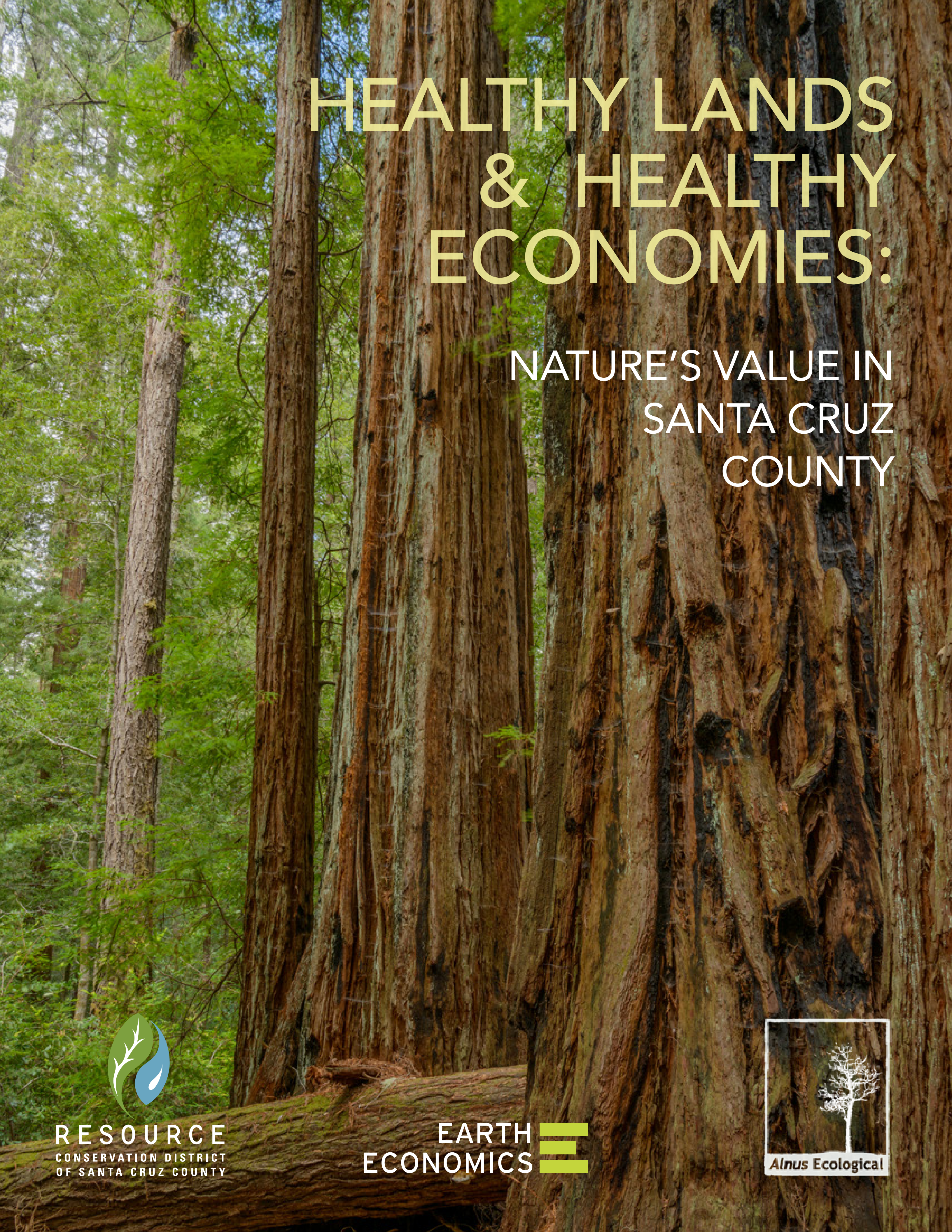

HEALTHY LANDS & HEALTHY ECONOMIES:

NATURE'S VALUE IN SANTA CRUZ COUNTY

RESOURCE CONSERVATION DISTRICT OF SANTA CRUZ COUNTY

EARTH ECONOMICS

Alnus Ecological

HEALTHY LANDS & HEALTHY ECONOMIES:

NATURE'S VALUE IN SANTA CRUZ COUNTY

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The authors are responsible for the contents of this report.

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"Every economy requires the right balance of built, human, and natural capital."

David Batker, Chief Economist and Executive Director — Earth Economics

"Every farmer knows you should not eat your seed corn, and every banker knows you should not spend your principal. Yet that is exactly what we are doing with and to our natural capital."

Mark Tercek, CEO — The Nature Conservancy

"$H_2$0 = GDP

Santa Cruz Chamber of Commerce (2013)

Natural beauty from the mountains to the sea, mild weather, world renowned research and learning institutions, fertile soils, recreational activities and proximity to the Silicon Valley all contribute to the economic activity and quality of life in Santa Cruz County. A strong stewardship and conservation ethic, decades of conservation leadership, and innovative land use policies have significantly highlighted and protected these natural resources. Yet we are at a critical time as we continue to struggle with legacy impacts from historic extractive industries and new challenges, including water supply shortages exacerbated by drought, degraded habitat and water quality, loss of endangered species and increased fire and flood risk. These challenges affect the sustainability of our health, community and economic viability. This is why we took on the effort of assessing the economies of conservation and their relationship to the health and vitality of our local community.

The *Nature's Value in Santa Cruz County* Report is the first-ever comprehensive economic valuation of natural capital and ecosystem services completed in the County, and it represents a new way of thinking to help us address our most pressing challenges. The Report highlights the basic idea that we must consider our natural resources as capital assets that provide a significant and sustained flow of economic benefits and require investment in order to do so. Just as we must maintain our built capital investments such as roads, bridges and buildings, so must we steward our natural resources to ensure their long term health. This report is one of several products of a multi-county initiative (Healthy Lands & Healthy Economies - HLHE) that includes Santa Clara, Sonoma and Santa Cruz Counties and is funded by generous grants from the Gordon and Betty Moore Foundation, S.D. Bechtel, Jr. Foundation, and the State Coastal Conservancy. While this report focuses on the value of natural capital in Santa Cruz County, companion reports for Santa Clara and Sonoma Counties are also produced through HLHE. A number of studies over the past five years have begun to establish the economic benefit communities derive from parks, preserves and scenic lands through tourism, public health and quality of life. The HLHE initiative and this report directly link open space conservation and stewardship to these economic benefits, which we all enjoy but too often take for granted.

Nature's Value in Santa Cruz County provides critical new information that will broaden our understanding of the importance and economic value of natural capital and will assist the region's decision makers, elected officials, business community and citizens in making critical long-term investment and land-use decisions. The numbers documented in this report are staggering: Natural capital in Santa Cruz County provides a stream of ecosystem services valued at $800 million to $2.2 billion to the local and regional economy every year. Importantly, in contrast to built capital, the value of natural capital can actually appreciate with effective conservation and stewardship. We have a lot to be proud of in our work to date. We look forward to utilizing this information to further strengthen and invest in our future together.

If Santa Cruz County is to remain a vibrant and attractive community, we must support investment in natural capital. Our vision is that this important new effort and conversation acknowledges and supports numerous partners in Santa Cruz County as innovative leaders in creating a sustainable and resilient community. Now is the time for this analysis, discussion and identification of critical strategies for the benefit of our community and future generations. Please join the conversation and participate with us in our efforts to address this critical work that is truly the backbone behind our way of life in Santa Cruz County.

Chris Coburn and Karen Christensen
Resource Conservation District of Santa Cruz County

EXECUTIVE SUMMARY

The health of Santa Cruz County's public and private lands sets the foundation for an outstanding quality of life for its citizens and for a prosperous economy. Today, continued stewardship of the County's natural ecosystems and agricultural lands is of critical and increasing importance in the face of growing population, changing climate and numerous other pressures.

In contrast to human or built capital, natural capital and the array of ecosystem services it produces have not been valued in traditional economic analysis. Ecosystem services include important benefits such as water filtration, climate stability (carbon cycling), pollination, recreation, and many more. Quantifying the value of our natural capital and ecosystem services, as well as stewardship actions that result in conservation and restoration of these assets, enables us to make far wiser public and private investments. Understanding the connection between healthy lands, communities and economies is essential to a thriving and resilient Santa Cruz County.

Healthy Lands & Healthy Economies: Demonstrating the Economic Value of Natural Areas and Working Landscapes is a regional collaboration estimating and articulating the economic value of local ecosystem services and the direct role they play in maintaining sustainable economies and communities in Santa Cruz, Santa Clara, and Sonoma Counties. *Healthy Lands & Healthy Economies* is not focused on developing markets for specific ecosystem services or landscapes; instead, this initiative seeks to generate information that can be used to improve decision-making, policies and investment related to stewardship of natural capital.

This report, *Nature's Value in Santa Cruz County*, is the first-ever attempt at a comprehensive valuation of Santa Cruz County's natural capital and ecosystem services. Using novel techniques and case studies for calculating value and rates of return on investment in natural capital, this report shows that **stewardship of natural capital provides significant goods and services with a high return on investment.**

Findings

This report provides data to inform the required scale of investment and potential funding mechanisms to enhance the protection and stewardship of our threatened natural capital assets, which is critically important to Santa Cruz County's continued economic vitality.

Santa Cruz County's natural capital provides at least $800 million to $2.2 billion in benefits to people and the local economy each year. By way of comparison, in 2013 the Santa Cruz County government's budget was $523 million, the total direct revenue from agriculture in the County was $600 million, and the budget for the University of California Santa Cruz was $633 million. This estimate was calculated using a federally-accepted and scientifically validated *Benefit Transfer Methodology* that applied findings from 85 peer reviewed studies to Santa Cruz County's landscape and ecosystems. This methodology enables the monetization of things like the benefit that open space confers to property values, the public's willingness to pay for outdoor recreation, and the water quality benefits contributed by wetlands.

The minimum total value of Santa Cruz County's natural capital as an economic asset is between $22 billion and $61 billion, calculated over 100 years at a 3.5% discount rate. This conservative approach to valuation treats natural capital in a similar manner as built capital (i.e. depreciating its value over time). For example, roads and bridges are usually analyzed over a 50 year period using a similar discount rate, in order to reflect their predicted deterioration timeframe. Unlike built capital, under proper stewardship, forests, farms, wetlands, and aquifers are largely self-sustaining, renewable, and long-lived far beyond a 50-100 year analysis period. Recognizing this fundamental difference and using a zero discount rate over a 100-year period, **Santa Cruz County's natural capital asset value is alternatively estimated between $81 and $220 billion.**

The estimated total value of ecosystem services in Santa Cruz County will almost certainly increase as more studies become available in the future. Ecosystem service economics is a growing field, and datasets have many gaps. For example, the value of groundwater recharge areas has yet to be valued in peer-reviewed literature, leaving this critical service, and others like it, with zero value.

The results of this study support the following conclusions:

1. Santa Cruz County's landscape of natural capital assets and their associated ecosystem services are highly valuable, as they provide the foundation for our economy and support the health and well-being of our communities.
2. Investment in and stewardship of these natural capital assets provide a high rate of return.
3. Greater investment in natural capital assets and stewardship will enhance the continued prosperity and a high quality of life for the people of Santa Cruz County.

In summary, investing in the protection and stewardship of Santa Cruz County's natural capital and the goods and services it provides, will support clean air, clean water, vibrant agriculture, leisure & hospitality, and a strong economy for present and future generations.

The Importance of Stewardship

Stewardship of natural capital through restoration, conservation, and active management of both private and public lands is critical to maintaining and often increasing the flow of valuable ecosystem services from natural assets such as wetlands, riparian areas, agricultural lands, streams, and aquifers. Stewardship activities can also create jobs, expand revenue from activities like tourism, increase resiliency of both landscapes and communities (by recharging local aquifers, for example), and raise the quality of life through improved open space access or drinking water quality, which supports greater health and well-being. This report emphasizes the role of stewardship and provides examples of the kinds of economic benefits it contributes to the county and the region.

The Resource Conservation District of Santa Cruz County, and its many partners, focus on assisting both public and private landowners and managers with technical assistance and funding to guide and implement stewardship of the County's natural capital. As an example, The Bokariza Managed Aquifer Recharge Project in the Pajaro Valley is a stewardship project on private lands that generates multiple economic benefits. The project's primary function is to capture runoff from agricultural lands and recharge groundwater through restored wildlife habitat. During large storm events, the captured runoff has the additional benefit of alleviating downstream flooding. A conservative valuation estimated that this project provides at least $1.87 in return for every dollar invested (an 87% return on investment) over 10 years and more than $5.67 for every dollar invested over 25 years. The average annual return on investment from this project (approximately 6.4% per year over 25 years) is comparable to or better than expected real returns from traditional economic investments (after dividend/income taxes, inflation, expenses etc.), such as the stock market (the average annual investment return for stocks on the S&P 500 index was 6% over the past 30 years) or municipal bonds (average annual investment return of 3.6% over the past 30 years). This project is typical of the kind of multiple-benefit stewardship of natural capital and working lands promoted through partnership-based efforts in the County.

Crews from California's Department of Parks and Recreation help to implement the Laguna Creek Floodplain Restoration Project in 2010. This project reconnected Laguna Creek with its historic floodplain and improved ecosystem services like biodiversity, flood attenuation, groundwater recharge, and carbon sequestration. *Credit: Jim Robins.*

Recommendations

The following recommendations highlight specific actions that can be taken to incorporate ecosystem service values into Santa Cruz County decision-making and stewardship financing.

1. Work with state, federal, and local funding, infrastructure, and policy institutions to incorporate the detailed ecosystem service values developed through this effort into traditional economic planning tools such as return-on-investment analysis and benefit-cost analysis to inform decision-making for capital investments (detailed values for specific services by land cover types can be found in Appendix C).
2. Utilize this report and its findings to catalyze a county-wide discussion on the need for and complexion of a local funding mechanism and investment strategy to increase the pace, scale, and effectiveness of natural capital conservation and stewardship in Santa Cruz County.
3. Incentivize conservation and stewardship actions across the landscape that protect and enhance the flow of ecosystem services from both public and private lands, through a combination of targeted tax relief, payment for ecosystem service programs, permit streamlining, permit fee waivers or reductions, and simplification of sustainability standards compliance protocols for productive activities in working lands.
4. Allocate funds from AB 32, State Bonds, Transportation Funds (SB 375), and other sources to incentivize and prioritize multi-benefit, natural infrastructure projects that restore or protect vital ecosystem services and appreciate (versus depreciate) over the coming decades.
5. Use a multi-benefit ecosystem services approach and the information on this report to better integrate and foster new partnerships across historically disconnected entities and develop better, more cost-effective, and longer-lasting investments and decision-making in support of natural capital assets.
6. Develop and implement local ecosystem service valuation studies to further refine and complement the economic data developed in this analysis and address specific, high priority services of concern such as groundwater recharge, the value of riparian corridors, fire protection and multiple benefits from working lands.

The following chapters provide extensive details about Santa Cruz County's natural resources, a primer on natural capital and ecosystem services, an appraisal of the County's natural capital, and a review of stewardship activities and economic case studies in Santa Cruz County. The report concludes by framing this study in the context of a new vision for integrating natural capital into economic decisions and investments.

Santa Cruz County's landscape of natural capital assets and their associated ecosystem services provide significant value to the economy. *Credits: Below: Will Henry. Next page: Angie Gruys.*

CHAPTER 1: Healthy Lands & Healthy Economies

Economies Operate within Landscapes

Every barn, building, and business in Santa Cruz County resides within a landscape. The County's economic development evolved from mainly extractive activities in the 1800's (lumber, limestone, tanneries) to more stewardship-based and service-oriented activities (agriculture, tourism, arts, sustainable forestry) today. At every step along the way, natural resources and landscapes (*or natural capital assets*[1]) have been foundational to these economic sectors. History shows that when landscapes are healthy and allowed to replenish themselves, economies can thrive; but when they are overexploited or degraded, economies hit physical limits and can quickly stagnate or fail (Diamond, 2005; Brown, 2001; Ponting, 1992; Brown, 2011; Abrams and Rue, 1988; Culbert, 1973). The downfall of agriculture in certain areas of the mid-west after massive soil loss during the dust bowl is a common example (Hornbeck, 2012; Hansen and Libecap, 2004), but the rise and fall of sardine fisheries in Monterey Bay or lumber extraction in Santa Cruz Mountain redwood forests are also important local examples (Williams et al., 2003; Chiang, 2004; Lehmann, 2000).

Today, Santa Cruz County's attractiveness as a place to live, work and visit is inextricably linked to the health of its landscapes and natural assets. Set on the northern end of Monterey Bay, bordered by the Santa Cruz Mountains to the east and the Pacific Ocean to the west, Santa Cruz County enjoys a Mediterranean climate and hosts diverse landscapes including grasslands, redwood forests, wetlands, beaches, fertile soils and rolling hills (Figure 1). These landscapes are home to a number of small cities and towns as well as productive farms, rangelands, woodlands, aquifers and shorelines that support rural and urban lifestyles and a thriving local economy.

As a county that is almost entirely reliant on local water resources (Santa Cruz County Planning Department, 2014), one of Santa Cruz's biggest challenges today is to manage and invest in its landscapes in a way that protects water sources and ensures a continued water supply, which is critical to all economic sectors. The County's multiple water districts and management agencies have a strong ally in a network of land conservation agencies and engaged stakeholders that help them in their on-going efforts to secure the long-term reliability and quality of the local water supply.

[1] Chapter 2 of this document elaborates on the concepts of *natural capital* and *ecosystem services*.

FIGURE 1: Map of county in relation to California

A view of Santa Cruz County's north coast from the hills above Wilder Ranch State Park, including Monterey Bay, lush grasslands, redwood and fir forests, and irrigated agriculture. *Credit: Jim Robins.*

Santa Cruz County's Rich Portfolio of Natural Capital Supports a Diverse Economy

Agriculture in Santa Cruz County is concentrated three times more densely than the state average and has the highest per-acre production value (BAE Urban Economics, 2013). In 2013, about 18,000 acres of agricultural lands in the County generated $600 million in direct revenue (roughly $33,000 per acre), with over 14,000 acres producing berries and vegetables, 1,176 acres in nursery stock and flowers, and over 3,000 acres producing apples, wine grapes, and other tree and vine fruits (County of Santa Cruz, Office of the Agricultural Commissioner, 2014). Looking at the broader economic impacts from this sector, a 2013 report indicates that in 2011, a direct revenue of $566 million from agriculture in Santa Cruz County contributed $1.46 billion to the local economy in both direct and indirect economic output, supporting more than 11,000 jobs (Agricultural Impact Associates, 2013).

Santa Cruz County's available water supply, fertile soils and moderate climate support its agricultural success. Specialty crop production leaders such as Driscoll's, Naturipe, Well-Pict, Dole, Lakeside Organics and Martinelli's as well as agri-businesses such as Newman's Own Organics, Santa Cruz Nutritional, SunOpta, and the California Certified Organic Farmers are based (or operate) in Santa Cruz County. Santa Cruz County farms also have strong direct sales with more than nine certified farmers' markets that directly supply fresh local fruits and vegetables to the County's communities (Santa Cruz Chamber of Commerce, 2014). Additionally, the University of California in Santa Cruz has a nationally renowned agro-ecology program, which trains many young farmers who later go on to produce food locally. Sustainable timber harvesting (and cattle ranching to a lesser extent) also contributes a number of valuable goods and services to the county's economy, and has the potential to generate multiple ancillary benefits, as further discussed in Chapter 4.

Agricultural fields around Watsonville in Santa Cruz County. *Credit: Sacha Lozano.*

A view of the Pajaro Valley in Santa Cruz County: housing, industry, farms are all housed within watersheds. *Credit: Pajaro Valley Water Management Agency.*

Other key sectors of Santa Cruz County's economy, including tourism, education, retail, arts & crafts, and leisure & hospitality depend on the county's natural capital. Tourism generates over $500 million in travel expenditures annually (Santa Cruz County Conference and Visitors Council, 2014), and the industry is bolstered by popular beaches and scenery along the County's coastline (Box 1 discusses the economic impact of beaches in Santa Cruz County) including the famous Santa Cruz Boardwalk, which attracts 3 million visitors each year. Numerous festivals and sporting events such as mountain bike races, triathlons, and marathons take advantage of attractive landscapes and natural venues to generate revenue for the tourism industry. Local companies such as O'Neill and Santa Cruz Bicycles have created widely-known brands that are closely tied to the region's abundant natural beauty (BAE Urban Economics, 2013). The arts and culture industry also plays a substantial role in the Santa Cruz County economy, and is largely inspired by its scenic beauty. The recently published Arts & Economic Prosperity Economic Impact Study IV, published by Arts Council Santa Cruz County, estimated nonprofit arts and culture to be a $38 million industry within the County, supporting 877 jobs. This industry serves both the local community and tourists, who in turn support a variety of other local businesses (Americans for the Arts, 2014).

BOX 1: Santa Cruz County Beaches: An Economic and Ecological Gem

Beaches in California are the most popular tourist attraction in the state and account for more than 72% of State Park visits, outweighing amusement park attendance 20 to 1. This popularity generates roughly $1.1 billion in state tax revenue and supports over 516,000 jobs, demonstrating the importance of healthy and well-maintained beaches (California Coastal Coalition, 2014). According to an Army Corps of Engineers estimate, for every $1 of federal expenditures spent on shore protection for California, the federal government avoids tax losses of $41 to $62 (Houston, 2013). One model estimated that if Huntington State Beach were to close for even one month, for example, the total economic loss for the beach and surrounding area would be over $1 million in output and over $600,000 in value added (Leeworthy et al., 2006).

Santa Cruz County's 29 miles of beaches and the recreational opportunities that they provide are critical to the local tourism industry. The beaches in the City of Santa Cruz in particular have given rise to the unique reputation of "Surf City" among tourists and surfers (Marble, 2009). The County boasts world-class surf breaks, including the iconic Steamer's Lane and Pleasure Point, and a rich history for the sport of surfing (Wright, 2012). Each year, Santa Cruz County attracts the world's best surfers for its O'Neill Coldwater Classic, a surf competition that draws more than 10,000 visitors and lends a boost to the local economy (Baxter, 2012). A 2011 survey by the Surfrider Foundation found that visiting surfers to Santa Cruz County spend an average of $70 per visit, contributing to a total economic impact of almost $2 million each year (Wagner et al., 2011). In support of these services, a host of non-profit organizations focused on ocean protection (*Save the Waves Coalition, Surfrider Foundation, Save Our Shores*) have helped protect numerous coastal zones in Santa Cruz County and around the world through education and activism.

Public parks, preserves, streamside trails and other open spaces are essential to Santa Cruz County's economy, health and social well-being. Access to open spaces helps attract and retain businesses and has proven to be a more important criterion to determine company location than a region's economic development goals (Headwaters Economics, 2012; Crompton et al., 1997). Increased access to open spaces and parks also encourage people to exercise more, reducing overall health care expenditures in the region; a 2003 study in Prevantative Medicine quantified an average reduction of $2,200 per person for annual health care costs in those who were able to change from a sedentary to active lifestyle (Institute at the Golden Gate, 2010; Gies, 2006). Furthermore, researchers have found that when compared to walks in urban areas, leisurely forest walks lead to a significant decrease in the stress hormone cortisol, and increased exposure to green spaces can result in long-term mental health improvements (Williams, 2012; Alcock et al., 2013). In fact, the presence of a nearby urban park can result in the same mental health benefits to a community as a decrease in unemployment by 2% (Sturm and Cohen, 2014).

Santa Cruz County's beaches boast world-class surf breaks and attract the world's best surfers. *Credit: Will Henry.*

Natural Capital Conservation and Stewardship in Santa Cruz County

Over 105,000 acres, or about one-third of Santa Cruz County, are protected through either permanent ownership or conservation easement and management by public agencies (State, County and City parks) or private conservation investors (Land Trust of Santa Cruz County, Sempervirens Fund, Trust for Public Lands, etc.) (Applied Survey Research, 2013). Approximately 65,000 of these acres are currently available for public recreation, mostly as part of the County's vibrant park system including more than 50,000 acres of State, County, and City parks, and 231 miles of trails (see Chapter 5 in this report for an economic analysis of State Parks in Santa Cruz County) (Mackenzie et al., 2011).

In addition to the network of public parks and other protected lands, thousands of acres of forest, woodland, grassland, wetland, and farmland is privately owned. While these lands are not formally protected through easements or other mechanisms, they still produce significant flows of ecosystem goods and services that continue to benefit the local communities.

Agencies like the Resource Conservation District of Santa Cruz County (RCDSCC) and its federal partner the Natural Resource Conservation Service, working in concert with large conservation landowners like the Land Trust of Santa Cruz County, the U.S. Bureau of Reclamation, California State Parks, as well as a private landowners, road associations, and industry are particularly well-positioned and experienced with a long track record of projects and leveraged investment to facilitate stewardship work on both public and private lands and multi-partner collaboration in the county. One of these collaborative efforts is the *Conservation Blueprint*, described in Box 2.

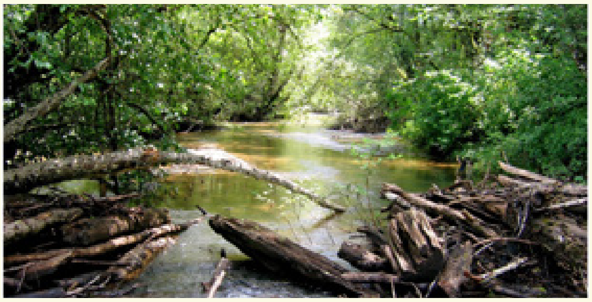
BOX 2: Santa Cruz County's Roadmap for Natural Capital Stewardship

A Conservation Blueprint: An Assessment and Recommendations from the Land Trust of Santa Cruz County (Blueprint), a 2011 document prepared by a number of partners and led by the Land Trust of Santa Cruz County provides a thorough and peer-reviewed summary of natural capital assets (biodiversity, ecosystems, water resources and land uses), as well as historical background on conservation and stewardship initiatives, within the County (Mackenzie et al., 2011). According to the Blueprint, even though a series of community-based efforts have accomplished significant protection of wildlands, watersheds, and working lands (currently about one third of the County (Applied Survey Research, 2013)) over the last century, various natural systems and species' populations were still in decline in 2011. The Blueprint provides a number of recommendations, identifies priorities, and suggests a potential network of critical multi-benefit conservation areas, which together chart a comprehensive strategy for the County's natural capital stewardship and protection.

Specifically, The Blueprint: a) recommends conservation priorities, recognizing that financial resources are limited; b) provides practical suggestions to address water overdraft and sustain local farming; c) offers new ideas on protecting the health of the forests that make up two-thirds of Santa Cruz County; d) proposes means of sustaining a resource-rich environment for today's residents, as well as future generations.

The Blueprint recognizes the importance of traditional land protection strategies such as fee acquisition, conservation easements, and voluntary land management agreements. But in order to increase the scale, impact, and efficiency of conservation, it also recommends ***"…expanding the use of voluntary stewardship incentives, including payment for ecosystem services. Such programs provide financial incentives to protect or enhance production of food, clean water, habitat, and other natural values."*** The Blueprint views financial incentives as *"…a cost-effective way to protect the conservation values of the County's vast working lands, including rangelands and forests, while keeping these areas in private hands, on the tax rolls, and in production."*

The dollar values provided in this report build upon this recommendation and can be used as an initial step to explore potential financial incentives and/or market-based mechanisms.



The water from Scotts Creek supports economically critical services including residential and agricultural water supply and coho salmon habitat. *Credit: Jim Robins.*

The *Healthy Lands & Healthy Economies* Initiative

In 2012, the *Healthy Lands & Healthy Economies: Demonstrating the Economic Value of Natural Areas and Working Landscapes Initiative (Healthy Lands & Healthy Economies)* was initiated as the first-ever economic valuation of natural capital (and related conservation efforts) in three counties in California: Santa Cruz, Santa Clara, and Sonoma. Led by the Resource Conservation District of Santa Cruz County, the Santa Clara Valley Open Space Authority, and the Sonoma County Agricultural Preservation and Open Space District, *Healthy Lands & Healthy Economies* partnered with Earth Economics and *Alnus* Ecological to describe the economic value and community benefits of the unique landscapes of these three counties and their stewardship activities.

Healthy Lands & Healthy Economies began with the following questions:

1. What goods and services are provided by different landscapes within each County, and who are the beneficiaries?
2. What is the economic value provided by these services to the local communities, region, and state? What is the return on investment of conservation projects that protect and enhance these services?
3. What are the roadblocks to developing cost-effective and multi-benefit conservation actions in the project areas and beyond? What solutions are possible?
4. What are innovative, sound financing mechanisms for conservation of natural areas and working landscapes?

The ecosystem service valuation reports for these three counties represent a starting point for answering these questions. Healthy Lands & Healthy Economies aligns with state, regional, and local efforts that are both currently underway and expected to come on-line in the foreseeable future to more effectively measure, manage, and finance natural capital.

This study, ***Nature's Value in Santa Cruz County***, represents a comprehensive appraisal of Santa Cruz County's natural capital assets. The study calculates the overall economic value of natural capital in Santa Cruz County, and uses local case studies to quantify and demonstrate how conservation and stewardship actions benefit the local economy. Case studies include a Managed Aquifer Recharge Project in the Pajaro Valley (Bokariza MAR project), the multi-partner Integrated Watershed Restoration Program (IWRP), and acquisitions by California Department of Parks and Recreation (State Parks) in Santa Cruz County.

The *Healthy Lands & Healthy Economies Initiative* is scoping additional studies to provide finer resolution and local analyses of various conservation efforts and the economic value they create in our local, regional, and state economies. Many of these studies will focus on the linkage between terrestrial land-use/land-management and the ecosystem services of groundwater recharge, water purification, and/or water storage. These studies will create a framework for natural capital economic analysis at the asset, project, and county scales. This framework could easily be applied at the state and national scales.

Nature's Value in Santa Cruz County: How to Use This Study

Assessing the economic value of landscapes and ecosystem services is challenging. Many ecosystem services such as genetic diversity or place-based cultural significance have tremendous *intrinsic* value to society or specific communities, but remain difficult to value using dollars. This study does not attempt to capture the intrinsic or symbolic values of landscapes and ecosystems, and it recognizes that there are other approaches and non-monetary methods for describing and making decisions based on those kinds of values (Aldred and Jacobs, 2000; Gregory and Wellman, 2001; Wilson and Howarth, 2002). In addition, the study does not focus on the *market values* of goods and services that are already monetized, traded, and regularly analyzed in traditional economic analyses such as agricultural goods, timber, and cattle. For example, the market values of commercial crops (strawberries, lettuce etc.), which are already reported in the Santa Cruz County Crop Report, represent the value of labor and capital inputs required to grow those crops, rather than the ecosystem services they also contribute. The dollar values in this study represent the contributions of nature to these goods and services before they enter the market.

Instead, this study classifies Santa Cruz County's landscapes as *natural capital assets*; it identifies the ecosystem services these assets provide; and it offers an initial estimate of the economic value that a subset of these assets and services contribute to communities in the County. This study's conceptual framework, definitions, and values can be used in many practical applications, including:

Assessing economic impacts of local disasters through Benefit-Cost Analysis (BCA)

Following a flood disaster, California, Santa Cruz County, and city officials can apply the ecosystem service values in this study in place of the general (and lower) BCA values found in the Federal Emergency Management Agency's (FEMA) BCA disaster mitigation toolkit in order to secure post-disaster flood mitigation funding (see Box 4 in Chapter 2).

Considering ecosystem service values in proposed policy and project assessments

Values can be used in National Environmental Policy Act Environmental Impact Statements to more accurately reflect the environmental and economic costs and benefits of proposed projects and policies. In addition, ecosystem service values can be integrated into the Sustainable Transportation Analysis and Rating System ("STARS"), a framework adopted by the Santa Cruz County Regional Transportation Commission to incorporate sustainability measures into transportation planning and design as well as a host of other infrastructure planning, assessment, and decision-support tools that rely on BCA.

Estimating economic rates of return for conservation projects

The spatial data, economic values, and methods described in this report can be used to estimate a rate of return on conservation investments such as easements, open space acquisitions, and stewardship/restoration activities. In the correct context, these values can also be applied to economic analysis of projects included in Integrated Regional Water Management Grant applications.

Scaling investments in natural capital to the size of the asset

Understanding the scale of natural capital asset value in Santa Cruz County, combined with an understanding of the potential return on natural capital investment, can be used to inform future investments and determine the appropriate scale of conservation investments.

Encouraging investment in natural capital and its stewardship

The information in this report can incentivize and enable private and public investment in natural capital stewardship. For example, ecosystem service values can be used to show how payments for these services or investment in natural assets (including those by the RCDSCC and other public agencies) can support jobs, conserve biodiversity, build resiliency, and provide high returns on that investment to a broad spectrum of beneficiaries.

Provided it is not degraded, our natural capital will continue to provide benefits long into the future. *Credit: Angie Gruys.*

CHAPTER 2: A Primer on Natural Capital: Ecosystem Goods and Services

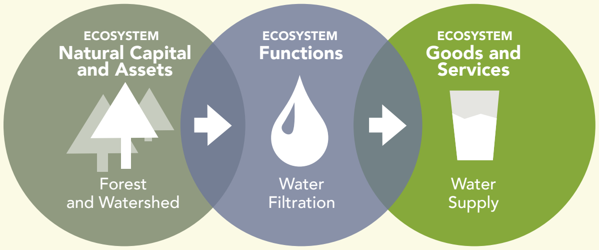
What is Natural Capital?

