From: Linda Whetton

To: Begay, Steven; Broscheid, Bob; Bulletts, Charley; Burman, Brenda; Caan, George; Groseclose, Jay; Jackson Kelly, Loretta; James, Leslie; Kuwanwisiwma, Leigh; Martin, Steve; Orton, Mary; Potochnik, Andre; Rampton, Ted; Ramsey, Nikolai; Sabo, David; Seaholm, Randy; Shields, John; Spiller, Sam; Steffen, Mark; Stevens, Larry; Strong, Dennis; Walkoviak, Larry; Warren, Brad; Werner, Bill; Zimmerman, Gerald

Date: 1/7/2008 9:22:26 AM

Subject: TWG Report to BOR on Desired Future Condition Targets for Resources

See message from Kurt Dongoske below:

- - - - - - - - - - - - -
From: "Kurt Dongoske" <kdongoske@cableone.net>
To: <RPETERSON@uc.usbr.gov>
Date: 1/4/2008 4:30:37 PM
Subject: TWG Report to BOR on Desired Future Condition Targets for Resources

Randy,

Please see the attached report which responds to your June 25, 2007 request of the TWG to dedicate sufficient effort toward the development of a set of technical options for desired resource condition targets. These defined desired resource condition targets would be utilized in the development of the Long Term Experimental Plan EIS. You specifically requested that the TWG initially address the desired targets for two specific resources: sediment and humpback chub.

The attached report is being submitted to you in partial fulfillment of your request to the Technical Work Group. Additional recommendations were made by the TWG to the AMWG concerning the development of desired condition targets for the other important resources covered by the Adaptive Management Program and those recommendations will be presented to the AMWG prior to their next meeting.

Would you please ask Linda to forward this email transmittal and the attachment to the AMWG and TWG stakeholders? I seem to be having trouble transmitting it to everyone. Thank you.

If you have any questions please contact me at 928/289-9259 or respond to this email.

Best regards and Happy New Year,

Kurt Dongoske, Chair
Technical Work Group

CC: "Linda Whetton" <LWHETTON@uc.usbr.gov>, "Dennis Kubly" <DKUBLY@uc.usbr.gov>, <mary@maryorton.com>

- - - - - - - - - - - - - - -
cc: Amy Heuslein/Garry Cantley (e-mail message only, report distributed at Dec. 4-5 TWG Meeting)

CC: Andersen, Matthew; Balsom, Janet; Barger, Mary; Barrett, Clifford; Bryant, Nora; Burke, Kelly; Capron, Shane; Christensen, Kerry; Damp, Jonathan; Davis, William E.; English, Jeff; Garrett, L. David; Hamill, John; Harris, Christopher; Henderson, Norm; Johnson, Rick; Kaplinski, Matt; Kincaid, Chris; King, Robert; Knowles, Glen W.; Kubly, Dennis; McMullen, Ken; Melis, Ted; Miller, Anthony; O'Brien, John; Ostler, Don; Palmer, Clayton; Persons, Bill; Peterson, Randall; Rogers, Roland; Skrzynski, LeAnn; Steffen, Tim; Yeatts, Michael

Memorandum

To: Randy Peterson, Upper Colorado Regional Office, Bureau of Reclamation

From: Kurt Dongoske, Chair of the Technical Work Group

Date: January 4, 2008

Re: Recommendation with regard to Desired Future Conditions

During the Technical Work Group (TWG) meeting held on June 25, 2007 Reclamation requested the TWG to dedicate sufficient effort toward the development of a set of technical options for desired resource condition targets. These defined desired resource condition targets would be utilized in the development of the Long Term Experimental Plan EIS. You specifically requested that the TWG initially address the desired targets for two specific resources: sediment and humpback chub.

The TWG formed a multi-disciplinary ad hoc group (Desired Future Conditions Ad Hoc Group) to respond to this request. The Desired Future Conditions Ad Hoc Group (DFC Ad Hoc) reported back to the TWG during our 04 and 05 December 2007 meeting. The attached report from the DFC Ad Hoc was reviewed and accepted by the TWG on 05 December 2007 and the recommendations in the report were supported by the TWG membership in a vote of 20 yes, 1 no, and 2 abstentions.

The attached report is being submitted to you in partial fulfillment of your request to the Technical Work Group. Additional recommendations were made by the TWG to the AMWG concerning the development of desired condition targets for the other important resources covered by the Adaptive Management Program and those recommendations will be presented to the AMWG prior to their next meeting.

Memorandum

To: Technical Work Group members

From: Desired Future Conditions Ad Hoc Group

cc: TWG alternates and interested persons

Date: November 20, 2007

Re: Recommendation with regard to Desired Future Conditions

RECOMMENDATION

The Desired Future Conditions Ad Hoc Group (DFCAHG) is pleased to make the following recommendations to the Technical Work Group (TWG):

- That the TWG forward the attached four sets of targets for Humpback chub and sediment to AMWG (see Attachments 1, 2, 3, and 4, starting on page 4), and advise AMWG that TWG has found all four sets to be scientifically and technically credible.
- That the TWG recommend to the AMWG that the TWG be charged with developing a range of options for targets for the remaining resources in the AMP Strategic Plan.

BACKGROUND

The DFCAHG met for three days (November 6, 7, and 13) in a workshop to assist the TWG to fulfill the **charge from the Bureau of Reclamation** (see Attachment 5, page 27). Note that the charge asks that the TWG recommend "a range of options" for targets of Management Objectives from the approved AMP strategic plan, and that the TWG first focus on Humpback chub and sediment. The charge also requests that TWG address short-term (10-year) and long-term targets; the Ad Hoc Group agreed that the timeframe for the 10-year targets is assumed to begin in 2008.

The DFCAHG considered certain **excerpts of the AMP strategic plan** (see Attachment 6, page 28), so that it could ensure that the targets were consistent with the plan, per the charge. The DFCAHG also reminded itself of the **approved Management Objectives** for those two resources (see Attachment 7, page 30). The DFCAHG notes that the principles from the AMP strategic plan, included in Attachment 6, apply to the attached targets.

The DFCAHG spent many hours planning for the workshop in order to ensure that it would be productive. Part of its deliberations prior to the workshop included developing a **purpose and decision rule** (see Attachment 8, page 35). The DFCAHG agreed to operate somewhat differently from the usual TWG operations, as follows:

- It agreed to operate by consensus, not by majority vote; and
- It agreed that its task was to determine whether the rationale used to develop targets was scientifically and technically credible, rather than to choose among targets; leaving the latter task up to the AMWG as a policy decision.

All Ad Hoc Group members were invited to submit targets for consideration. **Two sets of targets** were proposed by Ad Hoc Group members: one from the National Park Service, and one from Western Area Power Administration. The workshop attendees thoroughly discussed the proposed targets, raised questions, and identified unspoken assumptions. Both proposers (NPS and Western) made numerous changes to their proposed targets as their thinking was advanced by discussion of the group. Finally, and in accordance with the "purpose and decision rule" document (Attachment 8, page 35), all four sets of targets that are attached as Attachments 1-4 (starting on page 4) were determined, by consensus, to met the standard of scientific and technical credibility. There is not consensus, however, that all targets meet all applicable law.

The DFCAHG recommends that the TWG use the same process of determining scientific and technical credibility, and forward to AMWG all targets that meet that standard.

Because the operating procedures of the AMWG and TWG require that TWG work only on tasks given it by the AMWG, the DFCAHG further recommends to the TWG that it recommend to the AMWG that the TWG be charged with developing ranges of targets for the remaining resources in the AMP Strategic Plan. It will be important to develop targets for other resources to support the targets developed for Humpback chub and sediment.

Attachment 1: Sediment Targets

These targets were **originally proposed by Western Area Power Administration**, and were determined by consensus to be scientifically and technically credible by the Desired Future Conditions AHG.

Short- and Long-Term Target

To slow or reverse the rate of decline of fine sediment deposits at all stages described in Management Objectives 8.1-8.5 over the next ten years and beyond, throughout the CRE, as measured by the number, volume, and areal extent of beaches and backwaters.

Bases, Assumptions, and Current Data

a. The purposes of Grand Canyon sediment, as approved by AMWG in 2002, are for "enough sediment to achieve the biological, recreational, and cultural goals. Given limited sediment inputs, we need to retain enough sediment in the system to achieve ecosystem patterns in these goals. For the biological goals, the purposes are habitat and nutrient storage. For the cultural goal, the purposes are enhancing plant habitat and preserving historical properties. For recreational goals, the purposes are camping beaches and trout spawning habitat."
b. We assume that backwaters are beneficial for native fish.
c. If we slow the decline of sediment in RM 1-87, we assume that the decline will be slowed throughout the Colorado River ecosystem.
d. The focus of evaluation for mass balance will be on RM 1-87 due to the fact that we have the best data for this reach.
e. In the recent past, we have been in a decline of 2% to 3% annually of total sediment in River Miles 1 through 87. (This has been validated by GCMRC.)
f. Given the current and near-future sediment, precipitation, and hydrology, we assume that a rough approximation of future sediment loss in the system will be 2-3% per year, with MLFF and no BHBFs.
g. If we add certain management "tools," e.g., BHBFs and HMFs, to be done a certain number of times per year or decade, we assume that we can reduce the decline.
h. The relationship of sediment balance and number of backwaters is unknown and should be monitored and tested during this period.

