Endangered species and adaptive management in the Grand Canyon

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Abstract

Environmental protection in the Colorado River basin and Grand Canyon National Park incorporates a range of complex legal mandates, resource uses, stakeholder groups, and managing agencies; two of the major frameworks to manage natural resources and protect wildlife are the Glen Canyon Adaptive Management Program and the Endangered Species Act. I present an overview of the adaptive management program, management actions, and conflicts with requirements of the Endangered Species Act, with a specific focus on the Kanab ambersnail *Oxyloma haydeni kanabensis* and three other listed species that are impacted by Glen Canyon Dam operations. Particular challenges in balancing the management and legal frameworks arise from differences in goals and priorities of each—whole ecosystem and resource priorities of adaptive management contrast with the species specific recovery aims of endangered species management. A major threat to these species is habitat loss and alteration, which is further impacted by adaptive management actions, specifically high flow experimental releases from Glen Canyon Dam. While there are relatively simple solutions to maintain Kanab ambersnail populations during flooding, impacts on other endangered species has been mixed and responses to management actions are still not clearly understood. Further experimentation within the adaptive management framework and a reevaluation of overall goals will be needed to establish feasible plans for future management of the threatened species and shifting ecosystems within the Grand Canyon.

Introduction

Adaptive management (AM) is an evaluative approach to natural resources planning and policies (Williams et al. 2009). AM uses an iterative, structured decision making process to address uncertainty in complex natural systems (Fig. 1). Adaptive management encourages an ecosystem level approach, with close monitoring of environmental outcomes of experimental policies (Jacobs and Wescoat 2002).

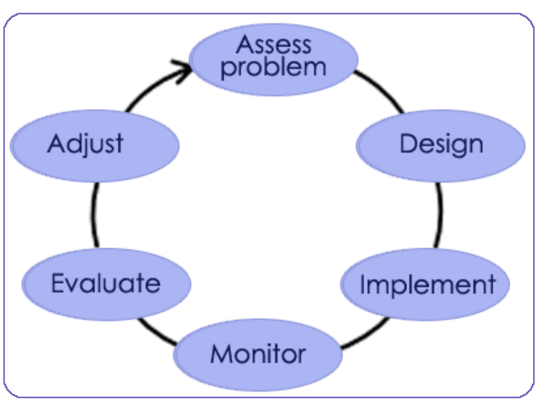

Figure 1. The adaptive management process as described in the Department of Interior Technical Guide to Adaptive Management (Williams et al. 2009).

The Glen Canyon Dam Adaptive Management Program (GCDAMP) was formally established in 1997 as a recognition of the changed conditions downstream of the dam and in compliance with the Grand Canyon Protection Act (1992). The GCDAMP is administered through the Department of the Interior and has several roles: 1) it provides the process for monitoring and assessing the effects of dam operations on downstream resources, 2) recommends operational adjustments, and 3) allows for experimentation to understand the effects of dam operation.

The GCDAMP consists of a work group, technical group, and research division. The work group is a federal advisory committee that facilitates the adaptive management program and makes recommendations to meet requirements of the Grand Canyon Protection Act. It includes representatives from federal and state agencies, Native American governments, environmental groups, recreation interests, and Glen Canyon Dam federal power purchase contractors. The Technical work group is a subcommittee of the work group, which translates policy and goals into resource management objectives and establishes criteria and standards for research and monitoring. The Grand Canyon Monitoring and Research center is a division of the USGS and the science arm of the AMP, which develops and administers plans for long term monitoring research, guided by needs specified by the work groups. Finally, the AMP also incorporates an independent, external peer review process to review monitoring and research programs.

The Endangered Species Act (ESA) aims to protect and recover imperiled species and the ecosystems on which they depend. Signed into law in 1973, the ESA is administered by the Department of Interior's U.S. Fish and Wildlife Service (terrestrial and freshwater) and the Department of Commerce's National Marine Fisheries Service (marine). The ESA evaluates habitat availability, use of a species, disease or predation, existing protection, and other natural or human factors that affects the continued existence to list any species. It takes a strongly individualistic approach—any "take" (harm, harass, hunt, shoot, wound, kill, trap, capture, collect) of listed animals is prohibited, along with any habitat modification or degradation that could kill or injure wildlife, or impair critical behavior (i.e. breeding, feeding, sheltering). While the ultimate goal of the ESA is to recover species, few have been fully recovered and delisted (Scott and Goble 2005). The National Park Service lists over 20 endangered, threatened, and sensitive species in the Grand Canyon. However, the species identified as at risk by Glen Canyon Dam operations are the federally endangered Kanab Ambersnail (*Oxyloma haydeni kanabensis*), humpback chub (*Gila cypha*), razorback sucker (*Xyrauchen texanus*), and southwestern willow flycatcher (*Empidonax triallii extimus)*.

