

## Notes

These notes are intended to help interested readers learn more about water policy, ecology and environmental ethics in the American Southwest. They are a companion guide to *Mythical River: Chasing the Mirage of New Water in the American Southwest*. They are not a comprehensive guide to my sources. Websites were current at time of publication.

### Prologue. The Good-Luck River

**when an expedition of ten Spaniards:** For an English translation of the expedition's journal, I used Herbert E. Bolton's *Pageant in the Wilderness: The Story of the Escalante Expedition to the Interior Basin, 1776* (Salt Lake City: Utah State Historical Society, 1972). See also Walter Briggs' *Without Noise of Arms: The 1776 Dominguez-Escalante Search for a Route from Santa Fe to Monterey* (Flagstaff: Northland Press, 1976).

**Rivers across the Southwest flowed 5 to 37 percent lower than normal:** Garfin, G., A. Jardine, R. Merideth, M. Black, and S. LeRoy, eds. *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment*. A report by the Southwest Climate Alliance. Washington, DC: Island Press, 2013.

**a mid-twelfth century drought:** During the mid-twelfth century most of the Anasazi great-houses (multistory stone buildings) were abandoned in the central San Juan Valley, and by the end of the thirteenth century the remaining great-houses and settlements in the Four Corners region were gone. Rapid population declines occurred during this time. See: Benson, Larry V. et al. "Possible impacts of early-11<sup>th</sup>-, middle-12<sup>th</sup>-, and late-13<sup>th</sup>-century droughts on western Native Americans and the Mississippian Cahokians." *Quaternary Science Reviews* 26.3-4(2007): 336-350. The reconstruction of the Colorado

River flow comes from: Meko, David et al. "Medieval drought in the upper Colorado River basin." *Geophysical Research Letters* 34.10(2007): L10705. For more about droughts in the tree-ring record, see: Woodhouse, C. A., Meko, D. M., MacDonald, G. M., Stahle, D. W. & Cook, E. R. "A 1,200 year perspective of 21st Century drought in southwestern North America." *Proc. Natl Acad. Sci. USA* 50(2010): 21283–21288.

**the Colorado will diminish 10 to 20 percent:** Various studies summarize predictions for climate change in the Southwest. See *Colorado River Basin Water Supply and Demand Study* (U.S. Bureau of Reclamation, 2012, [www.usbr.gov/lc/region/programs/crbstudy.html](http://www.usbr.gov/lc/region/programs/crbstudy.html)); the federal government's *National Climate Assessment* (2013, in draft form at the time of writing, <http://ncadac.globalchange.gov>); and *Assessment for Climate Change in the Southwest United States*, a report prepared for the National Climate Assessment by the Southwest Climate Alliance (eds. Gregg Garfin, Angela Jardine, Robert Merideth, Mary Black, and Sarah LeRoy. Washington DC: Island Press, 2013).

**water demand is expected to increase:** Nationwide increase in demand according to the draft *National Climate Assessment*. The U.S. Bureau of Reclamation offered similar numbers for the Southwest, 18 to 33 percent.

**Average temperatures have risen:** Lenart, Melanie. *Life in the Hothouse: How a Living Planet Survives Climate Change*. Tucson: U of Arizona P, 2010.

**Changes in precipitation:** *Assessment of Climate Change in the Southwest United States*, 2013.

**The Buenaventura would appear on maps:** See more about the Buenaventura in Gloria Griffen Cline's *Exploration the Great Basin*, originally published in 1963 (U of Nevada P, 1988). Also: Crampton, Gregory and Gloria Griffen Cline, "The San Buenaventura,

Mythical River of the West.” *Pacific Historical Review* 25.2 (May 1956): 163-171.

Richard V. Francaviglia discusses the Buenaventura from the context of cartography, and reprints many of the relevant maps, in *Mapping and Imagination in the Great Basin: A Cartographic History* (Reno & Las Vegas: U of Nevada P, 2005).

**an isohyetal line:** a line drawn on a map connecting roughly equal points of precipitation. The boundary is mutable. Precipitation in the Sierra Nevada can reach 80 inches a year, and portions of the Rockies receive 100 inches a year.

**Two rules regulate rivers and streams:** These rules are called prior appropriation (known colloquially as “first in time, first in right”) and beneficial use (“use it or lose it”). They largely replaced the riparian doctrine developed in the eastern United States, although all three rules exist in a patchwork across the West. For more about the development of water law and the influence of the Gold Rush, see: Apple, Daina Dravnieks. “Evolution of U.S. Water Policy: Emphasis on the West.” U.S. Forest Service, 2001.

<http://www.fs.fed.us/publications/policy-analysis/evolution-water-policy.pdf>

**“Water itself isn’t becoming more scarce”:** Fishman, Charles. *The Big Thirst: The Secret Life and Turbulent Future of Water*. New York: Free Press, 2011.

**careless of the water required to grow each boll and leaf:** Water embodied in commodities such as food or electricity is called “virtual water.” For example, one cotton shirt requires 660 gallons of water (2500 liters), according to [www.waterfootprint.org](http://www.waterfootprint.org).

**only a vital few needed to rain down on Earth:** Cowen, Ron. “Liquid acquisition: Two new scenarios ramp up debate over how Earth got its water.” *Science News* 15 (15 January 2011). Note that while water makes up 70 percent of the Earth’s surface, it comprises only 0.02 percent of the Earth’s mass. See a technical paper on the dust-grain theory of

water's arrival here: Leeuw, Nora H. et. al. "Where on Earth has our water come from?"  
*Chem. Commun.* 46 (2010): 8923-8925

**We cannot easily destroy water, but we also can't make any more:** It is possible to create water in a laboratory—all you need is oxygen, hydrogen and a spark, which unfortunately is also the recipe for an explosion. This would be a rather dangerous and inefficient way of making water for human use, and would require lots of energy. There is no easy way to remove water from the water cycle, or even make it too dirty to clean itself over the long run. The closest method of 'destroying' water at the moment is the process of hydraulic fracturing, in which companies will inject contaminated water deep into the bedrock, effectively removing it from the water cycle.

