EARTH ECONOMICS

The Value of the Sonoma Baylands

Introduction

About 150 years ago, some 300,000 immigrants flocked to California with the dream of striking it rich. With the rapid population growth of the Gold Rush era came the degradation of thousands of acres of healthy and productive marsh lands supporting the ecological health of San Francisco Bay. Californians diked, drained and filled the marshes and connected channels, reducing the size of the Pacific's largest estuary by about a third to support urbanization, agriculture and salt ponds.[1] Of the 200,000 acres of tidal marsh and wetlands that once existed, only 44,000 acres remain today, most of which have been created or altered by people.[2]

At the southern end of Sonoma County are the Sonoma Baylands, the lands around San Pablo Bay that are now or were historically submerged by the estuary's tides. While less urbanized than many other parts of the San Francisco Bay, ecosystems in the Baylands have been heavily impacted by development over the last century. Protecting and restoring the remaining Baylands will preserve critical ecological services that support our local and regional economy. This case study introduces a few of these ecological services and describes some of the biophysical and economic benefits they are known to provide, based on local and regional literature.

Restoring the San Francisco Bay

In 1998, a panel of expert scientists and natural resource managers issued the *Bayland Ecosystem Habitat Goals* report, which called for "habitat changes needed to ensure a healthy Baylands ecosystem." They recommended the restoration of approximately 60,000 acres of tidal marsh in the San Francisco Bay, including restoration of 22,000 acres of tidal marsh and the creation of 17,000 acres of diked wetlands in the North Bay subregion.[3] Between 1998 and 2009, approximately 3,000 acres of tidal marsh were restored, along with 5,000 acres of tidal flats. Another 30,000 acres of tidal marsh restoration have been planned or are underway since then, just over 50 percent of the 60,000-acre target. The North Bay is considered one of the most suitable areas for continued restoration activities.[4]

In 2007, Save the Bay estimated that it would cost almost $1.5 billion to fully restore the 36,000 acres of wetlands that were in hand at that time, not including the additional 23,000 acres that would be required to achieve the 60,000 acre goal. Restoration of wetland habitat in the San Francisco Bay will demand a significant investment, but for comparison, $1.5 billion is equivalent to just 0.3% of the Bay Area's annual GDP of $535 billion.[5] And considering the scale of benefits provided by healthy tidal

107 N. Tacoma Avenue T 253 539 4804 eartheconomics.org
Tacoma, WA 98403 F 253 539 5054

marshes including climate stability, water quality, biodiversity, recreation and protection against sea level rise and storm surges, these investments are worth serious consideration.

The Multiple Benefits of the Sonoma Baylands

Climate Stability

The wetlands of the Sonoma Baylands capture and store large quantities of carbon, supporting the socially and economically valuable service of global climate stability.

- A 2012 study measured carbon sequestration associated with salt marshes in three sites around San Pablo Bay: China Camp State Park, Petaluma Marsh Wildlife Area, and Coon Island. The study found that these salt marshes can accumulate, or sequester, between 150 and 850 grams of CO_2 per square meter each year, equivalent to 0.6 to 3.5 metric tons CO_2 per acre per year.[6] For comparison, the EPA estimates that the average car emits approximately 4.7 metric tons of CO_2 each year (assuming 11,400 miles and 21.6 MPG fuel economy).[7]

- CO_2 trades for $12.61 per metric ton in California's cap and trade program. So, each acre of wetlands restored or created in the Sonoma Baylands could therefore have an annual market value of between $8 and $44 depending on the rate of carbon sequestration.[1]

- The "social cost" of carbon emissions (or in other words, "social value" of carbon sequestration) is likely to be a lot higher than the market price for carbon suggests. The social cost of carbon refers to impacts on net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change, as a result of emitting one metric ton of carbon dioxide into the atmosphere. Climate change in San Pablo Bay, for example, could potentially expose thousands of acres of habitat (tidal marsh, tidal flat etc.) to sea level rise, leading to erosion of tidal wetlands, loss of species, and the spread of invasive species.[8] While estimates vary depending on the climate assessment model used, discount rate, and other assumptions, the U.S. Federal Government's Interagency Working Group on Social Cost of Greenhouse Gases for example estimates that the social cost of carbon is between $12 and $123 per metric ton in 2020, and that cost rises in future years.[9] A recent Stanford study put the social cost of carbon as high as $220 per metric ton.[10]

- Depending on the social value given to carbon sequestration (i.e. $12 – 123 per metric ton) and rate of carbon sequestration (i.e. 0.6 to 3.5 metric tons per acre per year), the annual social value of carbon sequestration for each acre of wetland in the Sonoma Baylands could be between $7 and $760 annually.

