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Reconciling the Colorado River Delta

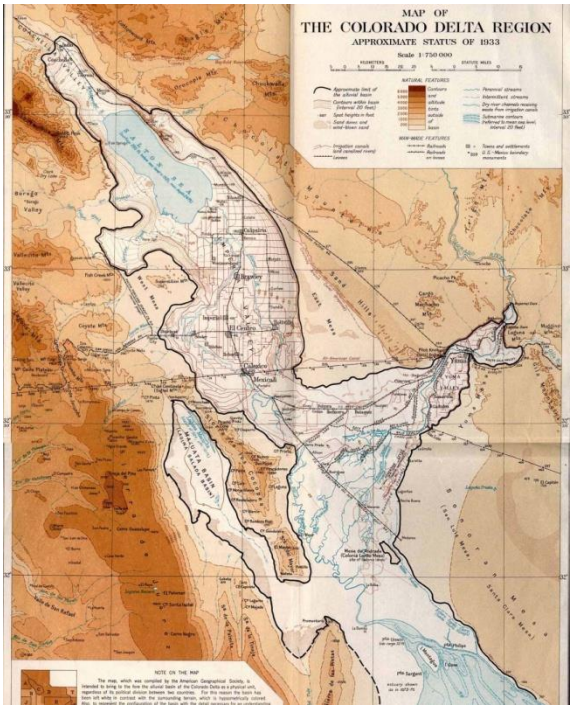
Abstract

The Colorado River Delta ("Delta") has experienced dramatic change over the past century. What was once a vast expanse of wetlands is now largely a desiccated landscape, with only 10% of the original wetlands remaining. Virtually every drop of water in the Colorado River is used before it reaches the Delta, and in all but the wettest years, the river no longer reaches the sea. The dewatering of the Delta has had dramatic impacts on the wildlife and the native people who depend on the Delta ecosystems. In recent years, restoration efforts have begun to reverse some of this degradation. The primary objective of most restoration efforts is to secure more water for Delta ecosystems—without water, successfully restoring sustainable populations of native plants and wildlife is unlikely or impossible. Some small, but major steps have been taken by the federal governments of Mexico and the United States and environmental groups to begin to return water to the Delta and to re-establish some of its native habitats. The increasing spirit of cooperation among government entities and the growing acknowledgement of the importance of the Delta's ecosystems is a trend that shows promise for improving conditions in the Delta, especially in the face of climate uncertainty.

Goals of the paper

The main question addressed in this paper is, "How are the ecological needs of the Delta being reconciled with the tremendous water demand upstream in the Colorado River Basin?" First, to understand the purpose of current restoration efforts, a brief history is given on what the Delta used to be like, followed by a summary of how and why the Delta has become what it is today. This is followed by an overview and some case studies of current restoration attempts, and finally by future outlooks, particularly in light of a changing climate.

Literature synthesis



Historical extent of the Delta, as mapped in 1933 by the American Geographical Society. Image: http://www.sci.sdsu.edu/salton/ImageryandCartography.html

Historical conditions

The Colorado River Delta was once an extensive system of riparian forest and freshwater, tidal, and brackish marsh that spanned 1,930,000 acres in northwestern Mexico (Luecke et al. 1999). The Delta was formed as the Colorado River fanned out into numerous braided channels as it neared its mouth in the Gulf of California, carrying with it a tremendous amount of water and sediment. It is estimated that from 1896-1921, average annual flow to the Colorado River Delta was approximately 16.7 million acre-feet (maf) (Adler 2007).

A vast oasis surrounded by desert, the Delta supported a rich diversity of life, including over 200 vascular plant species, hundreds of species of migratory birds and waterfowl, and numerous fish, invertebrates, and terrestrial and

estuarine mammals (Glenn et al. 1996, Luecke et al. 1999). These abundant resources were used by indigenous people, the Kwapa ("the people of the river"), for at least 1000 years. The Kwapa hunted and fished, cultivated the floodplains for crops such as beans, corn, and squash, and harvested wild grains. In the early 17th century, the Kwapa population was estimated to be around 5000-6000 (Sonoran Institute 2009).