**drought may have prompted:** Steward, Alisha L., et al. "When the river runs dry: human and ecological values of dry riverbeds." *Front Ecol Environ* 10.1(29 March 2012): 202-209.

River Notes: Buenaventura, 1804

**Alexander von Humboldt:** Crampton, Gregory and Gloria Griffen Cline. "The San Buenaventura, Mythical River of the West." *Pacific Historical Review* 25.2 (May 1956): 163-171. Humboldt's map is available online in the University of Tulsa's Special Collections: <http://www.lib.utulsa.edu/speccoll/collections/maps/humboldt/>

**"played a less gracious and more ambitious role":** Francaviglia, Richard V. *Mapping and Imagination in the Great Basin: A Cartographic History*. Reno & Las Vegas: U of Nevada P, 2005. You can find a copy of Pike's 1810 *Map of the Internal Provinces of New Spain* on pages 54-55.

**John Melish took the imaginative leap:** You can find a copy of John Melish's 1816 map on page 58 of Francaviglia's *Mapping and Imagination in the Great Basin*.

**Map of North America:** Tanner's 1822 map is available online at the University of Tulsa's Special Collections:

<http://www.lib.utulsa.edu/speccoll/collections/maps/tanner/tanner1.htm>

## Chapter 1. A River's Heartbeat

**200,000 cubic feet of water:** One cubic foot of water per second equals about 7.5 gallons per second. An Olympic-sized swimming pool holds roughly 660,000 gallons (the depth varies slightly). A flood of 200,000 cfs would be 2.3 Olympic-sized swimming pools every second. It's also the high end of the normal flow rate of the Mississippi River.

**she wrote the South African government:** King, Jackie. "Method to assess flow balances resource protection, development." *Arizona Water Resource* 14.6(July/August 2006).

**convened a workshop:** The development of environmental flows, including the work of the South Africans, is described by Sandra Postel and Brian Richter in *Rivers for Life: Managing Water for People and Nature* (Washington DC: Island Press, 2003). Another excellent source is David M. Gillilan and Thomas C. Brown's *Instream Flow Protection: Seeking a Balance in Western Water Use* (Washington DC: Island Press, 1997).

**avored saltcedar trees:** See descriptions of how the Bill Williams riparian community has changed in: Webb, R.H., S.A. Leake, and R.M. Turner. *Ribbon of Green: Change in Riparian Vegetation in the Southwestern United States*. Tucson: U of Arizona P, 2007. The 2007 survey is quoted in: *Bill Williams and Alamo Reservoir Biological Compilation: Final Report*. Prepared for the U.S. Fish and Wildlife Service by Tetra

Tech, Inc. (In author's possession, provided by Dr. Andrew Hautzinger, U.S. Fish and Wildlife Service).

**William Sherley Williams:** Biographical information about Bill Williams, the fur trapper, can be found in Alpheus Favour's *Old Bill Williams, Mountain Man* (U of Oklahoma P, 1962) and Robert Glass Cleland's *This Reckless Breed of Men: The Trappers and Fur Traders of the Southwest* (New York: Alfred A. Knopf, Inc., 1950).

**The 1860 census:** See population data in: Forstall, Richard L. *Population of States and Counties of the United States: 1790-1990*. Department of Commerce, U.S. Bureau of the Census, Population Division. Washington DC: U.S. Government Printing Office, 1996. For more about why Native Americans were not counted in the census until 1890, see: Jobe, Margaret M. "Native Americans and the U.S. Census: A brief historical survey." *Journal of Government Information* 30.1(2004): 66-80.

**The ore yielded a profit:** See Planet Ranch mining details in: *United States Investor* 16.1(16 February 1905): 161. Also Raymer, Robert G. "Early Copper Mining in Arizona." *Pacific Historical Review* 4.2(1935): 123-130. Raymer writes that Ryland's discovery occurred in 1858, but several other sources put the date at 1863. It may be the discovery date has been confused with the year of the first ore shipment.

**"will very soon be one of the most important":** J. Ross Browne and James W. Taylor. *Reports upon the Mineral Resources of the United States*. Washington DC: Government Printing Office, 1857.

**Apaches menaced mines:** See descriptions of Arizona's early copper industry in: Sheridan, Thomas. *Arizona: A History*. Tucson: U of Arizona P, 1995.

**“All water, whenever it occurs in the water cycle”:** The text of South Africa’s National Water Act is available on the Department of Water Affairs website:

[http://www.dwaf.gov.za/Documents/Legislature/nw\\_act/NWA.pdf](http://www.dwaf.gov.za/Documents/Legislature/nw_act/NWA.pdf)

**seven gallons per person per day:** The U.S. Environmental Protection Agency estimates that the daily direct water use of the average American is 100 gallons (379 liters), compared to 91 gallons (343 liters) for Canada and 40 gallons (150 liters) for the U.K. The South African law calculated 7 gallons (25 liters) to be necessary for basic needs. South Africa is considering increasing the basic needs requirement to 14 gallons (50 liters) per person per day, which is the United Nations’ standard. The United Nations officially recognized water as a basic human right in 2010.

**the only war that involved the dispatching of a military force:** See Marc Reisner’s description of the Arizona Navy incident in *Cadillac Desert: The American West and its Disappearing Water* (New York: Penguin Books, 1986, revised and updated 1993).

**Colorado River Compact:** Numerous articles and books describe the Colorado River Compact and the Law of the River. A good start for a short, readable history: Gelt, Joe. “Sharing Colorado River Water: History, Public Policy and the Colorado River Compact.” *Arroyo* 10.1(August 1997). <https://wrrc.arizona.edu/publications/arroyo-newsletter/sharing-colorado-river-water-history-public-policy-and-colorado-river>. For the actual text of the various policy documents, see: U.S. Bureau of Reclamation. “The Law of the River.” <http://www.usbr.gov/lc/region/g1000/lawofrvr.html>

**one acre-foot:** This is the standard unit of measurement for large quantities of water. It is roughly the amount consumed by a family of four in one year, although that varies widely. Put another way, one acre-foot is the amount of water required to fill that

family's average-sized American home (2,400 square feet floor plan), top to bottom, two stories tall, with two feet left over to slosh around in the attic.

