Memo

To: Members of the Technical Work Group

From: Mary Orton for the AMWG Ad Hoc Committee on Strategic Planning

Date: February 28, 2000

Re: Attached WORKING DRAFT of Management Objectives

Attached please find a work in progress – draft management objectives for the AMWG goals. Please review these before your meeting on March 2, when they will be discussed. We would like to have your comments on the following questions:

a. Are these MOs necessary and sufficient to achieve e the goal?
b. Do the MOs fit the new definition of MO (also attached)?
c. Is the goal properly stated?
d. Are the metrics correct?
e. Are the current and target levels correct?
f. Are the MOs consistent with our guiding documents?
g. Does the text in the "Purpose" column fit one of these four purposes: hypotheses, linkages to other goals, assumptions, notes when the stated element and attribute are surrogates.

Please note the following about the chart:

1. At the end of the chart, there is a list (by Goal and MO) of Information Needs, Management Actions, and Notes. These were captured during this process, and although they are not complete, they can amplify your understanding of the MOs. (Not every Information Need that is noted in the "current level" and "target level" column is listed here.) The full list of INs and MAs will be developed during a process to follow.
2. If the committee was not able to put a number in the "current level" or "target level" column, they did indicate the method they would use to fill in the blank. The methods are:
   - The number will be obtained from the literature;
   - The number will be developed through an Information Need, that is, through research; or
   - The number will be developed through a specific Decision Process (see #3, below).
3. The Decision Process is a one in which the target is developed within the range of operational flexibility (R_{OF}) of the dam, taking into account the range in which the target resource(s) thrive (R_{TR}), and the Range of Natural Variability (RNV).
4. Where there are data in the "current level" or "target level" columns, the source of the data will be footnoted in the final MO table.
5. Where there is a number in the target level, remember that those data will be validated through the monitoring program.
6. Some questions will be answered before going forward on the Information Needs. One example of this is the question under MO 3, "Is this a cost-effective measure?"

Goal 1. Protect or improve the aquatic foodbase so that it will support viable populations of species at higher trophic levels.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
1	Maintain or attain	Algae / periphyton	Biomass	Above the Paria River to GCD	150 g/m^2 AFDW, measured as a seasonal average	150 g/m^2 AFDW, measured as a seasonal average	Support desired populations of native fish as specified in Goal 2 and Rainbow trout as specified in Goal 4.
2	Maintain or attain	Algae / periphyton	Composition	Above the Paria River to GCD	x% algal species that support upright diatoms – obtain from literature	x% algal species that support upright diatoms – obtain from literature	Support desired populations of native fish as specified in Goal 2 and Rainbow trout as specified in Goal 4.
3	Maintain or attain	Algae / periphyton	Production (is this a cost-effective measure?)	Above the Paria River to GCD	x Cladophora g/m^2/time – Information Need	x Cladophora g/m^2/time – Information Need	Support desired populations of native fish as specified in Goal 2 and Rainbow trout as specified in Goal 4.
4	Maintain or attain	Benthic Invertebrates	Biomass	Above the Paria River to GCD	5000 g/m^2 AFDW	5000 g/m^2 AFDW	Support desired populations of native fish as specified in Goal 2 and Rainbow trout as specified in Goal 4.
5	Maintain or attain	Benthic Invertebrates	Composition	Above the Paria River to GCD	Relative percentages based on 91-97 data – obtain from literature	Relative percentages – Information Need	Support desired populations of native fish as specified in Goal 2 and Rainbow trout as specified in Goal 4.

Old MOs:

BRMO 1: Maintain and enhance the aquatic food base in the Colorado River ecosystem to support desired populations of native and non-native fish. At a minimum, maintain continuously inundated areas for Cladophora and aquatic invertebrates at or above 5,000 cfs discharge levels from Glen Canyon Dam.
BRMO 2: In the Colorado River downstream of Glen Canyon Dam to the confluence of the Paria river, sufficient ecological conditions (such as habitat, foodbase and temperature) should be maintained, which in conjunction with management by Arizona Game and Fish will produce a healthy self-sustaining population of at least 100,000 Age II+ rainbow trout that achieve 18 inches in length by Age III with a mean annual relative weight (Wr) of at least 0.90.

Goal 1. Protect or improve the aquatic foodbase so that it will support viable populations of species at higher trophic levels.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
6	Maintain or attain	Benthic Invertebrates	Production (is this a meaningful and cost-effective measure?)	Above the Paria River to GCD	Information Need	Information Need	Support desired populations of native fish as specified in Goal 2 and Rainbow trout as specified in Goal 4.
7	Maintain or attain	Algae / Periphyton	Biomass	Below the Paria River to the Western-most boundary of GRCA	50 g / m^2 on average	50 g / m^2 on average	Support desired populations of native fish as specified in Goal 2.
8	Maintain or attain	Algae / Periphyton	Composition	Below the Paria River to the Western-most boundary of GRCA	relative % of species – obtain from literature	relative % of species – obtain from literature	Support desired populations of native fish as specified in Goal 2.
9	Maintain or attain	Algae / Periphyton	Production (Is this a cost-effective measure?)	Below the Paria River to the Western-most boundary of GRCA	x g / m^2 / time – obtain from literature and Information Need	x g / m^2 / time – Information Need	Support desired populations of native fish as specified in Goal 2.
10	Maintain or attain	Algae / Periphyton	Distribution	Below the Paria River to the Western-most boundary of GRCA	Information Need	Information Need	Support desired populations of native fish as specified in Goal 2.

Old MOs:

BRMO 1: Maintain and enhance the aquatic food base in the Colorado River ecosystem to support desired populations of native and non-native fish. At a minimum, maintain continuously inundated areas for Cladophora and aquatic invertebrates at or above 5,000 cfs discharge levels from Glen Canyon Dam.
BRMO 2: In the Colorado River downstream of Glen Canyon Dam to the confluence of the Paria river, sufficient ecological conditions (such as habitat, foodbase and temperature) should be maintained, which in conjunction with management by Arizona Game and Fish will produce a healthy self-sustaining population of at least 100,000 Age II+ rainbow trout that achieve 18 inches in length by Age III with a mean annual relative weight (Wr) of at least 0.90.