The method described herein is proposed for the development of targets for the Sediment MOs. There are two large steps and several smaller, intermediate steps as follows:

Step One – Determine long-term average sediment level that is sustainable given natural variables and application of management tools. Experiment with and/or model and document effects of potential management "tools" on sediment conservation. Each "tool" would be examined for its utility in sediment conservation, impact on other resources, impact on other "tools" and cost and legal parameters. The list of potential "tools" includes the five parameters of normal operations (upramps, downramps, minimums, maximums, and daily ranges), BHBFs, HMFs, and others.

After documentation of the natural variables (i.e. sediment inflow, precipitation and hydrology), apply various management tools in a modeling exercise to derive an optimum sediment mass that can be sustained and, when the management tools are applied, does no/insignificant long-term harm to key resources identified in the GCD EIS.

Evaluation
Two evaluation methods:
1. Mass Balance as calculated in RM 1-87 – measuring loss of sediment.
2. Evaluation of number, volume, and areal extent of beaches and backwaters.

In order to evaluate the efficacy of this course of action, perform the following three steps to determine what the sediment balance trajectory would have been with no action.
a. Document/model long-term average sediment inflow between Lees Ferry and the Grand Canyon Gage. (NOTE: This work may be done sufficiently to complete Step One.)
b. Document/model long-term upgradient precipitation in this reach. NOTE: This work may be done sufficiently to complete Step One.
c. Document/model GCD releases over the long-term, to include potential influences of climate change. NOTE: This work may be done sufficiently to complete Step One.

Step Two – In order to further quantify the long-term target, we will determine the number and size of camping beaches in critical reaches (Marble Canyon, Upper Granite, and Muav Canyon) and the area of backwater habitat that can be supported by Step One.

Translate the optimum sediment mass produced in Step One into an estimate of:
- The numbers and size of camping beaches in critical reaches.
- The area and number of backwater habitat.

Step Two provides the basis for maintaining the optimum sand volume. Once we know what sand volume we can reasonably produce (Step One), we translate that into numbers and sizes of beaches, grain-size and distribution (draft DFCs) and into backwater habitat area. Although the beaches and habitat produced may not be as many or of the size and area that all parties would prefer, they are a sustainable, scientifically based target. We could also determine the non-operational steps available to enhance the utility of shoreline areas for camping if there is less beach sand (e.g., vegetation removal from camping beach areas, sleeping cots for greater camping flexibility) and other non-flow actions that can benefit HBC.

Attachment 2: Sediment Targets

These targets were **originally proposed by National Park Service**, and were determined by consensus to be scientifically and technically credible by the Desired Future Conditions AHG.

Short-Term Targets (10 years)

1. Rebuild and stabilize sandbars, campsites, and backwater habitats to 40-45,000 cfs levels, moving toward 1983-1985 post flood values (abundance, grain size, and distribution including volume and areal extent).
2. Achieve a positive mass balance of fine sediment throughout the CRE.

Assumptions – Short-Term Targets

a. Under low water conditions, dam operations (including BHBFs up to 40-45,000 cfs) can be used to achieve targets.
b. Sediment supplies will be adequate to sustain and enhance shoreline habitats and protect and enhance camping beaches and other deposits.
c. By meeting the target, we will also make sand available for aeolian transport to upper benches to enhance native riparian community function and protect cultural sites.
d. Management actions other than dam operations may be used to reach the targets.

Long-Term Targets (more than 10 years)

1. Conserve sediment throughout the system to enhance near shore habitat and restore riparian function.
   - 'Restore' ecosystem function (elements and values TBD) that recognize specific influences on the ecosystem, such as existence of the dam and non-natives, to the extent possible through conservation of sediment.
   - Protect and maintain OHW zone/terrace deposits and vegetation.
   - Maintain a neutral mass balance in the mainstem after achievement of 1983-85 sediment deposits.
   - CRE cultural resources continue to be protected through sediment Aeolian transport and enhanced native riparian community function.
2. Rebuild and stabilize sandbars, campsites, and backwater habitats to 1983-1985 post flood values (abundance, grain size, and distribution including volume and areal extent) as hydrologic and safety conditions and operational constraints permit (e.g., 60,000-93,000 cfs releases assuming water availability).

Assumptions – Long-Term Targets

a. Assumes higher water volume availability which permits discharges greater than power plant and jet tube capacity.
b. Enough sediment will accumulate in the system to provide sufficient sediment to achieve targets.
c. Despite historical losses of sediment in the system, the dam can be operated to meet the targets.
d. Management actions other than dam operations may be used to reach the targets.

Process

Over the 10-year period beginning in 2008, determine if the short-term assumptions are valid.

> NOTE: Not everyone agrees with the assumption that these targets can be met with existing sediment inputs and operational "tools."

Scientific Rationale Specific to Sediment Targets

The NPS has provided a reasonable way to address DFC's for sediment. Our rationale to select post-1983 sandbar/beach area was; that 1983 provided high flow levels of greater than 60,000 cfs, that sediment dispersal and habitat reconstruction was at acceptable levels, that key stretches of the river near-shore and sandbar area were restored to acceptable levels, including camping beaches; and most importantly, 1983 showed that post-dam flows could attain our desired conditions relative to sediment use and riparian function. Also, that the HBC population was still at an acceptable level in the mainstem.

We believe the sandbar, beach, and backwater area could be calculated for key reaches by using collected sediment data, remote sensed data collected since 1990 (e.g. first used), and early aerial photography from post-1983. Once a reliable value for sandbar/beach area is determined, it should be possible to calculate a useable value of sediment volume present in these reaches in 1983-84. This will require using sediment data/information gained from past sediment modeling and/or sediment measurements, and to assess erosion rates under the flow regime conducted at that time (as applicable). A reasonably accurate baseline condition or target for future desired conditions could be developed that would define the sediment DFC for sandbar/beach area, near shore habitat development and maintenance requirements.

Our short-term target is to restore the shoreline sediment distribution, volume and areal extent up to the 45000 cfs level, to show progress towards meeting the long-term goal. An important assumption to support both targets is that sufficient sediment and water inputs will occur, and the dam can be operated, to achieve these targets over the long-term. Since GCMRC is still studying the effects of BHBFs, particularly tied to sediment triggers, the ultimate feasibility of achieving the targets is unknown; however, we choose to set targets for desired future conditions that represent improvement over present conditions, until proven otherwise.

Additionally, by meeting the sediment targets, we assume we will also make sand available for aeolian transport to upper benches to enhance native riparian community function and protect cultural sites.

<u>Relationship to AMP MOs</u>

MOs 8.1-8.4 are all addressed by the short- and long-term targets by the parenthetical statement (abundance, grain size, and distribution including volume and areal extent).

Attachment 3: Humpback chub Targets

These targets were **originally proposed by National Park Service**, and were determined by consensus to be scientifically and technically credible by the Desired Future Conditions AHG.

Short-Term Targets (10 years)

1. The Grand Canyon population is maintained as a core over a 5-year period, starting with the first point estimate acceptable to the Fish and Wildlife Service, such that the trend in adult (age 4+ years) humpback chub estimates does not decline significantly.
2. HBC population estimate is at least 6,500 adult fish, age 4+ years, and a positive trend is maintained from 2008 onwards as determined by ASMR; thus, progress towards the long-term target is being made.
3. Mean estimated recruitment of age-3 years (150–199 mm TL) naturally produced fish equals or exceeds mean annual adult mortality.
4. All aggregations in the mainstem outside the LCR as defined in Valdez and Ryel (1995) have been maintained or restored to 1993 levels, and at least one spawning aggregation outside the LCR in the mainstem of at least 500 adult (age 4+ years) fish has been established so that the historic range is partially restored.
5. Develop at least one spawning aggregation in a tributary.
6. Prepare, adopt, and implement an emergency response/contingency plan, e.g., for the two Cameron bridges spanning the LCR, to protect HBC populations from hazardous material spills that could result in catastrophic loss of population.
7. Assess other emerging threats and develop a contingency plan to address them.
8. Implement the other highest priority projects listed within the HBC Comprehensive Plan that are achievable within 10 years.
9. Implement requirements of Biological Opinions, as necessary.

Long-Term Targets (more than 10 years)

1. HBC population estimate is at least 10,000 adult fish, age 4+ years, as determined by ASMR.
2. HBC population and distribution will meet or exceed short-term targets based on further evaluation of the CRE habitat and carrying capacity of the river and perennial tributaries.
3. A spawning aggregation of at least 1,667 adult (age 4+ years) fish has been established in the mainstem.
4. Spawning aggregations in at least three tributaries have been developed.
5. Implement the remaining projects listed within the HBC Comprehensive Plan.
6. Implement requirements of Biological Opinions, as necessary.
7. All threats criteria for this recovery unit have been met or eliminated.
8. The Fish and Wildlife Service has issued a non-jeopardy, non-adverse modification Biological Opinion on the operation of Glen Canyon Dam.

Assumptions and Rationale

a. The long-term target of 10,000 fish as determined by ASMR will not include fish in the mainstem spawning aggregations or tributaries other than the LCR.
b. With regard to Short-Term Target #4, the current population numbers of the mainstem aggregations are unknown. The assumption is that the target is achievable in the timeframe noted. If the target is not achievable in the short-term, it would become a long-term goal.

c. The HBC monitoring program will be maintained and enhanced to support evaluation of progress toward targets.
d. The HBC Comprehensive Plan will be finalized and implemented, and will include in-situ refuges and translocations, and address hazardous material spills.
e. Establishment of in-situ refuges and translocation of HBC, and other actions, will meet NPS management policies regarding restoring historic range.
f. If there were a lower basin recovery implementation program, and the actions listed in the recovery goals were implemented, it would assist in reaching the long-term targets.
g. Meeting the delisting criteria and issuance of a non-jeopardy opinion will contribute to meeting NPS' and other agencies' management responsibilities.
h. The 10-year short-term target period will begin in 2008.