Economies depend upon built, natural, and human capital. Built capital consists of cars, houses, infrastructure, machinery, computers, and all of the other "tangible systems that humans design, build and use for productive purposes" (Daly and Farley, 2004). All built capital is created from a combination of natural capital and human capital. It is composed of energy and materials from nature. Natural capital consists of the "minerals, energy, plants, animals, ecosystems, [climatic processes, nutrient cycles and other natural structures and systems] found on Earth that provide a flow of natural goods and services" (Daly and Farley, 2004). Human capital consists of people, their education, health, skills, labor, knowledge, and talents.[2]

Natural capital provides a flow of goods and services, like other forms of capital. **These ecosystem goods and services are defined as the benefits people derive from nature.** The natural capital assets of different ecosystems (e.g. forests or wetlands) within a watershed perform critical functions (such as intercepting rainfall and filtering water) and provide goods and services that humans need to survive. In fact, ecosystem goods and services provide the basis of all economic activity through a clean water supply, breathable air, nourishing food, flood risk reduction, waste treatment, and a stable climate. Without natural capital, many of the services (benefits) that we often take for granted (and receive for free) could not exist, or would need to be replaced at a very high cost. Figure 2 illustrates the relationship between natural capital assets, ecosystem functions and the production of ecosystem goods and services.

[2] This report does not discuss the importance of human capital. However, people's health and well-being, as well as their work and enjoyment, are closely tied to the built and natural capital around them and are deeply intertwined with economic prosperity.

FIGURE 2: Ecosystem Goods and Services Flow from Natural Capital Assets and Ecosystem Functions



A Framework for Assessing Ecosystem Services

In 2001, an international coalition of over 1,360 scientists and experts from the United Nations Environmental Program, the World Bank, and the World Resources Institute initiated an assessment of the effects of ecosystem change on human well-being. A key goal of the assessment was to develop a better understanding of the interactions between ecological and social systems, and in turn develop a knowledge base of concepts and methods that would improve our ability to "...assess options that can enhance the contribution of ecosystems to human well-being." (Millennium Ecosystem Assessment, 2003). This study produced the landmark Millennium Ecosystem Assessment, which classifies ecosystem services into four broad categories according to how they benefit humans.

This pond within the Molino Creek floodplain is an example of natural capital enhancement through improved provision of wildlife habitat. *Credit: Jim Robins.*

Ecosystem services, which are broadly defined in Table 1, can be categorized as follows:

- **Provisioning services** provide physical materials that society uses. Forests provide timber. Agricultural lands grow food. Rivers provide drinking water as well as fish for food.
- **Regulating services** are benefits obtained from the natural control of ecosystem processes. Ecosystems regulate processes such as climate, water quality and delivery timing, and soil erosion or accumulation. Balanced ecosystems can keep disease organisms in check, whereas degraded systems propagate disease organisms, to the detriment of human health.
- **Supporting services** include primary productivity (natural plant growth) and nutrient cycling (nitrogen, phosphorus, and carbon cycles). These services are the basis of the vast majority of food webs and life on the planet.
- **Cultural services** are functions that allow humans to interact meaningfully with nature. These services include providing spiritually significant species and natural areas, natural places for recreation, and opportunities for scientific research and education.

TABLE 1: Ecosystem Goods and Services

Good/Service	Economic Benefit to People
PROVISIONING SERVICES	
Food	Producing crops, fish, game, and fruits
Medicinal Resources	Providing traditional medicines, pharmaceuticals, and assay organisms
Ornamental Resources	Providing resources for clothing, jewelry, handicraft, worship, and decoration
Energy and Raw Materials	Providing fuel, fiber, fertilizer, minerals, and energy
Water Supply	Provisioning of surface and groundwater for drinking water, irrigation, and industrial use
REGULATING SERVICES	
Biological Control	Providing pest and disease control
Climate Stability	Supporting a stable climate through carbon sequestration and other processes
Air Quality	Providing clean, breathable air
Moderation of Extreme Events	Preventing and mitigating natural hazards such as floods, hurricanes, fires, and droughts
Pollination	Pollination of wild and domestic plant species
Soil Formation	Creating soils for agricultural and ecosystems integrity; maintenance of soil fertility
Soil Retention	Retaining arable land, slope stability, and coastal integrity
Waste Treatment	Improving soil, water, and air quality by decomposing waste and removing pollutants
Water Regulation	Providing natural irrigation, drainage, groundwater recharge, river flows, and navigation
SUPPORTING SERVICES	
Habitat and Nursery	Maintaining genetic and biological diversity; growth of commercially harvested species
Genetic Resources	Improving crop and livestock resistance to pathogens and pests
CULTURAL SERVICES	
Natural Beauty	Enjoying and appreciating the presence, scenery, sounds, and smells of nature
Cultural and Artistic Inspiration	Using nature as motifs in art, film, folklore, books, cultural symbols, architecture, and media
Recreation and Tourism	Experiencing the natural world and enjoying outdoor activities
Science and Education	Using natural systems for education and scientific research
Spiritual and Historical	Using nature for religious and spiritual purposes

Source: Adapted from de Groot et al., 2002 and Sukhdev et al., 2010

The following sections provide more detailed descriptions on several key ecosystem services in Santa Cruz County.

Provisioning Services

Food

Providing food is one of the most important functions of an ecosystem. Agricultural lands are our primary source of food; farms are considered modified ecosystems, and food is considered an ecosystem good with inputs from humans and built capital.

Agricultural lands both produce and depend on ecosystem services. Agricultural production depends on healthy soil, pollinators, a consistent water supply, and a stable climate. With these natural inputs, agricultural lands produce food and can also support a suite of other services, including groundwater recharge, carbon sequestration, flood risk reduction, biodiversity, and aesthetic value.

The dollar values of agricultural crops are not included in this study because they are already counted in the market economy, and because these values also depend on significant human (labor, machinery etc.) inputs. However, this study does identify and value many of the non-market co-benefits that can be produced on agricultural lands, in addition to food.

Agricultural lands in Santa Cruz County produce food and a variety of co-benefits. *Credit: Angie Gruys.*

Water Supply

Watersheds provide fresh water for human consumption, agricultural production, and manufacturing. This service includes both surface water and groundwater, which supply metropolitan areas, wells, industrial uses, and irrigation. The hydrological cycle is affected by structural elements of a watershed such as vegetation, soils, and geology, as well as processes such as evapotranspiration (the natural absorption of water into the atmosphere), percolation, and climate variability.

Regulating Services

Climate Stability

Ecosystems help to regulate atmospheric chemistry, air quality, and climate. This process is facilitated by the capture and long-term storage of carbon as a part of the global carbon cycle. Forests, woodlands, and grasslands play essential roles in absorbing carbon and contributing oxygen to the atmosphere.

Moderation of Extreme Events

Wetlands, grasslands, riparian buffers, and forests all provide protection from flooding and other disturbances. These ecosystems are able to slow, absorb, and store large amounts of rainwater and runoff during storms. Changes in land use and the potential for more frequent storm events due to climate change make disturbance regulation one of the most important services to economic development. Built structures in the floodplain such as houses, factories, and wastewater treatment plants all depend on the flood protection services provided upstream. The retention of natural, permeable cover and the restoration of floodplains and wetlands contribute to flood risk reduction in these

A historic levee is breached along Scotts Creek to increase connectivity between the channel and the floodplain. This project supports floodwater storage, fisheries, and groundwater recharge. *Credit: Jim Robins.*

Protection of honeybees and other natural pollinators supports Santa Cruz County's extensive agricultural productivity. *Credit: John Morley.*

areas. Enhanced flood and storm protection can reduce the devastating effects of floods including property damage, lost work time, and human casualties.

Pollination

Pollination supports wild and cultivated plants and plays a critical role in ecosystem productivity. Many plant species, and the animals that rely on them for food, would go extinct without animal- and insect-mediated pollination. Pollination services contribute to crop productivity for many types of cultivated foods, enhancing the basic efficiency and economic value of agriculture (Nabhan and Buchmann, 1997). The loss of forests, riparian areas, and shrubs reduces habitat and the capacity of wild pollinators to perform this service.

Cultural Services

Recreation and Tourism

Attractive landscapes, clean water, and fish and wildlife populations form the basis of the recreation economy, which in the United States supports 6.1 million jobs and generates $646 billion in direct spending each year (Outdoor Industry Association, 2012). Tourism and recreation are often tied to aesthetic values of open space and natural areas. Recreational fishing, swimming, bird watching, and hunting are all activities that can be enhanced by ecosystem services. Ecosystem goods like wildlife and clean water attract people to engage in recreational activities and can also increase property values and attractiveness for business (Crompton et al., 1997).

Outdoor recreation is enhanced by ecosystem services such as beautiful views and healthy habitats. Credit: photo released under the creative commons share-alike license by Richard Masoner.

The Importance of Valuing and Accounting for Ecosystem Services and Natural Capital

In 1930, the United States lacked measures of Gross Domestic Product (GDP), unemployment, inflation, consumer spending, or money supply. Benefit-cost analysis and rate of return calculations were initiated after the 1930s to examine and compare investments in built capital assets such as roads, power plants, factories, and dams. Decision-makers were blind without these basic economic measures, which are now taken for granted and help guide investment at an enormous scale in today's economy. Just as understanding the condition, production capacity, and value of our built assets was important to economic progress in the 1900s, valuing and accounting for natural capital assets, and the ecosystem services they provide, can better inform our investments in the 21st century.

The benefits of ecosystem goods and services are similar to the economic benefits typically valued in the economy, such as the services and outputs of skilled workers, buildings and infrastructure. Many ecosystem goods, such as salmon, strawberries, and water, are already valued and sold in markets. However, some ecosystem services, such as flood protection and climate stability, are not amenable to markets and have not been traditionally valued, even though they provide significant economic value. For example, when the flood protection services of a watershed are lost, economic damages include job losses, infrastructure repairs, reconstruction and restoration costs, and property damage (see Box 3).

Conversely, when investments are made to protect and support these services, local economies are more stable and less prone to the sudden need for burdensome expenditures on disaster mitigation. For example, during Superstorm Sandy, New York City's Catskills Watershed provided naturally filtered, clean, gravity-fed water with virtually no interruption in service. In contrast, New Jersey's damaged pumps, filtration plants, and contaminated intakes left much of New Jersey without potable water for weeks after the storm, and a $2.6 billion tab for water infrastructure repair (Salzman, 2012; Appleton and Moss, 2012; Johnson, 2013). In addition to the economic value associated with these avoided costs, healthy watersheds provide myriad other services including water supply, carbon sequestration, water filtration, and biodiversity.

BOX 3: The Value of Retaining Flood Protection Services in the Upper Pajaro Valley

In the upper Pajaro Valley, the Nature Conservancy, the U.S. Army Corps of Engineers, and other partners are demonstrating the importance of flood protection services provided by existing open space and natural capital. According to their report, protection of Upper Pajaro Valley floodplains, like those in Gilroy, "… ensures critical flood protection for the lower floodplain, more specifically for the towns of Pajaro, Watsonville and the surrounding berry and vegetable farms" (Gennet and Klausmeyer, 2012). In addition, the upper Pajaro Valley's Soap Lake acts to attenuate flooding during large flow events, making it a "very important flood management feature for downstream areas in the Pajaro River Watershed" (RMC Water and Environment, 2005). Without these natural flood protection services, it is estimated that the cost of flood risk mitigation for the lower Pajaro Valley would increase by $60 million, and require 44 acres of land for constructed levees and the modification or retrofit of several bridges. According to the Pajaro River Watershed Study, "the Lower Pajaro Project may not be feasible without the Soap Lake and its attenuation of large peak flows" (RMC Water and Environment, 2005).

Today, economic methods are available to value natural capital and many non-market ecosystem services (details in Chapter 3). When valued in dollars, these services can be incorporated into a number of economic tools including benefit-cost analysis, accounting, environmental impact statements, asset management plans, and return on investment calculations. Inclusion of these values strengthens decision-making. When natural capital assets and ecosystem services are not considered in economic analysis, they are effectively valued as zero, which can lead to inefficient capital investments, higher incurred costs, and poor asset management (World Wildlife Foundation, 2014).[3] Many conservation investments provide high rates of return, and demonstrating the potential for high returns on conservation investments can lead to more efficient capital investments and reduce incurred costs (Polasky et al. 2012; Kovacs et al., 2013).

Policy Applications of Ecosystem Services

The practice of natural capital valuation is quickly becoming more common and accepted in addressing significant and complex policy issues. Earth Economics conducted an economic assessment of the damages to natural capital caused by California's third largest fire on record, the 2013 Rim Fire (Batker et al., 2013). After FEMA initially rejected California's application for a Major Disaster Declaration, Governor Jerry Brown included the analysis of impacts to natural capital and ecosystem services that showed significantly greater damage as part of an appeal package sent to FEMA and President Obama for a Major Disaster Declaration (Office of Governor Edmund G. Brown Jr., 2013). The appeal was granted, providing significant federal disaster assistance to Tuolumne County, San Francisco Public Utilities Commission (SFPUC), the State of California, and affected business and citizens.

[3] The same is true when *built* assets are not considered in economic analysis or asset management. See for example Grubisic et al., 2009.

California's application for Federal disaster assistance for the 2013 Yosemite Rim Fire was supported by a valuation of the damages to natural capital. *Credit: image released under the creative commons license by Mike McMillan, US Forest Service.*

Alison Anja Kastama, a spokeswoman for the SFPUC, noted that the inclusion of a natural capital valuation report in Governor Brown's appeal package "supports the recognition of natural capital values…by assessing the impacts of the Rim Fire, this report highlights the greater dollar value we can assign to our natural lands, which are a critical portion of our water system" (Stevens, 2013).

The value of natural capital will be increasingly reflected on the official balance sheets of water agencies and private companies. SFPUC took the first step toward accounting for its natural capital by discussing the value of its watersheds in the Transmittal Letter of its FY2012–2013 Comprehensive Annual Financial Report. Other utilities can also take this step immediately.

Advancements in bond disclosures regarding natural capital provide information on risk and resiliency to bond purchasers. This may lower interest rates for many government, utility, and private bonds where natural capital is healthy, and raise rates where natural capital is degraded and risk is greater.

The private sector and public agencies are formally recognizing the critical importance of including ecosystem service concepts and valuation in planning, management, and decision-making. For example:

1. The United States Federal Emergency Management Agency (FEMA) became the first federal agency to adopt ecosystem service valuation in formal policy. Faced with rising natural disaster costs and climate uncertainty, FEMA approved Mitigation Policy FP-108-024-01 in June of 2013 (Federal Emergency Management Agency, 2013), which allows the inclusion of ecosystem services in benefit-cost analysis for acquisition projects. This policy is being applied for all flood and hurricane disaster mitigation in all 50 states, for all private residential, business, public utility, city, county, and state impacted infrastructure. Under this policy, FEMA applies ecosystem service values nationwide. See Box 4 for more details on FEMA and ecosystem service valuation.

2. The State of California has also been a leader in the recognition and valuation of ecosystem services. In 2008, the California Department of Water Resources (DWR) published an Economic Analysis Guidebook, which included a chapter dedicated to ecosystem service valuation, describing valuation methods and monetization strategies (Cowdin, 2008). In 2012, the North Bay Watershed Association commissioned a *Handbook for Estimating Economic Benefits of Environmental Projects* (ECONorthwest, 2012). The Handbook provides guidance on how to value and incorporate ecosystem services into benefit-cost analysis for applications toward DWR grants, specifically those that support Integrated Regional Water Management Program goals (funded through measures such as Proposition 84 and 1E). The Handbook, along with this study, supports the efforts of agencies like the Department of Water Resources by providing federally accepted methods for valuing ecosystem services, as well as appropriate values, that local agencies in Santa Cruz County and the Bay Area can use to inform analysis or justification of projects that protect natural capital.

3. The United States Department of Agriculture (USDA) long recognized the value of a healthy environment and active stewardship, providing incentives to landowners through such programs as the Conservation Reserve Program, the Environmental Quality Incentives Program, and others. More recently, the Office of Environmental Markets (OEM) was established within the USDA in response to the Food, Conservation, and Energy Act of 2008 (the "2008 Farm Bill"). One of the OEM's primary stated goals is to "...to build a market-based system for quantifying, registering, and verifying environmental benefits produced by land management activities" (USDA Office of Communications, 2010). The OEM's website currently includes a number of resources and case studies on environmental markets such as water quality, carbon, and biodiversity & habitat.

4. Public agencies in the United States are exploring methods to incorporate natural capital assets into their traditional accounting systems. A coalition of water utilities, including the San Francisco Public Utilities Commission (SFPUC), has been working to reach out to the Governmental Accounting Standards Board[4] and demonstrate the need for natural capital accounting standards, especially for water utilities, whose business model depends on healthy watersheds. Currently natural capital only shows up for bare land or timber value. The SFPUC noted in its most recent Comprehensive Annual Financial Report that "Current financial accounting standards, relying solely on historical costs, do not take into sufficient consideration the value of the watersheds and natural resources that are part of our regional water system" (SFPUC, 2013). SFPUC further notes that of $5 billion in total assets, their most important asset—the watershed that filters and delivers water for 2.5 million people—is reflected on their books for only $28 million.

5. The private sector has also begun to utilize ecosystem services to better understand the environmental impacts of corporate decisions. The sportswear company PUMA was the first private company to include environmental and ecosystem service impacts in its Environmental Profit and Loss Account, released in 2011 (PUMA, 2011).

[4] The Governmental Accounting Standards Board (GASB) sets accounting standards for state and local government in the US, including state agencies, counties, municipal water utilities, public utility districts, and universities. See http://www.gasb.org/ for more information.

BOX 4: Reducing Harm, Saving Lives, and Saving Taxpayer Money: Valuing Ecosystem Services in Federal Benefit-Cost Analysis

Like other federal agencies, FEMA uses benefit-cost analysis (BCA) to determine where to invest its resources for the greatest benefits relative to taxpayer cost. FEMA's BCA Toolkit is a software package used for measuring the cost-effectiveness of disaster recovery projects eligible for funding through the agency's hazard mitigation program (such as assisting home and business owners to rebuild). However, the previous FEMA BCA Toolkit did not value floodplain lands (subject to buyout) for their flood risk reduction value. Such floodplain lands reduce flood risk on other properties by storing and/or better conveying floodwaters. These lands also protect water quality, reduce sedimentation, provide recreation, and secure other economic benefits. The reality of larger and more frequent floods and hurricanes, with historically low flood insurance rates, has contributed to rebuilding in disaster-prone areas. As a result of recurring flood and hurricane damage payments, the National Flood Insurance Program has accumulated $24 billion of debt (Joyce, 2014). FEMA has moved aggressively to correct these problems and lower costs by working to reduce and eliminate repetitive flood and hurricane damage that result in increased public and private costs.

In 2012, Earth Economics provided FEMA with 17 ecosystem service values for inclusion in the updated FEMA BCA Tool. An expert panel reviewed the values, along with FEMA staff and management. The values were tested on past flood applications and were found to improve decision-making, reduce repetitive damage, protect human life, and lower disaster expenditures. By valuing flood protection benefits of restored floodplains, for example, FEMA has the economic tools to better spend mitigation funds to relocate, rather than rebuild, structures in areas that experience frequent flood or hurricane damage. These values were approved for use beginning in 2013. Realizing the potential savings to taxpayers, homeowners, and businesses, FEMA also adopted these values for its portion of the $59 billion of mitigation and recovery funds allocated for Hurricane Sandy.

The Watsonville Slough Complex provides flood protection benefits for infrastructure such as Highway 1 and many homes in the City of Watsonville. These benefits and many others are now recognized by FEMA in its benefit-cost analysis. *Credit: Watsonville Wetlands Watch.*

CHAPTER 3: A Countywide Appraisal of Natural Capital in Santa Cruz County

Monetizing Ecosystem Goods and Services

The economic goods and services produced in a region can be quantified to provide a view of the region's economy. The value of these economic goods and services, from housing to industry, is typically estimated with market or appraisal values. Similarly, the value of the natural capital of Santa Cruz County—and the ecosystem goods and services it provides—can be quantified as an appraisal. Each land cover type, from wetlands to forests to agricultural lands, provides a suite of ecosystem goods and services. For example, the goods provided by redwood forests in Santa Cruz include timber for construction and wild mushrooms for nutrition; services include groundwater recharge (through interception and percolation of rainwater), carbon sequestration, recreational opportunities such as hiking and camping, and the removal of air pollutants such as S02 and particulate matter. The identification and monetary valuation of these ecosystem goods and services provides insight into the economic importance of the County's natural capital—which has previously received a default value of zero. There are several methods to estimate (directly or indirectly) the monetary value of ecosystem goods and services in a particular geographic location. This study utilized an indirect valuation method called *Benefit Transfer Methodology* to estimate the economic value of ecosystem services produced in Santa Cruz County.

Santa Cruz County's Natural Capital Valuation: Findings and Methods

The following sections of this chapter provide: First, a quick summary of valuation results and findings, and then a detailed description of the methods used to derive these findings, with explanations of the assumptions and limitations of this valuation and detailed tables presenting aggregate ecosystem service values per land cover type.

By quantifying the value of the services provided by open space such as redwood forests, we can more thoroughly assess the value of these lands to society. *Credit: Angie Gruys.*

Valuation Results at a Glance

Countywide Appraisal: Annual economic flow of benefits

Santa Cruz County's landscapes and ecosystems provide between **$800 million and $2.2 billion** in benefits to people each year (detailed valuation results by land cover type are presented in Table 7). These "big numbers" are important because they indicate that investments in open space can provide vast and long-term benefits when these assets are conserved or enhanced. Conversely, the numbers suggest that loss or deterioration of open space and natural assets represent significant costs to the Santa Cruz Country economy. Moreover, investment in natural capital can yield very high rates of return because of the low cost of investment relative to building new infrastructure assets and because natural capital typically supports a suite of ecosystem services and benefits (not just a single benefit).

Asset Value of Natural Capital in Santa Cruz County

In addition to the annual flow of ecosystem service benefits detailed in Table 7, these economic data were used to calculate an *asset value* for the County's natural capital. Specifically the value was calculated as the net present value of its expected future benefits (or future flows of ecosystem services). An asset calculation is useful for revealing the scope and scale of the economic value that Santa Cruz County's natural systems hold.

Calculating the net present value of an asset implies the use of a (positive) discount rate, which assumes that benefits to humans in the present time are more valuable than similar benefits in the future. Discounting at 3.5% likely results in underestimates when applied to natural capital, because with adequate stewardship and protection natural capital can provide value to society over longer periods of time compared with built capital such as roads and bridges that typically deteriorate over time (Arrow et al., 1996; Arrow et al., 2014).

Federal agencies like the Army Corps of Engineers use a 3.5% discount rate (2014 rate) for water resource projects, a rate that lowers the value of the benefits by 3.5% every year into the future (U.S. Army Corps of Engineers, 2013). The private sector tends to use higher discount rates, tied to the rate of return on capital in private markets. Provided the natural capital of a watershed is not degraded or depleted, its flow of value will likely continue (and even increase) into the future, and can be better represented using a 0% discount rate.

TABLE 2: Alternative Net Present Values of Santa Cruz County's Natural Capital

Discount Rate	Low Estimate	High Estimate
0% (100 years)	$81 billion	$220 billion
3.5% (100 years)	$22 billion	$61 billion

The net present value of Santa Cruz County's natural capital was calculated over 100 years using two discount rates: 3.5 and zero percent, as shown in Table 2. Treated with a 3.5% discount rate, the total asset value of natural capital in Santa Cruz County is $22-61 billion. Treated as an asset that provides the same value across time (i.e. 0 % discount rate over 100 years) yields a natural capital asset value range of **$81 billion to 220 billion.**

The significance of these annual economic benefits and asset values is better understood and put in context when compared to other revenue streams and asset values in the County. Figure 3 shows the value

The Scotts Creek Bridge is an example of built infrastructure that has reached the end of its useful life and is due to be replaced. *Credit: Jim Robins.*

The Watsonville Slough Complex is a natural capital asset that will continue to appreciate over time, provided it is properly stewarded. *Credit: Jim Robins.*

of annual ecosystem service benefits in comparison with total agricultural production in Santa Cruz County, as well as the annual budgets for the County of Santa Cruz and University of California, Santa Cruz. Figure 4 compares the asset value of natural capital in Santa Cruz with the assessed value of all taxable property (land, houses, buildings etc.) in Santa Cruz County as estimated by the County Assessor. The assessed value of property represents the "asset value" of the County's built environment, which like natural capital provides a flow of annual value to people (as reflected through the annual rent or mortgage payments that people make).[5]

Because this valuation does not include all ecosystem goods and services, it is likely an underestimate; yet even this conservative estimation demonstrates the substantial asset value of the natural capital of Santa Cruz County. The following sections discuss in detail the valuation methods used to estimate these numbers.

Benefit Transfer Methodology

Benefit Transfer Methodology (BTM) is a validated and well-established methodology that indirectly estimates the value of ecological goods or services by utilizing previous valuation studies (primary studies) of similar goods or services in comparable locations (Rosenberger and Johnston, 2013). The value transfer process begins by establishing a comparable land cover classification between the primary studies to be used and the region or ecosystems to be indirectly valued, and excluding primary studies that have incompatible assumptions or land cover types. Individual primary study values are then matched to each comparable combination of land cover type and ecosystem service(s) in the area of interest.

As in a house or business appraisal, BTM sums the value of various attributes (number of rooms in a house, or different assets in a business) and establishes the value based on closely related comparable valuations. All valuation appraisals include a degree of uncertainty. A house appraisal will have several comparables that range in value, though a single value is often chosen. In this chapter's valuation, Earth Economics provides a low to high value range to demonstrate the difference between comparable primary studies.

FIGURE 3: Annual Value of Ecosystem Services in Santa Cruz County Relative to other Revenue Streams[6]

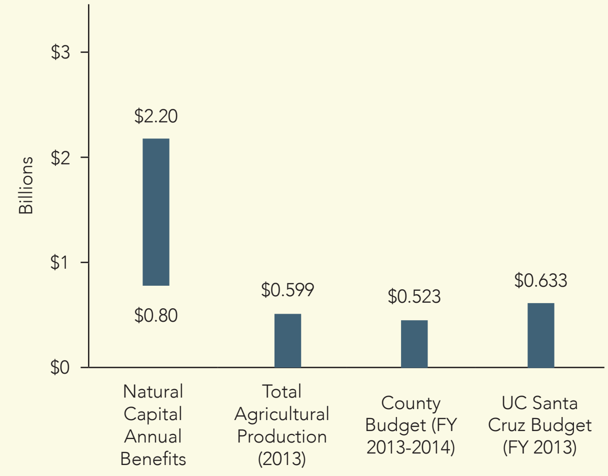
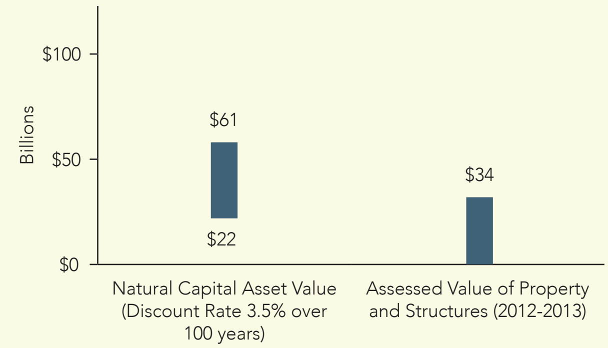


FIGURE 4: Natural Capital Asset Value Ranges relative to the Value of Assessed Property and Structures in Santa Cruz County[7]



[5] This statement requires several caveats: 1) The values used to represent Santa Cruz County's natural capital assets and its built capital assets are calculated through two different methods, though both are valid; 2) Many of the county's most valuable built assets, such as public infrastructure, are not assessed for taxation purposes, so the Assessed Value of Property and Structures underestimates the true value of the built landscape; 3) The actual "market value" of property in Santa Cruz County is likely to be significantly higher than its assessed value due to the passage of Proposition 13 in 1978, which limits the assessed value.

[6] Sources for data: Total Agricultural Production: County of Santa Cruz, Office of the Agricultural Commissioner, 2014; County Budget: County of Santa Cruz, 2013; UC Santa Cruz Budget: University of California Santa Cruz, Office of Planning and Budget, 2013.

[7] Sources for data: Santa Cruz County Assessed Value of Property and Structures: County of Santa Cruz, 2013.

The primary studies used in a BTM valuation are conducted in a number of different socioeconomic contexts, biophysical contexts, time periods, and geographic locations, and use a range of analytic methods. These and other factors can influence the correspondence between the primary study site and the BTM study site (in this case, Santa Cruz County). The next section of this chapter provides details on how primary studies were selected for this valuation and Appendix A contains more detail on general limitations of BTM.

BTM is normally used when the expense and time required to conduct primary valuation studies across an entire landscape for multiple ecosystem services are prohibitive. The BTM approach can be completed more quickly and at far less cost, and it serves as a strong, defensible placeholder until local valuations can be conducted. Considering that we have identified 357 potential combinations of land cover types and ecosystem services in Santa Cruz County (based on the land cover classification and valuation framework employed in this report), it is likely that at least 100-150 primary studies would be required to conduct a fully original valuation of Santa Cruz County's natural assets.[8] A single primary study can require upwards of $100,000 in research funding and years of effort.

The California Department of Water Resources noted in its 2008 Economic Analysis Guidebook that, "Although original studies are preferable to benefit transfer, researchers agree that…benefit transfer can provide a reasonable valuation of non-market values" (Cowdin, 2008). BTM is accepted at the federal level and by California state agencies. In June of 2013, FEMA approved Mitigation Policy FP-108-024-01 (Federal Emergency Management Agency, 2013), based on values Earth Economics developed with the methodology used in this report, for use in all hurricane and flood disaster mitigation in all 50 states. BTM has gained popularity in the last several decades as decision-makers have sought timely and cost-effective ways to value ecosystem services and natural capital (Wilson and Hoehn, 2006).

Selecting Primary Studies

Earth Economics maintains the largest and most comprehensive database of published, peer-reviewed primary valuation studies and scientific literature for BTM use in the world.[9] This database contains many primary studies with valuations applicable to Santa Cruz County. The valuation techniques employed in these studies include market pricing, replacement cost, avoided cost, production approaches, travel cost, hedonic pricing, and contingent valuation. These techniques have been developed and vetted within environmental and natural resource economics communities over the last four decades. Earth Economics used several criteria to select appropriate primary study values for Santa Cruz County, including geographic location, demographic characteristics, and ecological characteristics of the primary study site. Box 5 provides descriptions of primary valuation techniques, examples of how specific studies have employed them, and how Earth Economics applied them to this valuation.

All values included in this analysis were sourced from studies conducted in temperate ecosystems. Where available, ecosystem valuation studies based in Northern California were given preference (10 out of the total 85 studies). Where local studies were not available, ecosystem service valuations conducted within the greater United States were then prioritized. In the cases where no local or national figures were available, suitable studies from countries outside the United States were used (17 out of the total 85 studies, most of which were conducted in Canada). Through this filtering process, Earth Economics ensured that estimates from areas with considerably different ecologies or demographics to Santa Cruz County were excluded. For example, a valuation study that examined the soil retention value of mangroves in the Philippines (Samonte-Tan et al., 2007) was excluded due to demographic differences to Santa Cruz County (most importantly income levels), and also because no equivalent land cover type existed in Santa Cruz County.

[8] The calculator is available online at http://www.bls.gov/data/inflation_calculator.htm

[9] Earth Economics Ecosystem Valuation Toolkit (EVT). More information available at www.esvaluation.org.

BOX 5: Ecosystem Service Valuation Methods and their Application in Primary Studies Used for Santa Cruz County's Valuation

Revealed-preference approaches

Market pricing: Valuations are directly obtained from what people are willing to pay for the service or good on a private market. *Example: timber, agricultural products, and water are sold in markets, the price times quantity sold provides a value.*

The total agricultural production of Santa Cruz County could be used as the value for the Food ecosystem service. As noted in Chapter 2, this value is not included as part of our Benefit Transfer because 1) It is already counted in the market economy; and 2) The market price of food includes significant human inputs in addition to natural capital (e.g. labor, machinery) and would therefore overstate the value contributed by nature alone.

Travel cost: Based on the cost of travel required to consume or enjoy ecosystem services. Travel costs can reflect the implied value of the service. *Example: Recreation areas attract tourists whose value placed on that area must be at least what they were willing to pay to travel to it.*

In Wade et al. (1989), the authors calculate the recreational benefits of 83 fresh lakes and reservoirs in California, estimating ecosystem service values for boating, fishing, and swimming. The model is a gravity travel cost model, which utilizes data from surveys on recreational preferences, demographic information, and data on the recreation sites themselves. After calculating a demand function with coefficients including travel cost, boat lanes, fish yield, and parking availability, dollar value benefits are estimated. The results of the model are presented as Total Benefits (in dollar terms) for each reservoir. To utilize these values in benefit transfer, we establish a range by taking the lowest and highest total reservoir values and then dividing by reservoir size. For example, Perris Reservoir had an annual benefit value of $49.4 million and is 2,320 acres. Therefore, Perris Reservoir is estimated to provide open water recreation benefits of $21,293 per acre per year (1985 dollars).