[1] Wetland restoration is not yet an eligible project type in California's compliance offset program. However, standards are being developed for measuring California Deltaic and Coastal Wetlands, which will support future inclusion as an eligible project type. See for example: http://americancarbonregistry.org/carbon-accounting/standards-methodologies/restoration-of-california-deltaic-and-coastal-wetlands

- Restoring salt marshes, such as those in the Sonoma Baylands, may be more effective from a climate perspective than restoring freshwater wetlands, because methane (a potent greenhouse gas) is not produced as a byproduct of tidal wetland growth.

Removal of Pollutants

While nutrients such as nitrogen and phosphorous are essential to life, high nutrient concentrations can result in impairments to ecosystem processes, as well as the health of fish, wildlife and humans, ultimately impacting the economy. The wetlands of the Sonoma Baylands support the removal and breakdown of excess nutrients in the Bay.

- A 2014 report by the San Francisco Estuary Institute suggests that while the San Francisco Bay overall is relatively resistant to nutrient over-enrichment, the Bay may be trending towards nutrient impairment, or may already be impaired.[11]

- Many of the river systems that drain into San Pablo Bay, such as Sonoma Creek, Petaluma River, and Napa River, are listed as impaired on the EPA's 303(d) list for various pollutants, including sediment, pathogens and nutrients. In 2014, Sonoma Creek and the Napa River were removed from the 303(d) list for nutrients based on the available evidence, though overall nutrient runoff into San Pablo Bay is still significant.[12] For example, a 2013 study estimated the quantity of nutrient runoff into San Pablo Bay. The study found that approximately 11,047 kg of dissolved nitrogen compounds (NH_4 and NO_3) and 1,089 kg of phosphorous (as PO_4) enter the San Pablo Bay on a daily basis, above natural background levels, much of it due to runoff from agricultural landscapes.[13]

- One literature review looked at dozens of studies, and found that on average, a typical acre of tidal marsh, like that found in the Baylands, can remove and process about 29 kilograms of nitrogen compounds each year.[14]

- In addition to reducing overall nutrient levels in the Bay, saltwater marshes trap pollutants laden sediments from the watershed, which is the primary source of a range of pollutants that enter San Pablo Bay.[15] The plants and microorganisms that make up the tidal marsh and tide flats of the Sonoma Baylands play a crucial role in removing and breaking down excess nutrient loads.

- The program in the Chesapeake Bay that requires pollution abatement by industrial, agricultural and urban dischargers, is estimated to cost $14.27 for every kilogram of nitrogen removed.[16] If a similar nitrogen program were implemented in Sonoma County (or Bay Area), and if costs to reduce nitrogen discharges are similar to costs in the Chesapeake Bay region, then conserving an acre of tidal marsh could reduce costs to water dischargers by approximately $400 annually.

- The value of avoiding the release of excess nutrients into the environment is also significant. The table below shows results of a literature review in 2011, which quantified some of the economic costs associated with nitrogen compounds in the environment. This table is provided for illustrative purposes only, and actual costs for Sonoma County may be higher, lower, or not applicable for certain categories of costs.

Economic Costs Associated with Nitrogen Runoff[17]

Impact	Average Economic Cost (2015 $/kg)
PM and Tropospheric Ozone Effects	
Reduced Visibility	0.34
Human health costs of NOx	25.38
Human health costs of Nhy	5.42
Crop losses from ozone	1.66
Forest declines from ozone	0.98
Stratospheric ozone effects (N2O)	
UV damage - skin cancer, crop production, corals etc.	1.46
Greenhouse gas effects (N2O)	
Anticipated damages of climate change	2.44
Terrestrial Acidification	
Damage to buildings	0.10
Drinking water contamination	
Treatment for nitrate in drinking water wells	0.18
Health costs of nitrate in drinking water	1.94

Habitat & Biodiversity

Biodiversity is critical to the ecosystem functions and productivity of both terrestrial and marine habitats, including the Sonoma Baylands[18,19,20,21]

- The Baylands in and around Sonoma County are home to and provide migratory habitat for hundreds of species of waterfowl, shorebirds, fish, and other wildlife, including many endangered species such as the Ridgway's rail and salt marsh harvest mouse.[22]

- More than one million birds and waterfowl stop in the Sonoma Baylands during their annual migration.[23]

Sea Level Rise Adaptation and Storm Protection

Intertidal mudflats and tidal marshes buffer the coast against storm energy, reduce storm-generated water surges, and build up in height over time through deposition of sediment and plant matter, which often keeps pace with sea level rise.[24]

- Sea level rose approximately 7 inches in the San Francisco Bay during the 20th century and is expected to rise another 5-11 inches by 2030.[25] With more than $50 billion in critical infrastructure, property, and businesses located in low lying areas, coastal flooding poses a significant threat to economic output in the Bay Area.[26]

- A 2013 report on tidal marsh restoration in the San Francisco Bay found that a restored tidal marsh used as a buffer to a setback levee could provide the same level of flood risk reduction as a much larger levee, and at a lower cost.[27]

- The study also found that over a 50 year period, a traditional levee would cost about $12 million per mile to install and maintain, while a tidal marsh/levee combination would cost about $6-7 million per mile.[28]

Recreation & Tourism

Conservation and restoration of wetland ecosystems, such as the Napa Sonoma Marsh Restoration Project, increases recreational opportunities for hunting, fishing and nature viewing.