**Once her Model T broke down:** The story about Nellie repairing the Model T comes from:

Wedemeyer, Brian. "Nellie Bush didn't know the words 'I Can't.'" Today's News-Herald 16 July 2000. Other details about the Arizona Navy incident appear in the accompanying article by the same author, "Battle on the Colorado."

**"little of the war-time precision was in evidence":** This quote, and other details about the Arizona Navy incident, come from an untitled article in the *Prescott Evening Courier*, 16 November 1934, page 8.

**Nellie T. Bush:** Deanna Beaver and the Parker Area Historical Society published a small book of captioned pictures called *Parker* (Arcadia Publishing, 2008) which includes photographs of Parker Dam and Nellie Bush.

**gleeful headlines:** Linenberger, Toni Rae. *Parker-Davis Project*. U.S. Bureau of Reclamation, 1997. [www.usbr.gov](http://www.usbr.gov)

**"The changes now required":** King, J. and H. Pienaar, eds. *Sustainable Use of South Africa's Inland Waters: A situation assessment of Resource Directed Measures 12 years after the 1998 National Water Act*. Water Research Commission Report No. TT 491/11. Pretoria: Water Research Commission, 2011. You can obtain an electronic copy from [www.wrc.org.za](http://www.wrc.org.za) by entering report number TT/491, or request a hard copy from [orders@wrc.org.za](mailto:orders@wrc.org.za).

**Herman Stabler of the U.S. Geological Survey:** Smith, G.E.P. "A discussion of certain Colorado River problems." Tucson, Arizona: The University of Arizona College of



Agriculture, Agricultural Experiment Station, Bulletin No. 100(10 February 1925). 143-173.

**the 17 wet years averaged only 16.1 million acre-feet:** Wood, Chris. *Dry Spring: The Coming Water Crisis of North America*. British Columbia, Canada: Raincoast Books, 2008.

**the river has always fluctuated wildly:** U.S. Geological Survey. "Climate Fluctuations, Drought and Flow in the Colorado River Basin, Fact Sheet 2004-3062." August 2004. <http://pubs.usgs.gov/fs/2004/3062>. See also: Woodhouse, C.A., S.T Gray, and D.M. Meko. "Updated streamflow reconstructions for the Upper Colorado River Basin." *Water Resources Research* 42(2006): W05415.

**During its heyday between 1928 and 1956:** Reisner, *Cadillac Desert*.

**they adopted the committee's recommendation:** Shafroth, P.B. and V.B. Beauchamp, eds. "Defining ecosystem flow requirements for the Bill Williams River, Arizona." U.S. Geological Survey Open-File Report 2006-1314. Additional information about the Bill Williams project came from Patrick Shafroth (personal communication, 30 January 2012) and Andrew Hautzinger (personal communication, 6 January 2012).

**to reconsider the workings of eight dams:** More about the Sustainable Rivers Project:

<http://www.iwr.usace.army.mil/Missions/Environment/SustainableRiversProject.aspx>

The Nature Conservancy's approach, called the Savannah process after a river in Georgia, is similar to the Building Block Methodology and DRIFT (Downstream Response to Instream Flow Transformation) developed by Jackie King and colleagues in South Africa. Learn more about the Savannah process:

<http://www.conservationgateway.org/ConservationPractices/Freshwater/EnvironmentalFlows/MethodsandTools/TheSavannahProcess/Pages/savannah-process-0.aspx>

**In a conference room in Tempe:** A summary of the workshop can be found at: Hickey, John and Andy Warner. “Ecosystem flows defined for Bill Williams River.” *The Corps Environment* (October 2005). Available online at:

<http://www.iwr.usace.army.mil/Missions/Environment/SustainableRiversProject.aspx>

You can also obtain a workshop summary, “Ecosystem Flow Workshop. Bill Williams River Corridor,” March 16-18, 2005, from the U.S. Fish and Wildlife Service.

**Ecuador wrote a new constitution . . . New Zealand granted a legal voice:** Postel, Sandra. “A river in New Zealand gets a legal voice.” *Water Currents* 4 September 2012.

<http://newswatch.nationalgeographic.com/2012/09/04/a-river-in-new-zealand-gets-a-legal-voice>

**The new willows that took root on the Bill Williams:** Shaforth, Patrick B., et al. “Ecosystem effects of environmental flows: modeling and experimental floods in a dryland river.”

*Freshwater Biology* 55(2009): 68-85. See also: Levine, C.M. and J.C. Stromberg.

“Effects of flooding on native and exotic plant seedlings: implications for restoring southwestern riparian forests by manipulating water and sediment flows.” *Journal of Arid Environments* 49(2001): 111-131.

**“The neatest thing that the Bill Williams has to offer”:** Andrew Hautzinger, personal communication, 6 January 2013.

**A striking example comes from Glen Canyon Dam:** *USBR Glen Canyon Dam 2012 High Flow Experimental Release*. <http://www.usbr.gov/uc/rm/gcdHFE/2012>. Scientists have used the lessons learned to guide managers in creating a ten-year protocol for experimental releases at Glen Canyon Dam, which began in 2012.

**1980 Groundwater Management Act:** Find a useful overview of water farming and the 1980

Groundwater Management Act in: National Research Council. “Central Arizona: The Endless Search for New Supplies to Water the Desert.” *Water Transfers in the West: Efficiency, Equity, and the Environment*. Washington, DC: The National Academies Press, 1992. [www.nap.edu](http://www.nap.edu).

**The Arizona Republic reported:** Corbett, Peter. “Mining company agrees to acquire Planet Ranch.” *The Arizona Republic* 23 December 2011.

**“the most important tool in the toolbox”:** Andrew Hautzinger, personal communication, 9 July 2014.

**King answered with a question of her own:** See a report of this lecture: Downing, Renee.

“Liquid Principles.” *Tucson Weekly* 17 August 2006. Other quotes in this chapter from Jackie King come from my personal notes.

## Chapter 2. The River I Drink

**I knew that the water rippling through the cement-lined ditch:** Information about the Central Arizona Project is available at the project website, [www.cap-az.com](http://www.cap-az.com). Also see: Sheridan, Thomas E. “The Big Canal: The Political Ecology of the Central Arizona Project.” *Water, Culture and Power: Local Struggles in a Global Context*. Eds. John M. Donahue and Barbara Rose Johnson. Washington DC: Island Press, 1998. 163-186.