Current Status

Water diversions from the Colorado River and its tributaries began in the Colorado Basin in the late 19th century. Throughout the 1900s, construction of more and more dams and diversions incrementally decreased the amount of water in the Colorado River (Adler 2007). Ultimately, every drop of water in the Colorado River was formally claimed for human use through the signing of two major treaties. The Colorado River Compact, signed by the seven Colorado Basin states in 1922, allocated 7.5 maf (~45% of average annual base flow) each to the upper and lower basin (CRC 1922). Then in 1944, the United States and Mexico signed a treaty which stipulates that 1.5 maf of Colorado River water will be provided to Mexico annually, representing approximately the remaining 10% of base flows in the lower Colorado River (U.S-Mexico Treaty 1944). In most years, all of Mexico's allocated water is diverted for use by the Mexicali and San Luis irrigation districts, leaving no water for Delta ecosystems. In all but the wettest years, the river no longer reaches its mouth in the Gulf of California (Glenn et al. 1996).

Google Earth map of the Delta region in 2013. The area nearest the Gulf of California is now covered mostly by mudflat, salt flat, or exposed sandbar.

The Delta is now not only starved for water, but starved for sediment. River water used to transport an estimated 160 million tons of sediment downstream annually, much of which would ultimately be deposited throughout the Delta (Glenn et al. 2001). Now, much of that sediment is trapped behind the many dams on the Colorado River and its tributaries. Historically, the Delta was shaped by the opposing forces of erosion from tidal currents and sediment deposition from the river. Taking away the latter has left erosion as the dominant hydrodynamic force shaping the development and evolution of the Delta. Studies have shown that the amount of sediment entering the Gulf of California has not changed since the river was actively flowing into the Delta, suggesting that the Delta is undergoing rapid erosion (Carriquiry and Sanchez 1999).

The lack of freshwater flow to the Delta has had profound impacts on the estuarine and marine systems as well. The increased salinity near the mouth of the Colorado River has changed the circulation patterns in the Gulf of California, and has been implicated in the decline of many aquatic species, such as the Colorado delta clam, the totoaba fish, and the vaquita porpoise. The decreased nutrient influx has reduced productivity in the estuary, which has cascaded to populations of shrimp and other organisms in the food web (Glenn et al. 2001).

Today, more than one million hectares of land surrounding the Delta have been converted to agriculture, and the Delta itself has been reduced to approximately 150,000 acres of land, only

about 10% of its former area (Luecke et al. 1999). Much of the remaining land is now barren mudflat, exposed sandbar, or salt flat, and the plant community is comprised mostly of drought-tolerant arrowweed, iodinebush, and invasive tamarisk (Briggs and Cornelius 1998). The wetlands that do persist are small and isolated, and receive water mainly from agricultural return flows, municipal effluent, tidal influx, and occasional releases of flood waters (Glenn et al. 1996). The largest remaining wetlands are (1) the Rio Hardy wetlands, fed by the Rio Hardy River; (2) the Ciénega de Santa Clara, fed mainly through the Wellton-Mohawk Canal by agricultural drainage from Arizona; (3) the El Doctor and El Indio wetlands, immediately adjacent to the Ciénega wetlands, which get their water from springs; and (4) riparian habitats along the mainstem of the river (Briggs and Cornelius 1998, Luecke et al. 1999).

The Kwapa, pushed off their lands by Mexican settlers and unable to sustain their traditional way of life in a desiccated landscape, now number around 1500. The Kwapa currently make a living mostly through finding seasonal work in agricultural fields or in tourist camps, selling crafts, and through a casino in Somerton (Sonoran Institute 2009).

Despite their greatly reduced extent and poor water quality, the existing wetlands in the Delta are important habitat for many organisms, especially birds that migrate along the Pacific Flyway (Hinojosa-Huerta et al. 2013). Over 380 species of birds use Delta wetlands, including the endangered Yuma clapper rail. Though greatly diminished, the fisheries in the estuary still provide an important source of income for many local people (Gerlak et al. 2013). Environmental groups are looking to build on this existing productivity and diversity in the remaining Delta ecosystems by increasing the amount of water reaching the Delta and restoring wetland and riparian habitats.