Goal 1. Protect or improve the aquatic foodbase so that it will support viable populations of species at higher trophic levels.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
11	Maintain or attain	Benthic Invertebrates	Biomass	Below the Paria River to the Western-most boundary of GRCA	x g / m^2 on average – obtain from literature	x g / m^2 on average – obtain from literature	Support desired populations of native fish as specified in Goal 2.
12	Maintain or attain	Benthic Invertebrates	Composition	Below the Paria River to the Western-most boundary of GRCA	relative % of species – obtain from literature	relative % of species – obtain from literature	Support desired populations of native fish as specified in Goal 2.
13	Maintain or attain	Benthic Invertebrates	Production (Is this a meaningful and cost-effective measure?)	Below the Paria River to the Western-most boundary of GRCA	x g / m^2 / time Information Need	x g / m^2 / time Information Need	Support desired populations of native fish as specified in Goal 2.
14	Maintain or attain	Benthic Invertebrates	Distribution	Below the Paria River to the Western-most boundary of GRCA	Information Need	Information Need	Support desired populations of native fish as specified in Goal 2.

Old MOs:

BRMO 1: Maintain and enhance the aquatic food base in the Colorado River ecosystem to support desired populations of native and non-native fish. At a minimum, maintain continuously inundated areas for Cladophora and aquatic invertebrates at or above 5,000 cfs discharge levels from Glen Canyon Dam.
BRMO 2: In the Colorado River downstream of Glen Canyon Dam to the confluence of the Paria river, sufficient ecological conditions (such as habitat, foodbase and temperature) should be maintained, which in conjunction with management by Arizona Game and Fish will produce a healthy self-sustaining population of at least 100,000 Age II+ rainbow trout that achieve 18 inches in length by Age III with a mean annual relative weight (Wr) of at least 0.90.

Goal 1. Protect or improve the aquatic foodbase so that it will support viable populations of species at higher trophic levels.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
15	Maintain or attain	Foodbase drift	Abundance	Mainstem Colorado River below Glen Canyon Dam to Western boundary of GRCA	x g / m^3 obtain from literature	x g / m^+ obtain from literature	
16	Maintain or attain	Foodbase drift	Composition	Mainstem Colorado River below Glen Canyon Dam to Western boundary of GRCA	Obtain from literature	Obtain from literature	

Old MOs:

BRMO 1: Maintain and enhance the aquatic food base in the Colorado River ecosystem to support desired populations of native and non-native fish. At a minimum, maintain continuously inundated areas for Cladophora and aquatic invertebrates at or above 5,000 cfs discharge levels from Glen Canyon Dam.
BRMO 2: In the Colorado River downstream of Glen Canyon Dam to the confluence of the Paria river, sufficient ecological conditions (such as habitat, foodbase and temperature) should be maintained, which in conjunction with management by Arizona Game and Fish will produce a healthy self-sustaining population of at least 100,000 Age II+ rainbow trout that achieve 18 inches in length by Age III with a mean annual relative weight (Wr) of at least 0.90.

Goal 2. Maintain or attain viable populations of existing native fish and remove jeopardy from humpback chub and razorback sucker.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
17	Maintain or attain	Humpback chub (>=150 mm)	Abundance	LCR +/- 3 miles in mainstem	4,500 fish (1991 – 96 population estimates)	Some level based on: 91-96 popn estimate; PVA; & Ne – Information Need	
18	Maintain or attain	Humpback chub (>= 150 mm)	Abundance	Mainstem other than LCR +/- 3 miles	225 (1993 – 94 popn estimate)	Some level based on: 91-96 popn estimate; PVA; & Ne – Information Need	

Old MOs:

BRMO 3: Enhance the Little Colorado River population of HBC above 1987 levels determined by April/May hoop-net monitoring in the lower 1,200 meters of the Little Colorado River. (Focused at fish > 200mm, and should include a fish health assessment.) Maintain or enhance levels of recruitment of HBC in the Little Colorado River.

BRMO 4: Maintain or enhance levels of recruitment of HBC in the mainstem as indexed by size frequency distributions and presence and strength of year-classes. (Focused at young-of-year and juvenile fish, and should include a fish health assessment.)

Goal 2. Maintain or attain viable populations of existing native fish and remove jeopardy from humpback chub and razorback sucker.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
19	Increase	Humpback chub (> 50 mm and < 150 mm)	Abundance	Mainstem other than LCR +/- 3 miles	TBD CPUE – Information Need (we're not sure it's the right metric)	TBD CPUE – Information Need	For removal of jeopardy. Note: CPUE is a surrogate for abundance.
20	Maintain or increase	Humpback chub (> 50 mm and < 150 mm)	Abundance	LCR +/- 3 miles in mainstem	TBD CPUE Information Need	TBD CPUE Information Need	For removal of jeopardy. Note: CPUE is a surrogate for abundance.
21	Establish	Humpback chub	Population	CRE downstream of GCD	One self-sustaining popn (LCR)	One additional self-sustaining popn	Removal of jeopardy (other MOs or MAs may follow from review of the RPAs in the BO)
22	Attain	Humpback chub	Condition	LCR +/- 3 miles in mainstem	Information Need	Information Need	To measure health of HBC
23	Attain	Humpback chub	Condition	Mainstem	Information Need	Information Need	
24	Maintain or attain	Humpback chub	Spawning	LCR +/- 3 miles in mainstem	Information Need	Information Need (metric is unknown)	
25	Maintain or attain	Humpback chub	Spawning	Mainstem	Information Need	Information Need	

Old MOs:

BRMO 5: Remove jeopardy for the HBC in the Colorado River ecosystem (B.O. 1994).
BRMO 6: Establish a second spawning aggregation of HBC downstream of Glen Canyon Dam (RPM 4).

Goal 2. Maintain or attain viable populations of existing native fish and remove jeopardy from humpback chub and razorback sucker.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
26	Reduce	Non-native fish	Predation on native fish	CRE downstream of GCD	Information Need	Information Need	
27	Reduce	Non-native fish	Competition with native fish	CRE downstream of GCD	Information Need	Information Need	
28	Attain	Razorback Sucker	Populations	CRE downstream of GCD	None	Information Need: To the capability of the habitat to support the species	Removal of jeopardy
29	Maintain	Flannelmouth sucker	Abundance	CRE downstream of GCD	Information Need	Information Need	
30	Maintain	Bluehead sucker	Abundance	CRE downstream of GCD	Information Need	Information Need	
31	Maintain	Speckled dace	Abundance	CRE downstream of GCD	Information Need	Information Need	

Old MOs:

BRMO 5: Remove jeopardy for the HBC in the Colorado River ecosystem (B.O. 1994).
BRMO 6: Establish a second spawning aggregation of HBC downstream of Glen Canyon Dam (RPM 4).

