide info useful to determining appropriate target. |
| 113 | 5, A | 3 | 10.1.2 | What would be the effects on the Colorado River ecosystem and marketable capacity and energy of | SSQ 3-4. What are the projected costs associated with the various alternative flow regimes being discussed for future experimental science (as defined in the next phase experimental design?) | This is an EIN that presumably will be addressed in LTEP. |

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| | | | | increasing the upramp and downramp limit? | | |
| 114 | 5, A | 3 | 10.1.3 | What would be the effects on the Colorado River ecosystem and marketable capacity and energy of raising the maximum power plant flow limit above 25,000 cfs? | SSQ 3-4. What are the projected costs associated with the various alternative flow regimes being discussed for future experimental science (as defined in the next phase experimental design?) | This is an EIN that may be addressed in LTEP. |
| 115 | 5, A | | 10.3.1 | What are the effects of providing financial exception criteria? | SSQ 3-4. What are the projected costs associated with the various alternative flow regimes being discussed for future experimental science (as defined in the next phase experimental design?) | This is an EIN that may be addressed in LTEP. |
| 116 | 5, A | 2 | 11.1.1 .a | What and where are the geomorphic processes that link loss of site integrity with dam operations as opposed to dam existence or natural processes? | 2-1. Do dam controlled flows increase or decrease rates of erosion and vegetation growth at arch sites and TCPs, and if so, how?<br>SSQ 2-2. How do flows impact OHWZ terraces in the CRE, 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 terraces?<br>SSQ 2-3. If flows contribute to arch site/TCP erosion, what are the optimal flows for minimizing impacts to these cultural resources?<br>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?<br>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 those resources?<br>CMIN 11.1.1 (SPG revised) Determine the condition and integrity of prehistoric and historic sites in the Colorado River ecosystem through tracking rates of erosion, visitor impacts, and other relevant variables. Determine the condition and integrity of TCPs in the Colorado River ecosystem. | |
| 117 | 5, A | 2 | 11.1.1 | What are the terrace | SSQ 2-2. How do flows impact OHWZ terraces in the | |

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| | | | .b | formation processes and how do dam operations affect current terrace formations processes? | CRE, 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 terraces? | |
| 118 | 5, A | 2 | 11.1.1 .c | Determine if and where dam operations cause accelerated erosion to historic properties? | SSQ 2-1. Do dam controlled flows increase or decrease rates of erosion and vegetation growth at arch sites and TCPs, and if so, how?<br>SSQ 2-2. How do flows impact OHWZ terraces in the CRE, 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 terraces?<br>SSQ 2-3. If flows contribute to arch site/TCP erosion, what are the optimal flows for minimizing impacts to these cultural resources?<br>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 those resources? | |
| 119 | 5, A | 2 | 11.1.1 .d | What are the potential threats to historic properties relative to integrity and significance? | 2-1. Do dam controlled flows increase or decrease rates of erosion and vegetation growth at arch sites and TCPs, and if so, how?<br>SSQ 2-2. How do flows impact OHWZ terraces in the CRE, 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 terraces?<br>SSQ 2-3. If flows contribute to arch site/TCP erosion, what are the optimal flows for minimizing impacts to these cultural resources?<br>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?<br>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 those resources? | |

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| | | | | | CMIN 11.1.1 (SPG revised) Determine the condition and integrity of prehistoric and historic sites in the Colorado River ecosystem through tracking rates of erosion, visitor impacts, and other relevant variables. Determine the condition and integrity of TCPs in the Colorado River ecosystem. | |
| 120 | 5, A | 2 | 11.1.2 .b | How do specific sites meet National Register Criteria for Evaluation? | | This is a management decision, not a science question.. |
| 121 | 5, A | 2 | 11.1.2 .c | Identify AMP activities that affect National Register eligible sites? | CMIN 11.1.1 (SPG revised) Determine the condition and integrity of prehistoric and historic sites in the Colorado River ecosystem through tracking rates of erosion, visitor impacts, and other relevant variables. Determine the condition and integrity of TCPs in the Colorado River ecosystem. | NPS can make this determination through their project review process. Monitoring will provide some relevant data. |
| 122 | 5, A | 2 | 11.1.3 .a | Determine the necessary information to assess resource integrity. | CMIN 11.1.1 (SPG revised) Determine the condition and integrity of prehistoric and historic sites in the Colorado River ecosystem through tracking rates of erosion, visitor impacts, and other relevant variables. Determine the condition and integrity of TCPs in the Colorado River ecosystem. | Research and development studies for core monitoring development can provide data that assists in determining most appropriate answer, but science can not resolve differences of opinion among managers about what constitutes adequate integrity. |
| 123 | 5, A | 2 | 11.2.4 | What changes are occurring in cultural resource sites, and what are the causes of those changes? | 2-1. Do dam controlled flows increase or decrease rates of erosion and vegetation growth at arch sites and TCPs, and if so, how?<br>SSQ 2-2. How do flows impact OHWZ terraces in the CRE, 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 terraces?<br>SSQ 2-3. If flows contribute to arch site/TCP erosion, what are the optimal flows for minimizing impacts to these cultural resources?<br>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?<br>SSQ 2-7. Are dam controlled flows affecting TCPs and other tribally-valued resources in the CRE, and if so, in | |