Reconciliation Efforts

The Colorado River is a human-dominated system: Colorado River water is used by 30 million people in the United States and Mexico, irrigates over 3.7 million hectares of farmland, and generates 11.5 billion kilowatt-hours of energy every year (Gerlak et al. 2013). While there is no hope of ever turning the Delta back into the ecosystem it once was, the ecological and cultural harm caused by years of dewatering the Delta is starting to be addressed by environmental groups, and increasingly, the United States and Mexican governments. Below are summaries of some of the most significant actions that have been taken recently to begin to reconcile the ecosystems of the Delta with the extraordinary demand of water users upstream.

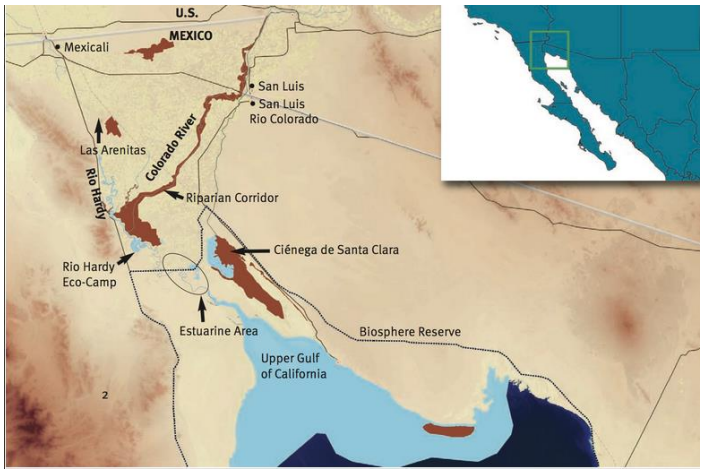
Las Arenitas Wetlands

Sewage from the city of Mexicali used to flow north through the New River into the Salton Sea, often creating a public health hazard. The Las Arenitas Wastewater Treatment plant began operation in 2007 with the intention of treating this water and then releasing it south into the Río Hardy, a tributary of the Colorado; however, the plant failed to meet water quality

Las Arenitas wastewater treatment wetlands. Photo: The Sonoran Institute

standards. Seeing this as an opportunity, the conservation groups Pronatura Noroeste and the Sonoran Institute approached the public services commission to create treatment wetlands to further improve water quality and provide habitat for wetland species. In 2009, a 100 hectare wetland was created, which now supports abundant resident and migratory bird populations. Inflow from the wetland has nearly doubled the flow of the Río Hardy, which has enhanced riparian habitat and recreation in the area. The treatment plant is set to double in capacity in the coming years, and plans are to create another 100 hectare wetland to accommodate this increase (Postel 2009, Sonoran Institute 2013a)

Colorado River Riparian Corridor



Map of major restoration sites in the Colorado River Delta. Image: The Sonoran Institute

Environmental groups, headed by the Sonoran Institute and Pronatura Noroeste, are targeting a 70 mile-long stretch of the Colorado River in Mexico for restoration of native riparian vegetation (Sonoran Institute 2012). In 2008, the Mexican government dedicated three sections of land along the Colorado mainstem (totaling 1,200 acres) for restoration (Gerlak et al. 2013). Active restoration on this land, deemed the Laguna Grande Restoration Area, has begun, with a goal of eventually establishing a Colorado River Delta Nature Preserve. In 2011-2012, 40 acres were planted with cuttings of willows and cottonwoods raised in the Sonoran Institute's native plant nursery, and the Institute has a goal of restoring an additional 50 acres of habitat every year. The Institute also piloted a 5-acre hydroseeding project in the riparian corridor, where a mixture of seeds, mulch, and water were sprayed onto prepared soil. They consider the project a great success, and plan to expand the use of hydroseeding in additional areas. To date, over 50,000 trees, including cottonwoods, willows, and mesquite, have been planted on 150 acres of land, and more is ongoing (Sonoran Institute 2012).

Change the Course Campaign

Recently, National Geographic, the Bonneville Environmental Foundation, and Participant Media teamed up to create a program called "Change the Course." The Change the Course campaign asks individuals to sign a pledge to use less water, and in return for each pledge made, the campaign claims they will restore 1,000 gallons of water to the Colorado Basin (Howard 2013). The program uses money from corporate sponsors to secure more water for the environment through various projects implemented by conservation organizations, such as upgrading irrigation infrastructure and buying or leasing water rights from current water users (Change the Course 2014). In addition, Change the Course is using social media, infographics, and short films to educate individuals on issues surrounding the Colorado River and how they can conserve water. According to changethecourse.us, the project's website, the campaign was halfway to their goal of 80,000 pledges (80 million gallons of water) as of February 2014.