The major conflicts between GCDAMP and ESA goals arise from the contrasting scope of each management scheme—GCDAMP focuses on overall resource management, including ecological, hydrological, and human use goals, while the ESA uses a much more specific, individualistic approach with wildlife preservation as a sole priority. Here I address the current issues and disconnect between the two frameworks with a particular focus on the Kanab ambersnail, and discuss if it is possible to reconcile adaptive management planning within the mandates of the ESA.

Scope of GCDAMP and management actions

GCDAMP states a suite of "desired future conditions" of key resources, which covers species and ecosystems, cultural value, hydropower, recreation, and sediment. The goals aligned with ESA priorities are included under species and ecosystems:

- Protect or improve the biotic riparian, wetland, spring and old high water zone plant communities and their associated biological processes (including threatened and endangered species and their habitat).
- Protect or improve the aquatic food base so that it supports viable populations at higher tropic levels.
- Maintain or attain viable populations of the Kanab ambersnail
- Maintain or attain viable populations of existing native fish, and prevent adverse modification to their habitat

However, other desired conditions can directly or indirectly impact endangered species and habitats, such as:

- Maintain power production capacity and energy generation, and increase where feasible and advisable (Hydropower)
- Maintain a self-sustaining recreational trout fishery in the Lees Ferry reach (Recreation)
- Maintain or improve the quality of recreational experiences for users (Recreation)
- Maintain or attain levels of sediment storage within the main channel and along shorelines (Sediment)

While some of these goals coincide with the ESA, under current conditions it is highly unlikely that these endangered species will be delisted given hydropower, sediment, and recreation goals of GCDAMP. Furthermore, the presence of these species can limit options for ecosystem management because of habitat requirements.

<u>High flow experiments</u>

The dominant approach to restoring pre-dam conditions has been a series of controlled, high flow experimental releases from Glen Canyon Dam. These are designed to mimic seasonal flooding and rebuild sandbars, deposit nutrients, and restore the dynamics of a natural system. However, management of aquatic and sediment related resources and processes may conflict with riparian resources and processes. GDCAMP desired ecosystem benefits of experimental floods must also be balanced with minimizing effects on endangered species under the ESA.