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| | | | | | what respects are they being affected, and are those effects considered positive or negative by the tribes who value those resources?<br>CMIN 11.1.1 (SPG revised) Determine the condition and integrity of prehistoric and historic sites in the Colorado River ecosystem through tracking rates of erosion, visitor impacts, and other relevant variables. Determine the condition and integrity of TCPs in the Colorado River ecosystem. | |
| 124 | 5, A | | 12.3.2 | What are the differences between western science and tribal processes for design of studies and for gathering, analyzing, and interpreting data used in the adaptive management program? How well do research designs and work plans incorporate Tribal perspectives and values into the standard western science paradigm? Is it more beneficial to keep the perspective separated? | 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 those resources?<br>CMIN 11.2.1 (SPG revised) Determine the condition of traditionally important resources and locations using tribal perspectives and values. | |
| 125 | 5, A | | 12.3.3 | How effective is the AMP in addressing the EIS statement "Long-term monitoring and research are … implemented to measure how well the selected alternative meets resource management objectives."? | None Proposed | Partially addressed through the Score report. Annual and 5 year assessments (by GCMRC and the AMP) are a component of the planning process included in the MRP |
| 126 | 5, A | | 12.5.1 | What are the most effective means to build AMP public support through effective public outreach? | None Proposed | A possible POAHG project |
| 127 | 5, A | | 12.5.2 | What are the most effective means to attain | None Proposed | The 2008 Science Symposium be be held jointly with sponsors of |

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| | | | | and maintain effective communication and coordination with other resource management programs in the Colorado River basin to ensure consideration of their values and perspectives into the AMP and vice versa? | | other restoration/science program sin the Colorado River basin. In addition the FY07 AMP effectiveness workshop may help to address this information need. |
| 128 | 5, A | | 12.5.4 | What is the most effective way to distribute information to our stakeholders and the public in a secure and accessible fashion? | None Proposed | A possible POAGH issue. The MRP recommends a study to assess the feasibility of using decision support tools to improve use of science information in the AMP process. FY07 AMP effectiveness workshop may help to address this information need. |
| 129 | 5, A | | 12.7.1 | How effective are the current strategies to achieve tribal consultation? | None Proposed | Policy topic for the CRAHG and PA to discuss and resolve. |
| 130 | 5, A | | 12.7.2 | How well do the current strategies to achieve tribal consultation meet legal and AMP protocols? | None Proposed | Policy topic for the CRAHG and PA to discuss and resolve. |
| 131 | 5, A | | 12.8.1 | How well does current tribal participation in the AMP research and long-term monitoring programs meet tribal needs and desires? | None Proposed | FY07 AMP effectiveness workshop may help to address this information need. |
| 132 | 5.5, A | | 1.2.4 | What are the habitat characteristics between Glen Canyon Dam and the Paria River that most affect benthic invertebrates? How are these characteristics affected by Glen Canyon | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations?<br>SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |

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| | | | | Dam operations? | | |
| 133 | 5.5, A | | 1.3.1 | How are the composition and biomass of primary producers in the Colorado River ecosystem below the Paria River affected by flow and water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), and water borne diseases, or other factors. | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations?<br>SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |
| 134 | 5.5, A | | 1.4.3 | How do top-down effects (grazing and predation) affect the abundance and composition of benthic invertebrates? | SSQ 1-6. Are fish populations, trends, or indicators from fish, such as growth, condition, and body composition, correlated with patterns in invertebrate flux? | |
| 135 | 5.5, A | | 1.5.1 | How are the composition and biomass of drift in the Colorado River ecosystem affected by flow and water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), and water borne diseases, or other factors? | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations?<br>SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |
| 136 | 5.5, A | | 4.2.4 | What is the target population size of RBT appropriate for the Lees Ferry reach that limits downstream emigration? | SSQ 3-6. What Glen Canyon Dam operations (ramping rates, daily flow range, etc.) maximize trout fishing opportunities and catchability?<br>CMIN 4.1.2. Determine annual proportional stock density of rainbow trout in the Lees Ferry reach.<br>CMIN 4.1.4. Determine annual standard condition and relative weight of rainbow trout in the Lees Ferry reach. | This will be one of the subjects addressed by the rainbow trout PEP in 2007. |
| 137 | 5.5, A | | 6.3.1 | How has the abundance, composition, and distribution of the OHWZ community changed since dam closure (1963), high flows (1984), interim | 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?<br>CMIN 6.1.1., 6.6.1., 6.2.1, 6.5.1. Determine and track the abundance, composition, distribution, and area of terrestrial native and nonnative vegetation species in the | |

