

Teaching notes:

1) **Title:** A River Ran Through It: Socio-environmental synthesis as a means of preparing ecological restoration goals – Glen Canyon Dam and the Colorado River

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3) **Abstract:**

Ecological restoration is frequently a complex issue, with ecological, social, political, and financial considerations. This case study explores the issue of the Glen Canyon Dam on the Colorado River, and examines whether, how, and what changes could be made to the dam in order to partially restore stream flow on the river. The case is intended for an introductory course in ecological restoration, but could also be used effectively in other courses related to environmental management, public policy, or land use.

4) **What courses is this case study appropriate for?**

Ecological restoration
Public policy
Environmental studies
Water resources
Etc.

5) **What level is this case study appropriate for?**

The case was designed for introductory courses, but could be readily adapted for advanced courses, particularly by encouraging students to read some/all of the recommended readings prior to class. Upper level or advanced classes could also make actual management recommendations – e.g., if they determined that the Glen Canyon Dam should release more water, more frequently, students could determine a specific level and frequency to simulate historic (pre-dam) water flow patterns. Additionally, students could be encouraged to download the data from the USGS website, design their own hydrographs, and evaluate the average or variability of the flow pre- and post-dam.

6) **SES learning goals:**

- 1) Ability to describe a socio-environmental system, including the environmental and social components and their interactions.
- 2) Ability to identify disciplines and approaches relevant to the problem
- 3) Ability to communicate across disciplinary boundaries
- 4) Ability to find, analyze, and synthesize existing data
- 5) Ability to consider the importance of scale and context in addressing socio-environmental problems

7) Learning objectives:

After completing the case study, students should:

- 1) Be familiar with competing economic, social, and environmental factors that influence ecosystem restoration goals.
- 2) Understand how competing economic, social, and environmental factors can be combined to determine restoration goals.
- 3) Be able to apply the concepts in the case to other restoration projects at different spatial scales.

8) Introduction/background

Ecological restoration is a complex proposition in many ecosystems. Competing land uses potentially reduce or alter the ability of land managers to make ecologically-sound management decisions. Non-ecological factors (including financial considerations and recreational uses) frequently alter the politically- or socially-feasible management options.

These complex issues are particularly relevant to the Colorado River, and the Glen Canyon Dam. By 1966, water had impounded above the dam to create the 250 mi² Lake Powell, the second largest artificial reservoir in the United States (after Lake Mead, located several hundred miles downstream). Initially, the Glen Canyon Dam was built to moderate flow of the Colorado River, reducing both floods and droughts in the region, and to provide a perpetual reservoir, and is the focal point of the popular Glen Canyon National Recreation Area. In addition to water, the Glen Canyon Dam provides hydroelectric generation, with a maximum power production of ~1300MW.

In the 1980s, the dam was nearly destroyed during a series of floods. In 1996, amidst concerns that the dam had changed the hydrology and geology of the Colorado River, floodgates were opened, allowing brief release of water at 45,000 ft³/sec. Although this treatment was initially thought to be successful, it appears to have been insufficient to restructure the river geology and ecological communities. The treatment was then repeated in 2004, 2008, and 2012.

In the late 1990s, the Sierra Club Board of Directors advocated the decommissioning of the dam, and draining of Lake Powell. This sparked an extensive, heated discussion about whether to maintain Lake Powell or to drain it. Although the complete removal of the dam (and subsequent draining of Lake Powell) is probably not politically feasible, additional alterations to the stream flow are likely to be proposed, in order to maintain stream hydrology.

9) Classroom management

This case study is designed as an interrupted-case style case study. In a smaller discussion-format classroom, it works well in groups of 3 or 4 students, who consider the questions individually, discuss each part in their small group, and then report back to the entire class after each part. In a larger class setting, students could either discuss the questions with a neighbor, or think about the responses individually. Regardless, since students will

invariably interpret the material differently, it is very beneficial to dedicate a substantial portion of the class time to foster synthesis between the groups.

In preparation for the activity, students can be recommended to examine the references and readings (listed below), however this is not essential.

10) Example answers for activities

In Part 1, the students should recognize that there are two distinct periods – prior to the dam being completed in the 1960s, and after the dam was completed. Before the 1960s, the river ran freely, with much more variability in stream flow (higher highs, lower lows), and frequent (nearly annual) peak flows around 100,000 cfs. After construction of the dam, there is a period when the reservoir was filling (until ~1980). In the mid 1980s, an extremely wet period necessitated the release of large volumes of water, and nearly destroyed the dam. Starting in 1996, the students should be able to identify several periods when larger volumes of water (~45,000 cfs) were released. These occurred in 1996, 2004, 2008, and 2012, and were intended to mimic some of the pre-dam hydrology and help restore the stream corridor.

In Part 2, students might identify average stream flow, peak flow in a certain period (e.g., a 10-year flood of 120,000 cfs), or some other measure to stream variability. Regardless, they should have reasons for determining those measures, and be able to justify their thoughts.

In Parts 3 and 4 students should see that the economic and social aspects of stream restoration might conflict with the “ideal” environmental restoration scheme. For instance, if a group determined that the dam should be decommissioned and the lake drained, they should then realize that there would be substantial impacts on power generation, sport fishing, and GCNRA tourism. These tradeoffs are neither absolute nor definitive, and may frequently be mitigated. However, the students should recognize that determining goals for ecological restoration is rarely just related to the “best” ecological possibility. Rather, social and economic aspects must be considered, and frequently will mandate feasible restoration options.

11) References and recommended reading

Cohn, Charles. 2011. Should Glen Canyon Dam be removed? University of California at Boulder. Honors thesis.

“Glen Canyon Dam” Wikipedia article. Available at:
en.wikipedia.org/wiki/glen_canyon_dam

Infalt, Susan B. 2005. Colorado River native riparian vegetation in Grand Canyon: How has Glen Canyon Dam impacted these communities? University of California Davis, Department of Geology. Available at: www.geology.ucdavis.edu/~shlemonc

Miller, Scott K. 2000. Undamming Glen Canyon: Lunacy, Rationality, or Prophecy? Stanford Environmental Law Journal. 19(1): 121-207

“Sediment and river sand bars in Grand Canyon”. 2006. Glen Canyon Dam Adaptive Management Program. Available at: www.gcdamp.gov/keyresc/sediment.html

12) Assessment:

This case is designed as an introduction to the multiple factors that influence restoration goals and feasibility. As such, it is intended to foster discussion in the classroom, and does not have a specific assessment per se. The concepts developed in the case study will be used throughout the rest of the semester, as the course explores other restoration projects, case and studies. Therefore, the material will be repeated and revised in upcoming lectures and discussions. However, the questions provided in the different parts could easily be used as the basis for a take-home writing assignment or a short quiz.

13) Funding:

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