Hedonic pricing: The value of a service can be estimated by comparing the prices of similar, but non-identical goods under the assumption that the price of a good can be broken down into its attributes. *A house along the coastline will be more expensive than an identical inland house because of the aesthetic value provided by a view or proximity to the coast.* This added value, "hedonic value," is measurable. It is only a partial estimate of aesthetic value, however, because many people who do not own "view" property still enjoy the view and that aesthetic value remains unmeasured.

Mahan (1997), prepared for the U.S. Army Corps of Engineers, values several wetland types and their effect on residential property values in Portland, Oregon, using the hedonic pricing method. Their findings show that wetlands have a significant influence on nearby residential property values; different types of wetlands have significantly different marginal implicit prices; and wetlands and non-wetland greenspaces (e.g. public parks, lakes, or rivers) have significantly different marginal implicit prices. The first step is to calculate a price function that relates the price of a property to several variables including distance to four wetland types. The authors then are able to estimate a willingness-to-pay function for different wetland types and sizes. Using their results we calculate an annual per acre value by taking the average willingness to pay per acre of wetland and multiplying it by the number of property sales per year in the study area.

Production approaches: Service values are assigned from the impacts of those services on economic outputs. *Example: Improvement in watershed health leads to an increase in commercial and recreational salmon catch.*

BOX 5 CONTINUED FROM PREVIOUS PAGE

Knowler et al. (2003) utilizes a production function approach by specifying a full bio-economic model of a coho fishery in British Columbia. They estimate the economic value of changing the quality of fish habitat by using empirical analyses to link fish population dynamics with indices of land use in surrounding watersheds. This allows the authors to estimate habitat ecosystem service values at different levels of degradation, which they express as a net present value per kilometer of stream length at a 5% discount rate. This length-based value (i.e. $/km of stream) was then converted to an annual area-based value ($/acre/year).

Cost-based approaches

Replacement cost: Cost of replacing ecosystem services with man-made systems. Example: *The cost of replacing a watershed's natural filtration services with a man-made water filtration plant.*

Using field data from eight U.S. cities, Nowak et al. (2002) estimates the total compensatory value of tree populations to range from $101 million in Jersey City, NJ, to $5.2 billion in New York, NY (with California values falling within this range). Compensatory value is defined as the compensation to owners for the loss of an individual tree, and can be seen as a valuation of trees as a property asset. In order to annualize the high and low values, we use the published dollars per square meter of tree cover value. We convert this value to dollars per acre. Finally, we obtain low and high values by amortizing dollars per acre over 19 years and 28 years, low and high estimates for the life span of urban trees.

Avoidance cost: Value of costs avoided or mitigated by ecosystem services that would have been incurred in the absence of those services. *Example: If wetlands (and their associated hurricane buffering services) are lost, additional costs are incurred during storms as coastal property is damaged.*

Rein (1999) investigates the economics of implementing vegetative buffer strips (VBS) as a tool to protect water quality from nonpoint pollution, based on avoided costs to the grower and to society as a whole The costs of installing a VBS include the loss of potential agriculture profits, and VBS installation and maintenance. Benefits include reduction of herbicide use, reduced farm damage from soil erosion, and avoided cost of road clearing due to sediment capture. Results indicate a net economic benefit to the grower for installing vegetative buffer strips within the first year. Benefits are expressed annually for a 1-acre VBS. Therefore, the only conversion necessary for benefit transfer is to adjust for inflation.

Stated-preference approaches

Contingent valuation: People are asked to state directly what they would pay for a specific environmental service. *Example: People are asked their willingness to pay to preserve a local wilderness area for aesthetic reasons.*

Colby and Smith-Incer (2005) measure willingness to pay for preservation and visitor expenditures in the Kern River Preserve (California), where a large number of recreational activities take place. The authors conduct a contingent valuation survey that asks for donations to promote water conservation in order to prevent streamflows from being diminished, which would lead to habitat degradation and reduced numbers and diversity of birds and other wildlife. The results estimate that visitors would be willing to pay roughly $77 per year to preserve the habitat, which is about $500,000 a year based on visitation numbers.

Source: Description of valuation methods adapted from Farber et al., 2006

Once compiled, all ecosystem service values were then standardized to 2012 dollars using the Bureau of Labor Statistics Consumer Price Index Inflation Calculator.[10] Appendix B lists the primary studies used to provide the value transfer estimates. Appendix D is an annotated bibliography that provides more information on each primary study transferred to Santa Cruz County, including the study's context and valuation methods used.

Assigning Comparable Land Cover Categories to Primary Study Values

Each primary study's ecosystem service value in the database was assigned a land cover category (based on the description of its study area) that was comparable to the land classification used in this valuation. In some cases, this required making the primary study's land cover classification more general (e.g. from a specific plant community to a broader land cover category), in order to enable value transferability from primary study locations in other parts of California and the U.S. to locations in Santa Cruz County. While grouping specific plant communities into a broader land cover category may sacrifice resolution in the analysis, it can be argued that at least in certain cases from both a supply and demand side, many "different" plant communities provide similar levels of ecosystem services. But more importantly, grouping primary studies into broader land cover categories increases the number of primary valuations that can represent ecosystem services for each land cover type in the area of interest. This is similar to home appraisers using the number of rooms to compare house attributes. The rooms themselves are certainly likely to be qualitatively different, but it would be impractical for an appraiser to consider every difference in each room.

Land cover categories provided by The National Oceanic and Atmospheric Administration's 2006 Coastal Change Analysis Program (C-CAP) Regional Land Cover dataset (NOAA, 2006), shown in Table 3 and Figure 5, were determined to provide the greatest practical resolution of land cover categories necessary for this study's purposes, while remaining valid and representative of the ecology in Santa Cruz County, and allowed Earth Economics to apply a wide range of studies from outside of California to this analysis through careful data review.

Some land cover/ecosystem service combinations are well represented in available valuation studies. Other combinations have few or no existing studies. Table 4 summarizes the suite of ecosystem services provided by each land cover type and the number of primary study values available for each land cover/ecosystem service combination.

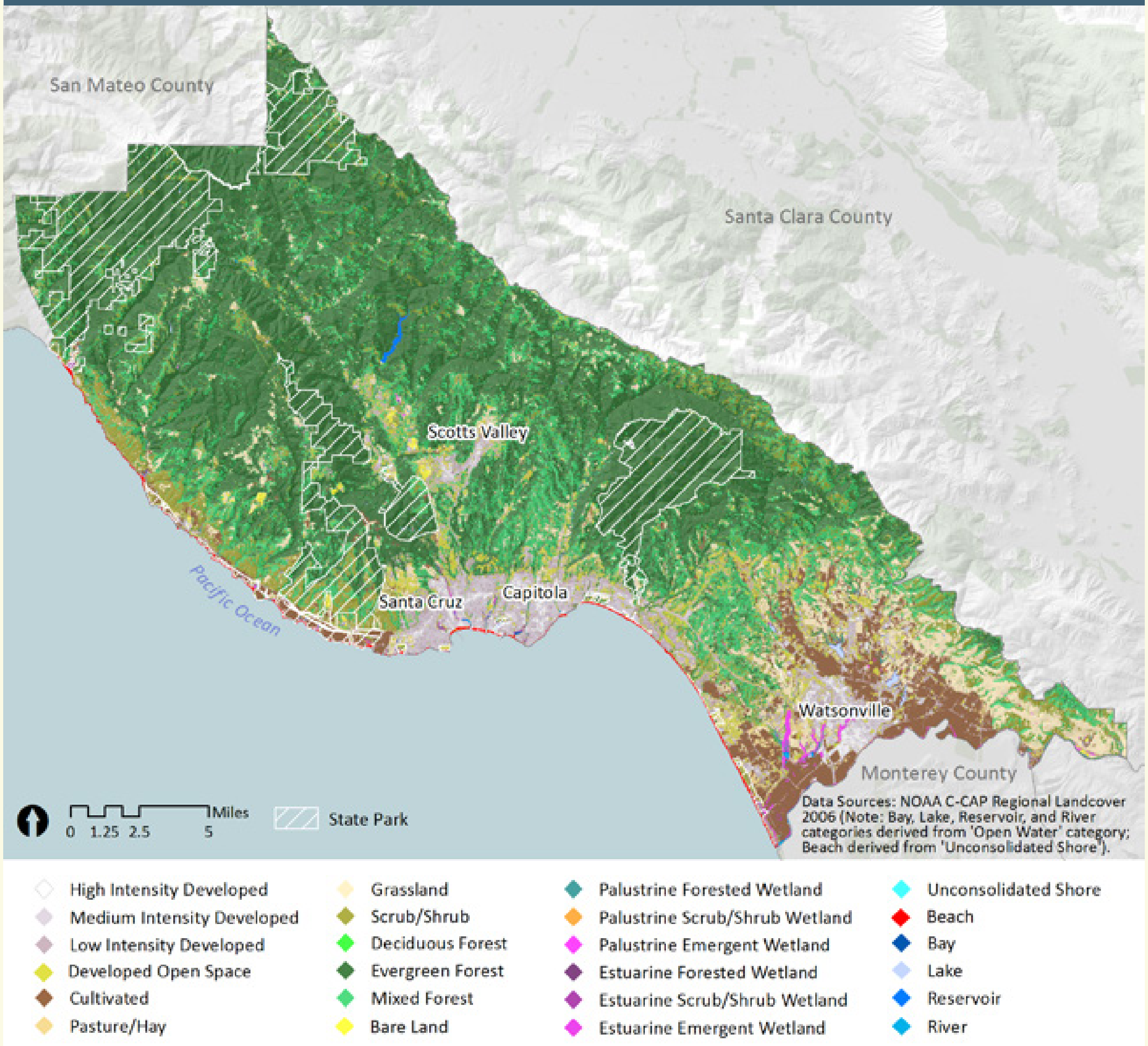
[10] The calculator is available online at http://www.bls.gov/data/inflation_calculator.htm

Ecosystem service values were assigned to land cover types present in Santa Cruz County. *Credit: Imaged licensed under creative commons by Sourav Das.*

TABLE 3: Coastal Change Analysis Program (C-CAP) Land Cover Types in Santa Cruz County

C-CAP Land Cover Type		Area (Acres)	Description
Deciduous Forest		129	Areas dominated by deciduous trees generally greater than 5 meters tall.
Evergreen Forest		143,514	Areas dominated by evergreen trees generally greater than 5 meters tall.
Mixed Forest		47,952	Areas including both evergreen and deciduous trees generally greater than 5 meters tall.
Scrub/Shrub		23,742	Areas dominated by shrubs; less than 5 meters tall. Includes true shrubs, young trees in an early successional stage.
Grassland		18,610	Areas dominated by grammanoid or herbaceous vegetation.
Estuarine Emergent Wetland		166	Tidal wetlands dominated by erect, rooted, herbaceous hydrophytes in areas with greater than 0.5 percent salinity.
Palustrine (freshwater) Emergent Wetland		857	Tidal and non-tidal wetlands dominated by persistent emergent vascular plants, emergent mosses or lichens in areas with less than 0.5 percent salinity.
Estuarine Forested Wetland		15	Tidal wetlands dominated by woody vegetation greater than or equal to 5 meters in height; in areas with greater than 0.5 percent salinity.
Estuarine Scrub/Shrub Wetland		199	Tidal wetlands dominated by woody vegetation less than 5 meters in height; in areas with greater than 0.5 percent salinity.
Palustrine (freshwater) Forested Wetland		820	Tidal and non-tidal wetlands dominated by woody vegetation greater than or equal to 5 meters in height; in areas with less than 0.5 percent salinity.
Palustrine (freshwater) Scrub/Shrub Wetland		235	Tidal and non-tidal wetlands dominated by woody vegetation less than 5 meters in height; in areas with less than 0.5 percent salinity.
Pasture/Hay		681	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops.
Cultivated		15,350	Areas used for the production of annual crops such as vegetables and berries; includes orchards and vineyards.
Open Water	Bay	14	Areas of open water off the coast of Santa Cruz County.
	Lake	352	Bodies of freshwater in the county not used as reservoirs.
	Reservoir	148	Bodies of freshwater in the county used as reservoirs.
	River	89	Rivers and streams.
High Intensity Developed		1,972	Highly developed areas where people reside or work in high numbers such as apartment complexes, row houses and commercial/industrial.
Medium Intensity Developed		9,531	Areas with a mixture of constructed materials (50-79% cover) and vegetation. Includes multi- and single-family housing units.
Low Intensity Developed		10,823	Areas with a mixture of constructed materials (21-49% cover) and vegetation, such as single-family housing units.
Developed Open Space		9,634	Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses.
Bare Land		538	Areas characterized by bare rock, gravel, sand, silt, clay, or other earthen material, with little or no "green" vegetation.
Unconsolidated Shore		75	Areas dominated by material such as silt, sand, or gravel that is subject to inundation and redistribution due to the action of water. Generally lacks vegetation.
Beach		665	Unconsolidated shoreline consisting primarily of sand.
TOTAL		286,107	

FIGURE 5: NOAA's C-CAP Land Cover Classification in Santa Cruz County



Credit: Jake Smith

Assigning Spatially Dependent Conditions to Primary Study Values

Ecosystem services may be spatially independent or may be spatially dependent on a physical location or proximity to beneficiaries. A ton of carbon sequestered in Santa Cruz County, for example, adds the same value to climate stability as a ton of carbon sequestered elsewhere. This is an example of a spatially *independent* service. On the other hand, the aesthetic attributes of a park are often more economically valuable (on a per-acre basis) in an urban area than in a rural area, because there are more beneficiaries in close proximity to the service and because the service is more scarce in the urban environment. Unlike carbon sequestration, this example illustrates a spatially *dependent* ecosystem service. In order to account for the economic effects of physical location and proximity to beneficiaries on the type and magnitude of flow from dependent ecosystem service, Earth Economics tagged many of the applicable primary study values with one or more spatially dependent qualifiers or "conditions" to reflect this reality and refine the accounting methodology.

TABLE 4: Santa Cruz County Ecosystem Services Present, Valued, and Number of Applicable Primary Studies

												Open Water										
	Deciduous Forest	Evergreen Forest	Mixed Forest	Scrub/Shrub	Grassland	Estuarine Emergent Wetland	Palustrine Emergent Wetland	Estuarine Forested & Scrub/Shrub Wetland*	Palustrine Forested & Scrub/Shrub Wetland**	Pasture/Hay	Cultivated	Bay	Lake	Reservoir	River	High Intensity Developed	Medium Intensity Developed	Low Intensity Developed	Developed Open Space	Bare Land	Unconsolidated Shore	Beach
PROVISIONING SERVICES																						
Food	1	1	1	1	1	3	3	3	3			3										
Medicinal Resources																						
Ornamental Resources																						
Energy and Raw Materials	1	1	1																			
Water Supply	3	3	3	2		6	6	6	6					1	1							
REGULATING SERVICES																						
Biological Control	2	2	2	1	2					1	1	1										
Climate Stability	4	4	4	3	3	7	7	5	5	3	3								1			
Air Quality	1	1	1									1							2			
Moderation of Extreme Events	2	2	2	1	1	8	8	6	6										1			2
Pollination	3	3	3	1	1					2	1											
Soil Formation	1	1	1	1						3	1											
Soil Retention	1	1	1	2	3					2	3											
Waste Treatment	4	4	4		2	9	9	11	11		1	6										
Water Regulation																			3			
SUPPORTING SERVICES																						
Habitat and Nursery	1	1	1			5	5	3	3			2			2							
Genetic Resources																						
CULTURAL SERVICES																						
Natural Beauty																						
Cultural and Artistic Inspiration																						
Recreation and Tourism	13	13	13	2	2	12	9	9	8	1		11	3	4	9							2
Science and Education	1	1	1																			
Spiritual and Historical																						

KEY

	Ecosystem service generally produced by land cover
n	Ecosystem service generally produced by land cover and valued in this report; n = number of primary study values assessed
	Ecosystem service generally not produced by land cover

*Includes areas of both Estuarine Scrub/Shrub Wetland and Estuarine Forested Wetland, which were combined for the purposes of valuation.

**Includes areas of both Palustrine Scrub/Shrub Wetland and Palustrine Forested Wetland, which were combined for the purposes of valuation.

Geographic Information Systems (GIS) tools were used to identify, define, and calculate acreage for five different conditions that were applied to the economic data in this study. Along with other factors already taken into account (e.g. similarities in land cover, geographic location), the five conditions were determined to broadly represent the spatial factors that commonly have a positive effect on a primary study's final calculated ecosystem services value. For example, a riparian condition for a primary study indicates that the study valued ecosystem services in a riparian corridor, and therefore its associated ecosystem service values, were only applied to lands in Santa Cruz County that were in close proximity to a stream or river. Table 5 summarizes and defines the conditions that were applied to primary studies.

Calculating Economic Value: Matching Primary Studies to Land Cover in Santa Cruz County

Each primary study provided a low and high value estimate (or a single estimate) for one or more ecosystem services provided by a particular land cover, and many of these were further refined by the conditions described above. Table 6 provides an example of one of these combinations, where "Evergreen Forest" is the land cover and "Riparian" and "Agriculture" are the conditions. Overall, 1,601 acres of land in Santa Cruz County match this combination. The table not only shows the total acreage of this combination of land cover and conditions in the County, but also the particular studies used to calculate the low and high values for each ecosystem service in dollars

TABLE 5: Conditions Applied to Primary Study Values for Transfer to Santa Cruz County

Condition	Description	Dataset	Definition
Urban	Areas where the value of the some ecosystem services tends to be higher when near urban or suburban populations; e.g., an urban park tends to have a greater positive impact on nearby property values.	California Department of Conservation Farmland Mapping & Monitoring Program, Santa Cruz County, 2010 (California Department of Conservation, 2010)	Within 2 miles of an FMMP Urban/ Built-up designated area that is either within an urban service area or is over 300 contiguous acres in size.
Riparian	Areas alongside streams and rivers where ecosystem services tends to be produced or demanded in greater quantities due to the higher ecological productivity of these areas or their proximity to water; e.g., some kinds of wildlife viewing or water-based recreational activities are possible only in riparian zones.	United States Geological Survey National Hydrography Dataset - 24k (National Oceanic and Atmospheric Administration, 2006)	Within 50ft of stream channel flowlines that have either perennial status or Geographic Name Information System identification number.
Agriculture	Areas that benefit nearby farms or provide benefits to others by reducing the (usually downstream) impacts of agriculture; e.g., native vegetation near farms can be home to wild pollinators that help to increase crop yields.	California Department of Conservation Farmland Mapping & Monitoring Program, Santa Cruz County, 2010 (California Department of Conservation, 2010)	Located within 3 miles of FMMP Prime Farmland, Farmland of Statewide Importance, Unique Farmland, or Farmland of Local Importance designated areas that are over 40 contiguous acres in size.
Developed High Intensity	Areas where ecosystem services tend to be more valuable near highly developed zones where people reside or work in high numbers, such as near apartment complexes or commercial/ industrial areas; e.g., wetlands near industrial areas often receive and detoxify a greater quantity of polluted runoff (on a per-acre basis) than those in remote areas.	National Oceanic and Atmospheric Administration 2006 Coastal Change Analysis Program (C-CAP) Regional Land Cover dataset (National Oceanic and Atmospheric Administration, 2006)	Within ¼ mile of lands identified as High Intensity Developed.
Greater than 5 contiguous acres	Continuous tract of a single land cover type that provides greater ecosystem services when it grows in size; e.g., a large urban park may provide a sense of open space (where a smaller urban park could not), adding to the value of adjacent properties.	National Oceanic and Atmospheric Administration 2006 Coastal Change Analysis Program (C-CAP) Regional Land Cover dataset (National Oceanic and Atmospheric Administration, 2006)	Greater than five contiguous acres of any single C-CAP 2006 land cover type.

per acre per year. This table illustrates, for example, how the values from the study by Colby and Smith-Incer (which was conducted in California and focuses on the recreational value of riparian areas—specifically bird and wildlife viewing) were applied locally.

Once all of these values were added to the database, the low and high values were summed for all ecosystem services that could be valued for a given land cover/condition combination, resulting in a low and high total dollar value per-acre per-year ($1,375 - $4,492 per acre per year in the Table 6 example). The total low and high values for each land cover/condition combination were then multiplied by the acreage associated with that combination to calculate the total low and high values in dollars per year. In the example provided in Table 6, the low value was $2,202,052 per year and the high value was $7,193,157 per year.

A total of 107 land cover/condition combinations were valued for Santa Cruz County (i.e. 107 tables like Table 6 were created for each combination). Individual tables for each combination (like Table 6) can be found in Appendix C. These tables are also available in Excel format on request through the RCDSCC. Requests can be sent to info@rcdsantacruz.org.

TABLE 6: An example showing one of the 107 valuation tables that were created for Santa Cruz County

Land Cover	Evergreen		
Conditions	Riparian; Agriculture		
Area Valued (ac)	1,601		
Ecosystem Service	**Author**	**Low ($/acre/year)**	**High ($/are/year)**
Biological Control	Wilson, S.J.	11.28	17.27
Climate Stability	Wilson, S.J.	10.83	124.14
Energy and Raw Materials	Haener, M. K. and Adamowicz, W. L.	3.83	3.83
Food	Knowler, D.J., et al.	17.51	51.19
Habitat and Nursery	Amigues, J. P., et. al.	306.00	578.91
Moderation of Extreme Events	Zavaleta, E.	45.61	63.07
Pollination	Wilson, S.J.	420.20	420.20
Science and Education	Bishop, K.	41.82	71.99
Soil Formation	Wilson, S.J.	2.54	2.54
Soil Retention	Wilson, S.J.	2.35	2.35
Waste Treatment	Lant, C. L. and Tobin, G. Zhongwei, L.	199.16 282.13	2,192.74 283.31
Water Supply	Lant, C. L. and Tobin, G. Zavaleta, E.	353.70 16.90	353.70 573.34
Recreation and Tourism Hiking Camping Bird and Wildlife Viewing	 Prince, R. and Ahmed, E. Boxall, P. C., et al. Colby and Smith-Incer	 91.09 0.22 205.71	1 15.69 0.22 274.29
	TOTAL ($/ACRE/YEAR)	1,375	4,492
	TOTAL ($/YEAR)	2,202,052	7,193,157

Table 7 provides a summary of the total values from each of these tables. These are the detailed value ranges of ecosystem service (or bundles of services) for each land cover type within the County. The sum of all of these values is shown at the bottom, and it represents the total annual economic flow (range) of benefits from ecosystem services in Santa Cruz County ($811 million to $2.2 billion).

It is important to note that we were not able to assign ecological health coefficients or conditions to the land cover types at the scale of a countywide analysis. Due to the large geographic scale of this analysis, these data assume an average level of ecological health for all analyzed land cover types. Also, a comparison of natural capital values across a range of stewardship conditions and management practices was not conducted. It is acknowledged that the health of the various land cover types across the county and the resulting flow of ecosystem services will vary based on a variety of factors including the patch size, abiotic and biotic factors, current and historic management, and a host of other variables that can affect the productivity and health of an ecosystem. As such, it is critical to note that land management, stewardship, and ecological restoration are essential tools to help maximize the flow of ecosystem services from a specific parcel, land cover type, or location within the County.

TABLE 7: Value of Natural Capital in Santa Cruz County by Land Cover Type[13]

Land Cover	Conditions					Area (acres)	Annual Per-Acre Value		Total Annual Value	
	Urban	Riparian	Agricultural	High Intensity	5 Acre		Low ($/acre/year)	High ($/acre/year)	Low ($/year)	High ($/year)
Bay						14.2	$4,611	$15,286	$65,632	$217,584
Lake						351.7	$2,840	$3,322	$998,783	$1,168,233
Reservoir						148.3	$4,735	$4,735	$702,244	$702,244
River						88.6	$2,840	$3,322	$251,677	$294,376
Deciduous Forest						15.9	$727	$782	$11,526	$12,395
			•			55.1	$1,148	$1,322	$63,200	$72,783
		•				0.3	$2,501	$3,658	$670	$980
		•	•			2.9	$2,922	$4,199	$8,599	$12,356
	•					15.9	$7,695	$21,782	$122,422	$346,556
	•		•			37.1	$7,655	$45,768	$284,129	$1,698,766
	•	•				0.2	$3,355	$22,986	$583	$3,993
	•	•	•			1.2	$3,349	$24,983	$4,065	$30,321
DECIDUOUS FOREST SUBTOTAL						**128.5**			**$495,194**	**$2,178,151**
Evergreen Forest						39,397.5	$900	$985	$35,443,501	$38,789,670
			•			50,454.2	$872	$1,494	$43,991,166	$75,377,606
		•				1,258.0	$755	$1,759	$949,511	$2,212,285
		•	•			1,601.4	$1,375	$4,492	$2,202,052	$7,193,157
	•					23,756.8	$7,695	$21,782	$182,799,019	$517,473,065
	•		•			25,263.3	$7,695	$21,793	$194,413,440	$550,561,657
	•	•				903.9	$3,561	$23,260	$3,218,424	$21,024,349
	•	•	•			878.4	$3,555	$25,258	$3,122,658	$22,186,659
EVERGREEN FOREST SUBTOTAL						**143,513.5**			**$466,139,770**	**$1,234,818,447**

[13] All values are in 2012 USD.

Continued from previous page

TABLE 7: Value of Natural Capital in Santa Cruz County by Land Cover Type[13]

Land Cover	Conditions					Area (acres)	Annual Per-Acre Value		Total Annual Value	
	Urban	Riparian	Agricultural	High Intensity	5 Acre		Low ($/acre/year)	High ($/acre/year)	Low ($/year)	High ($/year)
Mixed Forest						5,951.9	$828	$883	$4,927,483	$5,253,439
			•			18,644.3	$1,249	$1,423	$23,286,637	$26,531,777
		•				54.8	$758	$1,762	$41,519	$96,511
		•	•			288.7	$1,378	$4,495	$397,920	$1,297,806
	•					8,474.0	$7,886	$21,974	$66,829,682	$186,206,669
	•		•			14,154.9	$7,887	$21,985	$111,644,624	$311,192,261
	•	•				193.9	$3,753	$23,452	$727,738	$4,548,077
	•	•	•			189.0	$3,747	$25,449	$708,253	$4,810,741
MIXED FOREST SUBTOTAL						**47,951.5**			**$208,563,856**	**$539,937,280**
Scrub/Shrub						3,386.6	$281	$316	$952,142	$1,069,751
			•			12,254.9	$453	$756	$5,554,283	$9,263,356
		•				11.6	$361	$1,003	$4,189	$11,638
		•	•			68.3	$533	$1,443	$36,411	$98,563
	•					1,285.2	$281	$281	$361,301	$361,301
	•				•	402.7	$11,539	$11,539	$4,646,871	$4,646,871
	•		•			3,399.4	$453	$721	$1,540,589	$2,451,398
	•		•		•	2,868.0	$11,711	$11,979	$33,587,239	$34,355,659
	•	•				19.7	$532	$1,513	$10,505	$29,840
	•	•			•	1.2	$613	$12,227	$759	$15,156
	•	•	•			34.2	$785	$2,640	$26,806	$90,199
	•	•	•		•	10.4	$785	$12,667	$8,128	$131,224
SHRUB/SCRUB SUBTOTAL						23,742.2			$46,729,225	$52,524,955
Grassland						988.4	$2,128	$3,992	$2,103,736	$3,945,884
			•			7,730.6	$2,125	$7,502	$16,430,964	$57,994,660
		•				36.8	$2,146	$4,043	$78,885	$148,635
		•	•			45.9	$13,022	$23,608	$597,707	$1,083,561
	•					586.8	$5,249	$5,512	$3,080,229	$3,234,668
	•				•	659.5	$5,249	$11,959	$3,461,607	$7,887,289
	•		•			2,341.7	$5,246	$9,022	$12,284,137	$21,126,265
	•		•		•	6,128.9	$5,246	$8,914	$32,151,161	$54,631,868
	•	•				15.8	$5,266	$5,563	$83,050	$87,731
	•	•	•			33.3	$16,038	$25,023	$534,173	$833,420
	•	•			•	5.2	$5,266	$12,011	$27,321	$62,309
	•	•	•		•	36.8	$16,038	$31,471	$590,716	$1,159,104
GRASSLAND SUBTOTAL						18,609.8			$71,423,686	$152,195,394

Continued from previous page

TABLE 7: Value of Natural Capital in Santa Cruz County by Land Cover Type[13]

Land Cover	Conditions					Area (acres)	Annual Per-Acre Value		Total Annual Value	
	Urban	Riparian	Agricultural	High Intensity	5 Acre		Low ($/acre/year)	High ($/acre/year)	Low ($/year)	High ($/year)
Estuarine Emergent Wetlands			•			36.0	$7,859	$49,101	$282,632	$1,765,789
			•	•		29.6	$7,719	$53,350	$228,404	$1,578,669
				•		0.4	$7,719	$53,350	$3,433	$23,729
		•	•			7.1	$7,680	$49,101	$54,409	$347,844
		•	•	•		8.7	$7,546	$53,350	$65,916	$465,992
	•		•			19.4	$30,957	$47,669	$601,547	$926,299
	•		•	•		39.1	$25,412	$48,728	$994,428	$1,906,853
	•			•		14.3	$25,122	$49,897	$360,270	$715,549
	•	•	•			2.1	$737	$48,889	$1,513	$100,311
	•	•		•		9.2	$1,063	$59,350	$9,748	$544,196
ESTUARINE EMERGENT WETLANDS SUBTOTAL						165.9			$2,602,300	$8,375,231
Palustrine Emergent Wetlands			•			151.5	$7,609	$48,851	$1,152,955	$7,402,307
			•	•		12.7	$6,876	$51,849	$87,565	$660,294
				•		2.1	$6,876	$51,849	$14,544	$109,670
		•	•			17.6	$7,249	$49,470	$127,809	$872,271
	•		•			337.6	$859	$69,174	$289,880	$23,352,824
	•		•	•		204.8	$339	$66,250	$69,458	$13,569,536
	•			•		10.0	$339	$66,250	$3,395	$663,352
	•	•	•			55.7	$712	$67,060	$39,659	$3,736,599
	•	•		•		36.4	$578	$68,119	$21,028	$2,478,516
	•					28.2	$756	$75,378	$21,352	$2,128,717
PALUSTRINE EMERGENT WETLANDS SUBTOTAL						856.8			$1,827,646	$54,974,085
Pasture/Hay						196.4	$487	$10,454	$95,660	$2,052,887
	•					484.9	$487	$10,454	$236,252	$5,069,724
PASTURE/HAY SUBTOTAL						681.3			$331,912	$7,122,612
Cultivated						15,349.7	$121	$2,517	$1,862,251	$38,633,761
Bare Land						537.7	$0	$0	$0	$0
Unconsolidated Shore						74.7	$0	$0	$0	$0
Beach						665.4	$2,973	$9,221	$1,978,122	$6,135,304
High Intensity Developed						1,972.3	$0	$0	$0	$0
Low Intensity Developed						10,822.5	$0	$0	$0	$0
Medium Intensity Developed						9,531.0	$0	$0	$0	$0

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TABLE 7: Value of Natural Capital in Santa Cruz County by Land Cover Type[13]

Land Cover	Conditions					Area (acres)	Annual Per-Acre Value		Total Annual Value	
	Urban	Riparian	Agricultural	High Intensity	5 Acre		Low ($/acre/year)	High ($/acre/year)	Low ($/year)	High ($/year)
Developed Open Space						9,633.7	$524	$2,960	$5,049,678	$28,520,353
Estuarine Woody Wetlands						8.4	$1,821	$34,190	$15,331	$287,874
			•			42.0	$1,821	$34,190	$76,565	$1,437,703
			•	•		17.5	$1,680	$38,439	$29,443	$673,523
				•		23.6	$1,680	$38,439	$39,602	$905,914
		•				2.1	$1,649	$34,190	$3,395	$70,413
		•	•			2.8	$1,642	$34,190	$4,519	$94,097
		•		•		5.0	$1,508	$38,439	$7,485	$190,775
	•					0.7	$1,866	$66,443	$1,286	$45,788
	•		•			23.6	$1,866	$66,443	$44,048	$1,568,170
	•		•	•		36.8	$1,726	$67,502	$63,457	$2,482,016
	•			•		30.6	$1,726	$67,502	$52,815	$2,065,746
	•	•				0.6	$1,694	$66,443	$940	$36,869
	•	•	•			6.5	$1,687	$66,443	$10,886	$428,636
	•	•	•	•		7.9	$1,554	$67,502	$12,260	$532,678
	•	•		•		5.2	$1,554	$67,502	$8,066	$350,439
ESTUARINE WOODY WETLANDS SUBTOTAL						213.1			$370,097	$11,170,642
Palustrine Woody Wetlands						44.1	$1,571	$33,940	$69,183	$1,495,114
			•			209.3	$1,571	$33,940	$328,729	$7,104,122
			•	•		29.5	$1,430	$38,188	$42,236	$1,127,897
				•		3.9	$1,430	$38,188	$5,584	$149,124
		•				22.3	$1,398	$33,940	$31,209	$757,521
		•	•			65.2	$1,392	$33,940	$90,729	$2,212,774
		•		•		3.7	$1,258	$38,188	$4,715	$143,163
	•					86.5	$1,616	$66,193	$139,795	$5,726,211
	•		•			253.0	$1,616	$66,193	$408,899	$16,749,048
	•		•	•		140.9	$1,476	$67,252	$207,924	$9,476,909
	•			•		87.4	$1,476	$67,252	$128,996	$5,879,455
	•	•				29.4	$1,444	$66,193	$42,486	$1,947,892
	•	•	•			41.5	$1,437	$66,193	$59,704	$2,749,948
	•	•	•	•		19.1	$1,303	$67,252	$24,860	$1,282,840
	•	•		•		18.9	$1,303	$67,252	$24,671	$1,273,066
PALUSTRINE WOODY WETLANDS SUBTOTAL						1,054.9			$1,609,721	$58,075,084
SANTA CRUZ COUNTY TOTAL						286,107			$811,001,795	$2,197,043,736

Valuation Gaps and Study Limitations

The greatest limitation to this analysis is a lack of primary valuation studies representing all the ecosystem services provided in Santa Cruz County. Many ecosystem services that clearly have economic value, such as groundwater recharge, could not be quantified due to gaps in the literature. Some land covers, such as grasslands, beaches and cultivated crops, were valued for relatively few ecosystem services due to the limited number of applicable values available in the literature. Additionally, values were unavailable for five land cover types (Bare Land; Unconsolidated Shore; High Intensity Developed; Medium Intensity Developed; Low Intensity Developed). While these land cover types are not represented in this study, it is recognized that land covers such as Low Intensity Developed (and even High Intensity Developed) can often contain a significant amount of vegetation, such as urban trees that (especially when managed well) provide valuable services including storm water capture, air quality, and recreational value. The lack of available studies across many of the land cover/ecosystem service combinations suggests that the results presented here should be interpreted as a conservative estimate, and also underscores the need for investment in conducting local primary valuations.[14] The data provided in Table 4 clarifies ecosystem service/land cover data gaps, and can be useful in prioritizing local primary valuations to fill these gaps and further refine ecosystem service values in the region. Appendix A contains greater detail on the limitations of this study.