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| | | | | flows (1991), and the implementation of Record of Decision operations (1996)? | CRE. | |
| 138 | 5.5, A | | 6.7.5 | What is the need, feasibility, and priority of maintaining habitat suitability for southwestern willow flycatcher in the Colorado River ecosystem? | None Proposed | NPS is taking the lead for this resource in conjunction with USFWS. Not an AMP priority at this time |
| 139 | 5.5, A | | 8.5.2 | What is the reach-scale variability of fine-sediment storage throughout the main channel? | SSQ #4.1 (see above) | This information has been previously reported in synthesis final reports by Schmidt and others (2004); Grams and others (2003); Grams and others (in press) and in FIST ongoing reporting, at least upstream of river mile 87. |
| 140 | 5.5, A | | 8.5.5 | What are the historic and ongoing longitudinal trends of fine-sediment storage, above 25,000 cfs? | SSQ #4.1 (see above) | This information has been previously reported in synthesis final reports by Schmidt and others (2004); Grams and others (2003); Grams and others (in press) and in FIST ongoing reporting, at least upstream of river mile 87. |
| 141 | 5.5, A | | ** SIN 8.5.7 | What are the limiting factors that regulate substrate availability and its distribution? | SSQ #4.1 (see above) | Combination of tributary sediment supply and influence of dam operation, and larger tributary floods. |
| 142 | 5.5, A | | 9.4.1 | Identify the elements of wilderness experience specific to the Colorado River ecosystem. | SSQ 3-7. How do dam controlled flows affect visitor experiences, and what are the optimal flows for maintaining a high quality recreational experience in the CRE?<br>SSQ 3-8. What are the drivers for recreational experience in the CRE, and how important are flows relative to other drivers in shaping recreational experience?<br>SSQ 3-12. How do flow regimes positively or negatively affect group encounter rates, campsite competition, and other social parameters that are known to be important | NPS defined key elements of wilderness experience in CRE, with public input (e.g., CRMP). Indirectly, this issue will be addressed in the recreation trade off study proposed for FY08-09. |

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| | | | | | variables of visitor experience? | |
| 143 | 5.5, A | | 10.1.4 | What would be the effects on the Colorado River ecosystem and marketable capacity and energy of lowering the minimum flow limit below 5,000 cfs? | None Proposed | This is an EIN that may be addressed by LTEP. |
| 144 | 5.5, A | | 11.1.2 .d | Identify NPS permitted activities that affect National Register eligible sites. | None Proposed | NPS addresses this RIN through their internal project permit review process. |
| 145 | 5.5, A | | 11.1.5 | What are appropriate strategies to preserve resource integrity? | 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? | Science can determine whether preservation strategies work or not; managers and stakeholders need to define what is “appropriate”. |
| 146 | 6, A | | 1.1.3 | How do top-down effects (grazing and predation) on primary producers affect food base productivity? | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations?<br>SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |
| 147 | 6, A | | 1.2.3 | How do top-down effects (grazing and predation) affect the abundance and composition of benthic invertebrates? | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations?<br>SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |
| 148 | 6, A | | 1.3.3 | How do top-down effects on primary producers (grazing and predation) affect food base productivity? | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations?<br>SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |
| 149 | 6, A | | 1.3.4 | What are the habitat characteristics in the Colorado River ecosystem below the Paria River that most affect primary productivity? How are | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations?<br>SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |

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| | | | | these characteristics affected by Glen Canyon Dam operations? | | |
| 150 | 6, A | | 1.4.4 | What are the habitat characteristics in the Colorado River ecosystem below the Paria River that most affect benthic invertebrates? How are these characteristics affected by Glen Canyon Dam operations? | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations?<br>SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |
| 151 | 6, A | | 2.2.11 | What are the impacts of current recreational activities on mortality, recruitment and the population size of humpback chub? | None Proposed | NPS planned to fund a study on this topic in FY06-07 through their CRMP funding sources. Current status of the project is unknown. This issue will be brought up for discussion in the FY 08 PEP. |
| 152 | 6, A | | 2.6.3 | What are the physical and biological characteristics of habitats that enhance recruitment of flannelmouth sucker, bluehead sucker, and speckled dace populations in the Colorado River ecosystem? | 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 and juvenile stages in the mainstem, or by changes in growth and maturation in the adult population as influenced by mainstem conditions? | |
| 153 | 6, A | | *IN 6.1 | Develop GIS coverages of natural communities in the Colorado River ecosystem to use in identification of status and trends. | 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?<br>CMIN 6.1.1., 6.6.1., 6.2.1, 6.5.1. Determine and track the abundance, composition, distribution, and area of terrestrial native and nonnative vegetation species in the CRE. | This info need is being addressed by vegetation mapping, monitoring and synthesis projects in FY06-07 and beyond. It will also be a focus of the shoreline habitat |
| 154 | 6, A | | *IN 6.3 | How is the abundance of vertebrate consumers affected by seasonal shifts in food base abundance in the Colorado River ecosystem? | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations?<br>SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |

