

## **Water & the American West**

**Instructor: John Sabo**

**TA: TBA**

**Listing: HON/BIO/SOS 300 level**

**Enrollment Cap: 32**

**Lecture: T TH 9-12**

**Field Trips: Two (mandatory) weekend trips**

### **Synopsis**

This class is devoted to instilling a landscape & geographic perspective of water use practices in the Western US. A specific goal is to provide non-science majors with enough scientific background to interpret landscapes historically and understand how the West may have looked prior to modern water development vis-à-vis present day ecosystems. The class will be taught to juniors in the Barrett Honors College, School of Life Sciences and School of Sustainability. No formal training in biology, hydrology or ecology is necessary. My goal is to train future generations of policy makers, lawyers, doctors, real estate brokers and scientists to consider water as a limiting resource for humans and ecosystems. The teaching philosophy will be a hybrid between a standard science class and a discussion-based seminar course more typical of a small liberal arts college. Briefly, I will give one science based lecture and guide one reading-based discussion per week. Core, required readings for the class include:

- Stegner, W. 1954. *Beyond the Hundredth Meridian: John Wesley Powell and the Second Opening of the West*. Houghton Mifflin Company. New York.
- Reisner, M. 1993. *Cadillac desert*. Penguin Books. New York.
- Lichatowich, J.A. 2001. *Salmon Without Rivers: A History Of The Pacific Salmon Crisis*. Island Press. Washington, D.C.
- Glennon, R. 2002. *Water follies*. Island Press. Washington, D.C.
- A reader of key scientific papers relevant to Western water policy

Science-based lectures will be based on material from the reader and the following supplementary texts:

- Allan, J.D. 1995. *Stream ecology*. Chapman & Hall. New York.
- NRC. 2002. *Riparian Areas*. National Academy Press. Washington, D.C.

These science based lectures will be designed to provide non-scientists with enough technical information to discuss and form opinions about the balance between the beneficial services and detrimental impacts of major water projects in the West. They will typically be delivered in less than one hour and be followed up by student-led break-out groups in which students take turns teaching small groups of students the essentials from technical science papers from the reader.

Weekly discussions will be held either in the classroom—as debates in which students take on various assigned roles—or in the field on visits to key water resource landmarks in the greater Phoenix area. I will also take the class on 2 required overnight field trips (on weekends):

- Glen Canyon float trip with guest scientists from USGS and NPS
- San Pedro River: a road trip to see wet and dry reaches of the river

Students will be graded based on the following:

- Participation in discussions (debates) and attendance of field trips
- Performance on five key assignments
  1. Design of an educational project for K-12 about how water is delivered and used in the state of Arizona
  2. An op-ed piece written for the *Arizona Republic* about a local water controversy
  3. An op-ed piece written for the *LA Times* about a regional or international water controversy
  4. A short report summarizing and comparing the major revenues generated by the 10 largest dams in the US.
  5. An essay proposing an algorithm for calculating 'ecological footprints' that includes impacts on global carbon and regional water budgets

# Course Syllabus

## Background & Motivation

John Wesley Powell, the great American explorer, noted that if you diverted and distributed all of the surface water evenly from the Columbia River to the Gulf of California, this region would still have a desert almost indistinguishable from the one that is here today. This insight will provide the impetus for the science presented in this class. Since Powell's exploration days, nearly all of the great rivers of the American West have been significantly modified—dammed and/or diverted, rip-rapped and channelized under the auspices of irrigation, hydro-power, flood control and municipal water supplies.

A few examples underscore the scale of these modifications:

- Between 1933 and 1973, the US Reclamation Service (now Bureau of Reclamation) and the US Army Corps of Engineers built 36 dams on the Columbia River system.
- Over 700 river miles of the Missouri River Valley and 8 million acres of land in Oklahoma and Texas are under water behind dams.
- The Colorado River that Powell once bravely explored is now tamed behind some of the greatest dams ever built.

From an ecological perspective, freshwater systems are much different than those witnessed by pre-European settlement. Some examples include:

- Salinity levels are greatly increased in the Sea of Cortez and the San Francisco Bay due to reduced freshwater inputs from the Colorado and Sacramento Rivers, respectively.
- Vast seasonal wetlands like Tulare and Buena Vista Lakes in California are gone.
- The surface of Mono Lake is 35 feet below levels in 1941 when the City of Los Angeles began diverting water from its tributaries via the Los Angeles Aqueduct.
- The Salton Sea—an irrigation glitch—persists in the desert heat as a result of surface runoff from rich agricultural lands irrigated by diverted Colorado River water.

Less obvious on the surface, groundwater levels have also declined across the West and in other less arid regions of the continental US as a result of pumping for agriculture, mining and urban development. Many of the most productive desert riparian areas along the Gila River and its tributaries are now dry desert channels. These fertile river valleys—once farmed by the Tohono O'odham following seasonal monsoon rains and floods in the summer—are now planted with alfalfa (to feed livestock) grown with groundwater and cheap surface water diverted hundreds of miles from the Colorado River via the Central Arizona Project. In the Cosumnes River—the last free-flowing river in California—ground water pumping lowers flows, increases water temperature and threatens to extinguish one of the southern most populations of Chinook Salmon.