Goal 3. Restore populations of extirpated species as feasible.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
32	Restore	Colorado pikeminnow	Abundance	CRE downstream of GCD	None	TBD: obtain from literature and Information Need	To restore ecosystem patterns as articulated in Principle 6.
33	Restore	Bonytail	Abundance	CRE downstream of GCD	None	TBD: obtain from literature and Information Need	To restore ecosystem patterns as articulated in Principle 6.
34	Restore	Roundtail Chub	Abundance	CRE downstream of GCD	None	TBD: obtain from literature and Information Need	To restore ecosystem patterns as articulated in Principle 6.
35	Restore	River otter	Abundance	CRE downstream of GCD	None	TBD: obtain from literature and Information Need	Reintroduce a top predator into the CRE to re-establish ecosystem patterns and processes, as articulated in Principle 6.

Old MOs:

Old Goal 7: Establish population of Colorado pikeminnow.
Old Goal 8: Establish viable populations of river otter.

Goal 4. Maintain a wild reproducing population of rainbow trout above Lees Ferry, to the extent practicable and consistent with the maintenance of viable populations of native fish.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
36	Maintain or attain	Rainbow trout	Abundance	Above the Paria River	262,000 Age II+ (1998)	100,000 Age II+	Sufficient to meet population target of >= 100,000 Age II+
37	Maintain or attain	Rainbow trout	Growth Rate	Above the Paria River	~ 15” by Age III	~ 18” by Age III	Sufficient to meet population target of >= 100,000 Age II+
38	Maintain or attain	Rainbow trout	Health	Above the Paria River	Wr = 0.77	Wr = 0.90	Sufficient to meet population target of >= 100,000 Age II+
39	Maintain or attain	Rainbow trout	Spawning	Above the Paria River	Information Need	Information Need	

Old MOs:

BRMO 2: In the Colorado River downstream of Glen Canyon Dam to the confluence of the Paria river, sufficient ecological conditions (such as habitat, foodbase and temperature) should be maintained, which in conjunction with management by Arizona Game and Fish will produce a healthy self-sustaining population of at least 100,000 Age II+ rainbow trout that achieve 18 inches in length by Age III with a mean annual relative weight (Wr) of at least 0.90.

Goal 5. Establish water temperature, ~~chemistry~~quality, and flow dynamics to achieve GCDAMP ecosystem Goals.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
40	Attain	Water	Temperature range	Mainstem	47°	Use decision process	To restore a temperature range within RNV for the benefit of the target resources (e.g., native fish, aquatic food base, trout, recreation values, native ecosystem, cultural)
41	Attain	Water	Seasonal variability of temperature	Mainstem	Near constant 47° at the dam	Use decision process	To restore a temperature range within RNV for the benefit of the target resources (e.g., native fish, aquatic food base, trout, recreation values, native ecosystem, cultural)

Old MOs:
BRMO 2: In the Colorado River downstream of Glen Canyon Dam to the confluence of the Paria river, sufficient ecological conditions (such as habitat, foodbase and temperature) should be maintained, which in conjunction with management by Arizona Game and Fish will produce a healthy self-sustaining population of at least 100,000 Age II+ rainbow trout that achieve 18 inches in length by Age III with a mean annual relative weight (Wr) of at least 0.90.
BRMO 9: Attain riverine conditions, including appropriate habitat, that support all life stages of endangered and native fish species.
RMO 4: Maintain flows (under approved operating criteria) and habitat suitable for quality cold water fishery opportunities in Glen Canyon.
RMO 5: Maintain flows (under approved operating criteria) and habitat suitable for waterfowl sport hunting and wildlife viewing opportunities in Glen Canyon.
SRMO 1: Maintain a long-term balance of river-stored sand to support maintenance flow (in years of low reservoir storage), beach/habitat-building flow (in years of high reservoir storage), and unscheduled flood flows. Maintain system dynamics and disturbance by annually (in years which Lake Powell water storage is low) redistributing sand stored in the river channel and eddies to areas inundated by river flows between 20,000 cfs and maximum power plant capacity.
WRMO 2: Maintain water quality at levels appropriate to support physical, biotic, and human resource needs of various ecosystems downstream of Glen Canyon Dam as mandated by the Grand Canyon Protection Act and incorporated into the Record of Decision.
LPMO 1: Prevent impacts that adversely affect the water quality (physical, chemical, biological) of Lake Powell due to dam operations and ensure that fully informed AMWG decisions are possible both now and in the future.
LPMO 2: Protect Lake Powell aquatic ecosystem from adverse impacts due to dam operations and subsequent effects, including but not limited to: temperature, reservoir surface elevations, elevated selenium levels, advective flow patterns, predator/prey relationships, and fish movements.

Goal 5. Establish water temperature, ~~chemistry~~quality, and flow dynamics to achieve GCDAMP ecosystem Goals.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
42	Maintain	Water	Quality (nutrients, salinity, pH, DO, nitrogen, phosphorus, microbiology, perhaps others)	Mainstem	Obtain from literature	Obtain from literature and use decision process	To maintain standards within the RNV for the benefit of the target resources (e.g., native fish, aquatic food base, trout, recreation values, native ecosystem, cultural)
43	Maintain	Flow dynamics	Power plant operations	Mainstem	ROD	ROD	For power plant operations
44	Maintain	Flow dynamics	BHBF flows	Mainstem	45,000 cfs March to April	Use decision process	Resources and ecosystem

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Old MOs:
BRMO 2: In the Colorado River downstream of Glen Canyon Dam to the confluence of the Paria river, sufficient ecological conditions (such as habitat, foodbase and temperature) should be maintained, which in conjunction with management by Arizona Game and Fish will produce a healthy self-sustaining population of at least 100,000 Age II+ rainbow trout that achieve 18 inches in length by Age III with a mean annual relative weight (Wr) of at least 0.90.
BRMO 9: Attain riverine conditions, including appropriate habitat, that support all life stages of endangered and native fish species.
RMO 4: Maintain flows (under approved operating criteria) and habitat suitable for quality cold water fishery opportunities in Glen Canyon.
RMO 5: Maintain flows (under approved operating criteria) and habitat suitable for waterfowl sport hunting and wildlife viewing opportunities in Glen Canyon.
SRMO 1: Maintain a long-term balance of river-stored sand to support maintenance flow (in years of low reservoir storage), beach/habitat-building flow (in years of high reservoir storage), and unscheduled flood flows. Maintain system dynamics and disturbance by annually (in years which Lake Powell water storage is low) redistributing sand stored in the river channel and eddies to areas inundated by river flows between 20,000 cfs and maximum power plant capacity.
WRMO 2: Maintain water quality at levels appropriate to support physical, biotic, and human resource needs of various ecosystems downstream of Glen Canyon Dam as mandated by the Grand Canyon Protection Act and incorporated into the Record of Decision.
LPMO 1: Prevent impacts that adversely affect the water quality (physical, chemical, biological) of Lake Powell due to dam operations and ensure that fully informed AMWG decisions are possible both now and in the future.
LPMO 2: Protect Lake Powell aquatic ecosystem from adverse impacts due to dam operations and subsequent effects, including but not limited to: temperature, reservoir surface elevations, elevated selenium levels, advective flow patterns, predator/prey relationships, and fish movements.