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| 155 | 6, A | | ** SIN 7.3.1 | Measure appropriate water quality parameters to determine the influence of these parameters on biological resources in the Colorado River ecosystem. | SSQ 3-5. How is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations?<br>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 near shore water temperatures throughout the CRE? | |
| 156 | 6, A | | ** SIN 8.5.8 | What is the total area of different aquatic habitat types (cobble, gravel, sand, talus, etc,) in the Colorado River ecosystem? | None Proposed | This info need is being addressed by shoreline habitat study initiated in FY07 as well other remote sensing methods (side-scanning sonar, underwater microscope, etc.) that have come from the FIST research and development project. |
| 157 | 6, A | | ** SIN 8.5.9 | How are sandbar textures related to cultural site stability? | None Proposed | This SIN is a legitimate science question and should be pursued as support becomes available. |
| 158 | 6, A | | 10.1.1 | What would be the effects on the Colorado River ecosystem and marketable capacity and energy of increasing the daily fluctuation limit? | SSQ 3-4. What are the projected costs associated with the various alternative flow regimes being discussed for future experimental science (as defined in the next phase experimental design?) | This RIN will be addressed through the LTEP. |
| 159 | 6, A | | 10.4.1 | What are the effects on the Colorado River ecosystem and marketable power and energy of increasing Automatic Generation Control at Glen Canyon Dam? | SSQ 3-4. What are the projected costs associated with the various alternative flow regimes being discussed for future experimental science (as defined in the next phase experimental design?) | This RIN may be addressed through the LTEP. |
| 160 | 6, A | | 12.5.3 | To what extent does the public understand and support the GCDAMP? | None Proposed | A possible task for the POAGH |
| 161 | 6.5, A | | 5.1.1 | What constitutes population viability for Kanab ambersnail at Vasey's Paradise? | None Proposed | Mostly a policy and management question, data to help support this question are collected consistent with the monitoring described in CMINs. |
| 162 | 6.5, A | | 5.2.3 | How can remote sensing | None Proposed | Not a current high AMWG |

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| | | | | technologies be used to less intrusively and more cost effectively characterize and monitor Kanab ambersnail habitat at Vasey's Paradise (vegetation type and distribution)? | | priority. |
| 163 | 6.5, A | | *IN 6.2 | Develop or adopt an existing ecological community classification system. The system should describe the composition and frequency of vascular plants, vertebrates, arthropods, and mollusks to an appropriate taxonomic level. | 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?<br>CMIN 6.1.1., 6.6.1., 6.2.1, 6.5.1. Determine and track the abundance, composition, distribution, and area of terrestrial native and nonnative vegetation species in the CRE. | |
| 164 | 6.5, A | | 7.2.4 | What are the water-borne pathogens that are a threat to human health? How should they be monitored? Where and how often? | SSQ 3-7. How do dam controlled flows affect visitors' recreational experiences, and what are the optimal flows for maintaining a high quality recreational experience in the CRE?<br>SSQ 3-11. How do varying flows positively or negatively affect visitor safety, health, and navigability of the rapids?<br>CMIN 9.1.1 Determine and track the changes attributable to dam operations in recreational quality, opportunities and use, impacts, serious incidents, and perceptions of users, including the level of satisfaction, in the Colorado River ecosystem. | |
| 165 | 6.5, A | | 8.6.1 | How do ongoing inputs of coarse-sediment from tributaries influence storage of fine sediment within pools, runs and eddies throughout the Colorado River ecosystem? | None Proposed | Work published by Webb and others, 2001 and Melis, 1997 already provide some information about this topic (see section of USGS Fact Sheet #FS 019-01, on "Sand Storage"). (No additional SSQ because of relatively low AMWG priority.) |

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| 166 | 7, A | | 9.5.1 | What effects do administrative trips, including research and monitoring activities have on recreational users? | CMIN 9.5.1 Determine and track the frequency and scheduling of research and monitoring activity in Glen and Grand Canyons. | CRMP research sponsored by NPS may be addressing this issue at some level. |
| 167 | 7, A | | * IN 10.1 | Determine and track the impacts to power users from implementation of Record of Decision dam operations and segregate those effects from other causes such as changes in the power market. | SSQ 3-3. What are the hydropower replacement costs of the MLFF (annually, since 1996?)<br>CMIN 10.1.1 Determine and track the marketable capacity and energy produced through dam operations in relation to various release scenarios. | |
| 168 | 7.5, A | | 7.3.1. a | Determine the status and trends of chemical and biological components of water quality in Lake Powell as a function of regional hydrologic conditions and their relation to downstream releases. | (No additional SSQ because of relatively low AMWG priority) | Annual Lake Powell monitoring program is collecting these data. Need for an assessment of historical QW (physical and biological) data collected within Lake Powell reservoir has been identified since the late 1990s, but has yet to be published. The data exist and should be first published, then described and synthesized within a major interpretive report. This project should be completed as soon as funding is available. Program will be assessed in PEP in FY 09. |
| 169 | 7.5, A | | ** SIN 8.5.10 | How are sandbar textures related to recreational site stability? | | This SIN is a legitimate science question and should be pursued as support becomes available. |
| 170 | 8, A | | 1.3.2 | What is the estimated primary productivity in the Colorado River ecosystem below the Paria River? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations?<br>SSQ 3-5. How is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations?<br>SSQ 5-1. How do dam release temperatures, flows (average and fluctuating component), meteorology, canyon orientation and geometry, and reach morphology) | |