NOTE: Not everyone agrees with these assumptions.

Scientific Rationale Specific to Humpback Chub Targets

The DFC's presented to this AHG in November 2007 were based on the original 2006 DFCs, but were modified during the workshop and subsequent discussions with the park staff. We present additional information to support the scientific credibility of our targets. The language is similar to Recovery Goals, but makes certain targets more specific to Grand Canyon humpback chub. We have excerpted the more specific targets for further explanation here.

Relationship to AMP MOs

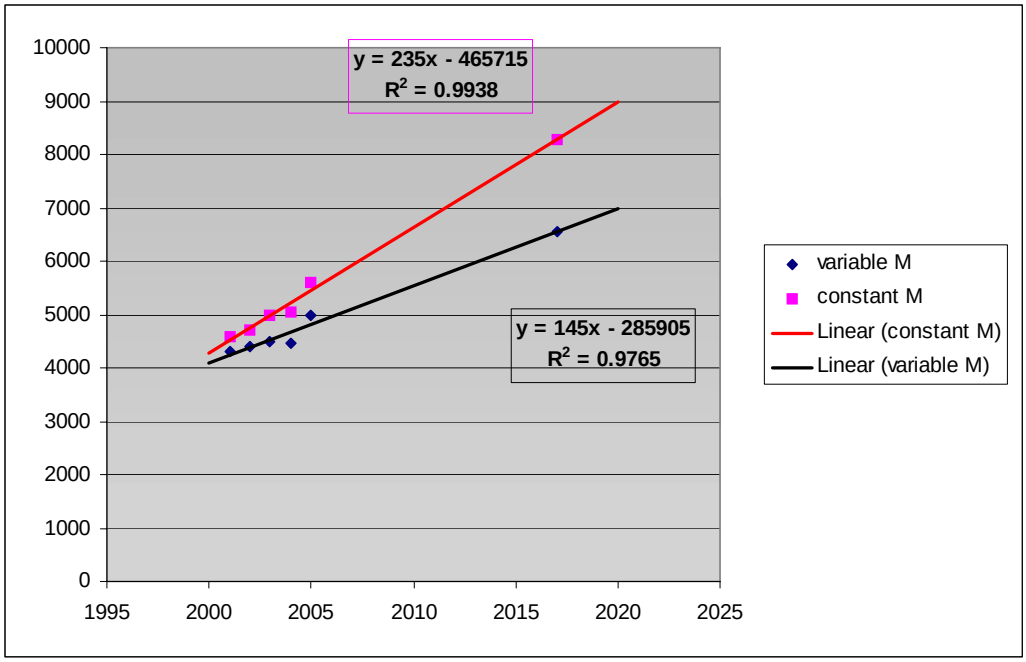
Short-term targets 1-4 and Long-term target 1 apply to M.O. 2.1 (Maintain or attain HBC abundance in the LCR and other aggregations…). Short-term targets 4-5, and Long-term targets 4-6 apply to M.O. 2.2 (Sustain or establish HBC spawning aggregations outside of the LCR). Remaining targets include addressing other threats, which would include the disease/parasite threat in MO 2.3.

Short-Term Targets (10 years)

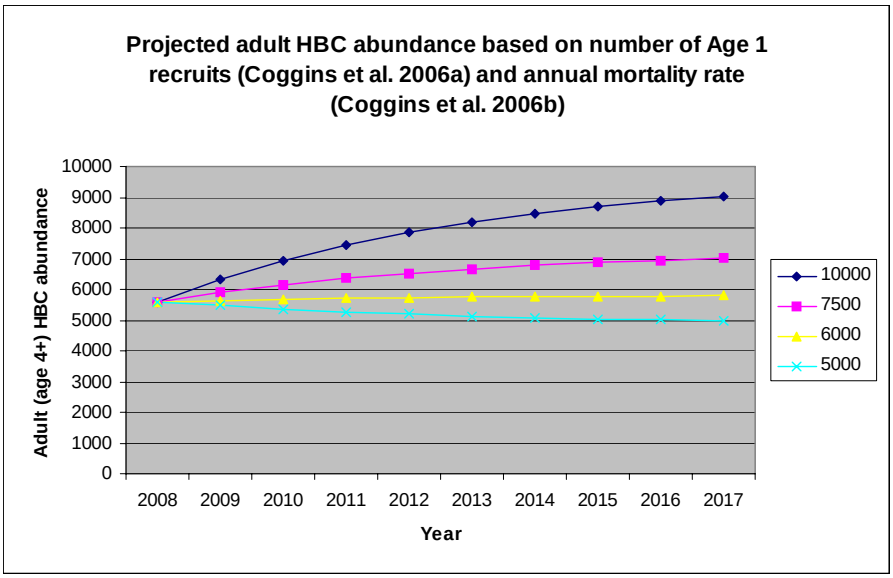
2. HBC population estimate is at least 6,500 adult fish, age 4+ years, and a positive trend is maintained from 2008 onwards as determined by ASMR; thus, progress towards the long-term target is being made.

We have set the short-term target at 6,500 adult fish by the end of the 10-year period beginning in 2008 and ending in 2017, to ensure that real progress is being made towards the long-term goal of 10,000 adult fish. We arrived at this number as being reasonable and feasible to achieve in 10 years by examining current abundance, recent trends, estimated mortality, and recruitment rates Coggins et al. 2006a, 2006b, Melis et al. 2006). While a precise number is not possible to predict, the analyses presented here show that it is possible to achieve this target if the present upward trend continues. Although these targets are above the minimum requirements in the recovery goals, there is nothing in the Recovery Goals that is intended to constrain any agency from striving to go beyond the minimum goals (Dr. Richard Valdez, Pers. Comm.).

Method 1. By graphing the recent stabilization and upward trend in adult population estimates from Melis et al. (2006), and generating a linear correlation equation, we projected adult abundance in 10 years to vary between 6260 and 8280 depending on whether variable or constant mortality rates were used. Our target of 6500 is near the low end of this range.



Method 2. We constructed life tables using estimated annual recruitment of 2000 age 2 fish (Coggins et al. 2006a) and simulated age 1 recruits varying from 5000 per year in the late 90s, to 10000 per year in 2000 and 2001 from Melis et al. (2006), and annual mortality rates which vary with age from 68% at age 2 to 18% for older adult fish (Coggins et al. 2006b). Graphing projected annual abundances at four different recruitment values, we see a range in projected abundance from less than 5000 – representing a decline – to over 9000, at the most optimistic values. Given that annual recruitment is likely to vary due to stochastic factors, an average of these projections is 6704 adults in 10 years. Thus the 6500 short-term target is conservative.



4. All aggregations in the mainstem outside the LCR as defined in Valdez and Ryel (1995) have been maintained or restored to 1993 levels, and at least one viable spawning aggregation outside the LCR in the mainstem of at least 500 adult (age 4+ years) fish has been established so that the historic range is partially restored.

Valdez and Ryel (1995) recognized 8 mainstem aggregations outside of the LCR. Sufficient captures and recaptures were made in 5 of the aggregations to develop population estimates in 1993. The other 3 had too few captures for an estimate, yet fish were consistently captured at these locations. In intensive riverwide sampling in 2000-2003, no HBC were captured in at least two of the aggregations: Bright Angel inflow, and Pumpkin Springs. It is worthwhile to note that the type locality for the original description of humpback chub as a species (Miller 1946) is the Bright Angel inflow. However, a population estimate made for Middle Granite Gorge in 2000 was for 180 adults, an increase from 1995, and reproduction has been recently observed in the 30-mile aggregation (R. Van Haverbeke, pers. Comm.). In their genetic study, Douglas and Douglas (2006) only recognized 5 aggregations, by collapsing some nearby aggregations, and dismissing very small ones. They did not include the Bright Angel area. However, the NPS believes that maintaining or restoring fish to the locations listed in Valdez and Ryel (1995) will better meet our mandate of restoring historic distribution of this native species (Management Policies 2006).

The target of 500 adults in at least one aggregation is expected to move us toward achieving the long-term goal of a second spawning aggregation in the mainstem (USFWS 1994). An N_e of 500 is commonly used for fishes to establish a minimum 'genetic effective population size' for maintaining a genetically viable population (USFWS 2002). Valdez et al. 2000 rated the Middle Granite Gorge (MGG) area as the only mainstem aggregation with enough existing fish to avoid inbreeding depression without augmentation (Table 1).

Table 1. Nine HBC aggregations as defined in Valdez and Ryel (1995).

RM	Aggregation	No. Adults captured	No. Adults Recaptured	N	SE(N)	Range of 95% CI
29.8-31.3	30-Mile	26	6	52	23	28-136
6557-65.4	LCR Inflow	1524	280	3482	408	2682-4281
65.7-76.3	Lava to Hance	15	3	-	-	-
83.8-92.2	Bright Angel inflow	9	1	-	-	-
108.1-108.6	Shinumo inflow	27	6	57	26	31-149
114.9-120.1	Stephen Aisle	17	2	-	-	-
126.1-129	Middle Granite Gorge	124	48	98	19	74-153
155.8-156.7	Havasu Inflow	7	1	13	12	5-70
212.5-213.2	Pumpkin Spring	6	2	5	2	54-16

5. Develop at least one spawning aggregation in a tributary.

Many of the 9 recognized aggregations are associated with tributary inflows. The NPS has been studying the possibility of translocating HBC into tributaries as one way to increase the Grand Canyon population. Valdez et al. (2000), Van Haverbeke and Simmonds (2004), and SWCA and the Wildlands Council (2006) all addressed various aspects of the feasibility of translocating HBC into one or more tributaries. The SWCA report, funded by NPS, and based largely on Valdez et al. 2000, ranked several perennial tributaries

for their potential to support a spawning population of HBC. The NPS, in cooperation with the FWS and AGFD plans to begin translocations into Shinumo Creek in 2008. As part of the LTEP EIS, a plan to translocate HBC into at least two additional tributaries was to be developed in the first year of implementation. We expect that plan will still be developed and implemented.