Goal 5. Establish water temperature, ~~chemistry~~quality, and flow dynamics to achieve GCDAMP ecosystem Goals.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
45	Maintain	Flow dynamics	Habitat maintenance flows	Mainstem	ROD	ROD	Resources and ecosystem
46	Maintain	Flow dynamics	Endangered fish research	Mainstem	ROD	Based on results of experiment	Resources and ecosystem

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Old MOs:
BRMO 2: In the Colorado River downstream of Glen Canyon Dam to the confluence of the Paria river, sufficient ecological conditions (such as habitat, foodbase and temperature) should be maintained, which in conjunction with management by Arizona Game and Fish will produce a healthy self-sustaining population of at least 100,000 Age II+ rainbow trout that achieve 18 inches in length by Age III with a mean annual relative weight (Wr) of at least 0.90.
BRMO 9: Attain riverine conditions, including appropriate habitat, that support all life stages of endangered and native fish species.
RMO 4: Maintain flows (under approved operating criteria) and habitat suitable for quality cold water fishery opportunities in Glen Canyon.
RMO 5: Maintain flows (under approved operating criteria) and habitat suitable for waterfowl sport hunting and wildlife viewing opportunities in Glen Canyon.
SRMO 1: Maintain a long-term balance of river-stored sand to support maintenance flow (in years of low reservoir storage), beach/habitat-building flow (in years of high reservoir storage), and unscheduled flood flows. Maintain system dynamics and disturbance by annually (in years which Lake Powell water storage is low) redistributing sand stored in the river channel and eddies to areas inundated by river flows between 20,000 cfs and maximum power plant capacity.
WRMO 2: Maintain water quality at levels appropriate to support physical, biotic, and human resource needs of various ecosystems downstream of Glen Canyon Dam as mandated by the Grand Canyon Protection Act and incorporated into the Record of Decision.
LPMO 1: Prevent impacts that adversely affect the water quality (physical, chemical, biological) of Lake Powell due to dam operations and ensure that fully informed AMWG decisions are possible both now and in the future.
LPMO 2: Protect Lake Powell aquatic ecosystem from adverse impacts due to dam operations and subsequent effects, including but not limited to: temperature, reservoir surface elevations, elevated selenium levels, advective flow patterns, predator/prey relationships, and fish movements.

Goal 6: ~~Increase~~ Maintain a sustainable fine sediment storage within the main channel and along shorelines to achieve GCDAMP ecosystem goals.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
47	Maintain or attain	Sediment	Abundance (area and volume)	Main channel below power plant capacity	x m^2 and x m^3 as a rolling average – obtain from literature	x m^2 and x m^3 as a rolling average – Information Need	To support deposition on channel margins.
48	Maintain or attain	Sediment	Grain-size characteristic	Main channel below power plant capacity	D50 x mm (obtain from literature)	D50 <= x mm (upper limit) Information Need based on flooding levels and transport capabilities	To support deposition on channel margins.
49	Maintain or attain	Sediment	Distribution (area and volume)	Main channel below power plant capacity	x m^2 and x m^3 average by reach -- Information Need	x m^2 and x m^3 average by reach – Information Need	To support deposition on channel margins.

Old MOs: BRMO 9: Attain riverine conditions, including appropriate habitat, that support all life stages of endangered and native fish species.
Old Goal 12: Increase fine sediment storage within the main channel and along shorelines to mimic historic spatial distribution.
SMO 1: Delineate baseline for fine sediment storage.
SRMO 1: Maintain a long-term balance of river-stored sand to support maintenance flow (in years of low reservoir storage), beach/habitat-building flow (in years of high reservoir storage), and unscheduled flood flows. Maintain system dynamics and disturbance by annually (in years which Lake Powell water storage is low) redistributing sand stored in the river channel and eddies to areas inundated by river flows between 20,000 cfs and maximum power plant capacity.
SRMO 2: As a minimum for each reach, maintain the number and average size (area and thickness) of sandbars and backwaters between the stages associated with flows of 8,000 and 45,000 cfs that existed during the 1990/91 research flows.
SRMO 3: Periodically increase the average size of sandbars above the 20,000 cfs river stage and number and average size of backwaters to the amounts measured during the high period of 1990/91 or the 1996 test of the beach/habitat-building flow in as many years as reservoir and downstream conditions allow.
SRMO 4: Maintain system dynamics and disturbance by redistributing sand stored in the river channel and eddies to areas inundated by river flows up to 45,000 cfs in as many years as possible when BHBF hydrologic and resource criteria are met.

Goal 6: ~~Increase~~ Maintain a sustainable fine sediment storage within the main channel and along shorelines to achieve GCDAMP ecosystem goals.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
50	Maintain or attain	Sediment	Abundance (area and volume)	Eddies up to power plant capacity	x m^2 and x m^3 Information Need and Obtain from literature	x m^2 and x m^3 Information Need	For backwater development and deposition on channel margins.
51	Maintain or attain	Sediment	Grain-size characteristic	Eddies up to power plant capacity	D50: x mm Information Need and Obtain from literature	D50: x mm Information Need	For backwater development and deposition on channel margins.
52	Maintain or attain	Sediment	Abundance and distribution	Eddies up to power plant capacity	x m^2 and x m^3 average by reach Information Need and Obtain from literature	x m^2 and x m^3 average by reach Information Need	For backwater development and deposition on channel margins.

Old MOs: BRMO 9: Attain riverine conditions, including appropriate habitat, that support all life stages of endangered and native fish species.
Old Goal 12: Increase fine sediment storage within the main channel and along shorelines to mimic historic spatial distribution.
SMO 1: Delineate baseline for fine sediment storage.
SRMO 1: Maintain a long-term balance of river-stored sand to support maintenance flow (in years of low reservoir storage), beach/habitat-building flow (in years of high reservoir storage), and unscheduled flood flows. Maintain system dynamics and disturbance by annually (in years which Lake Powell water storage is low) redistributing sand stored in the river channel and eddies to areas inundated by river flows between 20,000 cfs and maximum power plant capacity.
SRMO 2: As a minimum for each reach, maintain the number and average size (area and thickness) of sandbars and backwaters between the stages associated with flows of 8,000 and 45,000 cfs that existed during the 1990/91 research flows.
SRMO 3: Periodically increase the average size of sandbars above the 20,000 cfs river stage and number and average size of backwaters to the amounts measured during the high period of 1990/91 or the 1996 test of the beach/habitat-building flow in as many years as reservoir and downstream conditions allow.
SRMO 4: Maintain system dynamics and disturbance by redistributing sand stored in the river channel and eddies to areas inundated by river flows up to 45,000 cfs in as many years as possible when BHBF hydrologic and resource criteria are met.