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| | | | | is not worth the expense, this RIN will not be pursued.] | interact to determine mainstem and near shore water temperatures throughout the CRE?<br>SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |
| 171 | 8, A | | 1.4.2 | What is the estimated productivity of benthic invertebrates in the Colorado River ecosystem below the Paria River? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.] | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations?<br>SSQ 3-5. How is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations?<br>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 near shore water temperatures throughout the CRE?<br>SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |
| 172 | 8, A | | 2.5.4 | What is the feasibility and advisability of augmenting razorback sucker in the Colorado River ecosystem to attain a viable population including technical/legal/policy constraints? | None Proposed | Not a high AMP priority. |
| 173 | 8, A | | 6.7.1 | What is the function of the Colorado River ecosystem as a migratory corridor for southwestern willow flycatcher? | None Proposed | SWWF issues are currently being managed by NPS with USFWS. |
| 174 | 8, A | | 6.7.2 | What is the foodbase that supports southwestern willow flycatcher and other terrestrial vertebrates? | None Proposed | SWWF issues are currently being managed by NPS with USFWS. |
| 175 | 8, Done | | 6.7.3 | What constitutes suitable southwestern willow | None Proposed | This has been determined by USFWS; it is not an AMP |

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| | | | | flycatcher habitat? | | decision. |
| 176 | 8.5, A | | 6.6.3 | How has the composition, abundance and distribution of seep and spring communities changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)? | 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? CMIN 6.1.1., 6.6.1., 6.2.1, 6.5.1. Determine and track the abundance, composition, distribution, and area of terrestrial native and nonnative vegetation species in the CRE. | This is being addressed by vegetation synthesis project in FY07 and beyond. |
| 177 | 9, A | | 1.1.2 | What is the estimated productivity for the reach between Glen Canyon Dam and the Paria River? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.] | SSQ 1-5. What are the important pathways that link lower trophic levels with fish and how will they link to dam operations?<br>SSQ 3-5. How is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations?<br>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 near shore water temperatures throughout the CRE?<br>SSQ 5-2. Is invertebrate flux affected by water quality (e.g., temperature, nutrient concentrations, turbidity) and dam operations? | |
| 178 | 9, A | | 2.5.5 | What are the genetic and ecological criteria for reintroducing razorback sucker into the Colorado River ecosystem? | (No additional SSQ because of relatively low AMWG priority) | Not a current high priority of AMP |
| 179 | 9, A | | 4.1.2 | What is the minimum quantity and quality of spawning substrate necessary for maintaining a wild reproducing rainbow trout population in the Lees Ferry reach? | SSQ 3-6. What Glen Canyon Dam operations (ramping rates, daily flow range, etc.) maximize trout fishing opportunities and catchability? | Currently this is being addressed most directly (but not completely) by Korman's work. Current monitoring consistent with CMINs for this resource. |
| 180 | 9, C | | 5.1.7 | What is the historic range of Oxyloma haydeni? | (No additional SSQ because of relatively low AMWG priority) | Completed KAS review by USFWS may answer this |

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| | | | | Can this range be determined from subfossil or fossil evidence? [NOTE: This is intended to determine if this is a relict species and the initial work would be done at Vasey's Paradise, South Canyon and other probable sites within the Colorado River ecosystem.] | | information need. Current monitoring consistent with CMINs for this resource. |
| 181 | 9, A | | 6.6.1 | How is seep and spring habitat affected by variation in dam operations, variation in seep or spring flow, and variation in water quality? How do flow rates and water quality parameters at seeps and springs compare with historic measurements? | 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? | Current vegetation projects address species composition and distribution, but no projects are looking at effects of flow rates or water quality. Effects of exp flows on vegetation will be a component of the LTEP but specifics of the experiment are not yet determined. Current monitoring is consistent with CMINs for this resource. |
| 182 | 9, A | | 6.6.4 | What is the distribution, patch size, total area, and composition of seep and spring communities and the flow rate and water quality of all seeps and springs within the Colorado River ecosystem? | None Proposed | Current vegetation projects address species composition and distribution, but no projects are looking at effects of flow rates or water quality. Effects of exp flows on vegetation will be a component of the LTEP but specifics of the experiment are not yet determined. Current monitoring is consistent with CMINs for this resource. |
| 183 | 9, A | | 6.7.4 | How has the abundance, distribution and reproductive success of southwestern willow flycatcher changed since dam closure (1963), high flows (1984), interim | None Proposed | SWWF issues are currently being managed by NPS with USFWS. |