**The USBR plunged resolutely into the work of finding new water:** A brief discussion of water importation schemes, including towing icebergs to Los Angeles, appears in: Fradkin, Phillip L. *A River No More: The Colorado River and the West*. New York: Alfred A. Knopf, Inc., 1981.

**Project Skywater:** I thank Kristine Harper for providing information about the USBR's cloud seeding project (personal communication, 29 October 2011). For more information see: Harper, K.C. "Climate control: United States weather modification in the cold war and beyond." *Endeavour* 32.1(2008): 20-26.

**Bridge and Marble dams:** Marc Reisner's *Cadillac Desert: The American West and Its Disappearing Water* (Penguin Books: New York, 1986, revised edition 1993) has an exhaustively researched description of the battle over Bridge and Marble Dams, which I do not discuss in detail here. His book also gives a memorable biographical sketch of Floyd Dominy and describes the work of the University of Arizona economists discussed later in this chapter.

**"Regardless of how desirable it would be":** Smith, G.E.P. "The Colorado River and Arizona's interest in its development." Tucson, Arizona: The University of Arizona College of Agriculture, Agricultural Experiment Station, Bulletin No. 95(February 25, 1922).

**Engineers looked askance:** Zuniga, Jennifer E. "The Central Arizona Project." U.S. Bureau of Reclamation, 2000. [www.usbr.gov](http://www.usbr.gov)

**The Navajo Tribal Council . . . withdrew support:** Dickey, Sonia. "'Don't You Let That Deal Go Down': Navajo Water Rights and the Black Mesa Struggle." *Thinking Like a Watershed: Voices from the West*. Eds. Jack Loeffler and Celestia Loeffler. Albuquerque: U of New Mexico P, 2012. 67-89

**The local political cartoonist:** Gelt, Joe et.al. "Water in the Tucson Area: Seeking Sustainability." Water Resources Research Center, 31 July 1999. 1-55.

<http://wrrc.arizona.edu/publications/water-tucson-area-seeking-sustainability>

**In blind taste tests:** Innes, Stephanie. “CAP blend tops well water in taste test.” *Tucson Citizen* 18 December 1998. The article reports that 79 percent of the testers liked the CAP-groundwater blend. It ranked higher than pure groundwater but below bottled water.

**“In that part of the city things appeared deceptively normal”:** Johnson, Rich. *The Central Arizona Project, 1918-1968*. Tucson: U of Arizona P, 1977.

**To promote the project, the USBR circulated a brochure:** A speech given by Commissioner Gilbert G. Stamm in 1975, correspondence from Rich Johnson to Stamm, and the brochure cited here can be accessed at the Colorado State University library: <http://hdl.handle.net/10217/40964>. Stamm’s short-lived career as Commissioner was forever marred by the catastrophic collapse of Teton Dam in Idaho in 1976. Read more about him in Reisner’s *Cadillac Desert*.

**O’odham claim both ancient people . . . as their ancestors:** A record of an O’odham creation legend, and interviews with O’odham cultural experts about their relationship to the Hohokam, appear in: Ferguson, T.J. and Chip Colwell-Chanthaphonh. *History Is In the Land: Multivocal Tribal Traditions in Arizona’s San Pedro Valley*. Tucson: U of Arizona P, 2006. I have based my assertions in this paragraph largely on the material they present. The fate of the Hohokam and ancestry of the O’odham is a subject of much controversy among scholars. For a summary that conveys some of the confusion and conflicts among differing views, see: Bayman, James M. “The Hohokam of Southwest North America.” *Journal of World History* 15.3(2001): 257-311.

**“I very much resent the statement that I got fired”:** Dominy, Floyd E. Transcript of tape-recorded Bureau of Reclamation Oral History Interviews conducted by Brit Allan Story, Senior Historian, April 6, 1994, and April 8, 1996, at Bellevue Farm in Boyce, Virginia.

Edited by Brit Allan Storey. Repository for the record copy of the interview transcript is the National Archives and Records Administration in College Park, Maryland.

**“We should at least investigate the possibility”:** Martin, W.E and R.A. Young. “The economics of Arizona’s water problems.” *Arizona Review* 16(March 1967): 9-18.

**They gathered their findings in a hefty tome:** Kelso, Maurice M., William E. Martin, and Lawrence E. Mack. *Water Supplies and Economic Growth in an Arid Environment: An Arizona Case Study*. Tucson: U of Arizona P, 1973.

**“The thing got very serious when they said”:** Jimmye Hillman, personal communication, 6 April 2012.

**In 1984 the USBR announced prices for CAP water:** Haneman, W. Michael. “The Central Arizona Project.” Department of Agricultural and Resource Economics, University of California-Berkeley, Working Paper 937. October 2002.

**He established Black Mesa as a reservation:** See the following articles for more information on the relationships between the Navajo, Hopi, Peabody Coal Company and Central Arizona Project: Nies, Judith. “The Black Mesa Syndrome: Indian Lands, Black Gold.” *Orion Magazine* 1998. Whiteley, Peter and Vernon Masayesva. “The Use and Abuse of Aquifers: Can the Hopi Indians Survive Multinational Mining?” *Water, Culture and Power: Local Struggles in a Global Context*. Eds. John M. Donahue and Barbara Rose Johnson. Washington DC: Island Press, 1998. 9-34. Dickey, Sonia. “‘Don’t You Let That Deal Go Down’: Navajo Water Rights and the Black Mesa Struggle.” *Thinking Like a Watershed: Voices from the West*. Eds. Jack Loeffler and Celestia Loeffler. Albuquerque: U of New Mexico P, 2012. 67-89.

**The remainder, roughly 1,860,000 tons of coal annually, powers the CAP:** Eden, Susanna, Christopher A. Scott, Melissa L. Lamberton and Sharon B. Megdal. “Water-energy independencies and the Central Arizona Project.” *The Water-Energy Nexus in the American West*. Eds. Douglas S. Kenney and Robert Wilkinson. UK: Edward Elgar, 2011.