Goal 6: ~~Increase~~ Maintain a sustainable fine sediment storage within the main channel and along shorelines to achieve GCDAMP ecosystem goals.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
53	Maintain or attain	Sediment	Abundance (area and volume)	Shorelines > power plant capacity or up to maximum BHBF	x m^2 and x m^3 Obtain from literature	x m^2 and x m^3 Information Need	
54	Maintain or attain	Sediment	Grain-size characteristic	Shorelines > power plant capacity or up to maximum BHBF	D50: x mm Obtain from literature	D50: x mm Information Need	
55	Maintain or attain	Sediment	Distribution	Shorelines > power plant capacity or up to maximum BHBF	x m^2 and x m^3 average by reach Obtain from literature	x m^2 and x m^3 average by reach Information Need	

Old MOs: BRMO 9: Attain riverine conditions, including appropriate habitat, that support all life stages of endangered and native fish species.
Old Goal 12: Increase fine sediment storage within the main channel and along shorelines to mimic historic spatial distribution.
SMO 1: Delineate baseline for fine sediment storage.
SRMO 1: Maintain a long-term balance of river-stored sand to support maintenance flow (in years of low reservoir storage), beach/habitat-building flow (in years of high reservoir storage), and unscheduled flood flows. Maintain system dynamics and disturbance by annually (in years which Lake Powell water storage is low) redistributing sand stored in the river channel and eddies to areas inundated by river flows between 20,000 cfs and maximum power plant capacity.
SRMO 2: As a minimum for each reach, maintain the number and average size (area and thickness) of sandbars and backwaters between the stages associated with flows of 8,000 and 45,000 cfs that existed during the 1990/91 research flows.
SRMO 3: Periodically increase the average size of sandbars above the 20,000 cfs river stage and number and average size of backwaters to the amounts measured during the high period of 1990/91 or the 1996 test of the beach/habitat-building flow in as many years as reservoir and downstream conditions allow.
SRMO 4: Maintain system dynamics and disturbance by redistributing sand stored in the river channel and eddies to areas inundated by river flows up to 45,000 cfs in as many years as possible when BHBF hydrologic and resource criteria are met.

Goal 7: Maintain or attain viable populations of Kanab ambersnail.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
56	Maintain	Kanab ambersnail	Population[1]	Vasey's Paradise	95-97 population estimates with confidence intervals – Obtain from literature	Viable population level as indicated by the appropriate model or analytical technique – Information Need	Assumed to be a unique taxon endemic to Vasey's Paradise versus the last remnant of a meta-population.
57	Attain and maintain	Kanab ambersnail	Population	AZ (3 trans-location sites in GC)	Unknown -- Information Need	Viable Population – Information Need	To meet the existing BO until it is revised. As indicated in Principle 7, some actions may be outside the AMP.
58	Maintain	Kanab ambersnail	Habitat (composition and area in m^2)	Vasey's Paradise	Obtain from literature	Sustain viable population – Information Need	

[1] *The specific attribute will depend on how population viability is measured. Possible indicators include over-wintering abundance, health, recruitment, size class, patch size, etc.*

Old MOs:

BRMO 11: Protect, restore, and enhance survival of native and special status species (federal, tribal, and state designations). Ensure that the required habitat for these species is preserved.
BRMO 14: Sustain populations of Kanab ambersnail wherever they currently exist within the Colorado River ecosystem.
BRMO 15: Establish or discover and ensure the continued existence of a second population of Kanab Ambersnail in Arizona.

Goal 8. Protect the presence of Southwestern willow flycatcher in a manner consistent with riparian ecosystem Goals.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
59	Increase	SWWF	Nesting success	CRE	Obtain from literature	Information Need	
60	Reduce	SWWF	Brood parasitism	CRE	Obtain from literature	Information Need	
61	Maintain or increase	SWWF	Population (abundance, distribution, breeding pairs, etc.)	CRE below GCD	97-99 numbers – Obtain from literature	To the capability of the habitat to support the species – Information Need	As related to BO needs

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Old MOs:

BRMO 11: Protect, restore, and enhance survival of native and special status species (federal, tribal, and state designations). Ensure that the required habitat for these species is preserved.
BRMO 12: Maintain a natural age-class distribution of wildlife species throughout the majority of natural range in Glen and Grand Canyons, emphasizing the need to recruit into breeding age classes.
BRMO 13: Protect, restore, and enhance survival of native and special status avifauna.
SMO 3: habitat
SMO 4: parasitism

Goal 9. Protect or improve the biotic riparian and spring communities.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
62	Maintain	Marsh, NHWZ, OHWZ, and sand beach Communities (emphasizing native flora and fauna)	Abundance	CRE below GCD	91-96 estimates – Obtain from literature	Information Need and Decision Process	Habitat and food for species. Intrinsic value of the composition of the community itself. Patch dynamics, successional processes, and habitat availability.
63	Maintain	Marsh, NHWZ, OHWZ, and sand beach Communities (emphasizing native flora and fauna)	Distribution	CRE below GCD	91-96 estimates – Obtain from literature	Information Need and Decision Process	Habitat and food for species. Intrinsic value of the composition of the community itself. Patch dynamics, successional processes, and habitat availability.
64	Maintain	Marsh, NHWZ, OHWZ, spring, and sand beach Communities (emphasizing native flora and fauna)	Composition (diversity – emphasizing native species, successional stage, and age class)	CRE below GCD	91-96 estimates – Obtain from literature	Information Need and Decision Process	Habitat and food for species. Intrinsic value of the composition of the community itself. Patch dynamics, successional processes, and habitat availability.

Old MOs:
BRMO 11: Protect, restore, and enhance survival of native and special status species (federal, tribal, and state designations). Ensure that the required habitat for these species is preserved.
BRMO 12: Maintain a natural age-class distribution of wildlife species throughout the majority of natural range in Glen and Grand Canyons, emphasizing the need to recruit into breeding age classes.
BRMO 13: Protect, restore, and enhance survival of native and special status avifauna.
BRMO 16: Maintain, enhance or restore vegetative communities made up of diverse groups of native riparian and upland species with special emphasis on preservation of unique plant communities and special status species at different stages of succession and at different elevations above the water line.
SMO 2: Identify specific unique areas to protect.
Old Goal 16: Emphasizing native biodiversity, protect or improve the biotic riparian communities, and reduce or eliminate invasive nonnative species.
Old Goal 17: Prevent any further human-induced extirpation or extinction of native riparian species.