- A case study in the San Francisco Bay Area estimated the recreational fishing value for wetlands that support food and nurseries for halibut, rockfish and striped bass is about $21 - 27 per acre per year.[29]

- At $21-27 an acre in value, the 10,000-acre restoration area in the Napa Sonoma Project could potentially generate about $240,000 a year for commercial and recreational fishing (though most of that value would be realized in other locations in the San Francisco Bay and Pacific Ocean).

- Wetlands support waterfowl hunting, an activity that approximately 9,300 people in the Bay area participate in, spending between $3.3 and $4.1 million every year at local businesses.[30] If habitat degradation resulted in people leaving the area to waterfowl hunt, then the region might lose this economic activity.

- Wetlands attract birdwatchers, who spend upwards of $850 a year on food, lodging, transportation and bird watching equipment.[31] If habitat degradation resulted in people leaving the area to birdwatch, then the region might lose this economic activity.

Restoration Case Study: Sears Point

The Sears Point Restoration project is situated on a 2,327 acre expanse held by the Sonoma Land Trust. The project will restore 955 acres of tidal marsh, enhance 1,300 acres of seasonal wetlands and grasslands and increase access to the Bay shoreline. A levee included in the project has added some 2.5 miles to the Bay Trail, providing public recreational access point to the Bay, and help protect Highway 37 and the SMART railroad from flooding.[32] The Sears Point Restoration Project is expected to support sea level rise adaptation in the Sonoma Baylands.[33]

Restoration Case Study: Napa-Sonoma Marsh Restoration Project

The Napa-Sonoma Marsh Restoration Project involves the restoration of approximately 10,000 acres of wetland in the North Bay area at the former Cargill salt pond complex. Restoration work includes the opening of 3,000 acres of salt ponds up to the San Pablo Bay to allow for full tidal action. Much of the rest of the restoration area provides vital habitat for shorebirds and waterfowl.[34]

References

[1] Saving The Bay. *What If There Was No San Francisco Bay*? Retrieved December 22, 2016, from savingthebay.org: http://savingthebay.org/series-overview/what-if-there-was-no-san-francisco-bay/

[2] Mount, J., Lowe, J., 2014. Flooding in San Francisco Bay: Risks and Opportunities. Available at: http://sfbayrestore.org/docs/Sea_Level_Rise_report_Jan2014.pdf

[3] San Francisco Bay Area Wetlands Ecosystem Goals Project, 1998. Bayland Ecosystem Habitat Goals: A Report of Habitat Recommendations. Available at: http://www.sfei.org/sites/default/files/sfbaygoals031799.pdf

[4] Klatt, M. and Cayce, K. ca. 2009. Restoration Progress Toward Regional Goals in the San Francisco Baylands. Richmond, CA: San Francisco Estuary Institute. Available at: http://www.sfei.org/sites/default/files/biblio_files/SOE_poster_M_Klatt_FINAL_for_web-web.pdf

[5] Bay Area Council Economic Institute, 2015. Bay Area Fast Facts. Available at: http://www.bayareaeconomy.org/bay-area-fast-facts/

[6] Callaway, J.C., Borgnis, E.L., Turner, R.E., Milan, C.S., 2012. Carbon Sequestration and Sediment Accretion in San Francisco Bay Tidal Wetlands. Estuaries and Coasts 35,1163–1181.

[7] EPA. n.d. Greenhouse Gas Emissions from a Typical Passenger Vehicle. Available at: https://www.epa.gov/sites/production/files/2016-02/documents/420f14040a.pdf

[8] San Francisco Bay Conservation and Development Commission, 2011. Living with a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and on its Shoreline. Available at: http://www.bcdc.ca.gov/BPA/LivingWithRisingBay.pdf

[9] Interagency Working Group on Social Cost of Carbon (IWGSCC), United States Government. 2013b. Technical Update of the Social Cost for Regulatory Impact Analysis under Executive Order 12866. Revised August 2016.

