Adaptive Management of the Colorado River Ecosystem Below Glen Canyon Dam, Arizona: Using Science and Modeling to Resolve Uncertainty in River Management

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ABSTRACT

An Adaptive Management program is underway in the Colorado River ecosystem below Glen Canyon Dam, Arizona. The focus of this effort is to identify and test non-flow experiments and other treatments that can be used to protect native resources in Grand Canyon while also meeting the operational needs of Glen Canyon Dam. The adaptive management process assumes that ecosystem responses to management policies are inherently complex and often unpredictable. By emphasizing short-term, low-cost monitoring and modeling efforts, Adaptive Management can generate new information to managers regarding the range of possibilities for achieving resource conservation objectives. Similarly, if scientists can move beyond the restrictions of a single management hypothesis and instead embrace the uncertainties inherent in the complex ecosystem, then each research activity can also become learning opportunities for managers.

INTRODUCTION

An adaptive management effort is based on the premise that responses to management actions are highly complex and often surprising. By embracing these uncertainties and approaching management in an exploratory way, science can provide new information to managers regarding the range of possibilities for achieving resource conservation objectives. Similarly, if scientists can move beyond the restrictions of a single management hypothesis and instead embrace the uncertainties inherent in the complex ecosystems like Grand Canyon, then each research activity can also become learning opportunities for managers.

RESULTS

Using data from 1999-2005, to be included in the ASMR 2005 Report, a specially designed, lowly-selective, open population capture-recapture analysis indicates that humpback chub population dynamics can be summarized in three points:

1. Humpback chub population numbers have experienced large declines from the 1980's until the early 2000's (Figure 2). Humpback chub populations have experienced large declines from the 1980's until the early 2000's (Figure 2).

2. The catch rate of humpback chub from native fish monitoring programs has decreased sharply since 2003 for juvenile chubs and other native fish (Figure 3). The humpback chub modeling results show that the adult humpback chub population trends appear to have stabilized in recent years and may even be increasing slightly (Figure 5).

3. Variability in mortality rates of humpback chub species (e.g., cool-water species like rainbow trout), while simultaneously being more favorable to other species (e.g., warm-water species like channel catfish) have so far observed concurrent increases in juvenile chubs and other native fish in this section of the river. These recaptures provide the information to our model of which animals are alive and also serve as the base for estimating how many animals are in the population. The drought has provided managers with the opportunity for a unique “natural experiment” from 2003 through 2006, near the Little Colorado River confluence (Figure 1).

Figure 1: Adult humpback chub abundance and relative abundance of species (primarily juveniles) near the Little Colorado River confluence in 2005.

Figure 2: Adult humpback chub abundance and relative abundance of species (primarily juveniles) near the Little Colorado River confluence in 2005.

Figure 3: Relative abundance of humpback chub species (primarily juveniles) near the Little Colorado River confluence, inferred from electrofishing.

Figure 4: Conceptual Ecosystem Model.

Following the 1993 EIS, conceptual ecosystem models for the Colorado River in Glen Canyon were developed by the USGS and its science cooperator (see Watters et al., 2006). The Glen Canyon conceptual modeling approach focused on existing monitoring programs and various theories on Glen Canyon ecosystem function. This research was highly successful in identifying data gaps and proposed modifications that were needed to provide insight into ecosystem functions and condition affecting key Glen Canyon ecosystems (Watters et al., 2006). Conceptual modeling has also demonstrated its value in identifying a framework for non-flow experiments and experimental treatments to assist adaptive ecosystem management (AEM). The non-flow experiments and treatments are designed to provide a detailed understanding of specific aspects of the ecosystem and to better inform decision making. The core question is: what is the value of a given non-flow experiment for learning about ecosystem condition? This strategy used a combination of monitoring and interpretative modeling programs to identify goals and research needs for these short-term experiments. The concept of using controlled, high-release to river basins was first tried in 1996, and these experimental efforts resulted in strategic adaptive management (see Figure 3).

Native Fish Monitoring

Humboldt County, the native fishes of Grand Canyon consist of species such as: roundtail chub Gila robusta, humpback chub Gila cypha, speckled dace Rhinichthys osculus, Colorado pikeminnow Ptychocheilus lucius, bluehead sucker Catostomus discobolus, fathead minnow Pimephales promelas, and longnose sucker Rhinichthys odoratus. About 80% of the native fish in the Colorado River are endemic to this river system and found nowhere else. Today, only a few humpback chub, speckled dace, fathead minnow and longnose suckers remain in Grand Canyon and the other four species are considered extirpated from Grand Canyon. The modern Grand Canyon fish community is comprised of a diverse group of native warm-water species (e.g., gila cypha, cyprinid fish, fathead minnow, longnose sucker), channel catfish (Ictalurus punctatus), black bullhead (Ameiurus melas) and cold water species (e.g., rainbow trout Oncorhynchus mykiss, brown trout Salmo trutta). This “capture-probability” of 20%, while at first appearing low, is actually much higher than in most other rivers in the basin. Using Science and Modeling to Resolve Uncertainty in River Management

A five-year drought has affected the Colorado River’s flow conditions. Fluctuating flows and river temperatures on the early 1990’s facilitated the flow releases and native and non-native fish have also been critically evaluated by scientists. Evaluation of water releases and control structures in the Colorado River ecosystem was facilitated by the USGS with adaptive ecosystem management in 2002. The ASMR model has been very useful at estimating population size and abundance trends, while simultaneously being more favorable to other species.

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