Goal 9. Protect or improve the biotic riparian and spring communities.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
65	Maintain or increase	Culturally important species	Abundance	CRE below GCD	Information Need	Information Need	To enhance and preserve traditional cultures.
66	Maintain or increase	Culturally important species	Distribution	CRE below GCD	Information Need	Information Need	To enhance and preserve traditional cultures.
67	Reduce	Non-native species ("noxious" or actively filling a niche and out-competing native species)	Abundance	CRE below GCD	Information Need	Information Need	To enhance native species within riparian biotic communities.
68	Reduce	Non-native species ("noxious" or actively filling a niche and out-competing native species)	Distribution	CRE below GCD	Information Need	Information Need	To enhance native species within riparian biotic communities.

Old MOs:
BRMO 11: Protect, restore, and enhance survival of native and special status species (federal, tribal, and state designations). Ensure that the required habitat for these species is preserved.
BRMO 12: Maintain a natural age-class distribution of wildlife species throughout the majority of natural range in Glen and Grand Canyons, emphasizing the need to recruit into breeding age classes.
BRMO 13: Protect, restore, and enhance survival of native and special status avifauna.
BRMO 16: Maintain, enhance or restore vegetative communities made up of diverse groups of native riparian and upland species with special emphasis on preservation of unique plant communities and special status species at different stages of succession and at different elevations above the water line.
SMO 2: Identify specific unique areas to protect.
Old Goal 16: Emphasizing native biodiversity, protect or improve the biotic riparian communities, and reduce or eliminate invasive nonnative species.
Old Goal 17: Prevent any further human-induced extirpation or extinction of native riparian species.

Goal 10: Maintain or improve the quality of unique recreational experiences for users of the Colorado River ecosystem, within the framework of GCDAMP ecosystem goals.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
69	Maintain	River	Access	Mainstem	1999 level – Obtain from literature	GLCA and GRCA Manage-ment Plan levels	Safe river access and access to attraction sites for sports people.
70	Maintain or improve	Recreational opportunities	Diversity	Glen Canyon	1999 levels	GLCA Manage-ment Plan levels	Quality hiking, camping, hunting, fishing and boating, for the full spectrum of appropriate recreational experiences.
71	Maintain or increase	Camping beaches	Size	Mainstem	Obtain from literature – GCMRC draft report of June 2000	Decision process	To meet the goal for recreation with a quality of camping experience defined by the studies of T. Hall, B. Stewart, and C. Roberts.

Old MOs:

RMO 1: Provide quality recreation experiences consistent with other resource objectives.
RMO 2: Maintain flows (under approved operating criteria) and sediment processes that create an adequate quantity, distribution and variety of beaches for camping, as long as such flows are consistent with management of natural recreation and cultural resource values (other natural resource values).
RMO 3: Maintain flows (under approved operating criteria) that minimize impacts to navigability by authorized water craft and for boaters, waders, and campers in the riverine corridor.
SMO 5: periodic restoration (of beaches)
SMO 6: periodic stripping of vegetation, consistent with native ecosystem goals.
Old Goal 10: Protect or improve the size, number, quality, and distribution of camping beaches, consistent with native ecosystem goals.
Old Goal 13: Maintain navigability of rapids, consistent with native ecosystem goals.

Goal 10: Maintain or improve the quality of unique recreational experiences for users of the Colorado River ecosystem, within the framework of GCDAMP ecosystem goals.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
72	Maintain or increase	Camping beaches	Quality (vegetation, sanitation, shade)	Mainstem	Obtain from literature – GCMRC draft report of June 2000	Decision process	To meet the goal for recreation with a quality of camping experience defined by the studies of T. Hall, B. Stewart, and C. Roberts.
73	Maintain or increase	Camping beaches	Number	Mainstem	Obtain from literature – GCMRC draft report of June 2000	Decision process	To meet the goal for recreation with a quality of camping experience defined by the studies of T. Hall, B. Stewart, and C. Roberts.
74	Maintain or increase	Camping beaches	Distribution	Mainstem	Obtain from literature – GCMRC draft report of June 2000	Decision process	To meet the goal for recreation with a quality of camping experience defined by the studies of T. Hall, B. Stewart, and C. Roberts.

Old MOs:

RMO 1: Provide quality recreation experiences consistent with other resource objectives.
RMO 2: Maintain flows (under approved operating criteria) and sediment processes that create an adequate quantity, distribution and variety of beaches for camping, as long as such flows are consistent with management of natural recreation and cultural resource values (other natural resource values).
RMO 3: Maintain flows (under approved operating criteria) that minimize impacts to navigability by authorized water craft and for boaters, waders, and campers in the riverine corridor.
SMO 5: periodic restoration (of beaches)
SMO 6: periodic stripping of vegetation, consistent with native ecosystem goals.
Old Goal 10: Protect or improve the size, number, quality, and distribution of camping beaches, consistent with native ecosystem goals.
Old Goal 13: Maintain navigability of rapids, consistent with native ecosystem goals.

Goal 10: Maintain or improve the quality of unique recreational experiences for users of the Colorado River ecosystem, within the framework of GCDAMP ecosystem goals.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
75	Maintain or improve	Rapids	Navigability	Mainstem	Current NPS on-river accident rates – Obtain from literature	Information Need and Decision Process – threshold to be developed from NPS on-river accident rates	To achieve whitewater rafting experiences and boating access to Glen Canyon and Lake Mead.
76	Maintain or enhance	Experience	Wilderness	Grand Canyon	NPS current plans	NPS current plans – until modified	Including primitive character, unconfined experience, undeveloped natural and wild character, opportunities for solitude, sounds of nature and scenic beauty, to ensure a quality wild river experience for visitors and non-visitors.
77	Reduce	Historic properties and cultural resources	Impacts from recreation, science, and tribes	Mainstem	Level docu-mented by NPS monitoring data	Zero impact	To maintain integrity of sites and cultural and spiritual values to tribes and achieve NPS section 100 responsibilities.

Old MOs:

RMO 1: Provide quality recreation experiences consistent with other resource objectives.
RMO 2: Maintain flows (under approved operating criteria) and sediment processes that create an adequate quantity, distribution and variety of beaches for camping, as long as such flows are consistent with management of natural recreation and cultural resource values (other natural resource values).
RMO 3: Maintain flows (under approved operating criteria) that minimize impacts to navigability by authorized water craft and for boaters, waders, and campers in the riverine corridor.
SMO 5: periodic restoration (of beaches)
SMO 6: periodic stripping of vegetation, consistent with native ecosystem goals.
Old Goal 10: Protect or improve the size, number, quality, and distribution of camping beaches, consistent with native ecosystem goals.
Old Goal 13: Maintain navigability of rapids, consistent with native ecosystem goals.