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| | | | | flows (1991) and the implementation of Record of Decision operations (1996)? | | |
| 184 | 9, A | | 7.3.3 | How do dam operations affect reservoir limnology? | (No additional SSQ because of relatively low AMWG priority) | This is a legitimate science question that potentially warrants further study in the LTEP. |
| 185 | 9, A | | ** SIN 8.5.1 | How do sandbar textures influence biological processes? | (No additional SSQ because of relatively low AMWG priority) | This SIN is a legitimate science question and should be pursued as support becomes available. |
| 186 | 9.5, C | | 3.1.1 | What information (including technical, legal, economic, and policy issues) should be considered in determining the feasibility and advisability of restoring pikeminnow, bonytail, roundtail chub, river otter, or other extirpated species? | None Proposed | Policy and management question.. If restoration of one or more of these species is a priority then GCMRC can provide scientific support. |
| 187 | 9.5, A | | 8.5.3 | What is the pre- and post-dam range of grain-size in fine-sediment deposits, by reach? | None Proposed | See several publications containing information on this topic: Howard and Dolan, 1981; Schmidt and Graf, 1990; Topping and others 2005; Topping and others, 2000a and 2000b. |
| 188 | 10, A | | 4.1.1 | What is the target proportional stock density (i.e., trade-off between numbers and size) for rainbow trout in the Lees Ferry reach? | None Proposed | To a large degree, the target is a management decision, but current monitoring efforts provide supporting information. |
| 189 | 10, A | | 4.1.4 | How does the genetics or “strain” of rainbow trout in the Lees Ferry reach influence the average size of fish creeled by anglers? | (No additional SSQ because of relatively low AMWG priority) | This information need is not currently being addressed. |
| 190 | 11, A | | 2.5.1 | If razorback suckers were stocked into the Colorado | (No additional SSQ because of relatively low AMWG priority) | RBS are not a high AMP priority at this time. |

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| | | | | River ecosystem, what is the risk that hybridization with flannelmouth suckers would compromise the genetic integrity of either species? | | |
| 191 | 11, A | | 2.5.2 | How does existing hybridization between razorback suckers and flannelmouth suckers affect the genetic integrity of either species? What are the factors contributing to this ongoing hybridization? | None Proposed | RBS are not a high AMP priority at this time. (This question is well addressed in a paper by D.G. Buth and others, 1987 which suggests that the native level of hybridization was not detrimental to either species). |
| 192 | 11, C | | 2.5.6 | What are the measurable criteria that would need to be met to remove jeopardy for razorback sucker in the Colorado River ecosystem? | None Proposed | Policy question. |
| 193 | 11, A | | 7.3.2 | How accurately can modeling predict reservoir dynamics and operational scenarios? | None Proposed | Not a high AMP priority. Outside funding for modeling Lake Powell is identified in the MRP. The Bureau of Reclamation has developed a model for Lake Powell reservoir, but it has not been published in the peer reviewed literature to date. Therefore, the answer to this question remains unknown. |
| 194 | 11, A | | 9.1.1 | What are the attributes of a quality river experience? (How do you define a quality river experience?) | SSQ 3-7. How do dam controlled flows affect visitors' recreational experiences, and what are the optimal flows for maintaining a high quality recreational experience in the CRE?<br>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?<br>(See also SSQ 3-9, 3-10, 3-11, and 3-12.) | This is largely a NPS management decision. Social science studies can provide data on what the public considers to be a quality river experience, but ultimately NPS must determine what type of experience they are managing for. |

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| 195 | 11, A | | 9.1.2 | Determine the appropriate carrying capacity for recreational activities within the Colorado River ecosystem. | None Proposed | Appropriate carrying capacity is dependent on type of recreational experience that river corridor is being managed for and amount of crowding NPS is willing to allow; therefore, this RIN must be addressed by NPS managers in consultation with the public. Once target levels for crowding and encounter rates have been established, we can provide data on how flows are changing social encounters and campable area in relation to those targets. |
| 196 | 11, A | | 9.1.3 | How do ongoing inputs of coarse-sediment from tributaries diminish or enhance navigability of rapids throughout the Colorado River ecosystem? | SSQ 3-10. How can safety and navigability be reliably measured relative to flows?<br>SSQ 3-11. How do varying flows positively or negatively affect visitor safety, health, and navigability of the rapids? | This was proposed to be addressed as a component of the safety study proposed for FY07, and now deferred to FY08 or FY09. |
| 197 | 11, A | | 12.1.2 | What are the use (e.g., hydropower, trout fishing, rafting) and non-use (e.g., option, vicarious, quasi-option, bequest and existence) values of the Colorado River ecosystem | None Proposed | A question for the socioeconomic PEP to consider. |
| 198 | 11, A | | 12.1.3 | How does use (e.g., hydropower, trout fishing, rafting) and non-use (e.g., option, vicarious, quasi-option, bequest and existence) values change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? | SSQ 3-4. What are the projected costs associated with the various alternative flow regimes being discussed for future experimental science (as defined in the next phase experimental design?) | |