Long-Term Targets (more than 10 years)

1. HBC population estimate is at least 10,000 adult fish, age 4+ years, as determined by ASMR.
ASMR model: GCMRC has developed and extensively reviewed and published a model that estimates current adult population, annual recruitment, and trends of HBC in the LCR aggregation, and also backcasts population estimates to 1989. The model estimates about 10,000 adult HBC were in the LCR aggregation in 1989 (Coggins et al. 2006). Although the USGS science workshop (USGS 2007) suggests that the carrying capacity of the LCR is about 5000 fish, they limit this estimate to residents of the LCR itself, not including the associated mainstem area. We believe that the 13.5 km of mainstem near the LCR can support the remainder of this aggregation, particularly if the water temperature is warmed, sediment is conserved, and shoreline habitats are stabilized at least part of the year. Valdez et al. (2000) estimate that this reach was supporting about 3,800 adult fish in the early 90's, and could support 28,510 young fish per km. We are not proposing to return the HBC population to pre-dam levels, but to a time when we have a reasonably good estimate, and a time near to the passage of the GCPA.

4. HBC population and distribution will meet or exceed short-term targets based on further evaluation of the CRE habitat and carrying capacity of the river and perennial tributaries.
The reestablishment or maintenance of other mainstem aggregations achieved in the short-term should be maintained in the long-term. If new scientific evidence shows that carrying capacity has been reached before the targets have been met, the targets may be reconsidered.

5. A spawning aggregation of at least 1,667 adult (age 4+ years) fish has been established in the mainstem.
This is expected to be the same spawning aggregation that was targeted for 500 fish in the short-term. The value of 1,667 adult fish was suggested by Valdez et al. (2000) in their report on the feasibility of establishing a second spawning aggregation in the Grand Canyon mainstem. This number is based on genetic viability, but is lower than the Recovery Goal minimum number, because it does not include all the risk factors. Valdez et al. (2000) calculate that the estimated carrying capacity of the MGG area could support 3,611 adults, well above the calculated genetic effective population size of 1,667 adults need to achieve long-term viability.

6. Spawning aggregations in at least three tributaries have been developed.
As part of the LTEP EIS, in addition to Shinumo Creek, a plan to translocate HBC into at least two additional tributaries was to be developed in the first year of implementation. We assume that plan will be developed and implemented. Tributary fish would provide additional protection against catastrophic loss of the primary LCR aggregation.

Remaining Targets and Assumptions

The remaining targets serve to support the primary targets by ensuring that the threats to HBC are mitigated or eliminated. We believe that completion of the Humpback Chub Comprehensive Plan and implementation of actions outlined therein would contribute to addressing the threats.

Policy Rationale for Both Sets of Targets
There are two parts to the NPS rationale: Policy and Science. The following Policy rationale and the list of references apply to both sets of targets.

NPS Mandate for Resource Protection and Improvement
The NPS derives its management philosophy and direction from the 1916 Organic Act. The key management-related provision of the Organic Act is as follows:

[The National Park Service] shall promote and regulate the use of the Federal areas known as national parks…by such means and measures as conform to the fundamental purpose of the said parks…, which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations. (16 USC 1)

This direction is further clarified by the NPS Management Policies (as revised in 2006).
Several sections of the policies relate to resource conservation and management. We have excerpted portions of those sections here.

1.4.3 'The fundamental purpose of the NPS established by the Organic Act and reaffirmed by the General Authorities Act [1970], as amended [in 1978], begins with a mandate to conserve park resources and values.

1.4.7.2 The Service will also strive to ensure that park resources and values are passed on the future generations in a condition that is as good as, **or better than, the conditions than exist today**. In particular, the service will strive to restore the integrity of park resources that have been damaged or compromised in the past. [Restoration activities will be guided by policies identified in chapters 4 and 5]

- Note that other sections of the Policies do recognize applicability of other legislation that may impact park resources and management.

Recognizing that parks are integral parts of larger regional environments, throughout the policies there is repeated reference to cooperation with other agencies and communities:

'the Service will work cooperatively with others to protect park values, resolve conflicts, and address mutual interests in the community including matters such as compatible economic development and resource and environmental protection'

Chapter 4
4.1 Natural resources will be managed to preserve fundamental physical and biological processes, as well as individual species, features, and plant and animal communities.
The NPS will determine the **desired future conditions** and identify a strategy to achieve them. The strategy should include working cooperatively with adjacent land and resource managers, as appropriate

Biological or physical processes altered in the past by human activities may need to be actively managed to restore them to a natural condition or to maintain the closest approximation of the natural condition when a truly natural system is no longer attainable.

4.1.5 Restoration of Natural Systems

'The service will reestablish natural functions and processes in parks unless otherwise directed by Congress. …Impacts on natural systems…include the introduction of exotic species; [and] changes to hydrologic patterns and sediment transport.

"The Service will seek to return such disturbed areas to the natural conditions and processes characteristic of the ecological zone in which the damaged resources are situated. "

4.4 Biological Resource Management

4.4.1 The NPS will maintain as parts of the natural ecosystems of parks all plants and animals native to the park ecosystems…by…

Preserving and **restoring the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and the communities and ecosystems on which they depend**….and…

Minimizing human impacts on native plants, animals, populations, communities, and ecosystems, and the processes that sustain them.

4.4.2.3 Management of Threatened and Endangered plants and animals

The Service will fully meet its obligations under the NPS Organic Act and the Endangered Species Act to both proactively conserve listed species and prevent detrimental effects on these species. To meet these obligations, the Service will:

- Cooperate with both the U.S. Fish and Wildlife Service and the NOAA Fisheries to ensure that NPS actions comply with both the written requirements and the spirit of the Endangered Species Act.
- undertake active management programs to inventory, monitor, **restore**, and maintain listed species' habitats; control detrimental nonnative species; manage detrimental visitor access; and reestablish extirpated populations as necessary to maintain the species and the habitats upon which they depend;
- manage designated critical habitat, essential habitat, and recovery areas to maintain and **enhance their value** for the recovery of threatened and endangered species;

When GCD was authorized and built, Congress recognized that some impacts of GCD were expected and accepted; however, at some point both the American people and Congress decided that some additional protection of GRCA resources was necessary and required; thus, the GRCA PA was passed in 1992 which calls for improving resources:

Sec 1802. Protection of Grand Canyon National Park

(a) In general – The Secretary shall operate Glen Canyon Dam in accordance with the additional criteria and operating plans specified in section 1804 and exercise other authorities under existing law in such a manner as to protect, mitigate adverse impacts to, **and improve the values** for which Grand Canyon National Park and Glen Canyon National Recreation Area were established, including, but not limited to natural and cultural resources and visitor use.

The purpose of Grand Canyon National Park is based on the legislation establishing the park and the legislation governing the National Park Service.

As a place of national and global importance, Grand Canyon National Park is to be managed to:
* preserve and protect its natural and cultural resources and ecological processes, as well as its scenic, aesthetic, and scientific values
* provide opportunities for visitors to experience and understand the environmental interrelationships, resources, and values of the Grand Canyon without impairing the resources

The 1994 Biological Opinion (USFWS 1994) calls for a second spawning aggregation of humpback chub as an RPA. Further, the 1996 EIS called for resource protection; it speaks of minimizing adverse impacts, and permitting recovery and long-term sustainability of downstream resources. Further, the 2007 Notice of Intent to prepare the LTEP EIS – which provided the initial impetus for the charge to the AHG – called for 'improvement of resources' in the Grand Canyon. The NOI states:

"The LTEP is intended to ensure a continued, structured application of adaptive management **in such a manner as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established, including but not limited to natural and cultural resources and visitor use,** consistent with applicable federal law."

- Note that the language is identical with the GRCA Protection Act with the addition of the last reference to applicable federal law.

Clearly the intent of the Organic Act and Management policies was and is to both provide both for enjoyment by the public (recreation) and for preservation and/or restoration of natural processes and ecosystems. Subsequently, the Grand Canyon Protection Act affirmed the protection of the values for which Grand Canyon National Park was established. Thus, the NPS has set targets which we feel meet our mandate for resource protection and **improvement of resources** in Grand Canyon National Park. We hope to improve resources and return them to conditions observed in recent post-dam history, near the passage of the GCPA or earlier, and for which we have or can develop reasonably good estimates or measures of previous conditions.

Scientific Rationale for Both Sets of Targets
The Grand Canyon National Park (GCNP) resources staff held three one-day workshops to arrive at the DFC's and targets presented to the TWG/Science Plan AHG in 2006. GCNP followed this process to develop the original DFCs:

- Search NPS Management Policies for direction on resource management, protection, restoration and preventing impairment of park values;

- Identify legal mandates/requirements and park compliance responsibilities with applicable legislation (e.g. Organic Act, ESA, Clean Air, Clean Water, NHPA; Trust responsibilities, etc.,);

- Identify and comply with Park Management Plans and applicable management objectives for park and river corridor resources management, and Science and Resources Management Program direction;

- Staff consulted with or/and utilized previous and current park Resource Management and Cultural Resource Protection plans, funded projects or/and project plans, and applicable park activity plans to arrive at specific target levels. Also, many of the individual resource projects, and all NEPA directed management plans and projects are required to develop mitigation measures and measurable values that define project or plan "success" levels;

  These projects and implementation plans have specific methods to be used, measures and values for accomplishment, and funding and time frames for completion.