[14] Developed by the U.S. Forest Service, "iTree" is one commonly-used tool for conducting analyses of ecosystem services provided by urban trees. More information about the tool is available at http://www.itreetools.org/.

Groundwater recharge is one ecosystem service that could not be quantified at the County scale even though it clearly has economic value. The Bokariza managed aquifer project in Santa Cruz County, for example, has an estimated recharge capacity of more than 80 acre feet per year. *Credit: Emily Paddock.*

CHAPTER 4: Natural Capital Stewardship in Santa Cruz County

The Importance of Land Stewardship for Maintaining and Enhancing Santa Cruz County's Natural Capital Value

This chapter highlights a number of examples of stewardship efforts in Santa Cruz County, which are protecting and optimizing the flow of ecosystem services that support our local and regional economies. In this report, the term stewardship is used to refer to the broad array of active land management strategies that preserve, enhance, and restore various ecosystem services across the landscape.

Just like maintaining built capital such as buildings, highways or levees, natural capital often requires maintenance or capital improvement, though generally to a far lesser degree than built capital. Without adequate stewardship, environments can degrade over time, resulting in the loss of ecosystem services, often entailing greater costs to private landowners and taxpayers. In this way, stewardship is more accurately viewed as an investment rather than as a cost. Stewardship is also highly efficient, as assisting private landowners with land stewardship is less costly on a per acre basis than land acquisition.

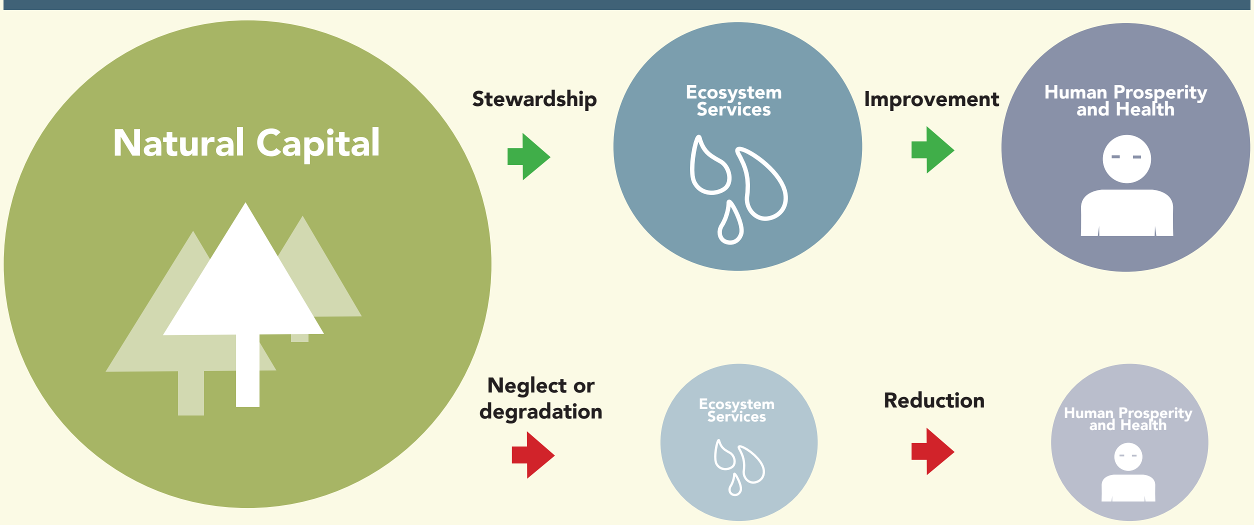
Stewardship is especially important in areas of Santa Cruz County where natural capital assets have been degraded by historic and current land uses and land use practices such as clear-cutting forests, draining wetlands, confining creeks, over-grazing grasslands, spoils and un-reclaimed land from surface and subsurface mining, and all of the related, often decaying, infrastructure.

The examples provided in this chapter and economic case studies in Chapter 5 demonstrate that while land acquisition clearly plays an important role in protecting natural capital, stewardship of open space in all of its forms (public, private, protected or productive lands) is equally or more critical and has been key to the effectiveness of conservation initiatives in Santa Cruz County. The examples also highlight the role of stewardship as a strategy that supports multiple benefits from natural capital and reduces economic costs for taxpayers and private landowners.

Figure 6 demonstrates the role of stewardship in the protection and enhancement of ecosystem services.

Ongoing stewardship is especially critical in agricultural production, where investing in and protecting regulating services such as soil formation and soil retention plays a key role in not only securing yields but also protecting water resources, controlling pests, and producing nutritious foods (Rodale Institute, 2014). Dr. Daphne Miller, a family physician affiliated with the University of California, San Francisco, examined the close connection between health of agricultural

FIGURE 6: How Stewardship Supports Human Prosperity and Health



lands and human health in her book Farmacology, and illustrated how healthy soils support the production of nutritious foods and increases their ability to raise consumers' immune system health (Brody, 2010; Fleischer, 2010; Miller, 2013). Without intentional and effective management to maintain and/or improve soil fertility, the soil properties that enable production of nutrient-dense foods as well as more efficient water use are quickly lost and need to be replaced with costly external inputs (Magdoff and van Es, 2009).

Rangeland management and sustainable forestry (and often a combination of both) offer good examples of the key role stewardship plays to ensure provision of ecosystem services. Active management of grasslands, rotational grazing, compost application, and invasive grasses removal, among other practices, can maintain or improve local water yields (both as groundwater recharge and surface water flow) (Dahlgren et al., 2010), sequester carbon, reduce fire fuel loads (Nader et al., 2007; Russell and McBride, 2003), reduce impacts of nitrogen deposition (Weiss, 1999), promote food and nectar for butterflies (United States Fish and Wildlife Service, 2009), maintain habitat for amphibians and small mammals (Constable et al., 2009; Hayes and Jennings, 1988; U.S. Fish and Wildlife Service, 2003), and provide opportunities for recreation. In a similar way, sustainable timber harvesting, forest stand management, road maintenance, soil erosion control, and other forest management practices, help ensure the continued provision of ecosystem services, such

BOX 6: San Vicente Redwoods—Producing ecosystem goods and services from working landscapes

The 8,500-acre San Vicente Redwoods property provides an innovative model for stewardship in working landscapes that can support multiple ecosystem services. This unique property includes redwood forests, mountain lion range, steelhead and coho salmon habitat, coastal hillsides, riparian corridors, and is a critical municipal drinking water source. Creative funding was pooled from a number of partnering conservation entities including the Peninsula Open Space Trust, the Sempervirens Fund, the Land Trust of Santa Cruz County, The Nature Conservancy, the Save the Redwoods League, the California State Coastal Conservancy, the David and Lucile Packard Foundation, the Gordon and Betty Moore Foundation, and Resources Legacy Fund to purchase this property for $30 million in 2011 (Living Landscape Initiative, 2011; Sempervirens Fund, 2014). The final $10 million of this amount, which secured an easement on the property in perpetuity, was provided by the California Wildlife Conservation Board in 2014.

The current plans for the San Vicente Redwoods property are to facilitate sustainable timber harvesting on approximately half of the total acreage in a way that both protects rare and irreplaceable old growth redwood stands, and increases forest stand and structure complexity. It was estimated that the fair market value of harvestable timber will be approximately $4.8 million with the easement, compared with $8 million without the easement (Craig Owyang Real Estate, 2014). These activities will support jobs and the tax base of Santa Cruz County in addition to securing ecosystem services such as a reliable and safe water supply, high quality wildlife habitat, biodiversity, carbon sequestration, natural vistas, and recreational opportunities. As an additional opportunity, the property lies adjacent to Coast Dairies and Wilder Ranch State Park (both large protected areas); the former is currently owned and managed by U.S. Bureau of Land Management and the Trust for Public Land and the latter is owned and managed by State Parks. This contiguous and now protected landscape totals over 26,000 acres from the headwaters of the Santa Cruz Mountains to the beaches along the County's north coast (Sempervirens Fund, 2012). Coast Dairies currently supports grazing leases as well as irrigated agriculture and Wilder Ranch supports organic agricultural leases.

The San Vicente Redwoods property and neighboring Coast Dairies and Wilder Ranch will continue to generate traditional economic activity through production of goods such as timber, cattle, and organic produce; while increasing their economic contribution via fees and associated revenue from public access/recreation and both protection and restoration of multiple valuable ecosystem services. Though protected, forward-thinking partnerships and innovative stewardship programs will still need to be designed, funded, and implemented to maximize the long-term, sustainable yield of critical ecosystem goods and services from these working lands.

as a reliable and safe water supply, high quality wildlife habitat, biodiversity, carbon sequestration, natural beauty and vistas, and recreational opportunities. Without effective management and stewardship, most of these services are either compromised or not provided. Box 6 highlights the importance of both acquisition and stewardship in the protection and management of the San Vicente Redwoods property.

Stewardship of Natural Capital Supports Multiple Benefits

Natural capital assets can simultaneously produce multiple ecosystem goods and services and multiple economic benefits to both the landowner and the community-at-large. The use and optimization of individual services can either create trade-offs or synergies depending on land use strategies and priorities. For example, clear-cutting a forest provides short-term, high-value timber at the expense of long-term soil formation, wildlife habitat, water quality, and water supply. On the other hand, timber harvesting can be designed to support production of traditional economic goods like timber and at the same time help reduce risk from catastrophic forest fire, improve opportunities for groundwater recharge, and improve forest stand structure and complexity. Box 7 demonstrates the importance of approaching land management and conservation in a way that supports production of traditional economic goods such as food, while protecting, enhancing, and restoring other critical ecosystem services.

BOX 7: College Lake—Natural Capital Stewardship that Balances Agricultural Water Supply, Flood Management, and Fisheries

College Lake provides a powerful local example of natural capital that yields multiple benefits. College Lake is a natural lake that drains a 11,000-acres of range, rural residential, and crop lands into Salsipuedes Creek, a key water supply and fisheries-producing tributary to the Pajaro River (Pajaro River Watershed Integrated Regional Water Management Plan, 2014). In the spring, the 260-acre lake is pumped dry to allow farming to take place during the late spring, summer, and fall. This practice continues today and a majority of the lakebed is used for row crops including vegetables, strawberries, flowers, and raspberries (Pajaro Valley Water Management Agency, 2013).

The Pajaro Valley Water Management Agency is considering College Lake as a key water supply project to help address significant aquifer overdraft and provide sustainable water supplies to support farming in the Pajaro Valley. Proposed alternatives include a combination of built and natural infrastructure to increase water storage capacity and pipe the water downstream to increase local agricultural water supplies and reduce pressure on the overdrafted Pajaro Valley Aquifer (at a cost of approximately $1,000 per acre foot of water (Pajaro Valley Water Management Agency, 2013)). In addition, the U.S. Army Corps of Engineers and local agency partners have identified College Lake as a unique natural flood attenuation and detention basin to address peak flood flows from Corralitos and Salsipuedes creeks into the Pajaro River as part of the Corps multi-billion dollar Pajaro River Project. In the 2011 College Lake Smolt Outmigrant Study, the lake was also shown to be "productive rearing habitat for juvenile steelhead prior to their outmigration to the ocean." (Podlech, 2011)

The College Lake Improvement and Watershed Management Plan, an effort funded by the California Department of Water Resources and led by the RCDSCC, is developing the necessary hydrologic data and modeling tools to assess the potential opportunities and constraints associated with various land-use and infrastructure modifications to support an integrated, multiple benefit project. Options include restoring and protecting wetland and riparian habitats in the College Lake area, and developing multiple use infrastructure and ecosystem elements that could be used to maximize water supply, flood attenuation, and habitat production. While the current modeling shows that the objectives of water supply, flood control, and fisheries habitat can be designed to work in tandem, agricultural production within the current lake bottom will be significantly more challenging to integrate into a project that meets PVWMA's water supply goals.

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BOX 7: College Lake—Natural Capital Stewardship that Balances Agricultural Water Supply, Flood Management, and Fisheries

Implementing the College Lake Improvement and Watershed Management Plan could ensure a number of economic benefits to the region as well as some localized impacts. The water supply benefits of the Plan that support regional agricultural production are significant. The Pajaro Valley supports an agricultural industry that generates more than $500 million in revenue but is threatened by the shortage of reliable water supplies. A management alternative at College Lake that includes water supply would provide approximately 2,400 acre feet per year to address the vital water supply needs in the Pajaro Valley (Pajaro Valley Water Management Agency, 2013). If used for a high-value crop such as strawberries, this water could support approximately $40 million in revenue each year.[15] By some estimates, College Lake can also provide up to 10% of the Army Corp's flood protection goals downstream of the Salsipuedes Creek/Pajaro River confluence (a reduction in flow of approximately 2,500 cubic feet per second) (Pajaro River Watershed Flood Prevention Authority, 2003).

Wetlands also contribute to global climate stability by sequestering and storing carbon for thousands of years. A recent study for example measured the carbon storage rates of "depressional" and "flow through" temperate wetlands, similar to those that would naturally have been found in and around College Lake (Bernal and Mitsch, 2012). The results showed these wetland types sequester approximately 2.1 and 4.7 metric tons of CO_2 per acre per year respectively.[16] Based on the current price of a metric ton of CO^2 in California's cap and trade program ($11.50), each acre of wetlands restored or created could therefore have an annual market value of between $24 and $54 for carbon sequestration.[17]

In addition to the ecosystem services of water supply, flood attenuation and carbon sequestration, if managed for multiple benefits or services, the lake could provide other ecosystem services such as supporting biodiversity, trapping and cycling nutrients and sediment, and provide for potential limited and controlled passive recreation such as bird watching. While the majority of the lake is currently owned by private entities and it is not open to recreation, restoration of seasonal wetlands and controlled and limited access for passive recreation such as bird watching on publically owned parcels could provide economic benefits. A meta-analysis by Woodward and Wui (2001) for example estimated that the non-market value of wetlands is between $928 and $4,887 per acre per year for bird watching activities (these values were applied to some of the wetlands in Santa Cruz County valuation; see Appendix C).

The College Lake project shows that natural capital can support multiple ecosystem services and maximize return on investment. At the same time, the project demonstrates that even multi-benefit projects require tradeoffs, as it is unlikely that use of the lakebed for agriculture will be compatible with maximized use of the lake for regional water supply.

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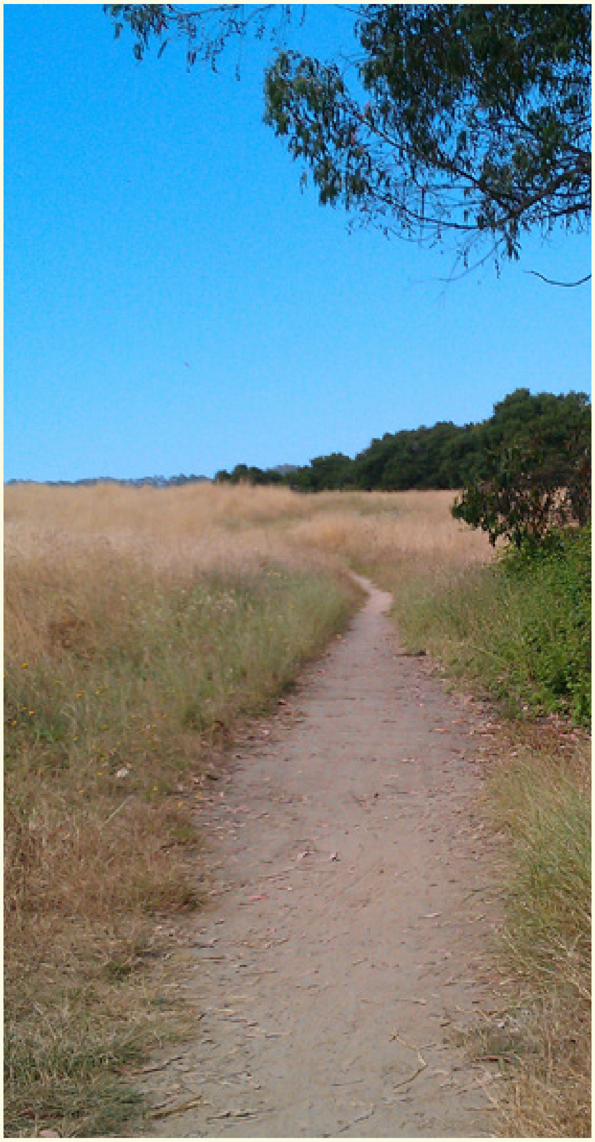
[15] This estimate is based on the following assumptions: 1) on average, strawberry crops require 3 acre feet of water per acre each year (Source: UC Cooperative Extension, 2010. Sample Costs to Produce Strawberries, Central Coast Region. Table 2. Available at: http://coststudies.ucdavis.edu/files/StrawberryCC2010.pdf); 2) one acre of strawberry crops generates approximately $49,800 in gross returns each year (Source: UC Cooperative Extension, 2010. Sample Costs to Produce Strawberries, Central Coast Region. Table 2. Available at: http://coststudies.ucdavis.edu/files/StrawberryCC2010.pdf);

[16] Reported in the study as 317 and 140 grams per square meter per year respectively.

[17] This calculation uses a price of $11.50 per metric ton C02, which was the most recent auction clearing price for the Cap and Trade program. Source: http://www.arb.ca.gov/cc/capandtrade/auction/august-2014/results.pdf

Stewardship of Natural Capital as a Cost Avoidance Strategy

Protection and stewardship of natural capital not only maximizes the benefits provided across the landscape, it also reduces downstream costs and risks to landowners, resource managers, water utilities and taxpayers. Natural capital can avoid costs associated with downstream flooding, sediment, and salmon restoration. A well-known example is New York City, which chose to invest $1.5 billion in watershed protection in its Catskills watershed, and has saved $6 billion in capital costs and $300 million in annual operating costs for a filtration plant it would otherwise have been required to build (National Research Council, 2004). Many other water utilities, including Sonoma County Water Agency, Seattle Public Utilities, and Portland Water Bureau also rely on natural capital to avoid the significant capital costs associated with filtration plants. More recently, the Sierra Nevada Conservancy commissioned a study in the Mokelumne Watershed, and found that fuel treatments (such as forest thinning) can significantly reduce the size and intensity of wildfires, and that the benefits of such investments can outweigh the costs by 2-3 times (Buckley et al., 2014). Box 8 provides a local example of real costs that can be avoided through upstream investment in natural capital in Santa Cruz County.



Arana Gulch, located in Santa Cruz County, provides a local example of real costs than have been avoided through investment in natural capital. *Credit: Image released under a creative commons license by Shani Heckman.*

Blue Trail Gully just after completion of the gully repair project. Since then, the site has revegetated and the impacts of the gully are no longer visible. *Credit: Balance Hydrologics, Inc.*

BOX 8: Arana Gulch: A Watershed Approach to Restoration that Delivers a High Return on Investment for the Community

Sediment retention is the key ecosystem service that warrant focus in the Arana Gulch Watershed, which sits at the edge of the City of Santa Cruz and drains a 3.5 square-mile area into Arana Gulch and Monterey Bay. This small area has received significant attention due to the large quantity of sediment that is deposited from the gulch into the Santa Cruz Small Craft Harbor.

Sediment mobilization, transport, and deposition within the main channel of the gulch has reached a level where habitat for spawning and rearing steelhead salmon has been impaired (Harris, 2006). In addition, the Santa Cruz Port District must dredge the harbor to maintain an appropriate water depth for boat access and egress. According to an estimate from 2005, Arana Gulch was releasing more than 1,500 cubic yards of sediment annually, and 23,000 cubic yards had accumulated in the North Harbor (Santa Cruz Port Harbor, 2005).

Due to the complexity of dredging and disposing of this material, dredging of the North Harbor has been estimated to cost around $24-29 per cubic yard, or a total of approximately $480,000-580,000 in a normal year (assumes removal of approximately 20,000 cubic yards per year) (Hopper, 2014). In particularly rainy years, sediment can overwhelm the harbor and increase these costs. In 2007 for example, sediment deposition in the harbor was beyond the Port District's permitted off-shore discharge capacity so it was forced to dispose of sediment at upland locations, at a significantly higher cost $85-100 per cubic yard (Hopper, 2014).

Implementation of the stewardship actions that facilitate upland erosion control, natural sediment storage, and ecological restoration, through partnerships such as the Integrated Watershed Restoration Program, Partners in Restoration Program, and Arana Gulch Watershed Alliance could result in significant cost savings to the Port District, as well as reduced impacts to the sensitive marine environment.

Between 2007 and 2010 the RCDSCC and its local partners in the watershed facilitated the implementation of eight projects involving sediment load reduction practices and both instream and riparian habitat improvements, which benefited not only the Port District but also local salmonid populations and California red-legged frog habitat. Specific stewardship actions in these projects included stabilizing stream banks, repairing gullies, fixing and/or replacing culverts, establishing critical planting areas, constructing bioswales for sediment retention, grading and paving highly erodible areas to guide runoff toward retention swales.

One of the larger sediment control projects focused on the repair of a large gully system known as the Blue Trail Gully, a site that accounted for an estimated 1,000 cubic yards of sediment loss annually. At the time the project was implemented in 2007, the site had already lost an estimated 16,000 cubic years of sediment.[18] The cost of the project was $208,113, but may reduce annual dredging costs for the Port District by $24,000-$29,000 in a normal year, and as much as $85,000-$100,000 during a rainy year. In addition, all of the Arana Gulch projects create additional benefits to the public through enhancement of ecosystem services such as flood attenuation, biodiversity, and recreation.

In the long-term, continued public investment in upland stewardship programs that reduce erosion and transport of sediment, and protecting and restoring ecosystem services like flood attenuation, soil stabilization, and biodiversity could represent wise investments and result in a high return on investment and cost avoidance for local taxpayers.

[18] According to field calculations completed for the 2002 Arana Gulch Watershed Enhancement Plan, 9,000 cubic yards of sediment had been lost by the year 2000 (Source: Chartrand et al., 2002). Assuming a continued rate of 1,000 cubic yards lost annually, it is estimated the site had lost 16,000 cubic yards by 2007.

CHAPTER 5: Case Studies on the Economic Benefits of Conservation and Stewardship Investments in Santa Cruz County

Conservation and Stewardship as an Investment

Whether investments are private or public, understanding their rate of return is essential to allocating capital efficiently and generating significant and real returns. Once economic benefits of natural assets have been quantified, Return-on-Investment (ROI) and Benefit-Cost Analysis (BCA) can be used as tools to better understand the economic benefits and rates of return from conservation investments. For example, ROI measures the relative efficiency of different investments by comparing the expected benefits of each investment to its cost over time. ROI can also take into account relative risk, which is another key factor in the decision-making process. The measurement of ROI has been proven to be superior to other decision-making tools for ensuring cost-efficiency and the maximization of benefits (Kovacs et al., 2013; Murdoch et al., 2010).

This chapter demonstrates an application of ecosystem service values in traditional methods to assess the economic benefits of three conservation and stewardship investments in Santa Cruz County: 1) an ROI analysis conducted on a Managed Aquifer Recharge project in the Pajaro Valley; 2) a BCA to evaluate the economic benefits of land acquisitions by the California Department of Parks and Recreation (State Parks) in the county; and 3) a leveraged funds and job creation analysis for the Santa Cruz County Integrated Watershed Restoration Program.

The Bokariza managed aquifer recharge project is located above the Pajaro Valley Aquifer in Santa Cruz County. This chapter discusses the return on investment analysis of this project. *Credit: Andy Fisher.*

Return on Investment Case Study: Bokariza Managed Aquifer Recharge Project

This section is a summary of the return on investment analysis that was conducted on the Bokariza Managed Aquifer Recharge project in the Pajaro Valley. The full analysis, including more detail on methods and project background, is attached to this report as Appendix E.

The Pajaro Valley Aquifer provides more than 90 percent of the water used by the $600 million agriculture industry in Santa Cruz County. This high-value, specialty crop industry has one of the highest annual profits per acre in the State of California (BAE Urban Economics, 2013). Groundwater is currently pumped from the Pajaro Valley Aquifer at a rate of approximately 54,000 acre-feet per year (AFY) over the past ten yeras to meet the needs of residents, businesses and agriculture (Pajaro Valley Water Management Agency, 2012). This water is being withdrawn much faster than it can be replenished; resulting in a serious annual overdraft (estimated at 12,000 AFY) (Pajaro Valley Water Management Agency, 2012) that poses many risks to the surrounding communities and the local economy.

This case study highlights the value of an individual managed aquifer recharge (MAR) project, part of a larger initiative called the *Community Water Dialogue* (CWD), which includes multiple stakeholders and a portfolio of strategies to address overdraft in the Pajaro Valley Aquifer. MAR projects manipulate runoff from the landscape and leverage natural capital such as soils with high percolation and infiltration rates to enhance groundwater recharge. The Bokariza MAR project is located above the Pajaro Valley Aquifer in the southern part of Santa Cruz County. It encompasses a drainage area of between 90-120 acres mostly used for commercial berry production, draining into a 2-acre recharge basin. The basin receives stormwater runoff from surrounding fields and hill slopes, and has an estimated recharge capacity (amount of water infiltrating back into the aquifer) of 80-100 acre AFY, based on infiltration and average precipitation rates (Fisher et al. 2011).

This case study translates the ecological and hydrological functions performed by the Bokariza MAR project into economic benefits and values. The benefits are compared to the costs of setting up and maintaining the project, in order to determine the economic efficiency of these types of investments. Water management agencies, planners, decision makers and stakeholder initiatives such as the CWD can use this information to allocate resources and optimize aquifer management beyond water supply by including other critical ecosystem functions in their decision making.

Calculating Return on Investment

An ROI calculation considers both costs and benefits. Costs can include fixed costs (such as the purchase of land), variable costs (such as maintenance costs), and environmental costs (impairments to ecosystem services). Benefits can include market benefits (e.g. rents, yields, jobs) and public or non-market benefits like ecosystem services.

In its simplest form, ROI is expressed as follows:

$$\text{ROI} = \frac{(\text{Gain from Investment - Cost of Investment})}{\text{Cost of Investment}}$$

Estimating the Costs of the Bokariza Managed Aquifer Recharge Project

The Bokariza Project was a relatively inexpensive project given that minimal equipment and infrastructure was used, and the 2-acre site did not need to be acquired due to an agreement with the landowner. The following costs were identified:

- **One-time costs.** Representing the costs associated with infrastructure, staff, and permit coordination, one-time costs were estimated at $70,000.
- **Maintenance Costs.** It was estimated that the Bokariza MAR would cost $5,000 per year on average to maintain.
- **Opportunity Costs.** Representing the net returns (i.e. profits) that could be generated by producing strawberries in the 2 acre recharge area if it was not being used as a recharge site, opportunity costs were estimated at $15,224 (i.e. $7,612 per acre per year).

Estimating the Benefits of the Bokariza Managed Aquifer Recharge Project

In order to value the Bokariza recharge area, we first identified a range of potential benefits that could be attributed to the site. Benefits we could find physical measurements for or satisfactory estimates of potential changes were then selected for valuation. Given the small size of the managed recharge area in relation to the overall aquifer, and difficulties in extrapolation, only some of the ecosystem services identified were deemed relevant for valuation. Different methods were used depending on the data available and the dimensions of the service that were found to be most important. The following benefits were valued and included in this analysis (all values are reported in 2012 dollars):

- **Water Supply.** The cost of substituting the 90 AFY of groundwater recharge provided by the Bokariza MAR (90 AFY on average) with a combination of future water supply projects currently proposed in the Pajaro Valley Water Management Agency's Basin Management Plan (2012 Update) (Pajaro Valley Water Management Agency, 2013). It is estimated that these projects will cost an average of $551 per AF of water (or $49,590 per 90 AF) for each of the first ten years (2015-2025) and rise to an average of $2,023 per AF of water (or $ 182,070 per 90 AF) for each of the following 15 years (2025-2040).
- **Flood Control.** The value of the Bokariza MAR for helping to avoid costs by protecting roads from soil erosion was estimated at $446 annually, based on a 1999 study conducted in Monterey Bay (Rein, 1999).
- **Habitat.** The value of wetlands for habitat based on the amount that landowners are paid through the Natural Resources Conservation Service's Wetlands Reserve Program. Estimated at $960 per year.

Estimating the Return on Investment of the Bokariza Managed Aquifer Recharge Project

After calculating costs and benefits, Earth Economics ran an ROI analysis over 25 years. Results indicate that after 10 years, the Bokariza MAR returns 87% (or $1.87 for every $1 invested), and after 25 years the project returns 467% (or $5.67 for every $1 invested). A summary of results is provided in Table 8.

Figure 7 shows a graphic representation of the ROI estimate for Years 1 through 25, and indicates that the ROI increases at a faster rate from Year 11 onwards due to the higher replacement value of each acre foot of water.

The average annual return on investment from this project (approximately 6.4% per year over 25 years) is comparable to or better than expected real returns from traditional economic investments (after dividend/income taxes, inflation, expenses etc.), such as the stock market (the average annual investment return for stocks on the S&P 500 index was 6% over the past 30 years) or municipal bonds (average annual investment return of 3.6% over the past 30 years) (Thornburg Investment Management, 2013).

FIGURE 7: Cumulative Return on Investment of Bokariza MAR over Years 1-25

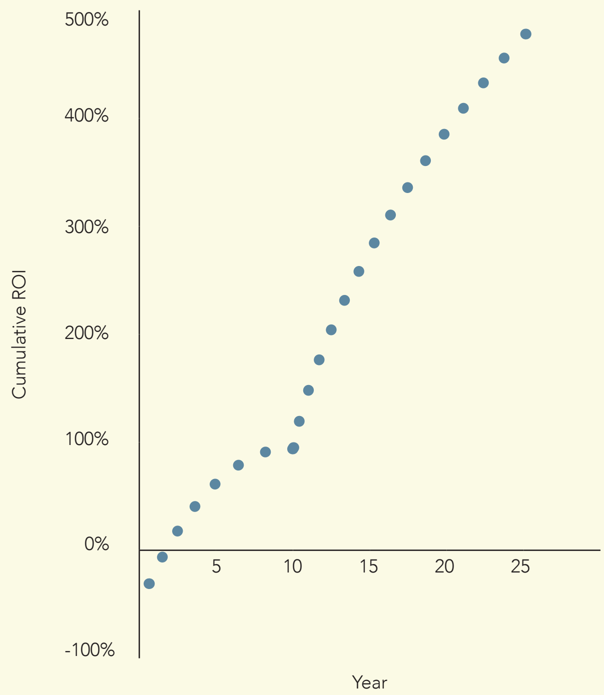


TABLE 8: Summary of Bokariza MAR ROI Results

Cumulative Costs	Year 1	Year 5	Year 10	Year 15	Year 20	Year 25
Maintenance Costs	$5,000	$25,000	$50,000	$75,000	$100,000	$125,000
One-time Costs	$70,000	$70,000	$70,000	$70,000	$70,000	$70,000
Opportunity Costs	$15,224	$76,120	$152,240	$228,360	$304,480	$380,600
TOTAL	$90,224	$171,120	$272,240	$373,360	$474,480	$575,600
Cumulative Benefits	**Year 1**	**Year 5**	**Year 10**	**Year 15**	**Year 20**	**Year 25**
Water Supply	$49,590	$247,950	$495,900	$1,406,250	$2,316,600	$3,226,950
Flood Control	$446	$2,230	$4,460	$6,690	$8,920	$11,150
Habitat	$960	$4,800	$9,600	$14,400	$19,200	$24,000
Total	$50,996	$254,980	$509,960	$1,427,340	$2,344,720	$3,262,100
TOTAL	$50,996	$254,980	$509,960	$1,427,340	$2,344,720	$3,262,100
Cumulative ROI	**Year 1**	**Year 5**	**Year 10**	**Year 15**	**Year 20**	**Year 25**
	-43%	49%	87%	282%	394%	467%

Benefit-Cost Analysis Case Study: Santa Cruz County State Parks

All federal and state agencies, cities, counties and many private firms utilize benefit-cost analysis (BCA) to make investment decisions. BCA covers a diverse set of investments including health care, levee construction, education investments, road building, economic development, tax breaks and others. BCA also forms the basis for most major water resource project decisions, including those made by the U.S. Army Corps of Engineers (Council on Environmental Quality, 2012). For example, BCA is the primary factor in flood protection investment decisions at the Army Corps of Engineers. They require that the benefit to cost ratio be above 1.0 during the project's period of analysis[19] for any flood control investment to even be considered for funding. This process of executive decision-making has become standardized in order to ensure equal focus is given to all potential benefits and costs across multiple projects.