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| 199 | 11.5, A | | 7.3.1.b | Determine stratification, convective mixing patterns, and behavior of advective currents in Lake Powell and their relation to Glen Canyon Dam operations to predict seasonal patterns and trends in downstream releases. | None Proposed | Some aspects of this RIN addressed by current modeling by BOR. No new SSQ because of low AMWG priority |
| 200 | 11.5, A | | 7.4.1 | What is the desired range of seasonal and annual flow dynamics associated with powerplant operations, BHBFs, and habitat maintenance flows, or other flows that meet AMP goals and objectives? | None Proposed | This is what the entire AMP is supposedly trying to answer and a focus of the current LTEP EIS. |
| 201 | 11.5, A | | 10.1.5 | How do power-marketing contract provisions affect Glen Canyon Dam releases? | None Proposed | Not an AMP priority at this time |
| 202 | 11.5, A | | 12.1.1 | What is the economic value of the recreational use of the Colorado River ecosystem downstream from Glen Canyon Dam? | None Proposed | Not an AMP priority at this time |
| 203 | No Sequence Order, A | | * IN 12.2 | Determine what information is necessary and sufficient to make recommendations at an acceptable level of risk. | None Proposed | Ultimately managers will need to decide what level of risk they are willing to accept. |

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| A | 1.1.1 | How does primary productivity for the reach between Glen Canyon Dam and the Paria River change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 1.2.1 | How do benthic invertebrates in the reach between Glen Canyon Dam and the Paria River change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 1.3.1 | How does primary productivity in the Colorado River ecosystem below the Paria River change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 1.4.1 | How do benthic invertebrates in the Colorado River ecosystem below the Paria River change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 1.5.1 | How does drift in the Colorado River ecosystem change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 2.1.1 | How does the abundance and distribution of all size classes of HBC in the LCR and mainstem change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 2.1.2 | How does the year class strength of HBC (51 – 150 mm) in the LCR and mainstem change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 2.1.3 | How does the abundance and distribution of recruiting HBC in the LCR and mainstem change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |

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| A | 2.3.1 | How do disease/parasite loads on HBC and other native fish found in the LCR and in the Colorado River ecosystem change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 2.4.1 | How does the abundance and distribution of non-native predatory fish species and their impacts on native fish species in the Colorado River ecosystem change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 2.6.1 | How does the abundance, distribution, recruitment and mortality of flannelmouth sucker, bluehead sucker and speckled dace populations in the Colorado River ecosystem change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 4.1.1 | How does RBT abundance, proportional stock density, length at age, condition, spawning habitat, natural recruitment, whirling disease and other parasitic infections change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 5.1.1 | How does Kanab ambersnail population abundance and recovery change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 5.2.1 | How does Kanab ambersnail habitat at Vasey's Paradise change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 6.1.1 | How do marsh community abundance, composition, distribution, and area change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 6.2.1 | How does the patch number, patch distribution, composition and area of the NHWZ community change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 6.3.1 | How do the abundance, composition, and distribution of the OHWZ community change in response to an experiment performed under the |

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| | | Record of Decision, unanticipated event, or other management action? |
| A | 6.4.1 | How does the abundance, composition, and distribution of the sand beach community change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 6.5.1 | How does the abundance and distribution of non-native species change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 6.6.1 | How do the composition, abundance, and distribution of seep and spring communities change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 6.7.1 | How do the abundance, distribution and reproductive success of southwestern willow flycatcher change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 7.1.1 | How does water temperature change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 7.3.1 | How does the water quality of releases from Glen Canyon Dam change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 8.1.1 | How do fine sediment abundance, grain-size, and distribution in the main channel below 5,000 cfs change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 8.2.1 | How does fine sediment abundance, grain-size, and distribution within channel margins (not eddies) from 5,000 to 25,000 cfs change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 8.3.1 | How does fine sediment abundance, grain-size, and distribution, within eddies below 5,000 cfs change in response to an experiment performed under the Record of Decision, unanticipated event, or other management |

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| | | action? |
| A | 8.4.1 | How does fine sediment abundance, grain-size, and distribution, within eddies between 5,000 to 25,000 cfs change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 8.5.1 | How does fine sediment abundance, grain-size, and distribution on shorelines between 25,000 cfs and the uppermost effects of maximum dam releases change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 8.6.1 | How does coarse sediment (greater than 2mm) abundance, grain-size and distribution change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 9.1.1 | How do recreational use trends, impacts, and perceptions change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 9.3.1 | How do the size, quality, and distribution of camping beaches change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? |
| A | 11.1.1 | Determine the effects of experimental flows on historic properties. |
| A | 11.3.1 | Determine if and how experimental flows and other AMP actions restrict tribal access. |
| A | 11.3.2 | Determine reasonable management actions that should be taken to facilitate tribal access. |