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Attachment 4: Humpback chub Targets

These targets were **originally proposed by Western Area Power Administration**, and were determined by consensus to be scientifically and technically credible by the Desired Future Conditions AHG.

Grand Canyon recovery unit and core population (includes the LCR)

The Grand Canyon recovery unit of humpback chub (HBC) has recovered as described in the 2002 Recovery Goals. Recovery actions necessary to meet recovery goals have been implemented and threats have been removed or eliminated to ensure the long-term survival of the recovery unit.

Short-Term Targets (10 years)

1. The Grand Canyon core population (recovery unit), trend in adult (age 4+ years) is stable or increasing (no significant decline) for a 5 year time period.
2. Each population estimate within that 5-year time period exceeds the average population estimates of years 2002-2006 (about 5,600), and as determined by ASMR (or other acceptable assessment method).
3. Mean estimated recruitment of age-3 years (150–199 mm TL) naturally produced fish equals or exceeds mean annual adult mortality (approximately 24%).
4. Fish condition can be monitored as a signal of potential changes in recruitment or survival of adults, but there should not be a numerical value establish for a target for fish condition. Poor condition may signal future declines, but may not signal specific outcomes.
5. Prepare, adopt, and implement an emergency response/contingency plan, e.g., for the two Cameron bridges spanning the LCR, to protect HBC populations from hazardous material spills that could result in catastrophic loss of population.
6. Assess other emerging threats and develop a contingency plan to address them.

Long-Term Targets (more than 10 years)

1. The Grand Canyon core population (recovery unit), trend in adult (age 4+ years) does not decline significantly for 8 years in a row from the average population estimates of years 2002-2006 (about 5,600).
2. Management measures are in place which ensure a high likelihood of continued population stability.
3. Mean estimated recruitment of age-3 years (150–199 mm TL) naturally produced fish equals or exceeds mean annual adult mortality (approximately 24%).
4. All threats criteria for this recovery unit have been met or eliminated.

Assumptions and Rationale

a. The 2002 Recovery Goals are currently undergoing revision in response to a court order requiring that the Service include time and costs estimates to recovery as required by the ESA. This revision is unlikely to result in significant changes to these goals, and thus, they are reasonable goals to consider when developing these targets.
b. Because the recovery goals (USFWS 2002) do not require a second spawning aggregation within the Grand Canyon recovery unit, it will not be required in any revised action which will undergo re-consultation in the LTEP.
c. Fish condition indices have been proposed as a method for determining health of populations and their likelihood of recovery. Although MO 2.3 describes fish condition as an important factor, it may be difficult or impossible to a) develop quantitative targets that are reasonable indicators of population

performance and b) collect the data necessary to evaluate and track fish condition. In the past few years the program has stopped or reduced collection of some fish condition data (e.g. weights) due to the excessive handling required and the potential adverse impacts on the fish from sampling. This MO is helpful in its current form without quantitative targets as fish condition data should be used whenever available to help support other evaluations, but may have little utility on its own and may actually harm fish if additional data was collected in order to evaluate progress toward condition targets. Likewise, although it is important to monitor trends in disease and parasite infection, we know too little about the effects of most of these conditions to develop meaningful targets. Rather, trends in these conditions may provide more general information that would be helpful to the program in understanding potential changes in demographics due to changes in condition/disease rates.

d. The goal of the recovery criteria is to establish stable populations above the 2,100 MVP guideline and that the Grand Canyon population should not decline significantly from credible estimates in the time frame from 2002-2006. It is assumed if this population was stable from an average population estimate from 2002-2006 (about 5,600 adults), that this would meet the demographic criteria in the 2002 Recovery Goals (subject to modification in the revised goals).
e. Viability – a population of 5,800 – 7,300 adults should have a 99% persistence probability over 40 generations (based on assumptions in Reed et al. 2003). The 2,100 value for adults in the recovery plan provides a guide for a minimum value for a viable population, which is somewhat risk-prone and based primarily in genetics, and it assumes limited population variability over a very short (1 year) time period.
f. All adult HBC found downstream of Glen Canyon Dam within the recovery unit designation would be considered toward the demographic goal.
g. The 2002 Recovery Goals require management actions to remove threats to the recovery of the Grand Canyon recovery unit. Many of these management actions are likely to be outside of the scope of the AMP, but may be important in reaching the recovery goals. The AMWG recommended that a recovery implementation program be developed in order to begin to address these needs. If there were a lower basin recovery implementation program, it would assist in reaching the targets, especially for efforts deemed "out" of the AMP.
h. Meeting the delisting criteria for the lower recovery unit of HBC and issuance of a non-jeopardy opinion will also meet NPS management responsibilities.

NOTE: Not everyone agrees with these assumptions.

Discussion and Background

Humpback chub status and trends below Glen Canyon Dam

The following text was taken from USGS (2007; page 15):

> "The participants were informed that the current population of adult humpback chub (age-4+) is less than 50% of what it was as late as 1990, according to the most recent capture and modeling information (Coggins and others, 2006a). This conclusion assumes that the initial 1989 population estimate was accurate. Since 2000, however, the number of adult fish stabilized at a new, lower level, which is estimated at 5,000 (Melis and others, 2006). The recent stabilization of the adult population could reflect the loss of humpback chub that resided primarily in the mainstem since the late 1980s and the inability of mainstem habitat to support successful recruitment. The current population of 5,000 adults may represent the capacity of the Little

> Colorado River. These population changes may or may not reflect a response of the population to changes in river conditions or actions taken under the auspices of the GCDAMP.
>
> The participants also reviewed available information regarding the recruitment abundance of humpback chub younger than 4 years old. This segment of the population seems to have reached a modern low in 1991. However, numbers of young humpback chub increased steadily during the 1990s, returning to approximately late 1980s levels, by 2001, the most recent year for which these data are available (U.S. Geological Survey, unpub. data)."

Thus, the population appears to have stabilized since about 2000 (see Figure 1 below), with good recruitment observed at the LCR. Recent unpublished data suggests that the population may have actually increased significantly from the low point at about 2000. This cannot be confirmed with published materials, but these peer reviewed publications are expected to be available before the completion of the draft EIS for the LTEP.

ESA Recovery Goals

The Humpback Chub Recovery Goals (USFWS 2002) established by the U.S. Fish and Wildlife Service (Service) group all of the humpback chub populations within the Colorado River below Glen Canyon Dam as one recovery unit (Lower Basin) and populations above Glen Canyon Dam as a second recovery unit (Upper Basin). As a recovery unit, the Service indicated under the ESA that the viability of the Lower Basin (Grand Canyon) is necessary to the long-term viability of the entire species, and if the Lower Basin was lost, would substantially increase the likelihood of extinction for the species as a whole. The Service also defined the Grand Canyon as a "core population" for purposes of the recovery criteria, which is supported by spawning within the Little Colorado River (LCR).

The USFWS (2002) describes the following populations:

> "Six self-sustaining populations of humpback chub are known to exist. Each of these populations consists of a discrete reproducing group of fish, with independent stock-recruitment dynamics, and is geographically separated from other populations. Five of the populations occur in the upper basin recovery unit: (1) Black Rocks, Colorado River, Colorado; (2) Westwater Canyon, Colorado River, Utah; (3) Yampa Canyon, Yampa River, Colorado; (4) Desolation/Gray Canyons, Green River, Utah; and (5) Cataract Canyon, Colorado River, Utah (Figure 1; Appendix A; Valdez and Clemmer 1982; U.S. Fish and Wildlife Service 1990a). The only population in the lower basin recovery unit occurs in the mainstem Colorado River in Marble and Grand Canyons and the Little Colorado River (LCR)."

The Recovery Goals argue that a stable population greater than 2,100 adults, within the Grand Canyon core population, would be a viable recovery unit if all of the threats were removed (i.e., threats criteria). Given the recent stabilization of the Grand Canyon population at numbers above the 2002 Recovery Goals (see Figure 1 below from USGS fact sheet 2006-3109), it is possible that no further increase in population size may be required under the ESA in order to meet the demographic recovery criteria for this recovery unit (assuming the revised goals are similar to the 2002 goals). The recovery goals are currently undergoing revision in response to a court order requiring that the Service include time and costs estimates to recovery as required by the ESA. This revision is unlikely to result in significant changes to these goals. The Court found that the challenge to the recovery goals themselves had no merit (see January 18, 2006 Order at page 9, lines 9-15):

> "Accordingly, we conclude that no cause of action arises under 16 U.S.C. §1540(g)(1)(C) for the failure to provide for the conservation and survival of the humpback chub, in contrast to the development and implementation of a plan to conserve them. We therefore grant defendants' motion for summary judgment on this claim (doc. 49). And because this claim is no longer before us, we grant defendants' motion to strike the declarations submitted by plaintiffs (doc. 52), which are only relevant to plaintiffs' challenges to the substance of the Recovery Goals."

The recovery goals provide a rational argument for lumping observed populations within the Grand Canyon as one population/recovery unit: "recent studies (Douglas and Marsh 1996; Valdez and Ryel 1995, 1997) show that humpback chub aggregations in the mainstem Colorado River in Marble and Grand Canyons are largely supported by reproduction and recruitment from the LCR, and hence, fish in these two systems are treated collectively as one Grand Canyon population." (USFWS 2002) This statement is further supported by recent findings from Douglas and Douglas (2007), which indicate no significant genetic differentiation in populations within the Grand Canyon recovery unit (the exception may be the 30-mile population which may exhibit some differentiation from the LCR population to include variation common in the upper river).