Minute 319

A milestone was reached with regards to returning water to the Delta in November 2012. For the first time ever, water was allocated specifically for Delta ecosystems in Minute 319, a formal amendment to the 1944 treaty between Mexico and the United States. The amendment establishes a five-year pilot program (2013-2017) initiated by the International Boundary and Water Commission that will "arrange for the means to create 158,088 acre-feet of water for base flow and pulse flow" for the Colorado River and Delta. Two thirds of this total amount is allotted for a pulse flow that will occur in one of the five years, while the remaining third will be used for base flows over the other four (IBWC 2012). The environmental impacts of increased flows are to be monitored for efficacy, to inform future decisions on water allocations to the Delta. As of January 2014, the date for release of water for the pulse flow had not been determined (Postel 2013).

As an additional provision to Minute 319, the United States is dedicating $21 million to water infrastructure improvement and environmental enhancement of riparian areas and the delta, including a 50-acre restoration of native willows, cottonwoods, and mesquites along the Colorado mainstem (IBWC 2012).

The United States government, Mexican government, and environmental groups are each responsible for providing one third of the total amount of water allocated in Minute 319. For their part, the environmental groups are purchasing water rights through the Colorado River Delta Water Trust, which was established in 2008 by three NGOs—the Sonoran Institute, Pronatura Noroeste, and the Environmental Defense Fund—to secure water for Delta ecosystems in perpetuity (Sonoran Institute 2013b).

Summary of restoration efforts

Restoration efforts in the Delta are numerous and varied in approach, and incorporate a large number of government and non-government entities at many levels of organization. The Sonoran Institute seems to be the leader of on-the-ground efforts, and according to their website (www.sonoraninstitute.org) one of their main goals is to "renew individual and community relationships with the Delta and promote long-term stewardship" by engaging members of the local community, including members of the Cocopah tribe. In addition to benefiting wildlife, the Sonoran Institute intends for restoration efforts to increase recreational and economic opportunities of the local people. They hope that seeing these positive effects will feed back into increased support for more restoration projects.

In terms of effectiveness, research and expert opinion suggest that the most successful restoration projects are those that address the underlying source of degradation—in most cases, lack of water—and that planting vegetation alone is unlikely to achieve sustainable results (Briggs and Cornelius 1998, Gerlak et al. 2013). Recent actions by major environmental groups and initiatives suggest an understanding of this philosophy, and appear to be having a positive effect. However, the long-term success of these projects is dependent on the availability of water in the future.

Conclusions and Future Outlooks

The amount of water that will be available to the Delta in the future is uncertain. Although predictions of climate models vary, on average, increased warming and greater drought frequency and duration is projected across the Colorado River Basin. Additionally, demand for water from the Colorado River is expected to increase, mostly due to population growth. The

decreased supply and increased demand is predicted to lead to an imbalance of around 3.2 maf by 2060 (USBR 2012). Though water has now been allocated to the Delta through Minute 319, it is unclear whether this water will be secure in the future; Minute 319 is only in effect until December 31, 2017. Future negotiations within and between the two nations and American Indian tribes to resolve water supply and demand issues may lead to a reduction in water apportioned for the Delta.

However, the current trend seems promising for the Delta. In Minute 319, the International Boundary and Water Commission states a desire for the governments of Mexico and the United States to work in "cooperation to proactively manage the Colorado River in light of the historical and potential future increased variability due to climate change," (IBWC 2012) and collaboration between the federal governments and environmental groups has been increasing (Gerlak et al. 2013). Provisions of Minute 319 give the countries much-needed flexibility with managing water flows under uncertain conditions: The Minute allows Mexico to store some of its water apportionment in Lake Mead. In addition, Mexico can receive more water when Lake Mead water levels are high, but agrees to receive less water when water levels are low (IBWC 2012). By taking cooperative actions to minimize the impact of potential droughts, there is a greater chance that water will remain available for the Delta. Perhaps more importantly though, for the first time ever, policy changes have been made at the federal level that recognize the importance of the Delta as an ecological system.