Goal 11: Maintain or increase power and energy generation within the framework of GCDAMP ecosystem goals.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
78	Maintain or restore	Energy	Value	GCD	Obtain from literature	Decision process	

Old MOs:

SEMO 1: Maximize the value of long-term power and energy generation within the criteria and operating plans established by the Secretary under Section 1804 of the Grand Canyon Protection Act.
SMO7: Explore installing turbines on outlet tubes.
SMO8: Investigate load following capability.

Goal 12: Preserve, protect, manage, and treat cultural resources ~~within the river corridor~~ for the inspiration and benefit of past, present and future generations.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
79	Preserve	Register-eligible properties	National Register integrity	CRE	Obtain from literature	100% of extant historic properties (as defined in NHPA)	MAs: 1) Preserve Register-eligible properties' integrity when possible using site preservation; 2) Treat damage to Register-eligible properties, using treatments, when site preservation is not possible, and 3) Recover register-eligible data, using data recovery, when neither preservation nor treatments are possible.
80	Preserve	Other cultural resources	Cultural values	CRE	Information Need	Information Need	
81	Attain and maintain	Management action	Consultation	CRE	Information Need	100% of mgt. actions	
82	Protect and maintain	Traditional cultural resources	Access by tribes	CRE	Information Need	Information Need	Preserve traditional tribal practices and beliefs.

Old MOs:
CRMO 1: Conserve in situ all the downstream cultural resources and take into account Native American cultural resource concerns in the Colorado River ecosystem.
CRMO 2: If in situ conservation is not possible, design mitigative strategies that integrate the full consideration of the values of all concerned tribes with a scientific approach.
CRMO 3: Protect, and maintain physical access to and use of traditional cultural properties and other cultural resources, where such access and use may be impacted by dam operations.
CRMO 4: Maintain and integrate all appropriate cultural data recovered from monitoring, remedial, and mitigative action and incorporate these data into the evolving research designs and mitigative strategies for understanding the human occupation and use of the Colorado River ecosystem.

Goal 12: Preserve, protect, manage, and treat cultural resources ~~within the river corridor~~ for the inspiration and benefit of past, present and future generations.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
83	Integrate (meaning archive, synthesize, and summarize)	Information	Cultural and other resources	CRE	Information Need	Information Need	Improve outreach, education, and research efforts.

Old MOs:
CRMO 1: Conserve in situ all the downstream cultural resources and take into account Native American cultural resource concerns in the Colorado River ecosystem.
CRMO 2: If in situ conservation is not possible, design mitigative strategies that integrate the full consideration of the values of all concerned tribes with a scientific approach.
CRMO 3: Protect, and maintain physical access to and use of traditional cultural properties and other cultural resources, where such access and use may be impacted by dam operations.
CRMO 4: Maintain and integrate all appropriate cultural data recovered from monitoring, remedial, and mitigative action and incorporate these data into the evolving research designs and mitigative strategies for understanding the human occupation and use of the Colorado River ecosystem.

Goal 13: Maintain a high quality monitoring, research, and adaptive management program.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
84	Incorporate	Socio-economic	Values	Place is specific to the information need	N/A	N/A	To ensure fully informed AMP decisions.
85	Attain	Monitoring & Research Program	Natural, cultural, and recreational resources of GRCA and GLCA	CRE			To determine the effects of the Secretary's actions and provide information to the Secretary and the AMP
86	(Alternative to ID #85) Attain	Monitoring & Research Program	That is sufficient to provide quality scientific information	CRE			To the Secretary and the AMP for decision-making

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Old MOs:
EAMO 1: Develop a conceptual model of the Colorado River ecosystem
GISMO 1: Management Objective to be added.
SMO 9: Maintain outside peer review of research proposals, reports, and other products produced by GCMRC and its contractors.
SMO 10: Build an effective Science Advisory Board.
SMO 11: Maintain an effective Technical Work Group and Adaptive Management Work Group process.
SMO 12: Develop an efficient and effective monitoring and research program.
SMO 13: Develop an effective metric to measure progress toward achieving adaptive management goals.
SMO 14: Maintain an objective experimental approach to adaptive management.
SMO 15: Utilize the National Research Council to conduct a five-year review of the effectiveness of the adaptive management program and processes.
SMO 16: Maintain an adequate level of high quality staff to accomplish adaptive management program goals.
SMO 17: Maintain independence of roles and parity among TWG, AMWG, and GCMRC (see NRC pg. 46-47)
SMO 18: Develop an experimental flows research program and implement it within a specific timeframe.
SMO 19: Re-evaluate goals and strategic plan every five years.

Goal 13: Maintain a high quality monitoring, research, and adaptive management program.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
87	Establish	AMP composed of all stakeholders	That embraces uncertainty and experimentation, uses monitoring & research				Bases its recommendations for resource management on sound scientific information
88	Attain	Full tribal participation	Funding	AMP			To meet the GCPA intent, for full participation in all aspects of the AMP

Old MOs:
EAMO 1: Develop a conceptual model of the Colorado River ecosystem
GISMO 1: Management Objective to be added.
SMO 9: Maintain outside peer review of research proposals, reports, and other products produced by GCMRC and its contractors.
SMO 10: Build an effective Science Advisory Board.
SMO 11: Maintain an effective Technical Work Group and Adaptive Management Work Group process.
SMO 12: Develop an efficient and effective monitoring and research program.
SMO 13: Develop an effective metric to measure progress toward achieving adaptive management goals.
SMO 14: Maintain an objective experimental approach to adaptive management.
SMO 15: Utilize the National Research Council to conduct a five-year review of the effectiveness of the adaptive management program and processes.
SMO 16: Maintain an adequate level of high quality staff to accomplish adaptive management program goals.
SMO 17: Maintain independence of roles and parity among TWG, AMWG, and GCMRC (see NRC pg. 46-47)
SMO 18: Develop an experimental flows research program and implement it within a specific timeframe.
SMO 19: Re-evaluate goals and strategic plan every five years.

Goal 14. Build a broad, effective outreach program.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
89	Build	Broad, informed public constituency	In support of the AMP	AMP	Information Need	Information Need	

SMO 20: Develop public support through information and education programs.
SMO 21: Develop an effective program for educating the AMWG and TWG on ecosystem knowledge and issues.

Goal 15. Broaden the funding base to achieve GCDAMP Goals and Objectives.