Viability

Implicit in the ESA definitions of threatened and endangered and in the principles of conservation biology is the need to consider genetics, demographics, population redundancy, and threats (as identified by the listing factors in the ESA). The ESA is mandated to recover species to the point that they are "not likely" to be in danger of extinction for the foreseeable future throughout all or a significant portion of their range. The "not likely" standard represents a minimum threshold of risk, and that recovery should also involve maintenance of multiple widespread populations that are independently viable because it is less likely that future singular threats will endanger widely separated multiple populations than a single population with the same abundance. Viable populations have sufficient numbers of individuals to counter the effects of deleterious gene mutations as a result of inbreeding, and to counter the effects of deaths exceeding births and recruitment failure for periods of time. Thus, the conservation biology principle of redundancy is satisfied by the required multiple genetically and demographically viable, self-sustaining populations. Furthermore, the principle of resiliency is satisfied with sufficiently large populations to persist through normal population variations, as well as through unexpected catastrophic events. A set of guidelines for viable populations is provided in USFWS (2002, page 9).

Population size is a major determinant of extinction risk. Reed et al. (2003) undertook a population viability analysis (PVA) of 102 vertebrate species to determine what a reasonable range of population sizes might be. The mean and median of these estimates was 7316 and 5816 adults. Interestingly, they did not find any correlation between taxa, latitude, or trophic level. They did however find a relationship between population size and study period. The greater the study period, the greater variation was observed, and thus the larger population size needed to buffer that variability over the long term. Without a PVA specific to this species, the estimates from Reed et al. (2003) may provide a method to evaluate the likelihood of extinction while considering long term population fluctuations due to environmental stochasticity, and other factors as described.

Rationale

Step 1: M.O. 2.2. The first critical question is whether two spawning populations are needed or just one (as required by the 1994 Biological Opinion). Our assessment is that only one spawning population is

necessary to recover the Grand Canyon recovery unit and meet the requirements of the ESA. As described above, the Grand Canyon recovery unit is but one of five self-sustaining populations within the species designation. Thus, five populations already exist and offer a substantial buffer against extinction (see USFWS 2002 at section 3.1.3). Adding a sixth self-sustaining population (second within the Grand Canyon) may offer some marginal increase in the viability, but would likely be susceptible to similar threats to the LCR aggregation below Glen Canyon Dam.

The RPA from the 1994 Biological Opinion requires two spawning aggregations of humpback chub in the Grand Canyon recovery unit, while the remanded 2002 recovery goals did not require this additional spawning aggregation. This has created a legal grey area that has not been resolved. This could have been resolved through reconsultation after the 2002 Recovery Goals were released.

In order to jeopardize under section 7, an action must be shown to jeopardize the continued survival and recovery of a species. An RPA is a substitute action presented in a jeopardy opinion, and is defined as those activities required to avoid the condition which resulted in jeopardy. Thus, an RPA cannot require actions beyond which would result in recovery of the species, or in this case the recovery unit. Looking at it differently, if the humpback chub population has met the demographic criteria in the recovery goals and the threats have also been satisfactorily ameliorated, then any reconsultation would be unlikely to reach a jeopardy conclusion. Because this population appears to have met the demographic criteria from the 2002 Recovery Goals, consultation should be (and is expected to be) reinitiated on the LTEP EIS preferred alternative. BOR is not bound to submit an alternative that conforms to a 13 year old biological opinion. In fact, that would ignore 13 years of science and learning, and would also ignore the recovery goals. Reconsultation allows an action agency to propose alternatives which avoid jeopardy in a manner different from a previously issued RPA. In order to conclude jeopardy on the two population issue, USFWS would have to argue that the action jeopardizes the recovery of HBC in the lower recovery unit by not allowing for the establishment of two populations of the one population that is required for recovery. On the face of it, it presents a logic problem. This is not to say that a jeopardy determination is not possible, only that one cannot argue for a second population solely based on the 1994 RPA.

Step 2: Determine the genetic effective population size (N_e) needed for this population. N_e is the number of individuals contributing genes to the next generation (Wright 1931). An N_e of 50 adults avoids inbreeding depression in the short-term; an N_e of 500 is needed to avoid serious long-term genetic drift; an N_e of 1,000 or more provides a conservative estimate beyond which significant additional genetic variation is not expected (Allendorf and Ryman 2002). An N_e of 500 is commonly used for fishes (Waples 1990; Bartley et al. 1992; Allendorf et al. 1997; Rieman and Allendorf 2001). USFWS (2002) used an N_e of 500, and represents a reasonable choice for long-term conservation.

Step 3: The next step is to determine what adult population size equates to an N_e of 500. This will be quite a bit larger than N_e because it is the number of adults contributing genes to the next generation. Due to various sex ratios, breeding cycles, and breeding types, N can be substantially higher depending upon the species. The ratio of N_e to N varies by species and with an overall average of about 0.30, which is the ratio reported for chinook salmon (McElhany et al. 2000) and other Pacific salmon species (Waples et al. 1990a, 1990b). This overall average ratio for fishes of 0.30 was used by USFWS (2002) to determine the number of adult humpback chub needed to support an N_e of 500. Given the lack of data available for humpback chub, this is a reasonable value available in the literature. This equates to an adult population size (N) of 1,667.

Step 4: Use a minimum viable population (MVP) approach; MVP is defined as a population that is sufficiently abundant and well adapted to its environment for long-term persistence without significant artificial demographic or genetic manipulations. Meffe and Carroll (1994) define an MVP as "the smallest isolated population size that has a specified percent chance of remaining extant for a specified period of time in the face of foreseeable demographic, genetic, and environmental stochasticities, plus natural catastrophes." Thus, the concept is that a viable population would not approach N_e in the time frame considered. The following factors could be considered in increasing the population number to reach a target MVP:

a. Demographic stochasticity (recruitment)
b. Potential for human-related impacts
c. Likelihood of sustained population declines
d. Environmental stochasticity
e. Other ecosystem related factors
f. Risk – consider the likelihood that various "bad" things (above) may happen and how often/likely the population should be able to survive them. Under the ESA this is often expressed as the likelihood of reaching a certain low population size in X amount of years (i.e., 10% chance in 100 years). For this species, redundancy of viable populations provide a substantial buffer against risk.

Examples of additions to the N_e value include the southern sea otter (potential for oil spills) and Steller sea lion (history of large declines due to a variety of threats). For humpback chub, USFWS (2002) reached a minimum viable population size of 2,100 adults. This was derived by adding 24% to the N_e of 1,667 to account for an estimate of the average annual mortality of adult humpback chub (1,667 x 1.24 = 2,067 or about 2,100, see USFWS 2002, Box 4; Valdez and Ryel 1995, 1997). An average annual adult mortality factor was added to buffer against an event that may result in recruitment failure for one year.

However, the intent of the 2002 Recovery Criteria was to establish stable populations above the 2,100 MVP guideline and that the Grand Canyon population should not decline significantly from credible estimates (presumably current). It is assumed if this population was stable from an average population estimate from 2002-2006 (about 5,500 adults), that this would meet the demographic criteria in the 2002 Recovery Goals (subject to modification in the revised goals). A population of 5,800 – 7,300 adults should have a 99% persistence probability over 40 generations (based on assumptions in Reed et al. 2003). The 2,100 value for adults in the recovery plan provides a guide for a minimum value for a viable population, which is somewhat risk-prone and based primarily in genetics, and it assumes limited population variability over a very short (1 year) time period.