Status and responses of endangered species to adaptive management actions

<u>Riparian species</u>

Kanab ambersnail, listed 1991

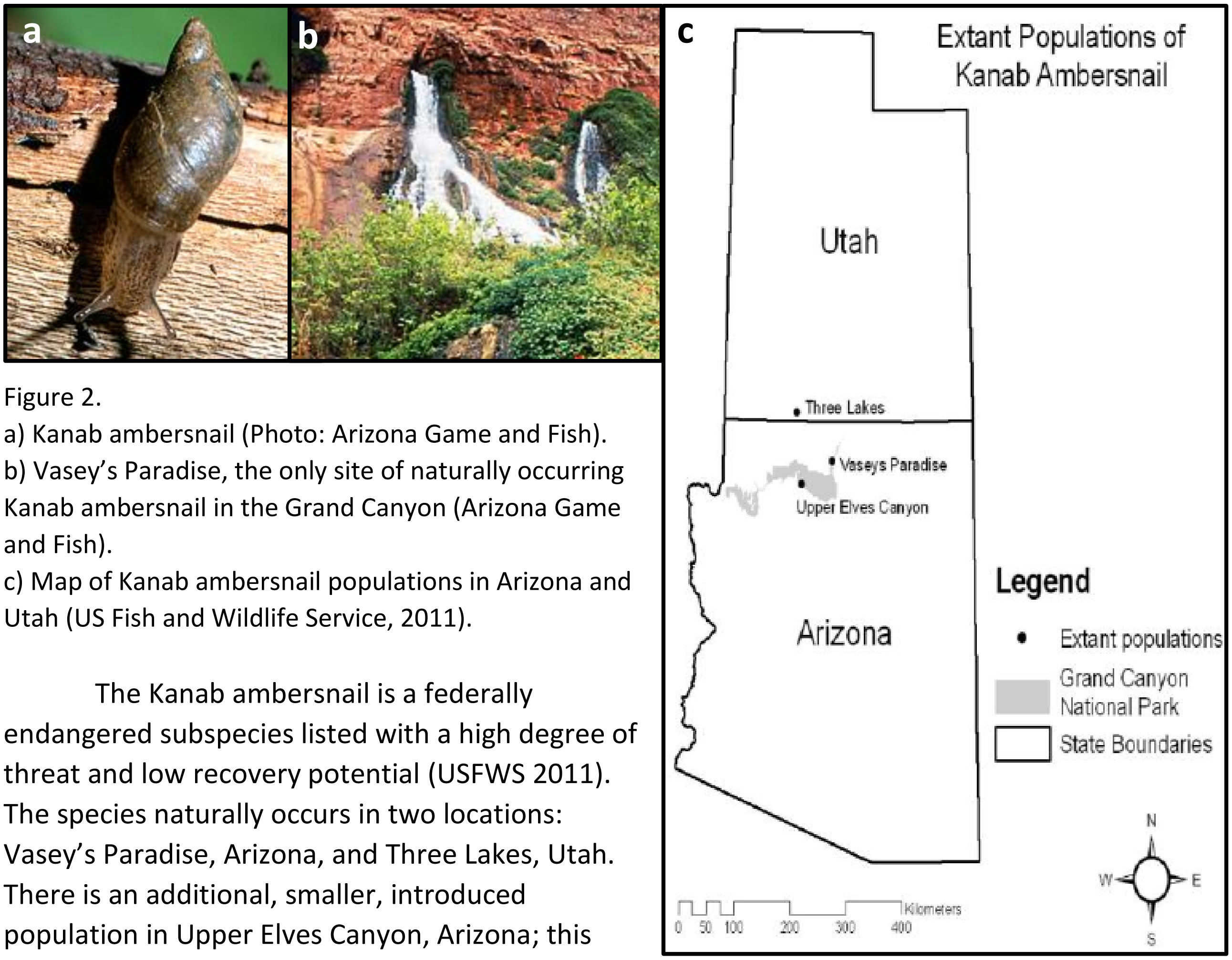

Figure 2.
a) Kanab ambersnail (Photo: Arizona Game and Fish).
b) Vasey's Paradise, the only site of naturally occurring Kanab ambersnail in the Grand Canyon (Arizona Game and Fish).
c) Map of Kanab ambersnail populations in Arizona and Utah (US Fish and Wildlife Service, 2011).

The Kanab ambersnail is a federally endangered subspecies listed with a high degree of threat and low recovery potential (USFWS 2011). The species naturally occurs in two locations: Vasey's Paradise, Arizona, and Three Lakes, Utah. There is an additional, smaller, introduced population in Upper Elves Canyon, Arizona; this was the only translocated population to persist in the Grand Canyon (USFWS 2011). Recent genetic analyses have not reached consensus on the taxonomic status of Kanab ambersnail, but studies concluded that the Vasey's Paradise Kanab ambersnail population is genetically distinct from the Three Lakes Population and from other *Oxyloma* species (Miller et al. 2000, Meretsky et al. 2000, USFWS 2011).

Estimates of the Vasey's Paradise population in 1995 ranged from 18,476 individuals in spring to 104,004 individuals in fall, and 35,000 in fall 1999 to 3,124 in spring 2002 (Sorensen and Kubly 1997 and Gloss et al. 2005, in USFWS 2011). However, population counts are highly variable and population trends have not been identified (USFWS 2011). The Upper Elves Canyon population was initiated with 340 translocated ambersnails from Vasey's Paradise and is currently thought to be fully self-sustaining (USFWS 2011).

At Vasey's Paradise the Kanab ambersnail occurs on two host plants: native scarlet monkeyflower (*Mimulus cardinalis*) and non-native watercress (*Nasturtium officinale*). Hydrologic changes caused by Glen Canyon dam have resulted in lowered habitat extent and a 40% increase in plant cover compared to pre-dam conditions (Meretsky et al. 2000, Stevens et al. 2001). At Upper Elves Canyon, the introduced population occupies habitat dominated by monkeyflower (Sorenson 2005 in USFWS 2011).

The primary threat to Kanab ambersnails is loss of habitat. When water levels are greater than 20,000 cubic feet per second, water inundates and scours away habitat and snails at Vasey's Paradise (Stevens et al. 1997). Prior to the first proposed release of 1996, the Bureau of Reclamation predicted that 17% of ambersnail habitat would potentially be destroyed by the experimental flood. Given ESA requirements to avoid harm and habitat destruction of endangered species, the US Fish and Wildlife Service required that 80% of the snails in the area below the high water line be relocated above the flood line at Vasey's Paradise. However, the experimental flow still scoured approximately 14% of habitat (USFWS 2000), which resulted in loss of snails and took over two years for vegetation to fully recover (Stevens et al. 1997).

In this case, the presence of endangered species did not significantly hinder management options. Meretsky et al. (2000) noted that the snails limited options for higher flood levels and also left no open areas of vegetation as controls because inundated loss was unacceptable under the ESA. But overall, USFWS provided a relatively low-cost (1275 snails were hand removed) solution to allow for experimentation to proceed and to contribute to adaptive management hydrologic and sediment goals. An additional tenet required by USFWS under the ESA required post-experiment monitoring of ambersnail populations and habitat. After the 1996 flood, recolonization began immediately, though the population didn't return to pre-flood levels until two years later and habitat remained in reduced condition through 1999 due to scoured bedrock in the floodzone (Stevens et al. 2001). Conservation measures related to the 2004 and 2008 releases included similar measures—transplantation of snails above flood zone—as well as temporary removal and holding of vegetation mats (approximately 25-40% of habitat) until inundation subsided and returned (USFWS 2011). In these releases, vegetation recovery occurred within 6 months and snail censuses showed no substantial decline in abundance (Melis 2011).