ID #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level (numbers to be validated by monitoring)	For some purpose
90	Increase	Foundation & Corporate	Funding		$0	Information Need	To support the AMP
91	Increase	Appropriated	Funding		Obtain from literature	Information Need	To support the AMP
92	Increase	State Agency	Funding		$0	Information Need	To support the AMP
93	Increase	Participation of	Externally-funded investigators		Obtain from literature	Information Need	On AMP issues
94	Maintain	Power revenue base	To support the AMP		Obtain from literature	Information Need	

Old MOs:

SMO 22: Raise funds from foundation and corporate sources.
SMO 23: Encourage outside researchers to work in the Grand Canyon, capitalizing on our extensive research and monitoring foundation.
SMO 24: Seek appropriations for research and monitoring programs.
SMO 25: Maintain strong financial support from power revenues.
SMO 26: Seek funding from other federal and state agencies.

Information Needs, Management Actions and Notes

All Goals

Information Needs

All MOs: Fill in any blanks.
All MOs: Validate target levels through monitoring.

Goal 1

Information Needs

MO 1-16: Native fish food requirements.
MO 1, 4, 7, 11: Biomass estimate that will sustain native fish.
Determine the adequacy of the foodbase in the LCR. (Not the responsibility of AMP.)

Notes

MO 14: We think distribution might be important but we are not sure. This item is here as a placeholder for now. We will look at the literature and make a decision on its inclusion.

Goal 2

Information Needs

MO 17: Regarding use of PVA or comparable approach or Ne to establish a target population target.
MOs 26 and 27: Quantify other survivability issues for native fish (e.g., disease, and parasites).
MOs 26 and 27: Identify predation rates of non-native fish on native fish and competition effects.

Management Actions

MOs 26 and 27: Reduce predation of non-native fish on native fish and competition between non-native and native fish.
MO 28: Determine feasibility of restoration of razorback sucker.

Goal 3

Information Needs

MO 32-34: Determine feasibility of restoration of Colorado pikeminnow, Bonytail, and Roundtail chub.
MO 35: What is the feasibility of otter restoration?
MO 35: What is the cumulative/additive impact on the HBC from otter predation?
MO 35: What is evidence of historic abundance and distribution of otter in GC?
MO 35: Ascertain reintroduction of otter on predator-prey dynamics.

Goal 4

Information Needs

All MOs: What do trout need by way of physical habitat (spawning beds)?
All MOs: How would the TCD affect habitat in general?
All MOs: Can water releases (to impact water temperature and level) be seasonal in order to sustain the trout fishery and not harm native fish?
All MOs: Determine the interaction of native fish and trout and the implication of river level on those interactions.

Goal 6

Information Need

MOs 53-55: Determine maximum flow for BHBFs.

Management Actions

Conduct habitat maintenance flows and BHBFs when resource and hydrologic criteria are met.
Conduct experimental flows.

Goal 7

Information Needs

Is the snail at Vasey's Paradise Kanab ambersnail or a unique taxon?
Determine if KAS is endemic to Vasey's Paradise or part of a meta-population.
What is minimum habitat size needed to maintain a viable KAS population?
What is minimum KAS population size needed to maintain population viability?

Goal 8

Information Needs

Site fidelity to inform appropriate target levels?
Understanding of habitat utilization as compared to habitat suitability and availability.
Examine potential conflict between SWWF MO and riparian vegetation MOs?
Quantify survivorship of SWWF.

Goal 9

Notes

Definitions:
Riparian - Those communities affected by riverine processes. Includes the Old High Water Zone (~ 100,000 cfs).
Spring - Those within the CRE.

Goal 12

Information Needs

MO 80: Determine what are the "other cultural resources" we are preserving.

Management Actions

MO 79: Preserve Register-eligible properties' integrity when possible using site preservation.
MO 79: Treat damage to Register-eligible properties, using treatments, when site preservation is not possible.
MO 79: Recover register-eligible data, using data recovery, when neither preservation nor treatments are possible.

Notes

Add an MO for floods to deposit sediment and buttress archeological sites?

Goal 13

Information Needs

Power – change in benefits
Air quality – regional impacts/costs
Wilderness values
Recreation – change in benefits
Social values
Tribal and spiritual values

Management Actions

Develop a conceptual model of the Colorado River ecosystem.
Management Objective to be added.
Maintain outside peer review of research proposals, reports, and other products produced by GCMRC and its contractors.
Maintain an objective experimental approach to adaptive management
Maintain an adequate level of high quality staff to accomplish adaptive management program goals.
Ensure monitoring and research activities are conducted in such a way as to minimize impacts on the aesthetic and spiritual values.

Build an effective Science Advisory Board.
Use the National Research Council to conduct a five-year review of the effectiveness of the adaptive management program and processes.
Maintain independence of roles and parity among TWG, AMWG, and GCMRC (see NRC pg. 46-47).
Annual SCORE report.

Goal 14

Management Action

Build a broad, effective outreach program by attaining and maintaining an AMP continuing education process.

Abbreviations

AFDW	ash-free dry weight
AMP	adaptive management program
BHBF	beach/habitat building flow
BO	biological opinion
BRMO	biological resources MO[2]
cfs	cubic feet per second
CPUE	catch per unit effort
CRE	Colorado River ecosystem
CRMO	cultural resources MO[2]
D50	median grain size
DO	dissolved oxygen
EAMO	ecosystem assessment MO[2]
GCD	Glen Canyon Dam
GCMRC	Grand Canyon Monitoring and Research Center
GISMO	geographic information system MO[2]
GLCA	Glen Canyon National Recreation Area
GRCA	Grand Canyon National Park
HBC	Humpback chub
KAS	Kanab ambersnail
LCR	Little Colorado River
LPMO	Lake Powell MO[2]
MA	management action
MO	management objective
Ne	effective population size
NHPA	National Historic Properties Act
NHWZ	new high water zone
NPS	National Park Service
OHWZ	old high water zone
popn	population
PVA	population viability analysis
Register	National Historic Register
RMO	recreation MO[2]
RNV	range of natural variability
ROD	record of decision
RPA	reasonable and prudent alternative
SEMO	socio-economic MO[2]
SMO	suggested MO[3]
SRMO	sediment resources MO[2]
SWWF	Southwestern willow flycatcher
TBD	to be determined
Wr	mean annual relative weight
WRMO	water resources MO[2]

[2] *From the document named DRAFT GLEN CANYON DAM MANAGEMENT OBJECTIVES, June 10, 1998.*
[3] *From the document named "Glen Canyon Dam Adaptive Management Work Group, Ad Hoc Committee on Goals, Report to AMWG, September 1999."*