[10] Moore et al., 2015. Estimate social cost of climate change not accurate, Stanford scientists say. Available at. http://news.stanford.edu/news/2015/january/emissions-social-costs-011215.html

[11] Novick, E. and Senn, D. B. (2014). External Nutrient Loads to San Francisco Bay. Contribution No. 704. San Francisco Estuary Institute, Richmond, California

[12] State of California Regional Water Quality Control Board, San Francisco Bay Region, 2014. Napa River and Sonoma Creek Non-tidal Portions – Delist for Nutrients from Impaired Water Bodies List – Adoption of Resolution Recommending Delisting. Available at:

http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/basin_plan/docs/121613/Item%206%20Napa%20Sonoma%20nutrient%20delist%20FINAL%20APPROVED.pdf

[13] Novick and Senn, 2013. External nutrient loads to San Francisco Bay. Available at: http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/amendments/estuarineNNE/NutrientLoadsDRAFT_Apr2013.pdf

[14] Jordan et al. 2011. Wetlands as Sinks for Reactive Nitrogen at Continental and Global Scales: A Meta-Analysis. Ecosystems 14, 144-155

[15] BCDC, 2011. Living With a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and on its shoreline. Available at: http://www.bcdc.ca.gov/BPA/LivingWithRisingBay.pdf

[16] Compton et al. 2011. Ecosystem services altered by human changes in the nitrogen cycle: a new perspective for US decision making. Ecology Letters 14, 804-815

[17] Compton et al. 2011. Ecosystem services altered by human changes in the nitrogen cycle: a new perspective for US decision making. Ecology Letters 14, 804-815

[18] Worm et al., 2006. Impacts of Biodiversity Loss on Ocean Ecosystem Services. Science 314(5800), 787-790

[19] Cardinale, B. J., Srivastava, D. S., Duffy, J. E., Wright, J. P., Downing, A. L., Sankaran, M., & Jouseau, C. (2006). Effects of biodiversity on the functioning of trophic groups and ecosystems. Nature, 443(7114), 989-992.

[20] Loreau, Michel, et al. "Biodiversity and ecosystem functioning: current knowledge and future challenges." science 294.5543 (2001): 804-808.

[21] Tilman, David, Peter B. Reich, and Johannes MH Knops. "Biodiversity and ecosystem stability in a decade-long grassland experiment." Nature 441.7093 (2006): 629-632.

[22] Bloom et al. 2013. Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California. Sacramento, California: USFWS Region 8.

[23] Sonoma Land Trust, N.D. Sonoma Baylands – Sears Point Wetlands and Watershed Restoration Project. Santa Rosa, CA: Sonoma Land Trust.

[24] ABT Associates, 2014. Estimating the Change in Ecosystem Service Values from Coastal Restoration. Washington, D.C.: Center for American Progress.

[25] BCDC, 2011. Living With a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and on its shoreline. Available at: http://www.bcdc.ca.gov/BPA/LivingWithRisingBay.pdf

[26] BCDC, 2011. Living With a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and on its shoreline. Available at: http://www.bcdc.ca.gov/BPA/LivingWithRisingBay.pdf

[27] ESA. 2013. The Bay Institute, 2013. Analysis of the Costs and Benefits of Using Tidal Marsh Restoration as a Sea Level Rise Adaptation Strategy in San Francisco Bay. San Francisco, The Bay Institute, San Francisco, CA: The Bay Institute.

[28] ESA. 2013. The Bay Institute, 2013. Analysis of the Costs and Benefits of Using Tidal Marsh Restoration as a Sea Level Rise Adaptation Strategy in San Francisco Bay. San Francisco, The Bay Institute, San Francisco, CA: The Bay Institute.

[29] ABT Associates, 2014. Estimating the Change in Ecosystem Service Values from Coastal Restoration. Washington, D.C.: Center for American Progress.

[30] ABT Associates, 2014. Estimating the Change in Ecosystem Service Values from Coastal Restoration. Washington, D.C.: Center for American Progress.

[31] Carver 2013, Birding in the United States: A Demographic and Economic Analysis – Addendum to the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Available at: https://www.fws.gov/southeast/economicImpact/pdf/2011-BirdingReport--FINAL.pdf

[32] Bay Area IRWMP. Sears Point Restoration Project. Retrieved April 9, 2015, from bairwmp.org: http://bairwmp.org/projects/sears-point-restoration-project

[33] Sonoma Land Trust. Sears Point Wetlands and Watershed Restoration Project. Available at: http://www.sonomalandtrust.org/pdf/SonomaBaylandsBrochure.pdf

[34] Napa Sonoma Marsh Restoration Project. Retrieved April 9, 2015, from napa-sonoma-marsh.org: http://www.napa-sonoma-marsh.org/overview.html