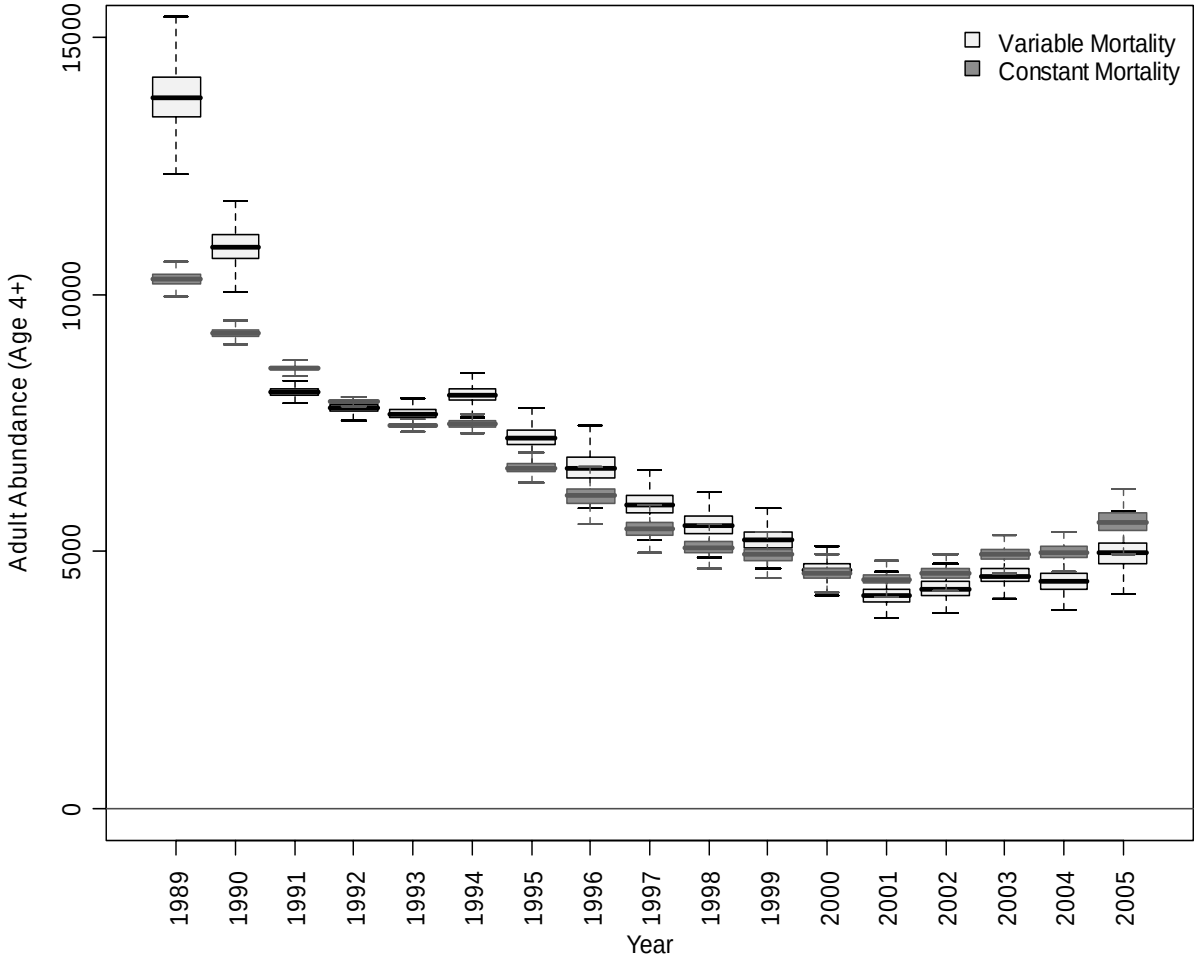
Discussion of the approach to achieve targets

Based on the proposed targets and the 2002 Recovery Goals, the focus should be the continued stabilization (or increase) of humpback chub within the Grand Canyon. Substantial changes to the current operating regime at Glen Canyon Dam should be considered with caution as these changes may introduce new threats which might undermine the recent stabilization and recovery. It is possible that this population may continue to stabilize and may soon meet the demographic recovery criteria of the 2002 Recovery Goals. At that point, the only obstacle between considering this recovery unit recovered would be positive evidence that the threats had been removed. Thus, one viable approach within the LTEP could be to continue stabilizing humpback chub while implementing experiments to further describe how the operation of Glen Canyon Dam affects the ability of this recovery unit to stabilize. Further, consultation on an LTEP alternative which implemented actions similar to those that resulted in recovery

should have a low likelihood of resulting in a jeopardy decision. Conclusions reached in the 1994 opinion did not consider relevant new scientific information such as the recent population stabilization and the 2002 goals, and thus, meets the reinitiation requirements under the ESA and the Section 7 Consultation Handbook. We expect that reconsultation will occur, and was described in the settlement agreement to occur by May 1, 2008 (see agreement August 25, 2006).

Given that the 2002 Recovery Goals consider a toxic spill upstream in the Little Colorado River to be a substantial threat, and s the primary threat to this core population, efforts should be considered which reduce this threat (e.g., bridge modifications), and efforts to develop additional spawning populations should be critically evaluated in light of these goals, especially those which result in take that does not relate directly to achieving the recovery goals.

Figure 1. Most recent HBC trend estimates through 2005 for the LCR only (from USGS Fact Sheet 2006-3109, July 2006).



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Attachment 5: Charge to the DFC Ad Hoc Group from the Bureau of Reclamation

. . . With the assistance of 16 cooperating agencies, Reclamation is now preparing an EIS in compliance with the National Environmental Policy Act. Consistent with input from the cooperating agencies, we anticipate that some of the alternatives in the EIS may utilize current and desired future resource conditions as triggering mechanisms for conducting or modifying specific experimental actions. **These desired resource conditions are also evidenced in the management objectives of the AMP strategic plan, but have never been quantified or finalized.**

Definition of these objective targets could improve future decision making during the term of the LTEP experiment, recognizing that the ultimate goal of the LTEP is to better define which management actions will lead to achieving these desired future resource conditions. . . . [A]fter discussion within DOI, Reclamation would like to request that the TWG dedicate sufficient effort to **develop a set of technical options for these desired resource condition targets**, and present its approaches on these targets for consideration by the full AMWG by December 2007.

These technical options for resource target levels should consider what would be desired over the long term and identify what may be achievable within the next 10 years to correspond to the potential duration of the LTEP. As these targets are considered, we would encourage that an **ecosystem perspective** be utilized as individual targets are discussed, while recognizing that dam capabilities and hydrology may limit actions to achieve these targets. **The TWG should consider targets for each of the strategic plan management objectives but should initially concentrate on the two main resources of focus in the LTEP, i.e., humpback chub and sediment conservation.** Ideally, options for these targets should be:

- Easily understandable
- Measurable
- Geographically specific
- Feasible both financially and scientifically
- Written at a level of detail consistent with current knowledge
- **Compatible with the AMP goals and management objectives**

Maps, photos, graphs, or other materials that would assist the AMWG in understanding the technical aspects of the target levels should be included. In addition, the TWG should assess such things as the potential effects of such target levels (including effects on other resources).

Thank you for your dedicated efforts in the AMP.

Attachment 6: AMP Strategic Plan – Relevant Excerpts

COMBINED VISION AND MISSION STATEMENT

The Grand Canyon is a homeland for some, sacred to many, and a national treasure for all. In honor of past generations, and on behalf of those of the present and future, we envision an ecosystem where the resources and natural processes are in harmony under a stewardship worthy of the Grand Canyon.

We advise the Secretary of the Interior on how best to protect, mitigate adverse impacts to, and improve the integrity of the Colorado River ecosystem affected by Glen Canyon Dam, including natural biological diversity (emphasizing native biodiversity), traditional cultural properties' spiritual values, and cultural, physical, and recreational resources through the operation of Glen Canyon Dam and other means.

We do so in keeping with the federal trust responsibilities to Indian tribes, in compliance with applicable federal, state, and tribal laws, including the water delivery obligations of the Law of the River, and with due consideration to the economic value of power resources.
This will be accomplished through our long-term partnership utilizing the best available scientific and other information through an adaptive ecosystem management process.

DEFINITION OF MANAGEMENT OBJECTIVE

"Management Objectives are defined as the desired future condition of a particular resource."

DEFINITION OF ECOSYSTEM MANAGEMENT

"An ecosystem management approach differs from an issue-, species-, or resource-specific approach. Ecosystem management is a method for sustaining or restoring ecosystems and their functions and values. "It is goal driven, and it is based on a collaboratively developed vision of desired future conditions that integrates ecological, economic, and social factors. It is applied within a geographic framework defined primarily by ecological boundaries." (Interagency Ecosystem Management Task Force 1995). Ecosystem management is a process that attempts to mimic appropriate ecosystem patterns (abundance and distribution of species and habitats) and ecosystem processes (drivers of ecosystem patterns). It includes managing for viable populations of all native species."

PRINCIPLES

The ten principles of the Glen Canyon Dam Adaptive Management Program are:

1. The goals represent a set of desired outcomes that together will accomplish our vision and achieve the purpose of the Grand Canyon Protection Act. Some of the objectives and actions that fall under these goals may not be the responsibility of the Adaptive Management Program, and may be funded by other sources, but are included here for completeness.

2. The construction of Glen Canyon Dam and the introduction of non-native species have irreversibly changed the Colorado River ecosystem.

3. Much remains unknown about the Colorado River ecosystem below Glen Canyon Dam and how to achieve the Adaptive Management Program goals.

4. The Colorado River ecosystem is a managed ecosystem. An ecosystem management approach, in lieu of an issues, species, or resources approach, will guide our efforts. Management efforts will prevent any further human-induced extirpation or extinction of native species.

5. An adaptive management approach will be used to achieve Adaptive Management Program goals, through experimentation and monitoring, to meet the intent of the Grand Canyon Protection Act, Glen Canyon Dam Environmental Impact Statement, and the Record of Decision.

6. Understanding cause and effect relationships is essential for managing the Colorado River ecosystem. The adaptive management approach will be geared toward gaining an improved understanding of the cause and effect relationships that occur within the Colorado River ecosystem, and their connection, if any, to dam operations, while also documenting resource status and trends.

7. Dam operations and management actions will be tried that attempt to return ecosystem patterns and processes to their range of natural variability. When this is not appropriate, experiments will be conducted to test other approaches.

8. Because management actions to achieve a goal may benefit one resource or value and adversely affect another, those action alternatives that benefit all resources and values will be pursued first. When this is not possible, actions that have a neutral impact, or as a last resort, actions that minimize negative impacts on other resources, will be pursued consistent with the Glen Canyon Dam Environmental Impact Statement and the Record of Decision.

9. If the target of a management objective proves to be inappropriate, unrealistic, or unattainable, the Adaptive Management Program will reevaluate that target and the methods used to attain it.

10. Recognizing the diverse perspectives and spiritual values of the stakeholders, the unique aesthetic value of the Grand Canyon will be respected and enhanced.

Attachment 7: Approved AMP Goals and MOs – HBC and Sediment

Goal 2. Maintain or attain viable populations of existing native fish, remove jeopardy for humpback chub and razorback sucker, and prevent adverse modification to their critical habitats.