Rationale for including BCA in decisions was expanded in multiple policy documents including the Water Resource Council's *Principles and Standards* released in 1973, the *Principles and Guidelines* released in 1983, and more recently in proposed changes to the same documents in the White House Council on Environmental Quality's 2009 report. A new proposed revision entitled *Principles and Requirements* was released by the Council on Environmental Quality in March of 2013 and is currently open for public comment. The new document and attached Interagency Guidelines promote the need to protect naturally occurring ecosystem services, stating, "Healthy and resilient ecosystems not only enhance the essential services and processes performed by the natural environment, but also contribute to the economic vitality of the nation". The 2013 update also acknowledges new and practical advancements in ecosystem service valuation, and makes this a required component of future BCA (White House Council on Environmental Quality, 2013).

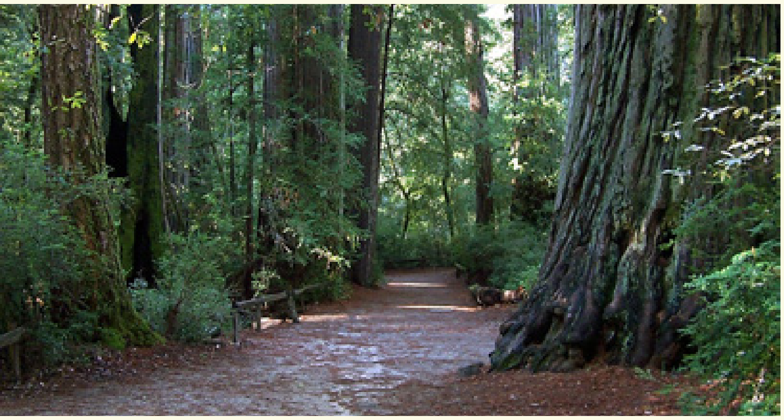
[19] The "period of analysis" is defined as "the time required for implementation plus the lesser of (1) The period of time over which any alternative plan would have significant beneficial or adverse effects; or (2) A period not to exceed 100 years." Source: U.S. Water Resources Council, 1983.

As noted previously in this report, FEMA has already adopted ecosystem service values for its BCA tool, and the State of California recognizes ecosystem service values as an input to decision making. The following case study demonstrates how ecosystem services can be taken into account in BCA, using the California State Parks system within Santa Cruz County as an example.

California's State Parks

California Department of Parks and Recreation ("State Parks") manages a system of 280 park units, covering almost one-third of California's scenic coastline and numerous parks, beaches, trails, wildlife areas, open spaces, off-highway vehicle areas, and historic sites. The State Parks system protects and manages some of the finest and most diverse collection of natural, cultural, and recreational resources to be found within California. It consists of approximately 1.59 million acres, including over 339 miles of coastline, 974 miles of lake, reservoir and river frontage, approximately 15,000 campsites and alternative camping facilities, and 4,456 miles of non-motorized trails. State Parks' mission is to provide for the health, inspiration and education of the people of California by helping to preserve the state's extraordinary biological diversity, protecting its most valued natural and cultural resources, and creating opportunities for high-quality outdoor recreation (California Department of Parks and Recreation, 2014).

Natural Bridges State Park is one of 14 State Parks units in Santa Cruz County. *Credit: image released under a creative commons license by Lori Branham.*



Big Basin Redwoods State Park in Santa Cruz County was established in 1902, making it California's oldest state park. *Public domain image.*

The State Parks system has 14 park units in Santa Cruz County, linking its mountain forests to the coastline, protecting wildlife corridors, and offering recreational opportunities to visitors via campgrounds and hiking trails through majestic old-growth redwoods, graceful waterfalls and streams, coastal bluffs, historic buildings, agriculture and range landscapes, and popular beaches (Santa Cruz County Conference and Visitors Council, 2014). These parks are one way to experience Santa Cruz County's natural beauty, and they represent an important economic asset to the local tourism and recreation industry.

Study Approach

BCA is typically conducted on projects that are being considered for the future, to decide whether or not the projects are economically justified. In this study, a different approach was taken. A retrospective (i.e. "looking back") analysis was conducted, comparing the benefits and costs of the State Parks units in Santa Cruz County from 1906 through 2011. In other words, if a typical BCA were conducted on the State Parks lands in 1905, it might have looked at the estimated future benefits and costs (i.e. from 1906-2011), and discounted the benefits and costs back to present value (i.e. 2005 dollars). This study, on the other hand, looks back at actual (and in some cases, estimated) benefits and costs in each year from 1906-2011, and inflates those values to present dollars (2012 dollars in this case). The total benefits over that period are then compared with the total costs. Only *public benefits* and *public costs* are considered. The following sections describe how benefits and costs were identified and calculated.

Isolating the Impacts of State Parks Investments

The goal of a BCA is to estimate the benefits of a particular intervention such as a project, program or policy as compared with its costs. In the context of this study, the intervention is acquisition and management of approximately 45,000 acres of lands by State Parks over the period 1906-2011. An important step for any BCA is to isolate the specific costs and benefits associated with an intervention, so as not to count benefits and costs that would have occurred anyway (i.e. in the absence of the intervention). To isolate these benefits and costs, two scenarios were defined, a *With Parks* scenario and a *Without Parks* scenario. The scenarios are defined as follows:

1. **With Parks.** This alternative represents what has actually happened. That is, during the period 1906-2011, approximately 45,000 acres of land were acquired and managed by the State Parks Department, and largely opened up for recreational activity. In this alternative, public benefits include both ecosystem services and State Parks revenue; public costs include acquisition costs, operations & maintenance costs, volunteer costs, opportunity costs and public infrastructure costs.
2. **Without Parks.** This alternative represents what might have happened if, during the period 1906 - 2011, State Parks did not exist and did not make any land acquisitions in Santa Cruz County. In this alternative, it is assumed that approximately 50% of today's State Parks lands were acquired and/or protected by private land trusts, though not as many of these lands became available for recreation as they did in the *With Parks* scenario. Of the other 50% of lands that were not acquired or protected, approximately 20% were developed into commercial, residential, or otherwise taxable land (i.e. 10% of the total). The other 80% of the half not protected were not developed due to inaccessibility or lack of demand for development. In both cases, the land provided a lower level of ecosystem services compared to the *With Parks* scenario, as they were not as actively managed for recreation or other services such as biodiversity, natural beauty, and cultural value. In this alternative, public benefits include ecosystem services and property tax revenue; public costs include public infrastructure costs.

Estimating the Benefits and Costs of State Parks in Santa Cruz County

Public benefits and costs of the state parks system in Santa Cruz County were estimated from 1906 through 2011. For each category of benefit (or cost), a maximum value was first determined, representing the annual value of the benefit (or cost) in 2012 dollars. Then for each year from 1906 through 2011, the annual benefit (or cost) was weighted according to how much of the Santa Cruz State Parks' 2011 total of 45,000 acres had been acquired in that year. For example, if the benefit (or cost) was being counted in the year 1916, when only 4,500 acres of land (or 10% of 45,000 acres) had been acquired, then only 10% of the maximum benefit (or cost) in 2012 would be counted. Finally, in order to isolate the specific contribution of State Parks to these benefits (or costs), a *Net Benefit* (or *Net Cost*) was calculated as the difference between the *Gross Benefits* (or *Gross Costs*) in the *With Parks* scenario and the *Gross Benefits* (or *Gross Costs*) in the *Without Parks* scenario.

Benefits

1. **Ecosystem Services.** State Parks lands today cover approximately 45,000 acres in Santa Cruz County. As previously discussed in this report, natural capital provides a range of ecosystem services that can be valued using benefit-transfer methodology.

   a. **Gross Benefits.** The value of ecosystem services provided on these lands was estimated using the same methods applied to the Santa Cruz county-wide valuation (as described in Chapter 3), but using only the land cover area (and applicable primary studies) corresponding to the 14 park units as of 2011. Ecosystem service benefits were estimated at between \$116 million and \$284 million annually in 2012 dollars. The average of this range, \$200 million per year, was used as the "maximum" value for this BCA. Weighted according to the proportion of land that State Parks had acquired at each year over the period 1906-2011 compared with today's total, this resulted in an estimated total value of \$11.7 billion in ecosystem service benefits.

   b. **Net Benefits.** It is likely that some level of ecosystem services would still have been provided on the lands that make up the 14 State Parks units, even in absence of State Parks protection and management. To better reflect the actual value of State Parks' interventions, the total benefit value of ecosystem services (\$11.7 billion) that occurred in the *With Parks* scenario was converted to a net benefit value by comparing it to the *Without Parks* scenario, in which only 10% of State Parks lands actually lose their ability to produce significant ecosystem services through conversion to commercial and residential land. By subtracting the benefits of the *Without Parks* scenario from the *With Parks* scenario, a net benefit value was estimated as \$1.2 billion.

2. **Parks Revenue.** The State Parks Department earns revenue through the sale of day passes, camping passes, and other means.

   a. **Gross Benefits.** Revenue data for the Santa Cruz District was approximately \$7.2 million for Fiscal Year 12-13. Because historical revenue data was not available, it was conservatively assumed that State Parks has been receiving the same level of revenue for the past 50 years (i.e. over the period 1961-2011). Weighted according to the proportion of land that State Parks owned at each year over the period 1906-2011 compared with today's total, this resulted in an estimated total value of \$313 million.

   b. **Net Benefits.** There would be no Parks Revenue benefits in the absence of State Parks, therefore the net value was \$313 million.

Costs

1. **Acquisitions.** The 45,000 acres of land currently managed by the Santa Cruz District have been acquired over a period of many years.

   a. **Gross Costs.** Acquisition records for the Santa Cruz District were available from 1906 through 2011, which included information on the date of acquisition, the cost (or "gift value") of each acquisition, the number of acres acquired, and the State Parks unit associated with the acquisition. The cost of each acquisition was converted to 2012 dollars from its original currency year. Over the period 1906-2011, the total cost of acquisitions was $153 million.

b. Net Costs. There would be no Acquisition Costs in the *Without Parks* scenario, therefore net costs were $153 million.

2. Operations & Maintenance (O&M). Following acquisition, State Parks lands are maintained and improved by the State Parks Department. Annual O&M costs for Santa Cruz State Parks lands were estimated at $15.2 million in 2012 dollars.

a. Gross Costs. Over the period 1906-2011, inflated to 2012 dollars, and weighted according to the percentage of land held at each year (compared with the present day total), O&M costs for the Santa Cruz District were approximately $893 million.

b. Net Costs. There would be no O&M costs in the *Without Parks* scenario, therefore the net costs were $893 million.

3. Volunteer Time. Volunteers contributed approximately 96,000 hours for Santa Cruz State Parks each year.[20] According to the Independent Sector, a national leadership forum focused on charities, foundations and corporate giving programs, the average hourly rate estimated for volunteer time in California was $26.34 in 2013 (converted to $25.96 in 2012 dollars) (Independent Sector, 2014).

a. Gross Costs. Over the period 1906-2011, the total value of volunteer time contributed to Santa Cruz State Parks is worth approximately $147 million.

b. Net Costs. There would be no Volunteer costs in the *Without Parks* scenario, therefore the net costs were $147 million.

[20] The latest data available was for 2010.

Benefit-Cost Analysis

The BCA was conducted over the period 1906 through 2011, for which actual cost data was available. Table 9 shows which benefits and costs were identified in each scenario, and of those identified, which could be valued. At least one category of benefit and one category of cost could not be valued.

Total benefits over the period 1906-2011 were compared to total costs, yielding a Benefit-to-Cost ratio. A summary of this calculation is provided in Table 10.

Discussion

This initial analysis indicates that State Parks acquisitions from 1906-2011 have produced benefits that outweigh their associated costs, with a Benefit-to-Cost ratio of 1.24. In other words, from a purely economic perspective, State Parks acquisitions over this period of analysis have been justified.

A basic sensitivity test was also conducted on the time horizon used for the analysis. An analysis over the last 50 years (1962-2011) of State Parks data results in a Benefit-to-Cost ratio of 1.32.

A number of improvements can be made to this limited analysis. While a conservative approach was taken to avoid over-counting benefits or under-counting costs, a more complete analysis may yield different results. For example, as shown in Table 9, this analysis does not include all the costs and benefits associated with residential and commercial development, if it were to occur in the *Without Parks* scenario. That is, if the State Parks lands had not been acquired and protected, some of that land could have been developed, generating property tax revenues for Santa Cruz County. The cost of not having the opportunity to develop the State Parks lands represents lost revenue to private developers, as well as associated tax revenue that could have been assessed by the government on those properties. On the other hand, development also entails public infrastructure costs, such as installing roads and water infrastructure that may not benefit the public at large. These would reduce the potential net benefits associated with residential and commercial development.

TABLE 9: Benefits and Costs Present vs. Valued in Each Alternative

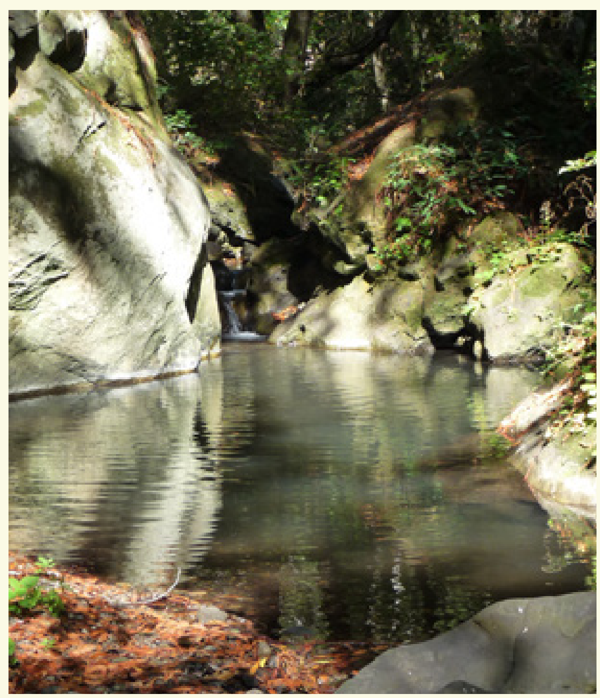
	With Parks Alternative	*Without Parks* Alternative
PUBLIC BENEFITS		
Ecosystem Services	X	X
Parks Revenue	X	
Property Tax Revenue[21]		X
PUBLIC COSTS		
State Parks Land Acquisition	X	
State Parks O&M	X	
State Parks O&M (Volunteers)	X	
Opportunity Cost (lost tax revenue)	X	
Public Infrastructure Costs[22]	X	X

KEY	
X	Benefit or cost is present and quantified in this BCA
X	Benefit or cost is present but not quantified in this BCA
	Benefit or cost is not present

[21] This category refers to property taxes that might have been assessed on residential and commercial development, had some portion of today's State Parks lands been developed in the *Without Parks* scenario.
[22] In the *With Parks* scenario, it is assumed that many of the public infrastructure costs associated with State Parks development are captured in the category "State Parks O&M." However, it is also acknowledged that State Parks acquisitions have likely entailed infrastructure costs at other agencies e.g. the California Department of Transportation installing a road that leads to a State Park. In the *Without Parks* scenario, this category refers to public infrastructure costs associated with housing and commercial development, such as residential roads and water infrastructure.

TABLE 10: Summary of Total Benefits vs. Total Costs for State Parks

	Total (1906-2011)
PUBLIC BENEFITS	
Ecosystem Services	$1,171,182,753
Parks Revenue	$313,343,774
Total	$1,484,526,527
PUBLIC COSTS	
State Parks Land Acquisition	$153,720,885
State Parks O&M	$892,895,643
State Parks O&M (Volunteers)	$146,703,434
Total	$1,193,319,962
BENEFIT-COST RATIO	1.24



Upper Y Creek, a tributary to Laguna Creek and within the Coast Dairies property. *Credit: Jim Robins.*

Local economic impacts of the Integrated Watershed Restoration Program

This section is a summary of the Integrated Watershed Restoration Program case study. The full analysis, including more detail on methods and project background, is attached to this report as Appendix F.

The Integrated Watershed Restoration Program (IWRP) is a countywide partnership effort to facilitate implementation of conservation projects that increase the quality and quantity of habitat for multiple listed species including salmonids and/or improve water quality conditions in 303(d)-listed waterways. Some of the key resource issues and environmental threats that IWRP addresses in Santa Cruz County include: Fine sediment loading from outdated culverts and road crossings; loss of functioning and "linked" healthy wetlands; loss of terrestrial and aquatic habitat for amphibians; man-made fish passage barriers; and diminished lagoon habitat, function, and water quality. In addition to these focal areas, IWRP is built on the concept of multiple benefits and has invested in projects that address either multiple focal areas or additional services such as flood attenuation, groundwater recharge, and recreation.

IWRP functions as a voluntary framework to engage and coordinate resource management, funding, and permitting agency staff and help ensure that the highest priority conservation projects are efficiently identified, funded, and permitted.

This study examined IWRP's economic impact through traditional economic methods such as leveraged funds and job creation for Santa Cruz County. Traditional economic metrics were used for this case study due to two key factors: 1) the diverse nature of projects funded through IWRP (over 100 projects have been completed across the County, many of which are very different, making large scale analysis difficult); and 2) the desire to demonstrate value through more traditional economic metrics. As such, this program-level economic impact analysis provides a complementary illustration of the economic value of conservation and stewardship actions in the County.

IWRP facilitates conservation projects that enhance, protect, and restore ecosystem services such as fish habitat. *Credit: Jim Robins.*

Key Findings

Between 2005 and 2012, the RCDSCC was able to leverage its $40-50K annual tax funding base (by several orders of magnitude) through partnership building and secure $17.1 million in investments for IWRP projects from public and private sources outside of the County. Most of these funds would not have come into Santa Cruz County in absence of IWRP. The analysis estimated that the activities supported with these investments resulted in a total economic output of about $38-43 million.[23] Based on jobs multipliers calculated for a range of restoration projects in Oregon, the $17.1 million is estimated to have supported approximately 200 full time and part time jobs, equivalent to approximately 140 Full Time Equivalent jobs.[24] It is also important to note that a significant amount of this infusion of funds and job creation occurred during the most recent economic recession, underlining the importance of its effect on the local economy.

[23] These results are based on a peer-reviewed output multiplier that was developed for restoration projects in Oregon, which found that a $1 million investment led to a total economic output of $2.3-2.5 million. Source: Nielsen-Pincus and Moseley, 2010.

[24] These results are based on a peer reviewed jobs multiplier developed for restoration projects in Oregon, including in-stream projects, riparian projects, wetland projects, fish passage projects, and upland projects. The study found that every $1 million invested in a restoration project supports approximately 4.3 direct jobs and 7.4 indirect jobs (11.7 jobs total). Direct jobs represent the jobs in the industries that carry out restoration work (contractors, project managers etc.), and the indirect jobs represent the jobs supported by purchases of supplies and services specific to restoration work. $17.1 million multiplied by 11.7 jobs/million yields 201.24 jobs. These numbers represent both full time and part time jobs, and not Full Time Equivalent (FTE) jobs. In order to convert this number to full time to FTEs, the number was weighted based on a survey-based study conducted in Humboldt County, CA, which found that 300 restoration jobs was equivalent to approximately 210 FTE jobs. This analysis assumes the restoration economy in Santa Cruz County has approximately the same composition of full time and part time jobs as that of Humboldt County. Source for Oregon study: Nielsen-Pincus et al. 2010. Source for Humboldt County study: Baker et al 2004.

CHAPTER 6: Integrating Natural Capital into Economic Decisions and Investments

For 100 years, the development paradigm in the U.S. has aimed at finding single solutions for single problems, with a clear emphasis on built infrastructure. In the 21st century the development paradigm is shifting to a more holistic "systems" approach where at least four different forms of capital and infrastructure—built, natural, human and social—are viewed as interdependent and must be balanced. In practice, this means that there is a need for governments and decision makers at various scales to adopt human well-being metrics, economic indicators and investment strategies that acknowledge and support the critical role played by natural capital and ecosystem services.

Santa Cruz County has been a leader in conserving and stewarding natural capital, laying the foundation for a world-class network of public parks, private reserves and other open spaces, many of which are working landscapes. But like much of the world, Santa Cruz County faces water scarcity, potential for increased flooding, climate uncertainty, loss of biodiversity, and stress on agricultural land, rangelands, and other open spaces that have been a key part of providing goods and services to support its healthy economy and high quality of life. In particular, the County's reliance upon tourism and agriculture as main drivers of the economy highlights the importance of natural capital and its services that flow into the local community.

California Red Legged Frog in San Vicente Creek. *Credit: Jim Robins.*

Using the results, concepts, methods and examples in this report, Santa Cruz County can continue to be an innovator, conservation leader, and economic leader by making wise investments in natural capital protection and stewardship. By understanding and quantifying the benefits of natural capital and its stewardship, public and private partners in the county can identify investment opportunities, measure outcomes, and continue to build on partnerships and policies that maintain open space and the vital ecosystem services it contributes.

Natural Capital: A Smart Investment Opportunity

Investing in natural capital through acquisition and continued stewardship can help to avoid future costs, and produce clear economic returns in the present and future. The appraisal results in this report indicate that open spaces provide highly valuable goods and services at a scale that far exceeds the current level of investment in natural capital stewardship. The State Parks and Bokariza MAR case studies also suggest that targeted stewardship of natural capital can yield a high return on investment, higher than many traditional economic investments such stocks and bonds, by producing benefits that outweigh their costs over time. Investments such as the Bokariza MAR create tangible benefits to the local economy including water supply reliability and flood risk reduction, while State Parks investments have supported both ecosystem service benefits, health benefits, and substantial visitor spending. In addition, the IWRP analysis demonstrates that conservation and stewardship activities not only create jobs, but also leverage funds from outside the county that generate significant economic activity.

Case studies such as Bokariza MAR and State Parks are examples of traditional analyses that incorporate the value of natural capital and ecosystem services. In addition to providing a more complete picture of the returns of open space and working land stewardship investments, these tools can be used to understand the beneficiaries of ecosystem services, and develop funding mechanisms (such as taxes, fees and charges) that protect natural capital in a logical and fair way. For example, at least six US water utilities include on their water bills natural capital charges that support investment in watershed restoration and easement purchases, and many more utilities allocate part of their budget to watershed protection. The City of Bellingham, Washington has raised more than $28 million since 2001, which has allowed it to purchase and steward nearly 1,800 acres of open space surrounding its water source, reducing phosphorous and associated drinking water treatment costs. Denver Water will raise $16.5 million for forest treatments and watershed protection over five years in order to reduce the risk of catastrophic wildfires such as the Buffalo Creek and Hayman fires, which resulted in more than $26 million in drinking water treatment and sediment/debris removal costs to utility ratepayers, and significantly higher costs for fire suppression and private insurance firms.

The results of this study should catalyze public dialogue regarding the development of a local funding source to both maintain existing economically and ecologically critical programs/projects, and to help position our community to continue to be highly competitive for state, federal and private grants through the ability to demonstrate significant and sustained local investment and cost-share.

A Framework for New Economic Measures and Incentives

Our capacity to measure and integrate natural capital benefits into traditional economic metrics is growing. Typically conservation projects have been measured by acres acquired, easements purchased, or trees planted. Today, the benefits of these conservation investments can also be estimated in dollar values. Economic valuation enables better funding mechanisms and accountability where returns can be calculated for public and private conservation investments. It also provides the basis for financial incentive structures that promote conservation. For example, "payments for ecosystem services" (PES) programs are an increasingly common voluntary arrangement in the United States, in which landowners receive payments for good land stewardship that improves water quality or other specified benefits. PES can be a powerful funding mechanism for rural areas that brings investment from urban areas (beneficiaries of ecosystem services) into rural areas (providers of ecosystem services).

Stewardship of natural capital, particularly in working lands, can also be substantially bolstered by implementing effective performance-based metrics, incentives and verification mechanisms. The "Performance-based Incentives for Conservation in Agriculture" (PICA) project led by the RCDSCC, is a good example of a public-private partnership addressing water supply and water quality protection in the Pajaro Valley, which may provide the basis for a future PES program in Santa Cruz County. In the PICA project, the RCDSCC is working with conservation partners, specialty crop industry groups, growers, shippers and technical advisors in the central coast of California to develop and test performance metrics, monitoring protocols and incentives around water and nutrient use. These metrics allow growers to measure and communicate their stewardship outcomes and better inform their management decisions. An incentive-based structure will stimulate better stewardship of groundwater resources, soil, surface waterways and wildlife habitat, through on-farm management decisions and practices.[25]

Building on Innovative Partnerships

Partnership building and maintenance has been a central feature of conservation initiatives in Santa Cruz County. This is particularly true for water resources management and conservation. For example, the Pajaro Valley groundwater basin has been in overdraft for the past 55 years, and population growth, increased agricultural production, and climatic variance are putting additional pressure on the already stressed water resources. In response to this situation, the Pajaro Valley Community Water Dialogue (CWD) was created in 2010 to bring together landowners, growers, government representatives, and environmental groups to collaboratively tackle this critical issue.

The CWD has generated some innovative management approaches. For example, CWD is removing barriers for growers to adopt technologies that allow them to track soil moisture in real time, and more efficiently decide when and for how long to irrigate. With support from

[25] More information on the PICA project at www.rcdsantacruz.org.

the RCDSCC, Driscoll's Berries, individual growers and private donors, the CWD has purchased and installed a number of communication towers, establishing an open-access wireless irrigation management network for growers to remotely retrieve real time data from soil tensiometers, virtually anywhere in the lower Pajaro Valley. This network significantly lowers the costs for growers to access technology that helps them use less water. Early adopters have reported 20-30% water savings. This project is estimated to decrease water usage by 1,000 to 2,000 acre-feet per year at a very low cost (relative to other water supply projects) of $10 per acre-foot.

In general, natural capital can provide a wide array of goods and services ranging from agricultural products to carbon sequestration, and from recreation to flood risk reduction. Thus, the concepts of natural capital and ecosystem services lend themselves to coordinated and integrated planning between state, regional, and local entities and between previously disparate sectors and agencies such as transportation, public health, and resource conservation.

Coordinated planning between agencies can save taxpayers and businesses money and increase public economic returns by pooling investments and favoring infrastructure projects that leverage and measure the multiple benefits of natural capital. For example, Integrated Regional Water Management, promoted by the California Department of Water Resources, incentivizes coordination between regional agencies to achieve sustainable water management in the state. Likewise, the State's Regional Advanced Mitigation Program ("RAMP") and our local Early Mitigation Partnership ("EMP") look to build non-traditional partnerships between state and federal public infrastructure agencies, local resource and planning agencies, and private and public landowners interested in conservation. These proactive efforts focus on maximizing sustainable public benefits while reducing taxpayer investment.

Ultimately this kind of multi-sector collaboration should support improved policy for all economic investments. For example, legislation proposed in Washington State would create a Watershed Investment District, an institution that can streamline investment in a watershed across private and public agencies from the federal to the local level. This type of natural capital institution could help Santa Cruz County and cities coordinate natural capital investments with existing agencies (e.g. Army Corps, FEMA) and districts (e.g. Pajaro Valley Water Management Agency). Preliminary analysis of the Watershed Investment District by Earth Economics indicates this mechanism could both save tax payers money by reducing redundancy and inefficiency, while at the same time generating a more robust and focused funding mechanism for natural capital investment. Taking an integrated (or "systems") approach to managing built and natural capital in this way can reduce infrastructure conflicts and costs, facilitate partnerships, and produce higher returns on public and private investment.

Supporting Stewardship through Policy and Planning

Integration of ecosystem service values into land use policies and regulation at all levels will help bolster conservation actions throughout the county by ensuring that natural capital is considered in tandem with other economic assets in decision making. With this data, more complete evaluation of stewardship and acquisition policies is possible. While voluntary conservation and stewardship will continue to be critical tools to support and enhance the flow of ecosystem services from private lands, policy and regulations (backed by robust funding sources and incentive programs) must continue to play a fundamental role in the management of natural capital assets.

State and federal legislation can have strong impacts on local policy decisions. For example, the Williamson Act (formerly known as the California Land Conservation Act of 1965) protects agricultural and open space land in California from development through contractual agreements between private landowners and local governments (California Department of Conservation, 2013). As of 2010, Santa Cruz County had 19,758 acres enrolled in the Williamson Act (Mackenzie et al., 2011). While the Williamson Act provides incentives for how land is used (e.g. tax incentives to keep lands in agricultural production), novel approaches are being developed that build on this model and encourage best management practices on rural lands. For example, the

Public Benefit Rating System in King County, Washington State, uses a points system that reduces property taxes (by 50-90%) for landowners who implement specific stewardship practices on their land (King County, 2011). Currently more than 14,000 acres are enrolled in King County, and this approach could also be effective for protecting and stewarding natural capital in California.

Land use planning can also allow for the provision of key ecosystem services while supporting demographic change and economic growth. In part due to its high quality of life, Santa Cruz County is experiencing pressures on the landscape (from a growing population). The county's population is predicted to increase by 20% by 2035, to 320,000 people (Kuczynski and Malson, 2013). In Watsonville, valuable agricultural lands are facing development pressure due to the region's access to the cities of Santa Cruz and San Francisco. The City of Watsonville's General Plan, Vista 2030, aims to address some of these concerns by creating an urban growth boundary, targeting specific growth areas, developing more walkable neighborhoods with access to parks and schools, and redeveloping underutilized areas with a mixed-used development model (City of Watsonville, 2013).

Santa Cruz County voters already made a significant commitment to preserving ecosystem services and open space through the adoption of Measure J in 1978 and implementation policies contained in the 1980 and subsequent general plans. These policies provide for watershed, water resources, and biotic protection, while redirecting the bulk of new development from the rural to the urban areas of the county. Policy and planning tools such as Measure J can collectively help ensure that the value of our natural capital assets and the services that flow from them appreciate, not depreciate like built capital. Incorporating today's understanding of ecosystem services and the central role they play in our economy into general plans and policies allows decision-makers to have full information about the ecological and economic costs and benefits of their investments.

Next Steps: Making Smart Conservation Investments

Smart investment is the key to securing prosperity and long-term value. An important advancement for private investment was the improved valuation and reporting required for private firms. Just as private investors were largely blind to a company's value 100 years ago, firms, citizens, and decision-makers may be unable to make the best investment decisions without policies that build ecosystem service values into reporting standards and investment opportunities.

Integrating the costs and benefits of conservation investments into infrastructure planning, finance, accounting, and climate change adaptation/mitigation can begin with the framework provided in this report. Well-informed land use decisions and natural resource management, integrated across the landscape and its services (e.g., water resources, parks, flood-risk reduction, biodiversity), build a more efficient economy and a foundation for successful firms and local governments.

The framework and information provided by this report can be used by Santa Cruz County, the State of California, city officials, and others to better inform decision-making and investment. Innovative economic measures, policies, funding mechanisms, and smart investment can come together in Santa Cruz County and California to provide multi-benefit, sustainable solutions to secure healthy lands and healthy economies.

The results of this study support the following conclusions:

1. **Santa Cruz County's landscape of natural capital assets and their associated ecosystem services are highly valuable and provide the foundation for our economy and support the health and well-being of our communities.**
2. **Investment in these natural capital assets and their stewardship provides a high rate of return.**
3. **Greater investment in natural capital assets and stewardship is warranted to ensure the continued prosperity and a high quality of life for the people of Santa Cruz County.**

Recommendations

The following recommendations provide starting points for fully integrating the value of natural capital stewardship into the economy of Santa Cruz County:

Recommendation 1. Work with state, federal, and local funding, infrastructure, and policy institutions to incorporate the detailed ecosystem service values developed through this effort into traditional economic tools such as return-on-investment analysis and benefit-cost analysis to inform decision-making for capital investments (detailed values for specific services by landcover types can be found in Appendix C).