While high flow experimental releases can directly reduce kanab ambersnail populations and habitat, conservation measures to mitigate negative impacts have limited losses of snail habitat and mortality. In this case, endangered species protection can be effectively maintained under broader adaptive management measures.

Southwestern willow flycatcher, listed 1995

The Southwestern willow flycatcher is found along the riparian corridor through the Grand Canyon and at upper Lake Mead. Similar to the Kanab ambersnail, the major threat to this species is habitat loss. Flycatchers are found in dense riparian habitat, including invasive Tamarisk, which may be impacted by high flow events and scouring. Conversely, maintaining dense vegetation and habitat along shorelines for flycatchers can negatively impact sandbar building (a recreational and sediment restoration goal under GCDAMP) by decreasing water velocities and sediment dynamics (Ralston 2010). Though management options are slightly limited because of potential threats to riparian habitat, no negative impacts were found on the flycatcher as a result of high flow experiments. The 2008 high flow experiment increased Tamarisk cover in the lower riparian zone, likely due to the timing of the flood and seedling establishment (Ralston 2010, USFWS 2011). However, management of invasive Tamarisk has affected riparian habitat for breeding willow flycatchers (Sogge 1995). Surveys have demonstrated that the birds exist as a very small, widely dispersed population, and while migrating flycatchers are present, breeding may be impacted as a result of limited habitat (McLeod and Pellegrini 2011).

Aquatic species

Humpback chub, listed 1967 and Razorback sucker, listed 1991

Glen Canyon dam operations have dramatically impacted humpback chub and razorback sucker habitats by altering water temperature, turbidity, and sediment processes. While many adaptive management goals and high flow experimental releases are focused on restoring hydrology and physical characteristics, results from these experiments have not demonstrated any clear, positive responses from the two fish species.

Unexpectedly, the high flow experimental events resulted in a strong response by nonnative trout, largely considered to be a result of highly successful recruitment events for this species after spawning habitats were improved and predation increased (Cross and Baxter 2011, USFWS 2011). Both rainbow and brown trout cause direct mortality of the endangered species through predation, particularly young of year and juveniles that are critical to sustaining viable populations (Coggins et al. 2006, 2011, Yard et al. 2011). It has also been hypothesized that the potential benefits of flows on humpback chub are weak and short lived, or cancelled out by the persistence of other variables such as fragmentation of habitat, and changes in thermal regime, sediment supply, and transport (Konrad et al. 2011, USFWS 2011, Yard et al. 2011, Gerig et al. 2014).

Conclusions

Conflicting goals and values

Adaptive management actions have had mixed impacts on endangered species and are increasingly complicated by a lack of prioritized GCDAMP goals and changing environmental regimes as novel ecosystems develop. Conflicting values in species and ecosystem protection (endangered species and invasive species) and conflicting goals in resource management (native fish restoration and a sustained trout fishery) have not been fully resolved. Furthermore, the varying habitat requirements of the endangered species pose many challenges; differing habitat preferences, life histories, and species interactions drive varying responses to streamflow and other environmental conditions (Stevens et al. 2001, Konrad et al. 2011). While the test floods had overall neutral or minimally negative impacts on endangered species, there have been few clear positive effects and there are still consequences that are not fully understood. The Kanab ambersnail is perhaps the most easily managed endangered species in the Grand Canyon; while it is the simplest case, the species is still under high threat with no recovery likely in the near future. Overall, the ESA has not significantly hindered adaptive management actions and has maintained an important role in preserving wildlife in the Grand Canyon.

Future of GCDAMP and the Grand Canyon

Nearly 20 years after its inception, it is still difficult to measure the success of GCDAMP. Experimental flows have had varying results on endangered species and ecosystem processes, and learning is still an active and ongoing part of overall management. Camacho et al. (2010) argue that the AMP essentially failed to stabilize the ecosystem and has made insignificant progress towards resolving resource conflicts or formulating a long term operations plan. The numerous temporal and spatial scales at which various stakeholders, species, and processes work in the Grand Canyon makes it difficult to gauge responses to management actions and to apply follow up actions, because problems are not uniformly perpetuated through the system over time (Schreiber et al. 2004). Given continuing dam operations and persistent human impacts, it may not be realistic nor feasible to manage the national park in its historical state; in which case, both the GDCAMP and ESA will be forced to reevaluate current goals and establish new priorities for a quickly growing novel ecosystem.

Citations

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