**predicated to reduce the Colorado’s average flow by 3 to 10 percent:** See: Vano, Julie A. et al. “Understanding uncertainties in future Colorado River streamflow.” *Bulletin of the American Meteorological Society*, 2013. Available online at: <http://dx.doi.org/10.1175/BAMS-D-12-00228.1>. For other explanations of climate-driven reductions in Colorado flow, see: *Colorado River Basin Water Supply and Demand Study* (U.S. Bureau of Reclamation, 2012, [www.usbr.gov/lc/region/programs/crbstudy.html](http://www.usbr.gov/lc/region/programs/crbstudy.html)); the federal government’s *National Climate Assessment* (2013, in draft form at the time of writing, <http://ncadac.globalchange.gov>); and *Assessment for Climate Change in the Southwest United States*, a report prepared for the National Climate Assessment by the Southwest Climate Alliance (eds. Gregg Garfin, Angela Jardine, Robert Merideth, Mary Black, and Sarah LeRoy. Washington DC: Island Press, 2013).

**Every acre-foot of tranquil blue water had consumed 3,140 kilowatt-hours:** Hoover, Joseph. *The Arizona water-energy nexus: electricity for water and wastewater service*. Master’s thesis, University of Arizona, 2009. Tucson, Arizona.

**only after decades of litigation and negotiation:** Learn more about the Tohono O’odham and CAP in David McCool’s *Native Waters: Contemporary Indian Water Settlements and the Second Treaty Era*. Tucson: The U of Arizona P, 2005.

River Notes: Buenaventura, 1804.

**It began with a love of fashionable hats:** A succinct summary of the fur trade appears in:

Outwater, Alice. *Water: A Natural History*. New York: Basic Books, 1996.

**General William H. Ashley:** My primary source for Ashley's biographical info: Dale, Harrison

Clifford. *The Ashley-Smith Explorations and the Discovery of a Central Route to the Pacific*. Revised Edition. Glendale, California: The Arthur H. Clark Company, 1941.

**Jedediah Smith:** My primary source for Smith's biographical info: Brooks, George R., ed. *The*

*Southwest Expedition of Jedediah S. Smith: His Personal Account of the Journey to California, 1826-1827*. Glendale, CA: The Arthur H. Clark Company, 1977. See also:

Morgan, Dale L. *Jedediah Smith and the Opening of the West*. Lincoln: The U of

Nebraska P, 1953. Smith, Alison J. *Men Against the Mountains: Jedediah Smith and the*

*South West Expedition of 1826-1829*. New York: John Day Company, 1965. Cleland,

Robert Glass. *This Reckless Breed of Men: The Trappers and Fur Traders of the*

*Southwest*. New York: Alfred A. Knopf, 1950.

**Shetskedee:** A Shoshone word—various spellings.

**“broad and easy way”:** Quoted in Morgan, 1953.

**“they did not exactly ascertain its outlet”:** Quoted in Gloria Griffin Cline's *Exploring the*

*Great Basin* (Reno & Las Vegas: The U of Nevada P, 1988).

**“The whole route lay through a level and open country”:** Quoted in Morgan, 1953.

**“The extermination of the beaver from North America”:** Hannibal, Mary Ellen. *The Spine of*

*the Continent*. Connecticut: Lyons Press, 2012.



**a small dam does barricade the river:** Pomerene Dam, located west of St. David and about a mile north of the Highway 80 bridge over the San Pedro, on private property. A dam has stood on the site since 1927; the first structure was washed out in 1931 and replaced in 1934. Source: Sandy Kunzer, in the Summer 2012 *River Roundup* newsletter of the Friends of the San Pedro River.

**In 1999 the BLM introduced 15 beavers:** Rekshynskyi, Mark. “San Pedro Riparian National Conservation Area—National Landscape Conservation System FY 2009 Annual Manager’s Report.” U.S. Bureau of Land Management, 2009. [www.blm.gov](http://www.blm.gov). The American Bird Conservancy recommended beaver reintroduction with the intent of raising the water table, slowing water velocity and mitigating erosion. See: Price, J., H. Galbraith, M. Dixon, J. Stromberg, T. Root, D. MacMykowski, T. Maddock, K. Baird. “Potential impacts of climate change on the ecological resources and biodiversity in the San Pedro Riparian National Conservation Area, Arizona.” A report to the U.S. Environmental Protection Agency from the American Bird Conservancy, 2005. 1-543. In another article, scientists recommended beaver reintroduction specifically to improve habitat for federally endangered and threatened species, such as the southwestern willow flycatcher, Huachuca water-umbel and Chiricahua leopard frog. See: Steiner, F., J. Blair, L. McSherry, S. Guhathakurta, J. Marruffo, M. Holm. “A watershed at a watershed: the potential for environmentally sensitive area protection in the upper San Pedro Drainage Basin (Mexico and USA).” *Landscape and Urban Planning* 49(2000): 129-148.

**In the last few decades hundreds of unregulated wells:** Robert Glennon’s *Water Follies* (Washington DC: Island Press, 2002) contains a chapter detailing some of the political

controversies surrounding the San Pedro River and groundwater pumping from Sierra Vista and Fort Huachuca.

**The first English speaker to record his arrival:** Pattie, James Ohio. *The Personal Narrative of James O. Pattie of Kentucky*. Ed. Timothy Flint. Cincinnati: E.H. Flint, 1831. You can find a brief discussion of Pattie's *Personal Narrative* in Peter Wild's *The New Desert Reader* (The University of Utah Press, 2006) and a biography of Pattie in Robert Glass Cleland's *This Reckless Breed of Men: The Trappers and Fur Traders of the Southwest* (New York: Alfred A. Knopf, 1950).

**On average, it takes a thousand years:** I am indebted to Juliet Stromberg and Barbara Tellman's excellent book, *Ecology and Conservation of the San Pedro River* (Tucson: U of Arizona P, 2009) for detailed descriptions of the river's hydrology, history, biodiversity and plight. Stromberg also provided information about the San Pedro's natural flow regime (personal communication, 28 September 2011).