1.1. Use the data contained within this report to support the Regional Transportation Commission's implementation of the Sustainable Transportation Rating System ("STARS")

1.2. Help state agencies such as the Department of Water Resources, Caltrans, Air Resources Board, Strategic Growth Council, among others to integrate ecosystem service valuation into their existing economic analysis tools to develop natural capital investment strategies for funding through state bonds, AB 32 revenues, transportation funding (SB 375), and other mechanisms.

Recommendation 2. Utilize this report and its findings to catalyze a county-wide discussion on the need for and complexion of a local funding mechanism and investment strategy to increase the pace, scale, and effectiveness of natural capital conservation and stewardship in Santa Cruz County.

2.1. Identify feasible and reliable funding mechanisms (considering an array of options from tax assessments to specific payment for ecosystem service programs) to fund natural capital investments by matching either entities that impact a particular service (i.e. developer paving over lands that would otherwise absorb stormwater and will instead increase downstream flooding) or directly benefit from a service (landowner downstream of floodplain that can absorb stormwater and reduce flooding) with willing landowners whose natural capital assets provide those services (owners of lands that can be managed to absorb additional stormwater and attenuate downstream flooding).

2.2. Use the analysis of the Integrated Watershed Restoration Program to articulate the clear economic benefits to the community-at-large in terms of jobs and money leveraged. This model is particularly relevant as state and federal grant programs are requiring an increasingly larger local cost-share for every dollar invested and local municipalities without funding mechanisms will become less competitive for those key external investments.

2.3. Work with both public agencies such as FEMA and private sector partners such as insurance companies to develop funding mechanisms that proactively fund stewardship of natural capital in a way that helps reduce the potential for catastrophic wildfire or floods, and increases resilience to drought.

2.4. Evaluate the feasibility of a local tax funding measure to enhance specific natural capital stewardship activities and partners.

Recommendation 3. Incentivize conservation and stewardship actions across the landscape that protect and enhance the flow of ecosystem services from both public and private lands, through a combination of targeted tax relief, payment for ecosystem service programs, permit streamlining, permit fee waivers or reductions, and simplification of sustainability standards compliance protocols for productive activities in working lands.

3.1. Use the valuation in this report to support funding for California's Williamson Act or new legislation that not only continues to successfully protect working lands but provides economic incentives to improve stewardship of these lands for several economically and ecologically critical ecosystem goods and services.

3.2. Account for ecosystem services such as carbon sequestration, nutrient cycling, flood attenuation, groundwater recharge, and others that result from protecting and stewarding open space and agricultural lands adjoining cities (Priority Conservation Areas) when implementing AB 32 and SB 375 and developing local and regional investment portfolios for public funds.

Recommendation 4. Use a multi-benefit ecosystem services approach and the information on this report to better integrate and foster new partnerships across historically disconnected entities and develop better, more cost-effective, and longer-lasting investments and decision-making in support of natural capital assets.

4.1 Santa Cruz County was an early adopter of the State's push for Integrated Regional Water Resource Management. Santa Cruz County's leadership in IRWM planning has resulted in a new level of integration across water resource planning and infrastructure entities and creation of the Regional Water Management Foundation. Now is the time to build off this success and increase the extent of integration to include new partners from sectors like transportation, public health, and private citizens and landowners.

Recommendation 5. Develop and implement local ecosystem service valuation studies to complement the economic data developed in this analysis and address specific, high priority services of concern such as groundwater recharge, the value of riparian corridors, fire prevention and multiple benefits from working lands.

5.1. Conduct BCA of open space strategies, such as the analysis conducted on State Parks in this report, to better understand both the ecological and economic implications of protecting working lands vs protected non-working lands

5.2. Develop a local valuation study of lands with high groundwater recharge potential to support either a payment for ecosystem services program or other funding program that will incentivize stewardship and natural capital investments to maximize groundwater recharge.

5.3. Calculate ROI for fire prevention efforts and target key geographic areas for implementation of those efforts to maximize the reduction of fire risk and impact of wildfire.

Recommenation 6. Use, adapt or develop decision support tools that integrate spatial data and economic data to target geographic areas and actions that will maximize return on investment in multiple services such as improved water quality, carbon sequestration, groundwater recharge , floodplain protection and flood attenuation, and overall community resilience.

6.1. Adopt measurable environmental metrics to monitor the health of natural capital, track benefits of stewardship and ensure a continued flow of value from ecosystem services.

6.2. Identify modeling toolkits to quantify and map the provisioning of ecosystem services, the beneficiaries of those services, and impacters of those services as well as identifying optimal locations to implement conservation and stewardship for the highest ROI for a suite of services.

6.3. Develop or adopt planning and investment tools that enable decision-makers to not only integrate economic data on ecosystem services that can be monetized (i.e. can have a dollar value assigned), but also the wide array of ecosystem services that can't be easily monetized and are equally critical to our sustained economic vitality.

Santa Cruz County's natural capital supports a high quality of life for residents.Credit: Angie Gruys.

REFERENCES

Abrams, E. M., Rue, D. J., 1988. The causes and consequences of deforestation among the prehistoric Maya. Human Ecology 16, 377-395. Available at: http://link.springer.com/article/10.1007/BF00891649

Agricultural Impact Associates, 2013. Economic Contributions of Santa Cruz County Agriculture. http://www.agdept.com/Portals/10/pdf/SC_Ag_Report.pdf

Alcock, I., White, M.P., Wheeler, B.W., Fleming, L.E., Depledge, M.H., 2013. Longitudinal Effects on Mental Health of Moving to Greener and Less Green Urban Areas. Environmental Science & Technology 48, 1247-1255. Available at: http://pubs.acs.org/doi/abs/10.1021/es403688w

Aldred, J., Jacobs, M., 2000. Citizens and wetlands: Evaluating the Ely citizen's jury. Ecological Economics 34, 217-32. Available at: http://www.sciencedirect.com/science/article/pii/S0921800900001592

Americans for the Arts, 2014. Arts and Economic Prosperity IV in Santa Cruz County. Available at: http://www.artscouncilsc.org/arts-economic-prosperity-study/

Appleton, A., Moss, D., 2012. How New York City kept its drinking water pure—in spite of hurricane Sandy. The Huffington Post. http://www.huffingtonpost.com/daniel-moss/new-york-drinking-water_b_2064588.html

Applied Survey Research, 2013. Santa Cruz Community Assessment Project (CAP) 2013 – Natural Environment Chapter. Available at: http://www.appliedsurveyresearch.org/projects_database/quality-of-life/santa-cruz-county-community-assessment-project-cap.html

Arrow, K.J., Cropper, M.L., Gollier, C., Groom, B., Heal, G.M., Newell, R.G., Nordhaus, W.D., Pindyck, R.S., Pizer, W.A., Portney, P.R., Sterner, T., Tol, R.S.J., Weitzman, M.L., 2014. Should Governments Use a Declining Discount Rate in Project Analysis? Review of Environmental Economics and Policy 8 (2), 145–163.

Arrow, K. J., Kline, W. R., Maler, K-G., Munasinghe, M., Squitieri, R., Stiglitz, J. E., 1996. Intertemporal equity, discounting, and economic efficiency, Climate Change 1995 – Economic and Social Dimensions of Climate Change. Available at: http://www.econ.yale.edu/~nordhaus/Resources/22073-Chap4-Intertemporal%20Equity.pdf

BAE Urban Economics, 2013. Draft Phase 1: Trends Report for the Santa Cruz County Economic Vitality Strategy. http://www.tellusventure.com/downloads/ccbc/santa_cruz_county_vitality_plan_11june2013.pdf

Baker, M., 2004. Socioeconomic Characteristics of the Natural Resources Restoration System in Humboldt County, California. Forest Community Research. http://community-wealth.org/content/socioeconomic-characteristics-natural-resources-restoration-system-humboldt-county

Batker, D., Christin, Z., Schmidt, R., de la Torre, I., 2013. The Economic Impact of the 2013 Rim Fire on Natural Lands. Earth Economics, Tacoma, Washington. Available at: http://www.eartheconomics.org/FileLibrary/file/Reports/Earth%20Economics%20Rim%20Fire%20Report%2011.27.2013.pdf

Baxter, S., 2012. Coldwater Classis draws crowds, dollars to Santa Cruz. Santa Cruz Sentinel. Available at: http://www.santacruzsentinel.com/ci_21935424/coldwater-classic-draws-crowds-dollars-santa-cruz

Bernal, B., Mitsch, W. J., 2012. Comparing carbon sequestration in temperate freshwater wetland communities. Global Change Biology 18, 1636-1647. Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2486.2011.02619.x/abstract

Boumans, R., Costanza, R., Farley, J., Wilson, M.A., Portela, R., Rotmans, J., Villa, F., Grasso, M., 2002. Modeling the Dynamics of the Integrated Earth System and the Value of Global Ecosystem Services Using the GUMBO Model. Ecological Economics 41, 529-560.

Brody, J.E., 2010. Head Out for a Daily Dose of Green Space. The New York Times, New York, NY. http://www.nytimes.com/2010/11/30/health/30brody.html?_r=0

Brown, L. R. 2011. World on the Edge: How to prevent environmental and economic collapse. W.W. Norton, New York, NY. Available at: http://www.tandfonline.com/doi/full/10.1080/09644016.2012.651912#.VFvF1_TF_Rk

Brown, L. R., 2001. Eco-economy: Building an economy for the Earth. W.W. Norton, New York, NY. Available at: http://www.earth-policy.org/books/eco/eech1_ss2

Buckley, M., Beck, N., Bowden, P., Miller, M.E., Hill, B., Luce, C., Elliot, W. J., Enstice, N., Podolak, K., Winford, E., Smith, S. L., Bokach, M., Reichert, M., Edelson, D., Gaither, J., 2014. Mokelumne watershed avoided cost analysis: Why Sierra fuel treatments make economic sense. Sierra Nevada Conservancy, The Nature Conservancy, and U.S. Department of Agriculture, Forest Service. Sierra Nevada Conservancy. Auburn, California. Available at: http://www.sierranevadaconservancy.ca.gov/mokelumne.

California Coastal Coalition, 2014. Coastal Tourism and Recreation. http://www.calcoast.org/Coastal-Tourism.html

California Department of Conservation, 2013. Williamson Act: Questions & Answers. California Department of Conservation. Available at: http://www.conservation.ca.gov/dlrp/lca/basic_contract_provisions/Pages/LCA_QandA.aspx

California Department of Parks and Recreation, 2014. About us. CA Department of Parks and Recreation. http://www.parks.ca.gov/?page_id=91

Chartrand, S., Hecht, B., Alley, D., Danzig, T., 2002. Arana Gulch Watershed Enhancement Plan Phase 1: Steelhead and Sediment Assessments. Arana Gulch Watershed Alliance, Santa Cruz, CA. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=10453

Chiang, C. Y., 2004. Novel Tourism: Nature, industry, and literature on Monterey's Cannery Row. The Western Historical Quarterly 35, 309-329. Available at: http://www.jstor.org/stable/pdfplus/25443010.pdf?acceptTC=true&jpdConfirm=true

City of Watsonville, 2010. City of Watsonville 2010 Urban Water Management Plan. City of Watsonville, CA, USA. http://cityofwatsonville.org/download/Public%20Works/Urban%20Water%20Management%20Plan%202010.pdf

City of Watsonville, 2013. Watsonville Vista 2030 General Plan. http://cityofwatsonville.org/permits-plans/major-projects

Constable, J. L., Cypher, B. L., Phillips, S. E., Kelly, P. A., 2009. Conservation of San Joaquin kit foxes in western Merced County, California. California State University-Stanislaus, Endangered Species Recovery Program, Fresno, California. http://esrp.csustan.edu/publications/reports/usbr/esrp_2009_wmercedkitfox_e.pdf

County of Santa Cruz, 2013. Auditor Budget. Santa Cruz, CA. http://sccounty01.co.santa-cruz.ca.us/AuditorBudget/2013-2014/i.pdf

County of Santa Cruz, 2013. Santa Cruz County Comprehensive Annual Financial Report Fiscal Year Ended June 30, 2013. County of Santa Cruz, Santa Cruz, CA. http://www.co.santa-cruz.ca.us/Portals/0/County/auditor/cafr13/CAFR_2013.pdf

County of Santa Cruz, Office of the Agricultural Commissioner, 2014. Santa Cruz Crop Report 2013. http://www.ksbw.com/blob/view/-/26423718/data/1/-/65elkqz/-/strawberries-crop-report-2013.pdf

Cowdin, S., 2008. Economic Analysis Guidebook, in: Department of Water Resources (Ed.). State of California The Resources Agency, California. Available at: http://www.water.ca.gov/economics/downloads/Guidebook_June_08/EconGuidebook.pdf

Craig Owyang Real Estate, 2014. Appraisal Review Report. Conservation Easement Cemex Santa Cruz Mountains Forest, Davenport CA. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=87358

Crompton, J.L., Love, L.L., More, T.A., 1997. An Empirical Study of the Role of Recreation, Parks, and Open Space in Companies' (Re) Location Decisions. Journal of Park and Recreation Administration, 37-58. Available at: http://agrilifecdn.tamu.edu/cromptonrpts/files/2011/06/Full-Text101.pdf

Culbert, T. P., 1973. The Classic Maya Collapse. University of New Mexico Press, Albuquerque, NM.

Dahlgren, R.A., Tate, K. W., Lewis, D.J., Atwill, E. R., Harper, J. M., Allen-Diaz, B. H., 2001. Watershed research examines rangeland management effects on water quality. California Agriculture 55, 64-71. Available at: http://californiaagriculture.ucanr.org/landingpage.cfm?articleid=ca.v055n06p64&fulltext=yes

Daly, H. E., Farley, J., 2004. Ecological economics: principles and applications, 1 ed. Island Press, Washington, DC. Available at: http://www.academia.edu/2334812/Ecological_Economics_Principles_And_Applications_Herman_E_Daly_Joshua_Farley

de Groot, R.S., Wilson, M.A., Boumans, R.M.J., 2002. A typology for the classification, description, and valuation of ecosystem functions, goods, and services. Ecological Economics 41, 393-408. Available at: http://portal.nceas.ucsb.edu/working_group/ebm-matrix/pdf-reprints/de%20Groot_2002.pdf

Diamond, J. M., 2005. Collapse: How societies choose to fail or succeed. Viking, New York, NY. Available at: http://85.17.122.144/bookreader.php/133781/Diamond_-_Collapse__How_Societies_Choose_to_Fail_or_Succeed.pdf

de Montis, A., De Toro, P., Droste-Franke, B., Omann, I. and Stagl, S., 2005. Assessing the Quality of Different mCdA Methods, in: M. Getzener, S., C., and Stagl, S. (Ed.), Alternatives for Environmental Valuation. Routledge, London, pp. 99-133.

Farber, S., Costanza, R., Childers, D.L., Erickson, J., Gross, K., Grove, M., Hopkinson, C.S., Kahn, J., Pincetl, S., Troy, A., Warren, P., Wilson, M., 2006. Linking Ecology and Economics for Ecosystem Management. Bioscience 56, 121-133. Available at: http://bioscience.oxfordjournals.org/content/56/2/121.short

Federal Emergency Management Agency [FEMA], 2013. FEMA Mitigation Policy- FP-108-024-01: Consideration of Environmental Benefits in the Evaluation of Acquisition Projects under the Hazard Mitigation Assistance (HMA) Programs. Federal Emergency Management Agency, Washington, D.C. Available at: http://www.fema.gov/media-library-data/20130726-1920-25045-4319/environmental_benefits_policy_june_18_2013_mitigation_policy_fp_108_024_01.pdf

Fisher, A., Los Heurtos, M., Woyshner, M., Strudley, M., Hecht, B., 2011. Percolation Test Results from the Bokariza-Drobac Property, Pajaro Valley, California. UCSC, California State University, The Recharge Initiative.

Fleischer, D., 2010. The Park Prescription: Dr. Daphne Miller Speaks @ Bay Area Open Space Council Conference: Take Five (Minutes) and Call Me In the Morning. Green Impact, San Francisco, CA. http://www.greenimpact.com/land-conservation/the-park-prescription-dr-daphne-miller-speaks-bay-area-open-space-council-conference-take-five-minutes-and-call-me-in-the-morning/

Gennet, S., Klausmeyer, K., 2012. Climate Smart Actions for Natural Resource Managers Workshop Case Study: Upper Pajaro River Floodplain Restoration Project. The Nature Conservancy. Available at: http://baeccc.org/pdf/Upper%20Pajaro%20River%20Floodplain%20Restoration.pdf

Gies, E., 2006. The Health Benefits of Parks: How Parks Help Keep Americans and Their Communities Fit and Healthy. The Trust for Public Land, San Francisco, CA. Available at: http://www.eastshorepark.org/HealthBenefitsReport_FINAL_010307.pdf

Gregory, R., Wellman, K., 2001. Bringing stakeholder values into environmental policy choices: A community-based estuary case study. Ecological Economics 39, 37-52. Available at: http://www.sciencedirect.com/science/article/pii/S0921800901002142#

Grubisic, M., Nusinovic, M., Roje, G., 2009. Towards efficient public sector asset management. Financial Theory and Practice 33, 329-362. Available at: http://www.fintp.hr/en/archive/towards-efficient-public-sector-asset-management_283/

Hansen Z. K., Libecap, G. D., 2004. Small farms, externalities, and the dust bowl of the 1930s. Journal of Political Economy 112, 665-694. Available at: http://www2.bren.ucsb.edu/~glibecap/DustBowlJPE.pdf

Harris, Susan, 2006. Arana Gulch Draft Master Plan. City of Santa Cruz Department of Parks and Recreation, Santa Cruz, CA. Available at: http://www.cityofsantacruz.com/Modules/ShowDocument.aspx?documentid=7832

Hayes, M. P., Jennings, M.R., 1988. Habitat correlates of distribution of the California red-legged frog (Rana aurora drytonii) and the foothill yellow-legged frog (Rana boylii): implications for management. General technical report RM-Rocky Mountain Forest and Range Experiment Station, US Department of Agriculture, Forest Service. http://www.fs.fed.us/rm/pubs_rm/rm_gtr166/rm_gtr166_144_158.pdf

Headwaters Economics, 2012. West is Best: How public lands in the West create a competitive economic advantage. Available at: http://headwaterseconomics.org/land/west-is-best-value-of-public-lands

Hopper, M., 2014. Santa Cruz Harbor Port Engineer, Santa Cruz Port District, personal communication. Correspondence with Mike Hopper, Santa Cruz Harbor, 3/29/2014.

Hornbeck, R., 2012. The enduring impact of the american dust bowl: Short- and long-run adjustments to environmental catastrophe. American Economic Review 102, 1477-1507. Available at: http://www.nber.org/papers/w15605.pdf

Houston, J.R., 2013. The economic value of beaches—a 2013 update. U.S. Army Engineer Research and Development Center. Available at: http://www.colliergov.net/modules/showdocument.aspx?documentid=51419

Howarth, R., Farber, S., 2002. Accounting for the Value of Ecosystem services. Ecological Economics 41, 421-429.

Independent Sector, 2014. Independent Sector's Value of Volunteer Time. Independent Sector. http://independentsector.org/volunteer_time

Institute at the Golden Gate, 2010. Park Prescriptions: Profiles and resources for good health from the great outdoors. Available at: http://www.parksconservancy.org/assets/programs/igg/pdfs/park-prescriptions-2010.pdf

Janssen, R., Munda, G., 2002. Multi-criteria Methods for Quantitative, Qualitative and Fuzzy Evaluation Problems, in: Van Den Bergh, J., Bruinsma, F.R. (Eds.), Handbook of Environmental and Resource Economics. Edward Elgar Publishing, Cheltenham, UK.

Johnson, T., 2013. Hurricane Sandy leaves state with $2.6b tab for water infrastructure. NJ Spotlight. http://www.njspotlight.com/stories/13/04/09/hurricane-sandy-leaves-state-with-2-6b-tab-for-water-infrastructure/

Joyce, C., 2014. Federal flood insurance program drowning in debt. Who will pay? NPR. http://www.npr.org/2014/01/01/258706269/federal-flood-insurance-program-drowning-in-debt-who-will-pay

King County, 2011. Public Benefit Rating System Resource Information. Department of Natural Resources and Parks, King County, WA. http://www.kingcounty.gov/~/media/environment/stewardship/sustainable_building/resource_protection_incentives/PBRS_Resource_Information_April_2011.ashx?la=en

King et al. (2012). Groundwater Remediation Technical Report 5: Addressing Nitrate in California's Drinking Water With a Focus on Tulare Lake Basin and Salinas Valley Groundwater. California State Water Resources Control Board. Center for Watershed Sciences, University of California, Davis.

Kovacs, K., Polasky, S., Keeler, B., Pennington, D., Nelson, E., Plantinga, A. J., Taff, S., 2013. Evaluating the return in ecosystem services from investment in public land acquisitions. PLoS ONE 8. Available at: http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0062202

Kuczynski, D., Malson, J., 2013. California Grew By 0.8 Percent in 2012; Total State Population Nears 38 Million, in: Department of Finance (Ed.), Sacramento, California. Available at: http://www.indio.org/Modules/ShowDocument.aspx?documentid=3019

Leeworthy, V. R., Wiley, P. C., Stone, E. A., 2006. Economic impact of beach closures and changes in water quality for beaches in Southern California. National Oceanic and Atmospheric Administration [NOAA]. Available at: http://marineeconomics.noaa.gov/scbeach/laobeach1.html#reports

Lehmann, S., 2000. Industrial development: Lumber, lime and cement, fishing. Context I: Economic Development of the City of Santa Cruz 1850-1950, City of Santa Cruz Planning and Development Department. Available at: http://www.santacruzpl.org/history/articles/49/

Limburg, K. E., O'Neill, R. V., Costanza, R., Farber, S., 2002. Complex systems and valuation. Ecological economics 41(3), 409-420.

Living Landscape Initiative, 2011. Bay Area Conservation Group Protect Largest Expanse of Threatened Redwoods and Wildlife Habitat in Heart of Santa Cruz Mountains. Living Landscape Initiative, Davenport CA. http://www.livinglandscapeinitiative.org/news/CEMEX-Redwoods-Press-Release-FINAL.pdf

Mackenzie, A.J., McGraw, J., Freeman, M., 2011. Conservation blueprint for Santa Cruz County: An assessment and recommendations from the Land Trust of Santa Cruz County, Santa Cruz, CA. Available at: http://www.landtrustsantacruz.org/blueprint

Magdoff, F., van Es, H., 2009. Building Soils for Better Crops: Sustainable Soil Management. Third edition. Sustainable Agriculture Research and Education (SARE) Handbook Series Book 10, United States Department of Agriculture. Available at: http://www.soilandhealth.org/03sov/0302hsted/030218bettersoils.pdf

Marble, S., 2009. The real surf city? Its Santa Cruz, says magazine. Los Angeles Times. Available at: http://latimesblogs.latimes.com/lanow/2009/06/the-real-surf-city-why-that-would-be-santa-cruz.html

Millennium Ecosystem Assessment, 2003. A framework for assessment. Available at: http://www.unep.org/maweb/en/Framework.aspx#download

Miller, D., 2013. Farmacology: What Innovative Family Farming Can Teach Us About Health and Healing. Harper Collins, New York, NY. Available at: http://drdaphne.com/books/farmacology/

Murdoch, W., Ranganathan, J., Polasky, S., Regetz, J., 2010. Using return on investment to maximize conservation effectiveness in Argentine grasslands. Proceedings of the National Academy of Sciences of the United States of America [PNAS] 107, 20855-20862. Available at: http://www.pnas.org/content/107/49/20855.full.pdf+html

Nabhan, G.P., Buchmann, S.L., 1997. Pollination Services: Biodiversity's direct link to world food stability, in: Daily, G. (Ed.), Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington DC.

Nader, G., Henkin, Z., Smith, E., Ingram, R., Narvaez, N., 2007. Planned Herbivory in the Management of Wildfire Fuels. Rangelands 29, 18-24. Available at: http://cdn.intechopen.com/pdfs-wm/43235.pdf

National Research Council, 2004. Valuing Ecosystem Services: Toward Better Environmental Decision-Making. National Academies Press, Washington, DC. Available at: http://www.nap.edu/catalog.php?record_id=11139

Nielsen-Pincus, M., Moseley, C., 2010. Economic and Employment Impacts of Forest and Watershed Restoration in Oregon. Ecosystem Workforce Program. Available at: https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/10776/WP24.pdf?sequence=1

Office of Governor Edmund G. Brown Jr., 2013. Governor Brown Appeals Denial of Presidential Major Disaster Declaration for Rim Fire. Available at: http://gov.ca.gov/news.php?id=18310

Outdoor Foundation and Outdoor Industry Association, 2012. The Outdoor Recreation Economy. Outdoor Industry Association. https://outdoorindustry.org/pdf/OIA_OutdoorRecEconomyReport2012.pdf

Pajaro River Watershed Flood Prevention Authority, 2003. Phase 2 Pajaro River Watershed Study. Pajaro River Watershed Flood Prevention Authority. http://www.pajaroriverwatershed.org/files/Phase_2_Report/PRWS%20Phase%202%20Report.pdf

Pajaro River Watershed, 2014. Pajaro River Watershed Integrated Regional Water Management Plan. http://www.pajaroriverwatershed.org/pdf/Pajaro%20IRWM%20Plan%20Update%202014.pdf

Pajaro Valley Water Management Agency, 2013. Pajaro Basin Management Plan 2012. Pajaro Valley Water Management Agency. http://www.pvwma.dst.ca.us/about-pvwma/assets/bmp_update_2012/2012_BMP_Update_Draft_Stamped_Jan2013_screen.pdf

Pajaro Valley Water Management Agency, PVWMA (2002). Revised Basin Management Plan.

Pajaro Valley Water Management Agency, PVWMA (2012). Basin Management Plan Update.

Podlech, M., 2011. College Lake Smolt Outmigrant Study, Spring 2011. Resources Conservation District of Santa Cruz County, Capitola, CA.

Polasky, S., Johnson, K., Keeler, B., Kovacs, K., Nelson, E., Pennington, D., Plantinga, A. J., Withey, J., 2012. Are investments to promote biodiversity conservation and ecosystem services aligned? Oxford Review of Economic Policy 28, 139-163. Available at: http://oxrep.oxfordjournals.org/content/28/1/139.short

Ponting, C., 1992. A Green History of the World: The environment and the collapse of great civilizations. St. Martin's, New York, NY. Available at: http://www.popline.org/node/340578

PUMA, 2011. Puma's Environmental Profit and Loss Account for the year ended 31 December 2010. PUMA. http://about.puma.com/damfiles/default/sustainability/environment/e-p-l/EPL080212final-3cdfc1bdca0821c6ec1cf4b89935bb5f.pdf

Reich, S., Hollingshead, A., MacMullen, E., 2012. Handbook for Estimating Economic Benefits of Environmental Projects. ECONorthwest. Available at: http://nbwatershed.org/library/NBWA_Handbook_2012-1221.pdf

Rein, F. A., 1999. An Economic Analysis of Vegetative Buffer Strip Implementation - Case Study: Elkhorn Slough, Monterey Bay, California. Coastal Management 27, 377-390. Available at: http://www.tandfonline.com/doi/abs/10.1080/089207599263785#.VF0lD_TF_Rk

RMC Water and Environment, 2005. Pajaro River Watershed Study: Phase 3 and 4A. Pajaro River Watershed Flood Prevention Authority. Available at: http://www.pajaroriverwatershed.org/files/PajaroPh3_4a/Ph3_4a_Report.pdf

Rodale Institute, 2014. Regenerative Organic Agriculture and Climate Change. Rodale Institute, Kutztown, PA. Available at: http://rodaleinstitute.org/assets/RegenOrgAgricultureAndClimateChange_20141001.pdf

Rosenberger R.S., Johnston, R.J., 2013. Benefit Transfer. In: Shogren, J.F., (ed.) Encyclopedia of Energy, Natural Resource, and Environmental Economics 3, 327-333. Elsevier, Amsterdam.

Russell, W. H., McBride, J. R., 2003. Landscape scale vegetation-type conversion and fire hazard in the San Francisco bay area open spaces. Landscape and urban planning 64, 201-208. Available at: http://www.sciencedirect.com/science/article/pii/S0169204602002335

Salzman, J., 2012. Our water system withstood hurricane sandy but the threats aren't over. The Washington Post. http://www.washingtonpost.com/opinions/our-water-system-withstood-hurricane-sandy-but-the-threats-arent-over/2012/11/09/10568eec-2902-11e2-b4e0-346287b7e56c_story.html

Samonte-Tan, G.P.B., A. T. White, M. A. Tercero, J. Diviva, E. Tabara and C. Caballes. 2007. Economic Valuation of Coastal and Marine Resources: Bohol Marine Triangle, Philippines. Costal Management 35, 319-338. Available at: http://www.oneocean.org/download/db_files/SamonteTan_White%202007_Economic%20valuation%20coastal.pdf

San Francisco Public Utilities Commission [SFPUC], 2013. Stronger Today: Building Towards 100 Years of Service to the Public, Comprehensive Annual Financial Report for the fiscal year ending June 30th 2013. San Francisco Public Utilities Commission, San Francisco, CA. Available at: http://www.sfwater.org/modules/showdocument.aspx?documentid=4728

Santa Cruz Chamber of Commerce, 2013. Water Business: H2O = GDP. City of Santa Cruz, Chamber of Commerce. http://www.santacruzchamber.org/cwt/external/wcpages/wcnews/NewsArticleDisplay.aspx?ArticleID=642

Santa Cruz Chamber of Commerce, 2014. Farmers Markets. http://www.santacruzchamber.org/cwt/external/wcpages/facts/markets.aspx

Santa Cruz County Conference and Visitors Council, 2014. Parks. Santa Cruz County Conference and Visitors Center. http://www.santacruzca.org/things/parks.php

Santa Cruz County Conference and Visitors Council, 2014. Tourism Facts. http://www.santacruzca.org/partners/tourism-facts.php

Santa Cruz County Planning Department, 2014. Water Resources. http://www.sccoplanning.com/Portals/2/County/Planning/env/Panel%206%20Water%20Resources.pdf

Santa Cruz Harbor, 2005. Letter of support for grant application number 36: The Arana Creek, Blue Trail Gullies erosion control project sponsored by the Santa Cruz County Resource Conservation District, cosponsored by the Arana Gulch Watershed Alliance (AGWA).

Schmidt (2011). Linking Denitrification and Infiltration Rates during Managed Groundwater Recharge. Environmental Science and Technology 45(22).

Sempervirens Fund, 2012. Mountain Echo. Sempervirens Fund, Los Altos, CA. http://sempervirens.org/wp-content/uploads/2014/05/Mountain_Echo_SP12.pdf

Stevens, M., 2013. Rim fire damage to environment, property could hit 1.8 billion. The Los Angeles Times. http://articles.latimes.com/2013/dec/27/local/la-me-ln-rim-fire-damage-study-20131227

Sturm, R., Cohen, D., 2014. Proximity to urban parks and mental health. The Journal of Mental Health Policy and Economics 17, 19-24.