The Delta has shown its resilience when, in the 1980s and 90s, several episodes of El Niño flooding caused water to be released into the Delta, resulting in natural regeneration and recruitment of native riparian and wetland vegetation. Based on these "accidental" floods, researchers have concluded that flood flows every 3-4 years may be enough to sustain vegetation (Luecke et al. 1999, Glenn et al. 2001). Though releases due to flooding may become less likely with climate change and increasing water demand, formal allocations of water may be enough to make up for reduced flooding.

In addition to actions by the Mexican and American federal governments, there are increasing efforts to ensure water for the Delta and to restore some of its ecosystems by environmental groups like the Sonoran Institute and initiatives like Change the Course. In this way, humans are a force of global change, transforming the Delta's ecosystems from barren salt and mud flats to functioning riparian and wetland ecosystems. If the current trends in restoration efforts continue, the Delta will become an increasingly reconciled ecosystem for both humans and nature.

Literature Cited

Adler, R. W. 2007. Restoring Colorado River Ecosystems: A Troubled Sense of Immensity. Island Press, Washington, D.C.

Briggs, M. K., and S. Cornelius. 1998. Opportunities for ecological improvement along the lower Colorado River and delta. Wetlands:513–529.

Carriquiry, J. D., and A. Sanchez. 1999. Sedimentation in the Colorado River delta and Upper Gulf of California after nearly a century of discharge loss. Marine Geology 158:125–145.

Change the Course. (n.d.). Frequently asked questions about the Change the Course campaign. http://newswatch.nationalgeographic.com/2013/02/13/change-the-course-help-save-the-colorado-river/.

Colorado River Compact. 1922. United States of America.

Gerlak, A. K., F. Zamora-Arroyo, and H. P. Kahler. 2013. A Delta in Repair: Restoration, Binational Cooperation, and the Future of the Colorado River Delta. Environment: Science and Policy for Sustainable Development 55:29–40.

Glenn, E. P., C. Lee, R. Felger, and S. Zengel. 1996. Effects of water Management on the Wetlands of the Colorado River Delta, Mexico. Conservation Biology 10:1175–1186.

Glenn, E. P., F. Zamora-Arroyo, P. L. Nagler, M. Briggs, W. Shaw, and K. Flessa. 2001. Ecology and conservation biology of the Colorado River Delta, Mexico. Journal of Arid Environments 49:5–15.

Hinojosa-Huerta, O., R. Guzmán-Olachea, J. Butrón-Méndez, J. J. Butrón-Rodríguez, and A. Calvo-Fonseca. 2013. Status of marsh birds in the wetlands of the Colorado River delta, México. Ecological Engineering 59:7–17.

Howard, B. C. 2013. Change the Course: Help Save the Colorado River. Water Currents.

Luecke, D. F., J. Pitt, C. Congdon, E. Glenn, C. Valdes-Casillas, and M. Briggs. 1999. A delta once more: restoring riparian and wetland habitat in the colorado river delta.

Postel, S. 2009, May. Once a Smelly Nuisance, Mexicali's Wastewater Now Brings Life to the Colorado Delta. Water Currents.

Postel, S. 2013, December. Scientists Plan for Grand Experiment in the Colorado River Delta. Water Currents.

Sonoran Institute. 2009. Colorado River Delta- Land of the Kwapa. http://www.sonoraninstitute.org/component/docman/doc_details/1299-colorado-river-delta-land-of-the-kwapa-english-08062009.html?Itemid=3

Sonoran Institute. 2012. Laguna Grande Restoration Area. http://www.sonoraninstitute.org/component/docman/doc_details/1550-colorado-river-delta-program-restoration-project-laguna-grande-09152013.html?Itemid=3

Sonoran Institute. 2013a. Las Arenitas Treatment Wetland. http://www.sonoraninstitute.org/component/docman/doc_details/1549-colorado-river-delta-program-restoration-project-las-arenitas-09152013.html?Itemid=3

Sonoran Institute. 2013b. Landmark Binational Agreement: Minute 319. http://www.sonoraninstitute.org/component/docman/doc_details/1552-minute-319-factsheet-09152013.html?Itemid=3

United States Bureau of Reclamation. 2012. Colorado River Basin Water Supply and Demand Study. http://www.usbr.gov/lc/region/programs/crbstudy/finalreport/studyrpt.html