**One study calculated that roughly two-thirds:** Cited in Stromberg and Tellman, 2009.

**The 1980 Groundwater Management Act:** For a brief overview of Arizona's approach to groundwater regulation, see: Megdal, Sharon. "Securing Sustainable Water Supplies in Arizona." IDS-Water White Paper. For an overview of the Arizona Groundwater Management Code, see the Arizona Department of Water Resources' Office of Assured and Adequate Water Supply Program:

<http://www.azwater.gov/AzDWR/WaterManagement/AAWS/default.htm>

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*Integrated Training Area Management – Fort Huachuca*. <http://ag.arizona.edu>

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value (the option value of any species is always greater than zero), that does not mean that the protection of all biodiversity is always economically justified. Other utilitarian benefits often ‘compete’ with the benefits of maintaining greater diversity.”

#### Chapter 4. The Thirsty Tree

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**84,000 dams known to exist in the U.S.:** American Society of Civil Engineers. 2013 Report Card for America’s Infrastructure. [www.infrastructurereportcard.org/dams](http://www.infrastructurereportcard.org/dams)

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## Chapter 5. Fossil Creek

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**“up and down pitches that try the best legs”:** Lummis, Charles. *Some Strange Corners of Our Country: The Wonderland of the Southwest*. New York: The Century Co., 1892.

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**“Mrs. Tutt is in personal appearance not the least bit mannish”:** Quoted in “Woman Manager of Big Power Plant, Project in Which the Sum of \$3,000,000 is Invested, Engineered by Her From the Start.” *The New York Times* 14 September 1903.

**“What shall we do with our girls?”** This quote came from an untitled article in *The Electrical Review* 43(1090) dated October 14 1898, on page 569. The column continues: “What a change there would be in the demeanor of some of our provincial town councilors who are now so complaining! What sweet music would reach the ears of the harassed and harassing contractor! But there! we dare not carry the thought farther at present, and someone even whispers that it is not yet necessary. True it is that we cannot give the name of a lady holding such an appointment in this country at the moment, but there is one in America, for Mrs. Iva E. Tutt has put down a \$50,000 installation for lighting the towns of Long Beach and San Pedro, California. . . . A jealous cynic, looking over our shoulder as we write, ventures to interpose: “What! Our girls run our complicated electric lightning plants! Tutt, Tutt!”

**The U.S. government had forcibly removed them:** For more about the Dilzhe’e and the effects of forced relocation, see: Coder, Christopher, Vincent Randall, Elizabeth Smith-Rocha, and Rozella Hines. “CHI CH’IL (Acorns): Dissolution of traditional Dilzhe’e gathering practice(s) due to federal control of the landscape.” *USDA Forest Service Proceedings RMRS-P-36(2005)*: 277-281.

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Adams, J.C. Marks, A.C. Wilcox. “Ecogeomorphic feedbacks in regrowth of travertine step-pool geomorphology after dam decommissioning, Fossil Creek, Arizona.”

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University School of Forestry, May 2007. For more on increased visitors to Fossil Creek,

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*Environmental Ethics and Forestry: A Reader*. Ed. Peter C. List. Philadelphia: Temple UP, 2000. 36-40.

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**“almost entirely upon the discarded crutches”:** This quote on the climate of Nogales is from page 726 of the Aldo Leopold files, *County, State and Foreign Files: States, Texas-Wyoming; Foreign*, accessed online at:  
<http://uwdc.library.wisc.edu/collections/AldoLeopold>.

### Chapter 7. Shallow Roots

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#### Chapter 9. The Ghost Dam

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#### Chapter 10. An Accidental Beauty

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**The Mexican Water Treaty of 1944:** Find the full text of the Mexican Water Treaty of 1944 on the International Boundary and Water Commission website,  
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**“When we got down there, it had filled in”:** Edward Glenn, personal communication, 2 May 2014.

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**It's true that heavy winter rains sent water into Mexico in 1997, 1998 and 1999:** Streamflow data for the Northern International Boundary above Morelos Dam provided by the USGS ([waterdata.usgs.gov](http://waterdata.usgs.gov)). In the dry years while Lake Powell filled behind Glen Canyon Dam (1963 to 1980) an average flow of 2,500 cfs reached the USGS gauge at Morelos Dam. In the two decades following the Gila River flood (1994 to 2012), just under that amount reached Morelos Dam: 2,455 cfs. The years 1997, 1998 and 1999 qualify as wet, but every other year falls significantly below the 50-year average for that stream gauge (2,684 cfs). Thanks to Cheryl Partin and Karen Peterson at the USGS for assistance in accessing the data.

**The Ciénega now covered 44,000 acres with mudflats:** The Ciénega is described in a special issue of *Ecological Engineering* on “Wetlands of the Colorado River Delta.” See, for example, Carrillo-Guererro, Ymilet K., Karl Flessa, Osvel Hinojosa-Huerta, Laura Lopez-Hoffman. “From accident to management: The Ciénega de Santa Clara ecosystem.” *Ecological Engineering* 59( October 2013). 84-92. Thanks to Ed Glenn for providing these articles while they were in press.

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[az.com/documents/planning/Shortage\\_Issue\\_Brief.pdf](http://www.cap-az.com/documents/planning/Shortage_Issue_Brief.pdf). Also Matt Jenkin’s article

“Arizona returns to the desert,” *High County News*, March 21, 2005. The article explains that even if shortages cut CAP down to two-thirds capacity, cities might lease water from Indian tribes or recover banked water before feeling the effects of shortage.

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Interviewed by Pam Stevenson, July 9 2007. Available online at: <http://www.cap-az.com/index.php/oral-histories>

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**Brock Storage Reservoir on the All-American Canal:** Learn more about the Warren H. Brock Storage Reservoir (formerly called Drop 2) at the USBR website:

[http://www.usbr.gov/lc/yuma/facilities/Brock/yao\\_brock.html](http://www.usbr.gov/lc/yuma/facilities/Brock/yao_brock.html)

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**Saudi Arabia . . . recently announced its intention to convert of all its desal facilities:**

Richter, Brian. *Chasing Water: A Guide for Moving from Scarcity to Sustainability*. Washington DC: Island Press, 2014.

**“enables a ‘business-as-usual’ water culture”:** Wilder, M., C. Scott, R. Varady, N. Pineda, G.

Gargin, and J. McEvoy. “Adapting across boundaries: Knowledge, social learning and resilience in the U.S-Mexico border region.” *Annals of the Association of American Geographers*, 100.4(2010): 1-12.