Sukhdev, P., Wittmer, H., Schröter-Schlaack, C., Nesshöver, C., Bishop, J., ten Brink, P., Gundimeda, H., Kumar, P., Simmons, B., 2010. Mainstreaming the economics of nature: A synthesis of the approach, conclusions and recommendations of TEEB. The Economics of Ecosystems and Biodiversity [TEEB]. Available at: http://www.teebweb.org/our-publications/teeb-study-reports/synthesis-report/

Thornburg Investment Management, 2013. A Study of Real Real Returns. http://www.thornburginvestments.com/pdfs/TH1401.pdf

U.S. Army Corps of Engineers, 2013. Memorandum for Planning Community of Practice: Economic Guidance Memorandum, 14-01, Federal Interest Rates for Corps of Engineers Projects for Fiscal Year 2014. Federal Discount Rates 1957-2014., in: US Army Corps of Engineers (Ed.), Washington, DC. http://planning.usace.army.mil/toolbox/library/EGMs/EGM14-01.pdf

U.S. Fish and Wildlife Service (USFWS). 2003. Endangered and threatened wildlife and plants; Listing of the central California distinct population segment of the California tiger salamander; proposed rule. Federal Register 68:28648. U.S. Fish and Wildlife Service. http://ecos.fws.gov/speciesProfile/profile/displayAllDocuments!fedreg.action?spcode=D01T

U.S. Water Resources Council, 1983. Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. U.S. Water Resources Council. http://planning.usace.army.mil/toolbox/library/Guidance/Principles_Guidelines.pdf

United States Fish and Wildlife Service [USFWS]. 2009. Bay checkerspot butterfly (Euphydryas editha bayensis) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office. http://www.fws.gov/ecos/ajax/docs/five_year_review/doc2517.pdf

University of California Santa Cruz, Office of Planning and Budget, 2013. The UC Santa Cruz Budget – A Bird's Eye View. University of California Santa Cruz, Santa Cruz, CA. http://planning.ucsc.edu/budget/reports/profile2013.pdf

UCSC (2013). The Recharge Initiative. Accessed January 1st 2014. http://es.ucsc.edu/~afisher/RechargeInitiative/index.htm

USDA Office of Communications, 2010. Secretary Vilsack announces details and objectives of USDA'S office of environmental markets. http://www.usda.gov/wps/portal/usda/usdahome?contentidonly=true&contentid=2010/03/0115.xml

Wagner, G.S., Nelsen, C., Walker, M., 2011. A Socioeconomic and recreational profile of surfers in the United States. Surf-first., Surfrider Foundation. Available at: http://www.surfrider.org/images/uploads/publications/surfrider_report_v13(1).pdf

Weiss, S. 1999. Cars, cows, and checkerspot butterflies: nitrogen deposition and management of nutrient poor grasslands for a threatened species. Conservation Biology 13, 1476-1486. Available at: http://onlinelibrary.wiley.com/doi/10.1046/j.1523-1739.1999.98468.x/abstract

Weitzman, M., L., Arrow, K. J., Cropper, M. L., Gollier, C., Groom, B., Heal, G. M., Newell, R. G., Nordhaus, W. D., Pindyck, R. S., Pizer, W. A. Portney, P. R., Sterner, T., Tol, R. S. J., 2014. Should Governments Use a Declining Discount Rate in Project Analysis? Review of Environmental Economics and Policy 8, 145-163. Available at: http://idei.fr/doc/by/gollier/reep_sept_13.pdf

White House Council on Environmental Quality, 2013. Principles and Requirements for Federal Investments in Water Resources. White House Council on Environmental Quality. http://www.whitehouse.gov/sites/default/files/final_principles_and_requirements_march_2013.pdf

Williams, F., 2012. Take Two Hours of Pine Forest and Call Me in the Morning. Outside Magazine 28 Nov 2012. Available at: http://www.outsideonline.com/fitness/wellness/Take-Two-Hours-of-Pine-Forest-and-Call-Me-in-the-Morning.html

Williams, J. G., Chavez, F. P., Ryan, Lluch-Cota, S. E., M. C., Ñiquen, 2003. Sardine fishing in the early 20th century. Science, New Series 300, 2032-2033. Available at: http://www.sciencemag.org/content/300/5628/2032.full

Wilson, M., Hoehn, J., 2006. Valuing Environmental Goods and Services Using Benefit-transfer: State-of-the-art and Science. Ecological Economics 60, 335-342 Available at: http://www.sciencedirect.com/science/article/pii/S0921800906004460

Wilson, M.A., Howarth, R.B., 2002. Discourse-based valuation of ecosystem services: Establishing fair outcomes through group deliberation. Ecological Economics 41, 431-443. Available at: http://www.sciencedirect.com/science/article/pii/S0921800902000927

World Wildlife Foundation [WWF], 2014. Accounting for Natural Capital in EU Policy Decision-Making. A WWF Background Paper on Policy Developments. http://d2ouvy59p0dg6k.cloudfront.net/downloads/background_accounting_for_natural_capital_in_eu_policy_decision_making_final.pdf

Wright, B., 2012. Steamer Lane's status as world-class surf break questionable. Santa Cruz Sentinel. Available at: http://www.santacruzsentinel.com/localnews/ci_21962647/steamer-lanes-status-word-class-questionable

APPENDIX A: Study Limitations

The results of the first attempt to assign monetary value to the ecosystem services rendered by Santa Cruz County have important and significant implications on the restoration and management of natural capital. A benefit transfer methodology estimates the economic value of a given ecosystem (e.g., wetlands) from prior studies of that ecosystem type. Like any economic analysis, this methodology has strengths and weaknesses. While these limitations must be noted, they should not detract from the core finding that ecosystems produce a significant economic value to society. Some arguments against benefit transfer include:

1. Every ecosystem is unique; per-acre values derived from another location may be irrelevant to the ecosystems being studied.
2. Even within a single ecosystem, the value per acre depends on the size of the ecosystem; in most cases, as the size decreases, the per-acre value is expected to increase and vice versa. (In technical terms, the marginal cost per acre is generally expected to increase as the quantity supplied decreases; a single average value is not the same as a range of marginal values.)
3. Gathering all the information needed to estimate the specific value for every ecosystem within the study area is not feasible. Therefore, the true value of all of the wetlands, forests, pastureland, etc. in a large geographic area cannot be ascertained. In technical terms, we have far too few data points to construct a realistic demand curve or estimate a demand function.
4. To value all, or a large proportion, of the ecosystems in a large geographic area is questionable in terms of the standard definition of exchange value. We cannot conceive of a transaction in which all or most of a large area's ecosystems would be bought and sold. This emphasizes the point that the value estimates for large areas (as opposed to the unit values per acre) are more comparable to national income account aggregates and not exchange values. These aggregates (i.e. GDP) routinely impute values to public goods for which no conceivable market transaction is possible. The value of ecosystem services of large geographic areas is comparable to these kinds of aggregates (see below).

Proponents of the above arguments recommend an alternative valuation methodology that amounts to limiting valuation to a single ecosystem in a single location. This method only uses data developed expressly for the unique ecosystem being studied, with no attempt to extrapolate from other ecosystems in other locations. An area with the size and landscape complexity of Santa Cruz County makes this approach to valuation extremely difficult and costly. Responses to the above critiques can be summarized as follows (see Howarth and Farber, 2002 for more detailed discussion):

1. While every wetland, forest, or other ecosystem is unique in some way, ecosystems of a given type, by their definition, have many things in common. The use of average values in ecosystem valuation is no more or less justified than their use in other macroeconomic contexts; for instance, the development of economic statistics such as Gross Domestic or Gross State Product. This study's estimate of the aggregate value of Santa Cruz County's ecosystem services is a valid and useful (albeit imperfect, as are all aggregated economic measures) basis for assessing and comparing these services with conventional economic goods and services.
2. The results of the spatial modeling analysis described in other studies do not support an across-the-board claim that the per-acre value of forest or agricultural land depends on the size of the parcel. While the claim does appear to hold for nutrient cycling and other services, the opposite position holds up fairly well for what ecologists call "net primary productivity" or NPP, which is a major indicator of ecosystem health. It has the same position, by implication, of services tied to NPP – where each acre makes about the same contribution to the whole, regardless of whether it is part of a large plot of land or a small one. This area of inquiry needs further research, but for the most part, the assumption that average value is a reasonable proxy for marginal value is appropriate for a first approximation. Also, a range of different parcel sizes exists within the study site, and marginal value will average out.

3. As employed here, the prior studies we analyzed encompass a wide variety of time periods, geographic areas, investigators, and analytic methods. Many of them provide a range of estimated values rather than single-point estimates. The present study preserves this variance; no studies were removed from the database because their estimated values were deemed to be "too high" or "too low." Limited sensitivity analyses were also performed. This approach is similar to determining an asking price for a piece of land based on the prices of comparable parcels; even though the property being sold is unique, realtors and lenders feel justified in following this procedure to the extent of publicizing a single asking price rather than a price range.

4. The objection to the absence of even an imaginary exchange transaction was made in response to the study by Costanza et al. (1997) of the value of all of the world's ecosystems. Leaving that debate aside, one can conceive of an exchange transaction in which, for example, all of, or a large portion of a watershed was sold for development, so that the basic technical requirement of an economic value reflecting the exchange value could be satisfied. Even this is not necessary if one recognizes the different purpose of valuation at this scale – a purpose that is more analogous to national income accounting than to estimating exchange values (Howarth and Farber 2002).

In this report, we have displayed our study results in a way that allows one to appreciate the range of values and their distribution. It is clear from inspection of the tables that the final estimates are not precise. However, they are much better estimates than the alternative of assuming that ecosystem services have zero value, or, alternatively, of assuming they have infinite value. Pragmatically, in estimating the value of ecosystem services, it seems better to be approximately right than precisely wrong.

The estimated value of the world's ecosystems presented in Costanza et al. (1997), for example, has been criticized as both (1) a serious underestimate of infinity and (2) impossibly exceeding the entire Gross World Product. These objections seem to be difficult to reconcile, but that may not be so. Just as a human life is priceless, so are ecosystems – yet people are paid for the work they do.

Upon some reflection, it should not be surprising that the value ecosystems provide to people exceeds the gross world product. Costanza's estimate of the work that ecosystems do is an underestimate of the infinite value of priceless systems, but that is not what he sought to estimate. Consider the value of one ecosystem service, such as photosynthesis, and the ecosystem good it produces: atmospheric oxygen. Neither is valued in Costanza's study. Given the choice between breathable air and possessions, informal surveys have shown the choice of oxygen over material goods is unanimous. This indicates that the value of photosynthesis and atmospheric oxygen to people exceeds the value of the gross world product – and oxygen production is only a single ecosystem service and good.

General Limitations

- **Static Analysis.** This analysis is a static, partial equilibrium framework that ignores interdependencies and dynamics, though new dynamic models are being developed. The effect of this omission on valuations is difficult to assess.
- **Increases in Scarcity.** The valuations probably underestimate shifts in the relevant demand curves as the sources of ecosystem services become more limited. The values of many ecological services rapidly increase as they become increasingly scarce (Boumans et al., 2002). If Santa Cruz County's ecosystem services are scarcer than assumed here, their value has been underestimated in this study. Such reductions in supply appear likely as land conversion and development proceed; climate change may also adversely affect the ecosystems, although the precise impacts are more difficult to predict.
- **Existence Value.** The approach does not fully include the infrastructure or existence value of ecosystems. It is well known that people value the existence of certain ecosystems, even if they never plan to use or benefit from them in any direct way. Estimates of existence value are rare; including this service will obviously increase the total values.

- **Other Non-Economic Values.** Economic and existence values are not the sole decision-making criteria. A technique called multi-criteria decision analysis is available to formally incorporate economic values with other social and policy concerns (see Janssen and Munda, 2002 and de Montis et al., 2005 for reviews). Having economic information on ecosystem services usually helps this process because traditionally, only opportunity costs of forgoing development or exploitation are counted against non-quantified environmental concerns.

GIS Limitations

- **GIS Data.** Since this valuation approach involves using benefit transfer methods to assign values to land cover types based, in some cases, on their contextual surroundings, one of the most important issues with GIS quality assurance is reliability of the land cover maps used in the benefits transfer, both in terms of categorical precision and accuracy.
    - *Accuracy:* The source GIS layers are assumed to be accurate but may contain some minor inaccuracies due to land use changes done after the data was sourced, inaccurate satellite readings, and other factors.
    - *Categorical Precision:* The absence of certain GIS layers that matched the land cover classes used in the Earth Economics database created the need for multiple datasets to be combined.
- **Ecosystem Health.** There is the potential that ecosystems identified in the GIS analysis are fully functioning to the point where they are delivering higher values than those assumed in the original primary studies, which would result in an underestimate of current value. On the other hand, if ecosystems are less healthy than those in primary studies, this valuation will overestimate current value.
- **Spatial Effects.** This ecosystem service valuation assumes spatial homogeneity of services within ecosystems, i.e., that every acre of forest produces the same ecosystem services. This is clearly not the case. Whether this would increase or decrease valuations depends on the spatial patterns and services involved. Solving this difficulty requires spatial dynamic analysis. More elaborate system dynamic studies of ecosystem services have shown that including interdependencies and dynamics leads to significantly higher values (Boumans et al., 2002), as changes in ecosystem service levels ripple throughout the economy.

Benefit Transfer/Database Limitations

- **Incomplete coverage.** That not all ecosystems have been valued or studied well is perhaps the most serious issue, because it results in a significant underestimate of the value of ecosystem services. More complete coverage would almost certainly increase the values shown in this report, since no known valuation studies have reported estimated values of zero or less.
- **Selection Bias.** Bias can be introduced in choosing the valuation studies, as in any appraisal methodology. The use of a range partially mitigates this problem.
- **Consumer Surplus.** Because the benefit transfer method is based on average rather than marginal cost, it cannot provide estimates of consumer surplus. However, this means that valuations based on averages are more likely to underestimate total value.

Primary Study Limitations

- **Willingness-to-pay Limitations.** Many estimates are based on current willingness-to-pay or proxies, which are limited by people's perceptions and knowledge base. Improving people's knowledge base about the contributions of ecosystem services to their welfare would almost certainly increase the values based on willingness-to-pay, as people would realize that ecosystems provided more services than they had previously known.
- **Price Distortions.** Distortions in the current prices used to estimate ecosystem service values are carried through the analysis. These prices do not reflect environmental externalities and are therefore again likely to be underestimates of true values.

- **Non-linear/Threshold Effects.** The valuations assume smooth responses to changes in ecosystem quantity with no thresholds or discontinuities. Assuming (as seems likely) that such gaps or jumps in the demand curve would move demand to higher levels than a smooth curve, the presence of thresholds or discontinuities would likely produce higher values for affected services (Limburg et al., 2002). Further, if a critical threshold is passed, valuation may leave the normal sphere of marginal change and larger-scale social and ethical considerations dominate, such as an endangered species listing.
- **Sustainable Use Levels.** The value estimates are not necessarily based on sustainable use levels. Limiting use to sustainable levels would imply higher values for ecosystem services as the effective supply of such services is reduced.

If the above problems and limitations were addressed, the result would most likely be a narrower range of values and significantly higher values overall. At this point, however, it is impossible to determine more precisely how much the low and high values would change.

APPENDIX B: Value Transfer Studies Used: List of References

Allen, J., Cunningham, M., Greenwood, A., Rosenthal, L. 1992. The value of California wetlands: an analysis of their economic benefits. Campaign to Save California Wetlands, Oakland, California.

Amigues, J. P., Boulatoff, C., Desaigues, B., Gauthier, C., Keith, J.E., 2002. The benefits and costs of riparian analysis habitat preservation: a willingness to accept/willingness to pay contingent valuation approach. Ecological Economics 43, 17-31.

Anderson, G. D., Edwards, S.F. 1986. Protecting Rhode Island coastal salt ponds - an economic-assessment of downzoning. Coastal Zone Management Journal 14, 67-91.

Bell, F.W., Leeworthy, V.R. 1986. An Economic Analysis of the Importance of Saltwater Beaches in Florida, Sea Grant Report SGR-82.

Bennett, R., Tranter, R., Beard, N., Jones, P. 1995. The value of footpath provision in the countryside: a case-study of public access to urbanfringe woodland. Journal of Environmental Planning and Management 38, 409-417.

Bergstrom, J. C., Dillman, B.L., Stoll, J.R. 1985. Public environmental amenity benefits of private land: the case of prime agricultural land. Southern Journal of Agricultural Economics 7 139-149.

Berrens, R. P., Ganderton, P., Silva, C.L. 1996. Valuing the protection of minimum instream flows in New Mexico. Journal of Agricultural and Resource Economics 21 294-308.

Bishop, K. 1992. Assessing the benefits of community forests: An evaluation of the recreational use benefits of two urban fringe woodlands. Journal of Environmental Planning and Management 35, 63-76.

Bockstael, N.E., McConnell, K.E., Strand, I.E. 1989. Measuring the benefits of improvements in water quality: the Chesapeake Bay. Marine Resource Economics 6 1-18.

Bowker, J.M., English, D.B., Donovan, J.A. 1996. Toward a value for guided rafting on southern rivers. Journal of Agricultural and Resource Economics 28, 423-432.

Boxall, P. C. 1995. The economic value of lottery-rationed recreational hunting. Canadian Journal of Agricultural Economics-Revue Canadienne D Economie Rurale 43 119-131.

Boxall, P. C., McFarlane, B.L., Gartrell, M. 1996. An aggregate travel cost approach to valuing forest recreation at managed sites. Forestry Chronicle 72, 615-621.

Breaux, A., Farber, S., Day, J. 1995. Using natural coastal wetlands systems for waste-water treatment - an economic benefit analysis. Journal of Environmental Management 44 285-291.

Breffle, W., Morey, E. Lodder, T. 1998. Using Contingent Valuation to Estimate a Neighborhood's Willingness to Pay to Preserve Undeveloped Urban Land. University of Colorado. Department of Economics. 1-29. http://www.colorado.edu/economics/morey/4535/cunning.pdf

Brouwer, R., Langford, I. H., Bateman, I.J., Turner, R.K. 1999. A meta-analysis of wetland contingent valuation studies. Regional Environmental Change 1 1, 47-57.

Canadian Urban Institute. 2006. Nature Counts: Valuing Southern Ontario's Natural Heritage. Toronto, Canada. http://www.canurb.com/media/pdf/Nature_Counts_rschpaper_FINAL.

Cleveland, C.J. Betke, M. Federico, P., Frank, J.D., Hallam, T.G., Horn, J., Lopez, Juan D.J., McCracken, G.F., Medellin, R.A., Moreno-Valdez, A., Sansone, C.G., Westbrook, J.K., Kunz, T.H. 2006. Economic value of the pest control service provided by Brazilian free-tailed bats in south-central Texas. Frontiers in Ecology and the Environment. 4(5). 238-243.

Colby, B., Smith-Incer, E., 2005. Visitor values and local economic impacts of riparian habitat preservation: California's Kern River Preserve.

Cooper, J., Loomis, J. B. 1991. Economic value of wildlife resources in the San Joaquin Valley: Hunting and viewing values. In Economic and Management of Water and Drainage in Agriculture eds. Diner and Zilberman., Vol. 23. Kluwer Academic Publishers.

Cordell, H. K., Bergstrom, J.C. 1993. Comparison of recreation use values among alternative reservoir water level management scenarios. Water Resources Research 29 247-258.

Costanza, R, d'Arge, R., deGroot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, RV., Paruelo, J., Raskin, RG., Sutton, P., van den Belt, M. 1997. The value of the world's ecosystem services and natural capital. Nature 387: 253-260.

Creel, M., Loomis, J. 1992. Recreation value of water to wetlands in the San-Joaquin Valley - linked multinomial logit and count data trip frequency models. Water Resources Research 28 2597-2606.

Croke, K., Fabian, R., Brenniman, G. 1986. Estimating the value of improved water-quality in an urban river system. Journal of Environmental Systems 16 13-24.

Duffield, J. W., Neher, C.J., Brown, T.C. 1992. Recreation benefits of instream flow - application to Montana Big Hole and Bitterroot Rivers. Water Resources Research 2 2169-2181.

Gascoigne, W.R., Hoag, D., Koontz, L., Tangen, B.A., Shaffer, T.L., Gleason, R.A. 2011. Valuing ecosystem and economic services across land-use scenarios in the Prairie Pothole Region of the Dakotas, USA. Ecological Economics. 70(10).

Greenley, D., Walsh, R.G., Young, R.A. 1981. Option value: empirical evidence from a case study of recreation and water quality. The Quarterly Journal of Economics 96, 657-673.

Haener, M.K., Adamowicz, W.L. 2000. Regional forest resource accounting: A northern Alberta case study. Canadian Journal of Forest Research 30, 264-273.

Hauser, A., Cornelis van Kooten, G. 1993. Benefits of Improving Water Quality in the Abbotsford aquifer: An application of contingent valuation methods.

Hayes, K.M., Tyrrell, T.J., Anderson, G. 1992. Estimating the benefits of water quality improvements in the Upper Narragansett Bay. Marine Resource Economics 7, 75-85.

Jaworski, E., Raphael, C.N. 1978. Fish, Wildlife, and Recreational Values of Michigan's Coastal Wetlands. Prepared for Great Lakes Shorelands Section, Division Land Resources Program, Michigan Department of Natural Resources.

Jenkins, W.A., Murray, B.C., Kramer, R.A., Faulkner, S.P. 2010. Valuing ecosystem services from wetlands restoration in the Mississippi Alluvial Valley. Ecological Economics. 69. 1051-1061.

Johnston, R. J., Grigalunas, T.A., Opaluch, J.J., Mazzotta, M., Diamantedes, J. 2002. Valuing estuarine resource services using economic and ecological models: the Peconic Estuary System study. Coastal Management 30, 47-65.

Kahn, J. R., Buerger, R.B. 1994. Valuation and the consequences of multiple sources of environmental deterioration - the case of the New-York Striped Bass fishery. Journal of Environmental Management 40 257-273.

Kazmierczak, R.F. 2001. Economic linkages between coastal wetlands and habitat/species protection: a review of value estimates reported in the published literature. LSU Agricultural Economics and Agribusiness Staff Paper. http://www.agecon.lsu.edu/faculty.

Kline, J. D., Swallow, S.K. 1998. The demand for local access to coastal recreation in southern New England. Coastal Management 26 177-190.

Knowler, D.J., MacGregor, B.W., Bradford, M.J., Peterman, R.M. 2003. Valuing freshwater salmon habitat on the west coast of Canada. Journal of Environmental Management 69 261–273.

Kreutzwiser, R. 1981. The economic significance of the long point marsh, Lake Erie, as a recreational resource. Journal of Great Lakes Resources 7 105-110.

Kulshreshtha, S. N., Gillies, J.A. 1993. Economic-evaluation of aesthetic amenities - a case-study of river view. Water Resources Bulletin 29 257-266.

Lant, C. L., Roberts, R.S. 1990. Greenbelts in the corn-belt - riparian wetlands, intrinsic values, and market failure. Environment and Planning 22 1375-1388.

Lant, C. L., Tobin, G. 1989. The economic value of riparian corridors in cornbelt floodplains: a research framework. Professional Geographer 41, 337-349.

Leschine, T. M., Wellman, K.F., Green, T.H. 1997. Wetlands' Role in Flood Protection. October 1997. Report prepared for: Washington State Department of Ecology Publication No. 97-100. http://www.ecy.wa.gov/pubs/97100.pdf

Loomis, J.B. 2002. Quantifying Recreation Use Values from Removing Dams and Restoring Free-Flowing Rivers: A Contingent Behavior Travel Cost Demand Model for the Lower Snake River. Water Resources Research 38.

Mahan, B. L. 1997. Valuing urban wetlands: a property pricing approach. Portland, Oregon: U.S. Army Corps of Engineers. Institute for Water Resources.

Mathews, L. G., Homans, F.R., Easter, K.W. 2002. Estimating the benefits of phosphorus pollution reductions: an application in the Minnesota River. Journal of the American Water Resources Association 38 1217-1223.

Mazzotta, M. 1996. Measuing Public Values and Priorities for Natural Resources: An Application to the Peconic Estuary System. University of Rhode Island.

McPherson, E. G., Scott, K.I., Simpson, J.R. 1998. Estimating cost effectiveness of residential yard trees for improving air quality in Sacramento, California, using existing models. Atmospheric Environment 32, 75-84.

McPherson, G., 1992. Accounting for benefits and costs of urban greenspace. Landscape and Urban Planning. 22.

McPherson, G., Simpson, J.R. 2002. A Comparison of Municipal Forest Benefits and Costs in Modesto and Santa Monica, California, USA. Urban Forestry. 1(2). 61-74.

Mullen, J. K., Menz, F.C. 1985. The effect of acidification damages on the economic value of the Adirondack Fishery to New-York anglers. American Journal of Agricultural Economics 67 112-119.

Nowak, D.J., Crane, D.E., Dwyer, J.F. 2002. Compensatory Value of Urban Trees in the United States. Journal of Arboriculture. 28(4). 194-199.

Nunes, P.A., Van den Bergh, J.C. 2004. Can people value protection against invasive marine species? Evidence from a joint TC-CV survey in the Netherlands. Environmental and Resource Economics 28, 517-532.

Opaluch, J., Grigalunas, T., Mazzotta, M., Johnston, R., Diamantedes, J. 1999. Recreational and Resource Economic Values for the Peconic Estuary, prepared for the Peconic Estuary Program. Peace Dale, RI: Economic Analysis Inc.

Pimentel, D. 1998. Benefits of biological diversity in the state of Maryland. Cornell University, College of Agricultural and Life Sciences. Ithica, New York.

Pimentel, D., Harvey, C., Resosudarmo, P., Sinclair, K., Kurz, D., McNair, M., Crist, S., Sphpritz, P., Fitton, L., Saffouri, R., Blair, R. 1995. Environmental and economic costs of soil erosion and conservation benefits. Science 267:1117-1123.

Piper, S. 1997. Regional impacts and benefits of water-based activities: an application in the Black Hills region of South Dakota and Wyoming. Impact Assessment 15, 335-359.

Pompe, J., Rinehart, J.R. 1995. Beach quality and the enhancement of recreational property-values. Journal of Leisure Research 27 143-154.

Prince, R., Ahmed, E. 1989. Estimating individual recreation benefits under congestion and uncertainty. Journal of Leisure Research 21, 61-76.

Qiu, Z., Prato, T., Boehm, G. 2006. Economic Valuation of Riparian Buffer and Open Space in a Suburban Watershed. Journal of the American Resources Association. 42. 6. 1583–1596.

Rein, F. A. 1999. An economic analysis of vegetative buffer strip implementation - Case study: Elkhorn Slough, Monterey Bay, California. Coastal Management 27, 377-390.

Rosenberger, R. S. and Walsh, R.G. 1997. Nonmarket Value of Western Valley Ranchland Using Contingent Valuation. Journal of Agricultural and Resource Economics.

Sanders, L. D., Walsh, R.G., Loomis, J.B. 1990. Toward empirical estimation of the total value of protecting rivers. Water Resources Research 26 1345-1357.

Shafer, E. L., Carline, R., Guldin, R.W., Cordell, H.K. 1993. Economic amenity values of wildlife - 6 case-studies in Pennsylvania. Environmental Management 17, 669-682.

Smith, W.N., Desjardins, R.L., Grant, B. 2001. Estimated changes in soil carbon associated with agricultural practices in Canada. Canadian Journal of Soil Science 81 221-227.

Soderqvist, T., Scharin, H. 2000. The regional willingness to pay for a reduced eutrophication in the Stockholm archipelago. In: Beijer Discussion paper No. 128. Stockholm, Sweden.

Thibodeau, F. R., Ostro, B.D. 1981. An economic analysis of wetland protection. J. Envtl. Mgmt. 19 : 72-79

Trust for Public Land. 2010. The Economic Benefits and Fiscal Impact of Parks and Open Space in Nassau and Suffolk Counties, New York. Available at: http://cloud.tpl.org/pubs/ccpe--nassau-county-park-benefits.pdf

Trust for Public Land. 2011. The Economic Benefits of Seattle's Park and Recreation System. Available at: http://cloud.tpl.org/pubs/ccpe-seattle-park-benefits-report.pdf

Tyrvainen, L. 2001. Economic valuation of urban forest benefits in Finland. Journal of Environmental Management 62, 75-92.

van Kooten, G.C., Schmitz, A. 1992. Preserving Waterfowl Habitat on the Canadian Prairies: Economic Incentives Versus Moral Suasion. American Journal of Agricultural Economics 74, 79-89.

Wade, W.W., McCollister, G.M., McCann, R.J., Johns, G.M. 1989. Recreation Benefits for California Reservoirs: A multi-scale facilities-augmented gravity travel cost model. Report. 1-32.

Ward, F.A., Roach, B.A., Henderson, J.E. 1996. The economic value of water in recreation: Evidence from the California drought. Water Resources Research 32 1075-1081.

Whitehead, J. C., Groothuis, P. A., Southwick, R., Foster-Turley, P. 2009. Measuring the economic benefits of Saginaw Bay coastal marsh with revealed and stated preference methods. Journal of Great Lakes Research, 35 3; 430–437.

Whitehead, J. C., Hoban, T.L., Clifford, W.B. 1997. Economic analysis of an estuarine quality improvement program: The Albemarle-Pamlico system. Coastal Management 25, 43-57.

Willis, K.G. 1991. The recreational value of the forestry commission estate in Great Britain - a Clawson-Knetsch travel cost analysis. Scottish Journal of Political Economy 38, 58-75.

Willis, K.G., Garrod, G.D. 1991. An individual travel-cost method of evaluating forest recreation. Journal of Agricultural Economics 42, 33-42.

Wilson, S.J. 2008. Ontario's wealth, Canada's future: Appreciating the value of the Greenbelt's eco-services. David Suzuki Foundation, Vancouver, Canada. Http://www.davidsuzuki.org/Publications/Ontarios_Wealth_Canadas_Future.asp.

Wilson, S.J. 2010. Natural Capital in BC's Lower Mainland: Valuing the Benefits from Nature.

Winfree, R., Gross, B., Kremen, C. 2011. Valuing pollination services to agriculture. Ecological Economics 71, 80-88.

Woodward, R., Wui, Y. 2001. The economic value of wetland services: a meta-analysis. Ecological Economics 37 257-270.

Wu, J., Skelton-Groth, K. 2002. Targeting conservation efforts in the presence of threshold effects and ecosystem linkages. Ecological Economics. 42(2). 313-331.

Young, C.E., Shortle, J.S. 1989. Benefits and costs of agricultural nonpoint-source pollution controls: the case of St. Albans Bay. Journal of Soil and Water Conservation 44, 64-67.

Zavaleta, E. 2000. The Economic Value of Controlling an Invasive Shrub. A Journal of the Human Environment. 29(8). 462-467. http://www.bioone.org/doi/full/10.1579/0044-7447-29.8.462

Zhongwei, L. 2006. Water Quality Simulation and Economic Valuation of Riparian Land-Use Changes. University of Cincinnati

Zhou, X., Al-Kaisi, M., Helmers, M.J., 2009. Cost effectiveness of conservation practices in controlling water erosion in Iowa. Soil & Tillage Research 106, 71-78.

APPENDIX C: Value Transfer Studies Used By Land Cover

Due to space considerations, Appendix C has been made available online here:
http://www.eartheconomics.org/FileLibrary/file/California/Santa_Cruz_ESV_Appendix_Values_by_Land_Cover.pdf

APPENDIX D: Value Transfer Studies Used: Annotated Bibliography

Due to space considerations, Appendix C has been made available online here:
http://www.eartheconomics.org/FileLibrary/file/California/Santa_Cruz_ESV_Appendix_Annotated_Bibliography.pdf

APPENDIX E: The Bokariza Managed Aquifer Recharge Project Return-on-Investment Analysis

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Introduction

The Pajaro Valley aquifer provides more than 90 percent of the water used by the $600 million agriculture industry in Santa Cruz County. This high value, specialty crop industry has the highest annual profit per acre in the State of California (BAE Urban Economics, 2013). Groundwater has been pumped from the Pajaro Valley aquifer at an average rate of 54,000 acre-feet per year (AFY) over the past ten years (Pajaro Valley Water Management Agency, 2012) to meet the needs of residents, businesses and agriculture. However, water is being withdrawn much faster than it can be replenished; resulting in a serious overdraft (estimated at 12,000 AFY) (Pajaro Valley Water Management Agency, 2012) that poses many risks to the surrounding communities and the local economy.

This case study highlights the value of a single managed aquifer recharge (MAR) project, which is part of a broader initiative called the Community Water Dialogue (CWD), involving multiple stakeholders and a portfolio of strategies to address aquifer overdraft in the Pajaro Valley. The Resource Conservation District of Santa Cruz County has been a key partner in developing both this project and the CWD to protect and enhance groundwater and surface water resources in the region.

MAR projects manipulate the landscape and leverage high water percolation and infiltration rates in specific locations to enhance groundwater recharge. The Bokariza MAR project is located above the Pajaro Valley aquifer in the southern part of Santa Cruz County. The site encompasses an area of 90-120 acres mostly used for commercial berry production, draining into a 2-acre man-made infiltration basin (Figure 8).

FIGURE 8: The Bokariza MAR Project Site

Satellite view of Bokariza MAR project site. The blue polygons represent a 90-120 acre drainage area. The larger polygon delineated in red is the 2 acre man-made aquifer recharge basin. The smaller polygon delineated in red is a sediment catchment basin that was built to enhance the MAR system's performance. The yellow arrows indicate channels, culverts and lined ditches that were built to funnel the water toward the recharge area. *Image credit: Sacha Lozano*

The basin receives stormwater runoff from surrounding fields and hill slopes, and has an estimated recharge capacity (amount of water back into the aquifer) of 80-100 AFY, based on infiltration and average precipitation rates (Fisher et al. 2011). Implementation of the Bokariza MAR project has been the result of a collaborative effort involving Driscoll's Berry Associates and Reiter Affiliated Companies, the Resource Conservation District of Santa Cruz County, USDA-NRCS, researchers from the University of California at Santa Cruz (UCSC) and California State University Monterey Bay (CSUMB), and landowners. Location-specific strategies were tested for routing runoff, minimizing siltation, cycling nutrients, and achieving other water quality benefits as excess surface flow (rainfall) is percolated into the underlying aquifers. Monitoring and quantification of improvements (aquifer recharge and water quality benefits) are an essential part of the project. The Community Water Dialogue is considering the implementation of at least 10 additional MAR projects with similar water recharge potential, in highly suitable areas throughout the valley, in order to accrue a significant contribution to reduce the overdraft.

This case study translates ecological and hydrological functions performed by the Bokariza MAR project into economic benefits and values. These benefits are compared to the costs of setting up and maintaining the project, in order to determine the economic efficiency and return of these types of investments. Water management agencies, planners, decision makers and stakeholder initiatives such as the CWD can use this information to allocate resources and optimize aquifer management beyond water supply by including other critical ecosystem functions in their decision making.

Environmental Valuation

In order to value the Bokariza recharge area, we first identified a range of potential benefits that could be attributed to the site (water supply, flood control, habitat maintenance and others) and to potential beneficiaries. Benefits we could find physical measurements for or satisfactory estimates of potential changes were then selected for valuation. Given the small size of the managed recharge area in relation to the overall aquifer, and difficulties in extrapolation, only some of the ecosystem services identified were deemed relevant for valuation. Different methods were used depending on the data available and the dimensions of the service that were found to be most important.

Table 11 provides a brief description of the environmental valuation methods that were used or considered in this study.