Management Objective	Attributes in Need of Targets	Original Metric	Original Comment (if any)
M.O. 2.1 Maintain or attain humpback chub abundance and year-class strength in the LCR and other aggregations at appropriate target levels for viable populations and to remove jeopardy.	Abundance	Number of HBC 150 mm and larger. (Length is based on the size at which a HBC is able to be pit-tagged.)	The target is viable populations and removal of jeopardy. Target to be based on 91-96 population estimate, PVA, & N_e.
	Year-class strength	# of HBC 51 mm to 150 mm Metric is catch per unit effort (CPUE). See Gorman and Bramblett.[9] See synthesis by Coggins.	Intended to be an index that will indicate spawning success. The target is viable populations and removal of jeopardy.
M.O. 2.2 Sustain or establish viable HBC spawning aggregations outside of the LCR in the Colorado River ecosystem below Glen Canyon Dam to remove jeopardy.	Spawning aggregation		The target is removal of jeopardy.
M.O. 2.3 Maintain HBC and other native fish condition and disease/parasite numbers in LCR and other aggregations at an appropriate target level for viable populations and to remove jeopardy.	Condition		There should be a minimum threshold of condition. The target is viable populations and removal of jeopardy. PEP should be asked to evaluate the method that would be used to calculate condition and the value to be established as the threshold.
	Disease and other parasites		

Management Objective	Attributes in Need of Targets	Original Metric	Original Comment (if any)
M.O. 2.4 Reduce native fish mortality due to non-native fish predation/competition as a percentage of overall mortality in the LCR and mainstem to increase native fish recruitment.	Mortality due to non-native fish predation/competition as a percentage of overall mortality		The target is reduction of non-native fish predation so it does not impinge on native fish viability. Linkages: The native fish MOs in Goal 2 and Goal 3.

Goal 8: Maintain or attain levels of sediment storage within the main channel and along shorelines to achieve GCDAMP ecosystem goals.

Management Objective	Attributes in Need of Targets	Original Metric	Original Comment (if any)
M.O. 8.1 Maintain or attain fine sediment abundance, grain-size, distribution in the main channel below 5,000 cfs	Abundance	Metric is volume (m^3) as a rolling average.	Target is current volumes or higher (trend), including some timeframe based on tributary inputs and high flows timing.
	Grain-size	Metric is D50 (median) grain size. Also, see Kondolf.[16]	Target is current level or finer (trend), including some timeframe based on reach, tributary inputs, and high flows timing.
	Distribution	Metric is patchiness and area (m^2) of sand on channel bottom.	Target is current level or more areally extensive (trend), including some timeframe based on tributary inputs and high flows timing.
M.O. 8.2 Maintain or attain fine sediment abundance, grain-size, and distribution within channel margins (not eddies) from 5,000 to 25,000 cfs	Abundance	Metric is area (m^2) and volume (m^3) as a rolling average.	Target includes some timeframe based on tributary inputs and high flows timing.
	Grain-size		Target includes some timeframe based on tributary inputs and high flows timing. See Kondolf.
	Distribution	Metric is number of sandbars by reach.	Target includes some timeframe based on tributary inputs and high flows timing.
M.O. 8.3 Maintain or attain fine sediment abundance, grain-size, and distribution, within eddies below 5,000 cfs	Abundance	Metric is volume (m^3) as a rolling average.	Target includes some timeframe based on tributary inputs and high flows timing.
	Grain-size		Target includes some timeframe based on tributary inputs and high flows timing.
	Distribution	Metric is number of sandbars by reach.	Target includes some timeframe based on tributary inputs and high flows timing.

Management Objective	Attributes in Need of Targets	Original Metric	Original Comment (if any)
M.O. 8.4 Maintain or attain fine sediment abundance, grain-size, and distribution within eddies between 5,000 to 25,000 cfs	Abundance	Metric is area (m^2) and volume (m^3) as a rolling average.	Target includes some timeframe based on tributary inputs and high flows timing. The target level should consider spawning habitat for trout in Glen Canyon and sediment needed for BHBFs.
	Grain-size		Target includes some timeframe based on tributary inputs and high flows timing. The target level should consider spawning habitat for trout in Glen Canyon and sediment needed for BHBFs.
	Distribution	Metric is number of sandbars by reach	Target includes some timeframe based on tributary inputs and high flows timing. The target level should consider spawning habitat for trout in Glen Canyon and sediment needed for BHBFs.
M.O. 8.5 Maintain or attain fine sediment abundance, grain-size, and distribution on shorelines between 25,000 cfs and the uppermost effects of maximum dam releases.*	Abundance	Metric is area (m^2) and volume (m^3) as a rolling average.	
	Grain-size		
	Distribution	Metric is number of sandbars by reach.	
M.O. 8.6 Maintain or attain coarse sediment (greater than 2 mm) abundance, grain-size and distribution throughout the Colorado River Ecosystem needed to achieve GCDAMP ecosystem goals.	Abundance		
	Grain-size		
	Distribution		

* This Management Objective is intended to include all shorelines (eddies and channel margins) between 25,000 cfs and the highest level of potential dam effects on pre-dam sand bars (about 125,000 cfs or pre-dam alluvium (pda) terrace of Hereford *et al.* 1998). The highest level will be determined through discussions with sedimentological, cultural, recreational, and riparian

workers on how best to constrain this boundary and in how many areas it should be monitored.

NOTE: Coarse sediment is important to the ecosystem, as is fine sediment. There is a Management Objective on rapids navigability under the recreation goal that indirectly addresses debris flows, as well as an MO on trout spawning habitat under the trout goal.

Information Need: consult with various researchers to determine how best to break out sub-reaches from the three broader fine sediment reaches as described above. The riparian group suggested developing a table that has various resource concerns on the *X*-axis and various processes on the *Y*-axis. The recreation group suggested developing a table that has river miles (-15 to 278) on the *X*-axis and various resources on the *Y*-axis (those resource areas impacted by sedimentological processes).

Attachment 8: Statement of Purpose and Decision Rule

Workshop Purpose and Product
The product of the Desired Future Conditions Workshop is a recommendation to the TWG on target levels for AMWG-approved Management Objectives for Humpback chub and sediment. These will be considered by the Technical Work Group (TWG) for use in the LTEP EIS by the Bureau of Reclamation (see the BOR charge to the TWG).

It is anticipated that members of the Desired Future Conditions Ad Hoc Group (DFCAHG) and TWG will have different perspectives on targets. In addition, it is consistent with the charge from BOR that a range of targets be forwarded to AMWG from TWG.

It is also anticipated that DFCAHG members can agree that the rationale for a particular target is scientifically and technically credible without necessarily agreeing with the assumptions themselves or the resulting targets. "Scientifically and technically credible" means that the rationale is based on

- plausible interpretations of science,
- rational arguments and methods, and
- reasonable assumptions,

and that its conclusions are supported by the available data.

Therefore, the purpose of this workshop is to review various proposed rationales used to develop target levels, and to come to consensus on the question:

"Is this rationale for developing target levels scientifically and technically credible?"

Those rationales (and the resulting range of targets) for which the group agrees that the answer to the question is "yes" will be recommended to TWG.

Workshop Decision Rule
At the end of the workshop, the Ad Hoc Group members will be asked to approve, by consensus, a recommendation to the TWG that will probably consist of several different rationales for developing targets, along with the resulting target levels. In order to reach that final recommendation, the group will consider individual rationales for developing targets, and develop at least provisional consensus on each one.

During discussion on individual rationales, if there is disagreement on whether the rationale is scientifically and technically credible, the Ad Hoc Group sincerely commits to reaching consensus: they will discuss the issues with a goal of thoroughly exploring and understanding the areas of agreement and disagreement, and try to find ways to reach consensus. This will entail each member committing to help others understand his or her point of view, as well as committing to learn from others about their points of view. Voting will not be needed or used in this process.

> An example of finding a way to reach consensus might be the addition of text that describes a plausible and different interpretation of the science in the proposed rationale, and notes that the

proposer of the rationale puts greater emphasis on a different interpretation. This allows others to better understand the rationale and a potential disagreement.

An example of how the consensus-building process might work is as follows: If someone objects to part of a rationale, the facilitator might say something like, "How can the rationale be modified so that it is acceptable to you?" If the modification is simple, the facilitator may ask the group, "Does anyone have an objection to modifying the rationale so that…?" If there is none, the group will have consensus on the modification. If there are objections, or if the modification is substantial, they will be thoroughly discussed and worked through.

If consensus cannot be reached that a particular rationale is scientifically and technically credible, the reasons will be recorded in the notes to the workshop, and the rationale and the resultant targets will not be included in the recommendation to the TWG.

Consensus Definition

In the course of the workshop, consensus on an individual rationale is defined as follows: Each member of the DFCAHG understands the proposed rationale for developing targets, and agrees that it is scientifically and technically credible. Each member can say that his or her point of view and concerns were heard, and, to the extent practicable and necessary, changes were made to accommodate those concerns.

At the end of the workshop, consensus on the recommendation to TWG is defined as follows: Each member of the DFCAHG endorses the DFC recommendation being forwarded to the TWG for consideration in the LTEP. Each member can say that her or his point of view and concerns were heard, and, to the extent practicable and necessary, changes were made to accommodate those concerns. Each member supports the rationale behind the target levels, to the extent that it describes the science and the assumptions used.

Participation and Determination of Consensus

Each agency represented on the Ad Hoc Group may have up to two people present, both of whom may freely participate in the workshop discussions. Only they will participate in the determination of consensus. If two representatives from an agency are participating in the workshop, a spokesperson who will announce whether the agency agrees with a proposed consensus will be identified at the beginning of the workshop.