**Perth is the exception that proves the rule:** Perth’s move to desalination is described in

Cynthia Barnett’s *Blue Revolution: Unmaking America’s Water Crisis*. Boston: Beacon Press, 2011.

River Notes, Buenaventura: 1845

**an appendix to *The Expeditions of John Charles Fremont*:** Jackson, Donald, ed. *The*

*Expeditions of John Charles Fremont – Map Portfolio*. Urbana: The U of Illinois P, 1970.

**Powell sent Almon Harris Thompson to the mouth of the Dirty Devil River:** Stegner,

Wallace. *Beyond the Hundredth Meridian: John Wesley Powell and the Second Opening of the West*. Boston: Houghton Mifflin, 1954.

**“that area of land, a bounded hydrologic system”:** Quoted on the U.S. Environmental

Protection Agency’s website “What is a watershed?”

<http://water.epa.gov/type/watersheds/whatis.cfm>

## Chapter 11. The Rights of Rivers

**Aldo Leopold was . . . nearing the end of the formative 15 years:** Aldo Leopold described his trip to the Delta in *A Sand County Almanac and Sketches Here and There* (Oxford UP, 1949). More details appear in Curt Meine's comprehensive biography, *Aldo Leopold: His Life and Works* (U of Wisconsin P, 2010).

**“wealth to the human spirit”:** This quote comes from a poignant essay called “The River of the Mother of God” that Leopold penned around 1924. Inexplicitly, *Yale Review* rejected the beautiful little story. It now appears in a book of Leopold's collected works, *The River of the Mother of God and Other Essays* (eds. Susan L. Flader and J. Baird Callicott, U of Wisconsin P, 1991).

**“To return not only spoils a trip”:** This quote, and other Aldo Leopold quotes in this section, come from *A Sand County Almanac*.

**the incoming tide funneling into the river's mouth:** Frank Waters described the tidal bore on November 18, 1922 that capsized the steamship *Topolobamp* around midnight when it was anchored in the mouth of the Colorado. Only 36 of the 125 passengers survived. See *The Colorado* (New York: Rinehart & Company, Inc., 1946.)

**No jaguars now. They may have vanished from this region:** Jessica Moreno, personal communication, 28 July 2014. Jaguars once roamed as far north as the Grand Canyon, and their history in the region deserves a book of its own (see *Borderland Jaguars* by David Brown and Carlos Lopez Gonzalez). James Ohio Pattie was the first Anglo-American to report seeing (and killing) a jaguar in the Delta, in the winter of 1827-1828. To my knowledge scientists are not tracking the movements of jaguars in the Delta today,

so it's unknown if any still live there; however, at least one jaguar has been known to be present in the Arizona/Sonora borderlands over the last 18 years, and as many as eight have been photographed during this time, according to Sky Island Alliance.

**Where steamboats full of passengers:** Leavitt, Francis Hale. "Steam navigation on the Colorado River (concluded)." *California Historical Society Quarterly* 22.2(June 1943): 151-174.

**abandoned rowboats list to their sides:** For a brief look at the modern Colorado River Delta, see: Waterman, Jonathan. "Where the Colorado Runs Dry." *New York Times* 14 February 2012. <http://www.nytimes.com/2012/02/15/opinion/where-the-colorado-river-runs-dry.html>

**The USBR released a report in response to the oft-quoted prediction:** *Colorado River Basin Water Supply and Demand Study*. U.S. Bureau of Reclamation, 2012. <http://www.usbr.gov/lc/region/programs/crbstudy/finalreport/index.html>

**Imagine every household, farm and industry in Arizona:** U.S. Geological Survey data shows that Arizona's freshwater withdrawals are around seven million acre-feet annually (2005 data). More recent data from the Water Resources Research Center puts the number closer to eight million acre-feet annually (2008 data). Arizona's population was close to six million in 2005, and close to 6.5 million in 2013. I described the effect of the predicted deficit using Arizona merely as an illustration. Although Arizona is likely to bear the brunt of shortage because of arrangements in the Colorado River Compact, in reality, such a deficit will probably be diffused throughout the seven states and Mexico.

**Christopher Stone, in his classic essay:** Stone, Christopher D. *Should Trees Have Standing? Toward Legal Rights for Natural Objects*. 1972. 2<sup>nd</sup> ed. California: Tioga Publishing

Company, 1988. The quote about rocks comes from the third edition, *Should Trees Have Standing? Law, Morality, and the Environment* (Oxford UP, 2010).

**Walt Disney Productions wanted to build a ski resort:** For a history of Mineral King Valley, see Chapter 9 in: Dilsayer, Lary M. and William C. Tweed. *Challenge of the big trees: a resource history of Sequoia and Kings Canyon national parks*. California: Sequoia Natural History Association, Inc., 1990.

[http://www.nps.gov/history/history/online\\_books/dilsaver-tweed/](http://www.nps.gov/history/history/online_books/dilsaver-tweed/). Also: Turner, Tom.

“The saga of Mineral King.” *High County News* 2 February 2009.

<http://www.hcn.org/wotr/the-saga-of-mineral-king>

**“a true academic”:** Christopher Stone, personal communication, 14 March 2013.

**“provide for the equitable division of water”:** Find the text of Colorado River Compact at the U.S. Bureau of Reclamation’s website:

<http://www.usbr.gov/lc/region/g1000/lawofrvr.html>

**climate change models have been underestimating:** Ault, Toby R., Julia E. Cole, Jonathan T. Overpeck, Gregory T. Pederson, and David M. Meko. “Assessing the Risk of Persistent Drought Using Climate Model Simulations and Paleoclimate Data.” *J. Climate* 27(2014): 7529–7549. Available online at: <http://dx.doi.org/10.1175/JCLI-D-12-00282.1>. Also: Cook, Benjamin, Toby R. Adult, and Jason E. Smerdon. “Unprecedented 21<sup>st</sup> century drought risk in the American Southwest and Central Plains.” *Science Advances* 1.1(12 February 2015).