TABLE 11: Valuation Methods Used or Considered for the Bokariza Analysis

Valuation Method	Description
Avoided Cost (AC)	Value of costs avoided that would have been incurred in the absence of particular ecosystem services. Example: Hurricane protection provided by barrier islands avoids property damages along the coast.
Replacement Cost (RC)	Cost of replacing ecosystem services with man-made systems. Example: Natural water filtration replaced with man-made filtration plant.
Factor Income (FI)	The enhancement of income by ecosystem service provision. Example: Water quality improvements increase commercial fisheries catch and incomes of fishermen.
Benefit Transfer (BT)	The adaptation of values derived in other primary studies to a target site considering factors such as size, population, or others.
Direct Market Price	Values based on existing markets and potential payments received. For example revenue from carbon markets based on the price per ton.

Ecosystem Services included in the Analysis

An aquifer and its recharge areas can provide a range of ecosystem services through the many ecological and hydrologic functions they perform and their structural characteristics. Below is a list of the ecosystem services identified and valued for the Bokariza MAR project.

Water Supply

In its most general form, water quantity was measured through the costs that have been estimated for substituting overdraft water consumption with various projects proposed in the Pajaro Valley Water Management Agency (PVWMA)'s Basin Management Plan (PVWMA 2002, 2012)). A weighted average was calculated given the different costs and capacities that make up the plan at different time horizons. It is estimated that these costs average $551 per AF of water for the first ten years (2015-2025) and rise to an average of $2,023 for the following 15 years (2025-2040). Given that scarcity of water is expected to increase, more costly technologies will have to be adopted. This basic pricing methodology values water at a constant rate irrespective of its use and represents the minimum value of water in terms of its physical quantity and availability. A constant (average) recharge rate of 90 acre feet per year (AFY) was assumed based on current studies in the area (Fisher et al. 2011, UCSC 2013).

Flood Control

The Bokariza MAR drainage area directs stormwater runoff away from areas where it can cause erosion or harmful flooding and into areas where it can percolate back into the aquifer. Through this process, it prevents negative impacts from runoff such as flooding, road damage, crop losses, and heavy sediment loadings which would result in costs to society. This function is valued based on a primary study conducted in nearby Monterey County (Rein 1999). Based on this study, costs associated with protection against soil erosion for road damage are estimated at $446 per year for the Bokariza site. Although they were not included as part of the calculation, culvert repairs are estimated to be between $1,000 and $3,000 per culvert (Rein 1999), which would be another real cost incurred as a result of increased sediment loadings from stormwater runoff.

Habitat

Depending on the amount of precipitation, the 2-acre recharge basin can function as a seasonal wetland (though not a perennial wetland), where shrubs and other water-prone vegetation can grow easily and attract aquatic species, some of which are migratory and depend on increasingly limited wetland habitat. Wetland habitats are also very valuable to humans, not only for their aesthetic attributes but also for providing important services like pollination, flooding buffers, nutrient regulation, and pest control. Protecting and restoring wetland habitat can actually yield economic profit to land owners through funding mechanisms like mitigation banking, or conservation easement incentives such as NRCS's Wetlands Reserve Program (WRP). Mitigation banking allows third parties to sell "habitat offset" credits to developers who have adversely impacted wetland habitat and therefore are required to comply with section 404 under the Clean Water Act. Wildlands Inc. operates a mitigation banking program in the Pajaro Valley area and it uses an average value of $225,000 per acre for its wetland mitigation credits. NRCS's WRP, on the other hand, provides a one-time payment of $12,000 per acre (on average) as a cost-sharing incentive for wetland protection easements. While the Bokariza site is unlikely to qualify as a wetland for the purposes of mitigation, it may qualify for a conservation easement such as a seasonal habitat or flood easement. [26] For the purposes of this ROI analysis we are using the more conservative value of $12,000 per acre (or $960 per year over 25 years) from NRCS's WRP.

[26] The authors believe that the presence of standing water on the site for at least several weeks per year, along with the presence of vegetation and potential habitat for birds, salamanders, frogs and other species, may qualify the site as a seasonal wetland for the purposes of a conservation easement. At the same time, it is recognized that the management actions required to keep the Bokariza site active as a groundwater recharge basin (such as ripping and sediment removal) could present a conflict for certain types of conservation easements that would restrict ground-disturbing activities necessary to maintain high percolation.

Estimating the Benefits of the Bokariza Managed Aquifer Recharge Project

A summary of the environmental values obtained from these services is provided in Table 12 below.

TABLE 12: Ecosystem Service Benefit Values for the Bokariza MAR Project

Ecosystem Services	Description	Valuation Method	Calculation	Value
Water Supply	Cost of alternative water sources based on PVWMA BMP 2000 alternatives: YEARS 1-10	Replacement cost	\$551 per AF x 90 AFY	\$49,590 per year (Years 1-10)
	Cost of alternative water sources based on PVWMA BMP 2000 alternatives: YEARS 11-25	Replacement cost	\$2,023 per AF x 90 AFY	\$182,070 per year (Years 11-25)
Flood Control	Costs of road protection against soil erosion based on a California study (Rein 1999)	Benefit transfer	\$223 per acre per year X 2 acres	\$446 per year
Habitat	Wetland Reserve Program as implemented under USDA Natural Resource Conservation Service (NRCS)	Direct Market Price	\$24,000 per 25 years	\$960 per year

*All values in 2012 dollars

Estimating the Costs of the Bokariza Managed Aquifer Recharge Project

The Bokariza MAR project was a relatively inexpensive project given that minimal equipment and infrastructure was used. The costs are summarized in Table 13 below.

TABLE 13: Summary of Costs for the Bokariza MAR Project

Ecosystem Services	Description	Calculation	Value
Opportunity Costs	The net returns (i.e. profits) that could be generated by producing strawberries in the 2 acre recharge area if it was not being used as a recharge site	\$7,612 per acre per year X 2 acres	\$15,224 per year
One-time Costs	Fixed Costs: Infrastructure and staff, permit coordination	Estimate provided by RCDSCC	\$70,000 total
Maintenance Costs	Maintenance costs associated with the Bokariza recharge site	Estimate provided by RCDSCC	\$5,000 per year

The largest cost component is the opportunity cost of the 2 acre depression for the recharge area, assuming that it could be used as a productive strawberry field. The other components include fixed costs, incurred only once for the project set-up, and maintenance costs per year.

Estimating the Return on Investment of the Bokariza Managed Aquifer Recharge Project

The return on investment is measured by calculating the ratio of costs to benefits and used in a range of applications including determining whether an investment is worthwhile, how it compares to alternate investments, calculating when the initial capital will be recovered, and in prioritizing policy actions.

Return on Investment Calculation:

$$\text{ROI} = \frac{(\text{Gain from Investment - Cost of Investment})}{\text{Cost of Investment}}$$

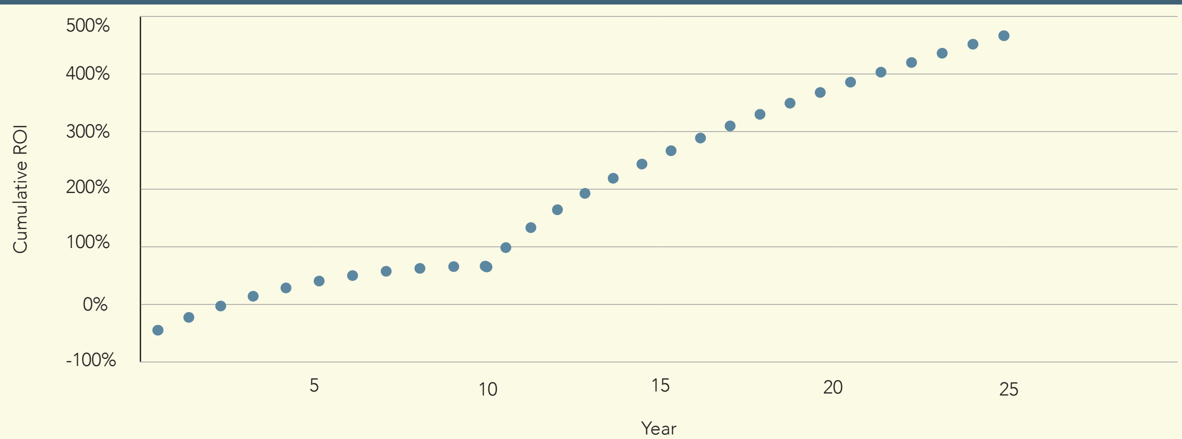
After calculating costs and benefits, an ROI analysis was run over 25 years. Results indicate that after 10 years, the Bokariza MAR project returns 87% (or $1.87 for every $1 invested), and after 25 years the project returns 467% (or $5.67 for every $1 invested). A summary of results is provided in Table 14.

Figure 9 shows a graphic representation of the ROI estimate for Years 1 through 25, and indicates that the ROI increases at a faster rate from Year 11 onwards due to the higher replacement value of each acre foot of water.

TABLE 14: Summary of Bokariza MAR Project ROI Results

Cumulative Costs	Year 1	Year 5	Year 10	Year 15	Year 20	Year 25
Maintenance Costs	$5,000	$25,000	$50,000	$75,000	$100,000	$125,000
One-time Costs	$70,000	$70,000	$70,000	$70,000	$70,000	$70,000
Opportunity Costs	$15,224	$76,120	$152,240	$228,360	$304,480	$380,600
TOTAL	$90,224	$171,120	$272,240	$373,360	$474,480	$575,600
Cumulative Benefits	**Year 1**	**Year 5**	**Year 10**	**Year 15**	**Year 20**	**Year 25**
Water Supply	$49,590	$247,950	$495,900	$1,406,250	$2,316,600	$3,226,950
Flood Control	$446	$2,230	$4,460	$6,690	$8,920	$11,150
Habitat	$960	$4,800	$9,600	$14,400	$19,200	$24,000
Total	$50,996	$254,980	$509,960	$1,427,340	$2,344,720	$3,262,100
TOTAL	$50,996	$254,980	$509,960	$1,427,340	$2,344,720	$3,262,100
Cumulative ROI	**Year 1**	**Year 5**	**Year 10**	**Year 15**	**Year 20**	**Year 25**
	-43%	49%	87%	282%	394%	467%

FIGURE 9: Cumulative Return on Investment of Bokariza MAR over Years 1-25



Discussion

Investments in water protection initiatives are critical to ensuring economic prosperity and human wellbeing in the region. The current economic structure is highly dependent on constant and abundant water supply, the price of which does not include the whole array of benefits this water provides. There has been a shift in the county to more water-intensive crops in recent years, with most of the necessary water supplied by the Pajaro Valley aquifer. Although the City of Watsonville remains the largest individual groundwater user in the valley, agriculture use is the largest form of regional water consumption. As water demand increases, the security of groundwater supplies will become more important, and the potential for greater overdraft and seawater intrusion will be greater concerns. For these reasons, initiatives like the Bokariza MAR project may play an important role in finding long-term solutions for sustaining groundwater supplies.

This economic analysis identified and to the extent possible monetized several of the main benefits of the Bokariza MAR project. The monetized benefits were water supply, flood and erosion prevention, and the creation of a wetland-like habitat. Many other benefits were identified but not monetized for various reasons. For example, as water infiltrates through a recharge area such as Bokariza, bacterial denitrification in the soil can remove a significant amount of nitrate pollution (Schmidt et al., 2011), helping to control water quality impairment. This service would cost approximately $384/AF to replace using conventional treatment technologies (King et al., 2012). However, some of the replacement cost estimates already applied to the water supply benefits of the Bokariza MAR project (as found in the Pajaro Valley Basin Management Plan) also included some ancillary water quality benefits (e.g. "Harkins Slough Recharge Facilities Upgrades") and were implicit in the water supply values. Therefore, to avoid the risk of double-counting, this water quality benefit was not monetized, but a future analysis should consider extracting and separating the water quality vs. supply benefits in more detail.

Other benefits of MAR projects identified but not monetized include water security through the availability of a natural reservoir (water storage) or the prevention of subsidence, which can occur when groundwater levels are lowered. The transport of water to different areas within the aquifer is also a valuable service. These services were too difficult to quantify in this small scale study but should be considered in a future analysis.

The ROI of the Bokariza MAR project is estimated to be approximately 467% over 25 years, which equates to average annual returns of 6.4% per year. This return is comparable to or better than expected real returns from traditional economic investments (after dividend/income taxes, inflation, expenses etc.), such as the stock market (the average annual investment returns for stocks on the S&P 500 index was 6% over the past 30 years) or municipal bonds (average annual investment returns of 3.6% over the past 30 years) (Thornburg Investment Management, 2013).

Given the array of water management proposals currently being studied and the possibility to replicate the Bokariza MAR project elsewhere around the basin, relative benefits and economic opportunities need to be understood. Moreover, in order to develop a strategy to avoid overdraft of the Pajaro Valley aquifer, a flexible and effective portfolio of water supply and water conservation approaches will be required. This study suggests that managed aquifer recharge projects that use stormwater runoff should be part of this long-term plan.

Bokariza recharge basin in the spring, viewed from bottom of 2 acre depression toward upstream drainage area. *Photo credit: Andy Fisher*

APPENDIX F: Local Economic Impacts of Santa Cruz County's Integrated Watershed Restoration Program (IWRP)

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Introduction to IWRP

The Integrated Watershed Restoration Program (IWRP) is a countywide partnership effort that facilitates implementation of voluntary conservation projects that increase the quality and abundance of habitat for multiple listed species and/or improve water quality in sloughs, streams, and lagoons. In addition to the focus on habitat restoration and improved water quality, IWRP works to ensure that most projects are designed to address multiple benefits including restoring natural processes, providing flood attenuation, enhancing groundwater recharge, and providing educational opportunities.

Beginning in the late 1990s, eight watershed restoration plans and a number of other related assessments were undertaken for seven watersheds in Santa Cruz County. By 2001 the conservation focus shifted away from planning and into ways to effectively implement these plan recommendations. Numerous stumbling blocks were identified, including:

- Competition between watershed partners for limited funding;
- Wasted time and money spent preparing proposals on grants not considered high priority by funding agencies;
- Few funding sources for project design and permits, resulting in stalled projects or a lack of "shovel-ready" projects;
- Limited guidance from agencies early in the design process, often leading to costly re-designs;
- Confusing and time-consuming permitting process;
- Shrinking resource and permitting agency staff time;
- Lack of a formal watershed partner forum to discuss priorities;
- Lack of a centralized watershed restoration information hub specific to Santa Cruz County.

Staff from the Resource Conservation District of Santa Cruz County (RCDSCC), California Coastal Conservancy, California Department of Fish and Wildlife (CDFW, formerly CDFG), Coastal Watershed Council, and the City and County of Santa Cruz developed the concept for the Integrated Watershed Restoration Program (IWRP) for Santa Cruz County to address these stumbling blocks. **IWRP was set up as a voluntary framework, put into place to coordinate local, state and federal resource, funding, and permitting agencies with the explicit goal of reducing impacts to agency staff time and helping ensure that the most critical projects across the county's watersheds are identified, funded, and permitted.** IWRP also provides resources to local watershed partners for developing projects.

At the same time, the RCDSCC worked with the Natural Resources Conservation Service (NRCS), Sustainable Conservation, and multiple regulatory agencies, to facilitate the *Partners in Restoration* (PIR) Program. The PIR Program has played a vital role enabling IWRP projects to be developed, reviewed, permitted, and completed in a timely and efficient manner. Project implementation is rigorously reviewed and vetted by a coordination team and a technical advisory committee, composed of federal, state, and local resource agencies. Active engagement of resource and regulatory agencies in the PIR Program has also helped to ensure the protection of sensitive resources during project development and implementation.

IWRP has been heralded as a model for collaborative, integrated watershed conservation by RCDSCC's partners and funders at local, state and federal levels. Due to the program's success in identifying, developing, and implementing high priority restoration projects, the staff and management at the National Marine Fisheries Service, US Fish and Wildlife Service, and the California Department of Fish and Wildlife requested that the State Coastal Conservancy expand IWRP and its associated funding to cover the neighboring counties of San Mateo and Monterey. Since IWRP's inception, the RCDSCC and its partners have been able to design, permit, and construct over **107 water quality improvement and habitat restoration projects throughout the County (Figure 10)**.

After ten years, IWRP has proven to be a highly effective process for implementing restoration projects in the Central Coast. IWRP brings federal, state, and local resource agencies and conservation partners together to identify high priority watershed restoration projects in San Mateo, Santa Cruz, and Monterey Counties, and to provide technical oversight of the preparation of designs and environmental compliance documents.

Watershed Stewardship Outcomes

IWRP projects are divided and evaluated in different categories or project types, as described in Table 15. Some of the key resource issues and environmental threats these projects address in Santa Cruz County include: fine sediment loading from outdated culverts and road crossings impacting fisheries habitat; loss of functioning healthy wetlands; restricted fish habitat by man-made fish passage barriers; and diminished lagoon water quality. The program favors projects that integrate multiple-benefits for water quality, restoration and sediment source control.

FIGURE 10: Location and types of IWRP projects implemented in Santa Cruz County between 2005 and 2014

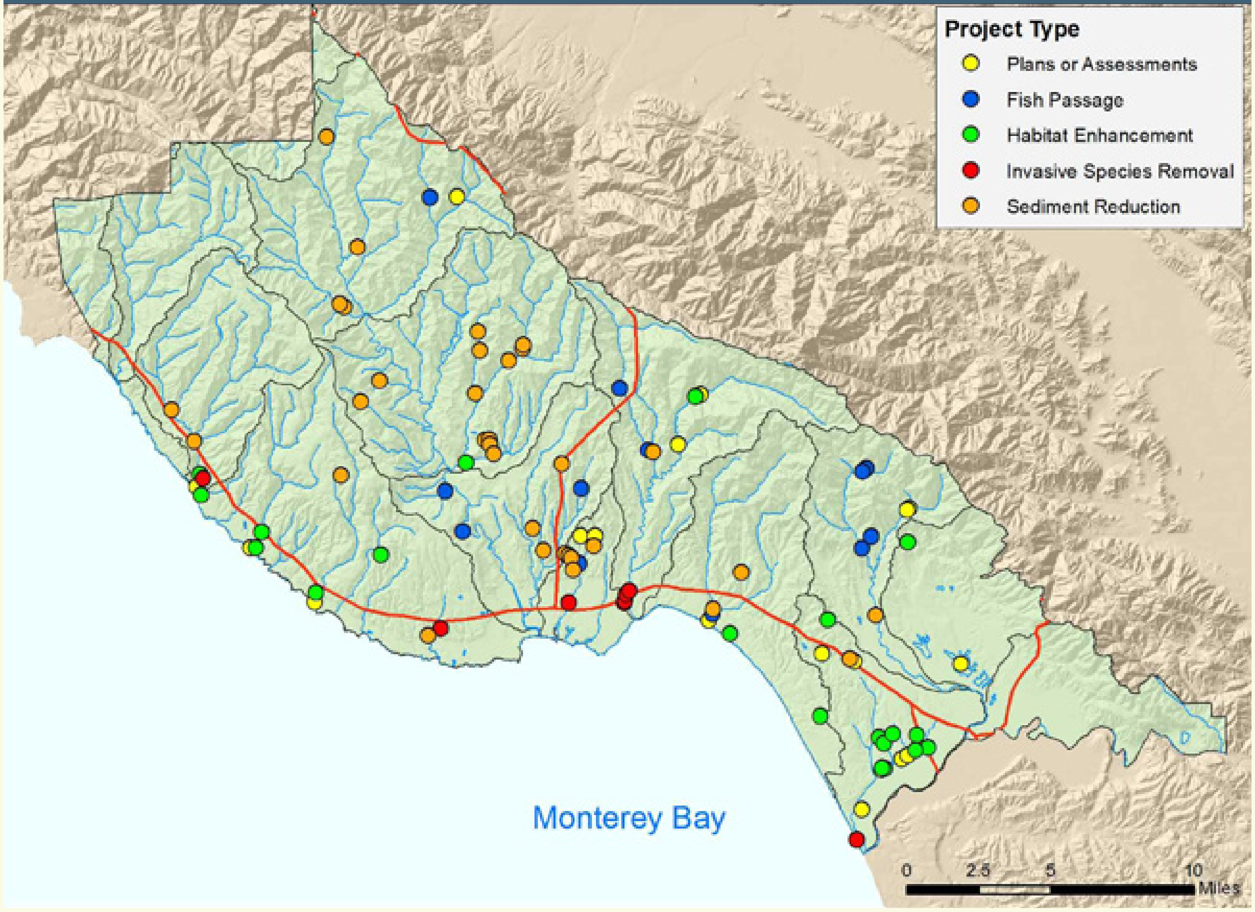

TABLE 15: Summary of IWRP goals and accomplishments per project type, period 2005-2013

Project Type	Goal	Accomplishments
Fish Passage	Improve fish passage characteristics at culverts, road crossings and fish ladders in local streams to facilitate seasonal migration (this includes: reducing jump height, improving structure materials and condition, improving channel stability, and minimizing deposition or erosion that would impede fish passage)	20 projects completed and implemented according to project design Combined, these projects resulted in restoring salmonid access to approximately 22 miles of habitat in the San Lorenzo River Watershed, and removal/modification of ALL man-made fish passage barriers in the Aptos/Valencia, Soquel, and Corralitos watersheds
Sediment Reduction	Reduce sediment load, aggradation and/or erosion affecting stream habitats (this includes: addressing drainage problems and upgrading culverts)	40 projects completed Biophysical impact was measured for 25 of these projects. Combined, these projects provided a total sediment load reduction of 14,000 Ton/yr
Wetland Enhancement (Wetland/ lagoon restoration and/or revegetation)	Restore and/or improve complexity and quality of wetland habitat Restore and/or increase vegetation in local wetlands and lagoons	12 projects completed Biophysical impact was measured for 8 of these projects. Combined, these projects benefited a total area of 32 acres and removed 40,355 cubic yards of sediment from wetlands.
Wetland Enhancement (Invasive Species Removal)	Restore and/or improve native wetland vegetation and habitat quality by removing invasive species and planting natives	18 projects completed Biophysical impact was measured for 10 of these projects. Combined, these projects benefited a total area of 16.61 acres
In-stream Habitat Enhancement	Improve in-stream habitat conditions for fish and other aquatic species (this includes: improving habitat complexity, removing excess of sediment, reconnecting floodplains, etc)	12 projects completed
Upland Habitat Enhancement	Restore and/or improve critical upland habitat for aquatic species that spend part of their life cycles in uplands (e.g salamanders, frogs)	5 projects completed
Permit Coordination	Facilitate project implementation by coordinating and expediting approval of multiple State and Federal agency permits	76 projects obtained permits through this program between 2005-2013
Assessments and Feasibility Analyses	Acquire necessary information about the system to guide intervention or restoration and assess feasibility of project implementation	30 assessments and feasibility studies completed

Leveraging Dollars for Stewardship Action

Seed funding to start the IWRP program resulted from a partnership between the RCDSCC and the State Coastal Conservancy, and included RCDSCC's modest tax base plus grant funding from the Conservancy (see Table 2). Leveraging this seed funding through new partnerships and grant writing, the RCDSCC was able to secure significant additional funding from various public and private sources, including: a) State Water Resources Control Board (SWRCB) grants through Proposition 40, Proposition 50 and the 2009 American Recovery and Reinvestment Act (ARRA), b) Federal grants (mainly from NOAA), c) other County funds, private investments, and in-kind support (see Table 2). SWRCB funds supported implementation of 16 components of the Santa Cruz Integrated Regional Water Management (IRWM) Plan, with the collective goal of promoting environmental stewardship and improving local water supply reliability, water quality, watersheds and habitats, and stormwater management. IWRP became one of the main tools to achieve these goals, and a mechanism to bring investments to the County, which could have not occurred in absence of an effective program.

TABLE 16: Summary of IWRP funding sources and leveraged funds, period 2004-2013

Funding Source	Amount
Seed Funding	
RCDSCC Tax base allocation (2004-2013)	$450,000[25]
CA Coastal Conservancy grants (2004-2013)	$3,983,183
Partnerships and Leveraged Funds	
Other State grants	$10,633,853
Federal grants	$1,202,090
Other County funds/grants	$727,190
Private investments / donations	$484,787
In-Kind support	$113,770
TOTAL LEVERAGED	$13,161,690

To summarize, the combined investment of $4.4M from RCDSCC and the State Coastal Conservancy has resulted in the raising of an additional $13.1M to design, permit and construct 107 watershed restoration projects in Santa Cruz County to date. In addition, the Conservancy's investment has provided a forum to coordinate recovery actions for the Central and South Central California Coast steelhead, Central California Coast Coho salmon, Santa Cruz long toed salamander (SCLTS), California red legged frog (CRLF), and other listed species in the Santa Cruz, San Mateo and Monterey counties. As an additional benefit IWRP has played an important role mediating long-standing resource conflicts in Santa Cruz County. Based on early program implementation success and the RCD's role as a neutral entity facilitating conservation, IWRP has helped to infuse historically charged issues with a sense of trust and collaboration, leading to issues being resolved and solutions being implemented.

[25] This overestimates the amount of seed funding, as only a fraction of the RCDSCC tax base was actually allocated to support IWRP.

There are a number of efforts underway by IWRP partners to develop long-term funding mechanisms to sustain the program into the future and maintain momentum of recovery actions for listed species. IWRP partners agree that continued funding for the design and permitting of high priority conservation projects will be critical for maintaining this high level of collaboration and building off past successes. Moreover, as public and private grant funding continues to require higher and higher local match and a stronger emphasis on multi-benefit "shovel-ready" projects, Santa Cruz County will have to develop new funding mechanisms to ensure that programs like this continue to spur local economic activity and protect vital ecosystem services.

Local Economic Effects of Investment in IWRP

Investment in the IWRP makes economic sense at many levels. It creates jobs, stimulates the economy, and provides many ecosystem services to the local population. In order to calculate the nature and magnitude of two key economic impacts emerging from investments made through IWRP, job and economic multipliers were estimated based on a study conducted in Oregon (Nielsen-Pincus and Moseley, 2010). These indicators show how much an initial investment can be multiplied in size as it cycles through the local economy. The idea is that money creates more money as it circulates among a group of economic actors. Multipliers are calculated from trends in expenditures made by restoration programs, job analyses, and from tracking the economic sectors affected.

Economic impacts can be divided into direct effects, indirect effects, and induced effects. Direct effects are those created by the planning and implementation of restoration programs. They include wages paid for the personnel doing the work, direct purchases for equipment used, or any other direct transaction made for the project. Indirect effects are secondary purchases or transactions made by the industries or contractors doing the work that enable the operation of equipment or supporting activities (like gasoline expenditures, materials for infrastructure, etc). Induced effects represent the household consumption expenditures made by employees or other wage earners from the restoration projects.

Between 2005 and 2012, the RCDSCC was able to leverage its $40-50K annual tax funding base (by several orders of magnitude) through partnership building and secure $17.1 million in investments for IWRP projects from public and private sources outside of the County. Most of these funds would not have come into Santa Cruz County in absence of IWRP. It is estimated that the activities supported with these investments resulted in a total economic output of about $38-43 million.[26] Based on jobs multipliers calculated for a range of restoration projects in Oregon, the $17.1 million is estimated to have supported approximately 200 full time and part time jobs, equivalent to approximately 140 Full Time Equivalent jobs.[27] It is also important to note that a significant amount of this infusion of funds and job creation occurred during the most recent economic recession, underlining the importance of its effect on the local economy, and that many of these jobs are likely to be high skilled and professional jobs, including expertise in ecology, impact assessment, engineering, education, and accounting.

[26] These results are based on a peer-reviewed output multiplier that was developed for restoration projects in Oregon, which found that a $1 million investment led to a total economic output of $2.3-2.5 million. Source: Nielsen-Pincus and Moseley, 2010.

[27] These results are based on a peer reviewed jobs multiplier developed for restoration projects in Oregon, including in-stream projects, riparian projects, wetland projects, fish passage projects, and upland projects. The study found that every $1 million invested in a restoration project supports approximately 4.3 direct jobs and 7.4 indirect jobs (11.7 jobs total). Direct jobs represent the jobs in the industries that carry out restoration work (contractors, project managers etc.), and the indirect jobs represent the jobs supported by purchases of supplies and services specific to restoration work. $17.1 million multiplied by 11.7 jobs/million yields 201.24 jobs. These numbers represent both full time and part time jobs, and not Full Time Equivalent (FTE) jobs. In order to convert this number to full time to FTEs, the number was weighted based on a survey-based study conducted in Humboldt County, CA, which found that 300 restoration jobs was equivalent to approximately 210 FTE jobs. This analysis assumes the restoration economy in Santa Cruz County has approximately the same composition of full time and part time jobs as that of Humboldt County. Source for Oregon study: Nielsen-Pincus et al. 2010. Source for Humboldt County study: Baker et al 2004.

These investments can also be seen as injections to the local economy which will more than double in size once the projects are implemented. The size and particularities of the effect will depend on the type of restoration project being carried out and decisions to purchase locally or regionally. The original analysis from which these figures were calculated was based on trends at the state level so these multipliers would reflect state level impacts. Table 17 below shows the economic effects that can be expected by project type.

TABLE 17: Employment and Economic Multipliers generated per $1 million invested in restoration projects

Employment (jobs)	All Projects (aggregate)	In-stream projects	Riparian projects	Wetland projects	Fish passage projects	Upland projects	Other projects
Direct effects	4.3	4.6	7.4	5.1	4.7	3.7	4.3
Indirect effects	7.4	5.9	10.1	7.4	5.9	7.1	6.1
Induced effects	4.6	4.2	5.6	5.1	4.6	4.2	4.3
Total effects	16.3	14.7	23.1	17.6	15.2	15.0	14.7
Multiplier	2.7-3.8	2.3-3.2	2.4-3.1	2.4-3.4	2.3-3.3	2.9-4.0	2.4-3.4

Source: Nielsen-Pincus, M. and C. Moseley (2010). Economic and Employment Impacts of Forest and Watershed Restoration in Oregon. Ecosystem Workforce Program. Working Paper Number 24.

It should be noted that these economic impacts do not include non-market benefits from ecosystem services. If these values were calculated, the total effect on well-being and prosperity would likely be higher. For example, projects that reduce sediment loads have benefits for fish populations, for water treatment infrastructure, for the efficiency of hydro-power generation, for quality of recreational activities, for controlling flood events and erosion, among others. All of these benefits can be associated with the avoidance of economic losses or with benefits for which consumers would be willing to pay (as calculated through non-market valuation methods).

An additional and often overlooked benefit of IWRP's collaborative and programmatic effort is the significant reduction in costs to taxpayers through a more efficient administrative process. IWRP has provided a forum and catalyst for developing regional and statewide programmatic permits to reduce the cost and time associated with securing various types of local, state and federal authorizations. While these costs are not quantified for this report, the financial impact resonates far beyond Santa Cruz County. In addition to the successful development and deployment of the RCD's Permit Coordination Program, IWRP and funds from the Coastal Conservancy were the catalyst for the NOAA Restoration Center completing the first of its kind programmatic Biological Opinion (BO) for salmonid restoration projects. This BO has significantly streamlined the approval processes for a suite of instream and upland projects focused on fisheries restoration that meet a pre-determined set of standard avoidance and minimization measures. This BO was completed in 2005 for NOAA's Santa Rosa office and a companion BO was completed for their Arcata office in 2012. These BO's now cover the coast from Del Norte County to San Luis Obispo. These efforts have evolved over the past few years and the BOs now also include programmatic Consistency Determinations with CDFW for state listed coho salmon and with the California Coastal Commission for impacts within the Coastal Zone. These efforts will continue to save private citizens and public agencies money for years to come in reduced staff time, reduced uncertainty, and expedited project delivery.

Conclusions and Recommendations

This case study demonstrates how investments in IWRP, and the high volume of restoration projects it has completed to date, have benefitted the local economy through leveraged funds, job creation, and money circulation. This economic impact is only a portion of IWRP's broader economic contribution, as this case study does not include the economic value of the ecosystem services that have been protected, restored and enhanced by IWRP stewardship activities.

Altogether, the 107 stewardship projects implemented to date have at the very least provided a total sediment load reduction of 14,000 Ton/yr, restored 32 acres of wetland vegetation, removed 40,355 cubic yards of sediment from local wetlands and floodplains, removed invasive species from 16.61 acres of wetlands, enhanced 22 miles of in-stream habitat and improved in-stream migrating corridors for endangered salmonids. IWRP pond projects have resulted in new breeding sites and habitat connectivity for the critically endangered long-toed salamander and other listed amphibians. IWRP fish habitat projects have addressed all of the salmonid barriers in the Corralitos System, all man-made barriers in Aptos/Valencia and Soquel, and implemented the first coho recovery projects south of the Golden Gate. All of these biophysical outcomes offer a significant contribution to the long-term maintenance of ecosystem services and natural capital in the County.

Continued investment in stewardship programs like IWRP will focus the community's attention on the benefits of protecting natural resources, and will continue to realize beneficial short-term economic impacts and long-term protection and restoration of key ecosystem services, which play a fundamental role in sustaining our regional and local economies.

This study highlights the importance of securing a stable funding source for land stewardship and conservation entities like the RCDSCC and its IWRP partners to be able to continue playing their critical role, and generating economic benefits to the Santa Cruz County's community by doing so.

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