| SEQUENCE | CATEGORY | IN NO. | IN TEXT |
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| 3 | A | 12.1 | Develop information that can be used by the TWG, in collaboration with GCMRC, to establish current and target levels for all resources within the AMP as called for in the AMP strategic plan. |
| 4.5 | A | 8.1 | If sediment cannot be preserved in the system using available management actions, what is the feasibility (including technical, legal, economic, and policy issues) of sediment augmentation as a means of achieving this goal? |
| 5 | A | 6.4 | How much allochthonous material (e.g., leaf litter) is exchanged between the terrestrial and aquatic systems? |
| 6 | A | 6.1 | Develop GIS coverages of natural communities in the Colorado River ecosystem to use in identification of status and trends. |
| 6 | A | 6.3 | How is the abundance of vertebrate consumers affected by seasonal shifts in food base abundance in the Colorado River ecosystem? |
| 6.5 | A | 6.2 | Develop or adopt an existing ecological community classification system. The system should describe the composition and frequency of vascular plants, vertebrates, arthropods, and mollusks to an appropriate taxonomic level. |
| 7 | A | 10.1 | Determine and track the impacts to power users from implementation of Record of Decision dam operations and segregate those effects from other causes such as changes in the power market. |
| **?** | A | 12.2 | Determine what information is necessary and sufficient to make recommendations at an acceptable level of risk. |

| SEQUENCE # | CATEGORY | SIN NO: | SIN TEXT |
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| 4 | A | 8.5.3 | What is the relationship between turbidity and biological processes? |
| 4 | A | 8.5.6 | What is the relationship between turbidity and biological processes? |
| 4.5 | A | 7.2.2 | Which water quality variables influence food base and fisheries in the Colorado River ecosystem? |
| 4.5 | A | 8.5.4 | What is the role of turbidity and how can it be managed to achieve biological objectives? |
| 5 | A | 7.2.1 | How do the hydrodynamics and stratification of Lake Powell influence the food base or fisheries downstream? |
| 5 | A | 8.5.2 | What is the relationship between the fine-sediment budget and turbidity? |
| 5 | A | 8.5.5 | How can the ongoing fine sediment supply be managed to achieve sustainable habitats? |
| 5.5 | A | 8.5.7 | What are the limiting factors that regulate substrate availability and its distribution? |
| 6 | A | 7.3.1 | Measure appropriate water quality parameters to determine the influence of these parameters on biological resources in the Colorado River ecosystem. |
| 6 | A | 8.5.8 | What is the total area of different aquatic habitat types (cobble, gravel, sand, talus, etc,) in the Colorado River ecosystem? |
| 6 | A | 8.5.9 | How are sandbar textures related to cultural site stability? |
| 7.5 | A | 8.5.10 | How are sandbar textures related to recreational site stability? |
| 9 | A | 8.5.1 | How do sandbar textures influence biological processes? |

## Appendix A

### TWG Minority Report concerning the Monitoring and Research Plan to Support GCDAMP FY2007-11 concerning recommendation to AMWG for adoption of the MRP (Vote of 11/9/2006)

Eight TGW members either voted against (6) or abstained from voting (2) to approve the 09/13/2006 draft GCMRC MRP. This minority believes that the current MRP draft has several significant deficiencies as specified below:

- Unclear relationship between the AMP Strategic Plan (and prioritized RINs) and the proposed strategic science questions posed in the MRP. A great deal of time was spent on development of the Strategic Plan and the MRP effort should add more detail and not redirect priorities or thei[r.] focus.
- Unclear relationship between the strategic science questions and the proposed GCMRC science programs (for the next five years).
- The core monitoring development process did not follow the process developed and recommended by the core monitoring team.
- The Humpback chub science questions and information needs only partially address the HBC questions and needs and those identified are not the top priorities. The top priorities identified were protection of the HBC in refuges the monitoring of HBC population size and composition in order to determine if recovery is being achieved. It is noted that the top priorities should be part of a separate recovery program and we agree. We would also note that all activities associated with the HBC should be part of a separate recovery program, the foundation for which is being developed as part of the Humpback chub management plan. The MRP should address the top HBC priorities or defer all HBC related activities to a separate recovery program. If tasks are going to be divided out, a much clearer description of how they will interface and work together is required.
- The sediment questions fail to provide a monitoring plan that will lead to the identification of the sediment lost or redistributed outside the primary study reach as a result of a BHBF.
- The five year food base program does not address how fluctuating flows affect production and delivery of the food base. As a result, a subgroup of stakeholders: Arizona Game and Fish, Western Area Power Administration, SWCA and Argonne National Labs, Federation of Fly Fishers and Arizona Wildlands Council provided a proposed science plan to GCMRC to expand or amend their program. This science plan, directed at a clear scientific uncertainty that would inform the policy debate has been ignored by GCMRC and is not included in the MRP.

Without addressing the above deficiencies, it is unclear whether specific high priority stakeholder science questions are being or will be answered over the next five years.

We recommend that the draft document be approved as a working document to help guide preparation of the '08/'09 workplan and budget but that GCMRC be charged with addressing the above concerns in a final FY2007-11 document and that document \ brought back to the AMWG for further consideration next summer.