**“some deeper feeling” . . . He called it a reverence for rivers:** Quotes are from two seminal speeches made by Luna Leopold, *A Reverence for Rivers* (1977) and *Ethos, Equity and the Water Resource* (1990). Online access: <http://waterethics.org/resources/>



**Dryland ecosystems cover 41 percent of the planet's surface:** Millennium Ecosystem

Assessment, 2005. Online access: <http://www.unep.org/maweb>

**“There is balance or harmony in natural systems”:** Leopold, 1977.

**Every household in Tucson and Phoenix could install:** The costs of rainwater harvesting vary

widely, from free to very expensive. \$2,000 is the amount that the City of Tucson currently offers as a rebate; simply sticking a barrel under a drainpipe costs quite a bit less, but designing a cistern system to use for drinking water requires quite a bit more.

The 2010 U.S. Census showed 230,000 households in Tucson and 590,000 households in Phoenix (averaging 2 to 3 people per household). The federal government spent \$3.6 billion constructing CAP. Arizona must repay \$1.65 billion of that over a 50-year period.

**A megawatt-hour generated by coal:** Lambertson, Melissa, David Newman, Susanna Eden and

Joe Gelt. “The Water-Energy Nexus.” *Arroyo*. Tucson: The Water Resources Research Center, 2010. A table on page 7 compares the water consumption of concentrated solar power, nuclear, coal, natural gas and photovoltaic solar power.

**A 2014 study by the Pacific Institute found that conservation:** “The Untapped Potential of

California’s Water Supply: Efficiency, Reuse, and Stormwater.” Pacific Institute and Natural Resources Defense Council, June 2014. Available online at:

<http://pacinst.org/publication/ca-water-supply-solutions/>. For an example of a critique: Boyd, Vicky. “Talk of enhanced ag water conservation is all wet.” *The Packer*, July 11, 2014. <http://www.thepacker.com/opinion/Talk-of-enhanced-ag-water-conservation-is-all-wet-266757351.html> (Note this was published in a news source for the produce industry).

Thanks to Aaron Citron, Environmental Defense Fund, for pointing out critiques. The

numbers from the U.S. Bureau of Reclamation were added up from the executive report of the *Colorado River Basin Water Supply and Demand Study*, 2012.

**The biggest savings come from urban-rural partnerships:** Richter, Brian D, et al. “Tapped out: how can cities secure their water future?” *Water Policy* 15(2013): 335-363.

**The average American can buy a thousand gallons:** Walton, Brett. “The Price of Water: A Comparison of U.S. Water Rates.” *Circle of Blue* 26 April 2010.

<http://www.circleofblue.org/waternews/2010/world/the-price-of-water-a-comparison-of-water-rates-usage-in-30-u-s-cities>. The cost of 1,000 gallons averages around \$1.50.

**In 1976 city council members proposed to raise rates:** Gelt, Joe et al. “Water in the Tucson Area: Seeking Sustainability.” Water Resources Research Center, 31 July 1999. 1-55.

<http://wrrc.arizona.edu/publications/water-tucson-area-seeking-sustainability>

**The Oregon Water Trust:** Robert Glennon’s *Unquenchable: America’s Water Crisis and What to do about it* (Washington: Island Press, 2009).

**“the last oasis”:** Postel, Sandra. *Last Oasis: Facing Water Scarcity*. New York: W.W. Norton & Company, 1997, 1992.

**“For the plaintiffs, the most serious possible injury”:** *Winters v. National Resources Defense Council*, November 2008. Chief Justice Roberts delivered the opinion of the court.

Online access: <http://www.supremecourt.gov/opinions/08pdf/07-1239.pdf>

**More sophisticated Navy analyses have increased:** “Marine Mammals and the Navy’s 5-Year Plan.” *New York Times* 11 October 2012. The Marine Mammals Protection Act of 1972, which preceded the Endangered Species Act, lists blue whales rather disturbingly as “depleted.”

**Research shows that contact with nature enhances creativity and intelligence:** Louv,

Richard. *The Nature Principle: Human Restoration and the End of Nature-Deficit*

*Disorder*. North Carolina: Algonquin Books of Chapel Hill, 2011.

**“the threads that bind life to life”:** Carson, Rachel. *Silent Spring*. Greenwich, Conn.: Fawcett

Publications, Inc., 1962.

**“We must save not only the wilderness but the vacant lots”:** Pyle, Robert Michael. *The*

*Thunder Tree: Lessons from an Urban Wildland*. Boston: Houghton Mifflin Company,

1993.

**“make the dictionary hum like a beehive”:** Berry, Wendell. “It All Turns on Affection.” 2012

Jefferson Lecture. Full text available at: [http://www.neh.gov/about/awards/jefferson-](http://www.neh.gov/about/awards/jefferson-lecture/wendell-e-berry-lecture)

[lecture/wendell-e-berry-lecture](http://www.neh.gov/about/awards/jefferson-lecture/wendell-e-berry-lecture)

Epilogue. Split Mountain Canyon

**It cut down through a bed of Tertiary sediments:** Hansen, Wallace R. *The Geologic Story of*

*the Uinta Mountains*. 2<sup>nd</sup> ed. USA: Globe Pequot Press, 2005.

**The Green River had not always borne this name:** For the information in this section, I relied

on *A Green River Reader* edited by Alan Blackstock (Salt Lake City: The U of Utah P,

2005), in particular, the essay by Wallace Stegner called “The Marks of Human Passage.”

Information also came from journals and reports of exploring expeditions (Dominguez-

Escalante, Fremont and Powell) noted elsewhere in this book.

**To a party of forty-niners who passed this way:** See William Lewis Manly’s account of this

expedition, *Death Valley in '49*. The relevant excerpt appears in *A Green River Reader*.

**Ellen Meloy described the geology here ... while Edward Abbey:** The quotes come from

Ellen Meloy's *Raven's Exile* (Tucson: The U of Arizona P, 1994) and Edward Abbey's

*Desert Solitaire* (New York: Ballantine Books, 1968).

**A hydroelectric dam was once planned:** See "Shall We Let Them Ruin Our National Parks?"

by Bernard De Voto and "The Battle for Echo Park" by Russell Martin in *The Green*

*River Reader*.