These and many other insights have been summarized by Stegner (Beyond the Hundredth Meridian: John Wesley Powell and the Second Opening of the West, Penguin Books), Reisner (Cadillac Desert, Penguin Books), Glennon (Water Follies, Island Press) Abbey (Desert Solitaire-A Season in the Wilderness, Touchstone), Lichatowich (Rivers Without Salmon, Island Press). These books will serve as primary textbooks for the class and guide us to relevant ecological concepts

### *Overview of Lectures & Discussions*

#### **Module 1: What is freshwater, where is it, how much is there?**

- Lecture: Hydrology I— The global water cycle: The ocean, El Nino & climate change.
- Lecture: Hydrology II— The regional water cycle: The aquifer, recharge, discharge, stream flows, dams & reservoirs
- **Discussion (In class): Less than 1% of the water on earth is potable, 95% of this potable water is underground.**
  - Reading: Glennon—Introduction and Chaps 1-4.
- **Discussion (In class): Educational media for teaching hydrology to K-12 students**
  - Students will be provided with educational kits (available via The Groundwater Foundation) for making basic aquifers to demonstrate concepts about groundwater to K-12 students.
  - Discussion will follow about ways to improve these media.
- Lecture: Hydrology III—The San Pedro River
- **Discussion (In class debate): Is Ft. Huachuca really to blame? Dwindling surface flows in the San Pedro River**

#### **Field Trip: San Pedro River Road Trip**

#### **Assignment 1: Design an educational activity for a K-12 classroom.**

- **Class presentations of educational activities.**

#### **Module 2: Groundwater withdrawal & its ecological effects**

- Lecture: Ecology I—What services do ecosystems provide and how are these services quantified economically?
- **Discussion (in class): How much does water cost? An introduction to assignment on quantifying the ecological water footprint**
- Lecture: Ecology II— What is a riparian zone & what services to riparian ecosystems provide?
- **Discussion (in field): Agua Fria River waste treatment plant & riparian preserve**
- Lecture: Ecology III—How have Western riparian ecosystems changed since Powell's explorations?

- **Discussion: Should we strive for functional vs. historically accurate riparian areas? Example: Lake Roosevelt & Grand Canyon Tamarisk invasions provide habitat for endangered birds.**

**Assignment 2: Op-ed piece for *Arizona Republic* about a local groundwater issue (e.g., the Verde and San Pedro River have drawn national attention)**

**Module 3: Cadillac Desert—how did we spread Powell’s water across the western US?**

- Lecture: Water Diversion I—How did ancient cultures provide water to their civilizations?
- **Discussion (in field): Visit to Hohokam water infrastructure on ASU campus**
- Lecture: Water Diversion II— Dams, dams and more dams. Major water projects in the Western US
- **Discussion (in class): Reisner’s apocalypses**
- Lecture: Water Diversion III—The Over-allocated Colorado River
- **Discussion (in class): Debate about allocation of Colorado River water**

**Assignment 3: Op-ed piece for *LA Times* about the 25<sup>th</sup> anniversary of *Cadillac Desert* and whether Reisner’s apocalypses were prophecy or alarmist agitation.**

**Module 4: Dams & their ecological effects**

- Lecture: River Ecology I—Principles of healthy river ecosystems
- **Discussion (in class): Salmon without rivers & Movie review (Jacques Cousteau & Salmon Migrations)**
- Lecture: River Ecology II— Dams and altered river ecosystems
- **Discussion (in class): Movie review—‘A river reborn’.**
- Lecture: River Ecology III—Case study of the Glen Canyon Dam
- **Discussion (in class): Debate about experimental floods in the Glen and Grand Canyon**
- Lecture: River Ecology IV—Case study of the Columbia River and salmon migrations
- **Discussion (in class): Debate about dam removal on the Elwah River, Washington**

**Assignment 4: Power, water delivery & recreation. How much revenue do America’s 10 largest dams return?**

**Field Trip: Glen Canyon Float Trip**

**Module 5: The Central Arizona Project & Population Growth in the Desert Southwest**

- Lecture: Arizona Water Supplies I—Why are lawns green in Phoenix but not Tucson? CAP and Groundwater supplies in Arizona’s population centers.

- **Discussion (in field): Visit to golf course, hike in South Mountain Park**
- Lecture: Arizona Water Supplies II — How much water does industry & agriculture use in Arizona?
- **Discussion (in field): Visit to CAP canal sites in Phoenix**
- Lecture: Arizona Water Supplies III—Where do small towns in rural areas get their water?
- **Discussion (in class): Debate about water issues related to proposed development of Buckeye, AZ. (ASU Decision Theatre)**

**Assignment 5: The ecological water footprint. An essay that guides environmentally conscious urbanites about how to balance a global carbon footprint with a more regional 'water footprint'.**

**Required readings:**

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- Abbey, E. 1968. Desert solitaire. McGraw-Hill. New York.
- Reisner. M. 1993. Cadillac desert. Penguin Books. New York.
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**Supplementary texts:**

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