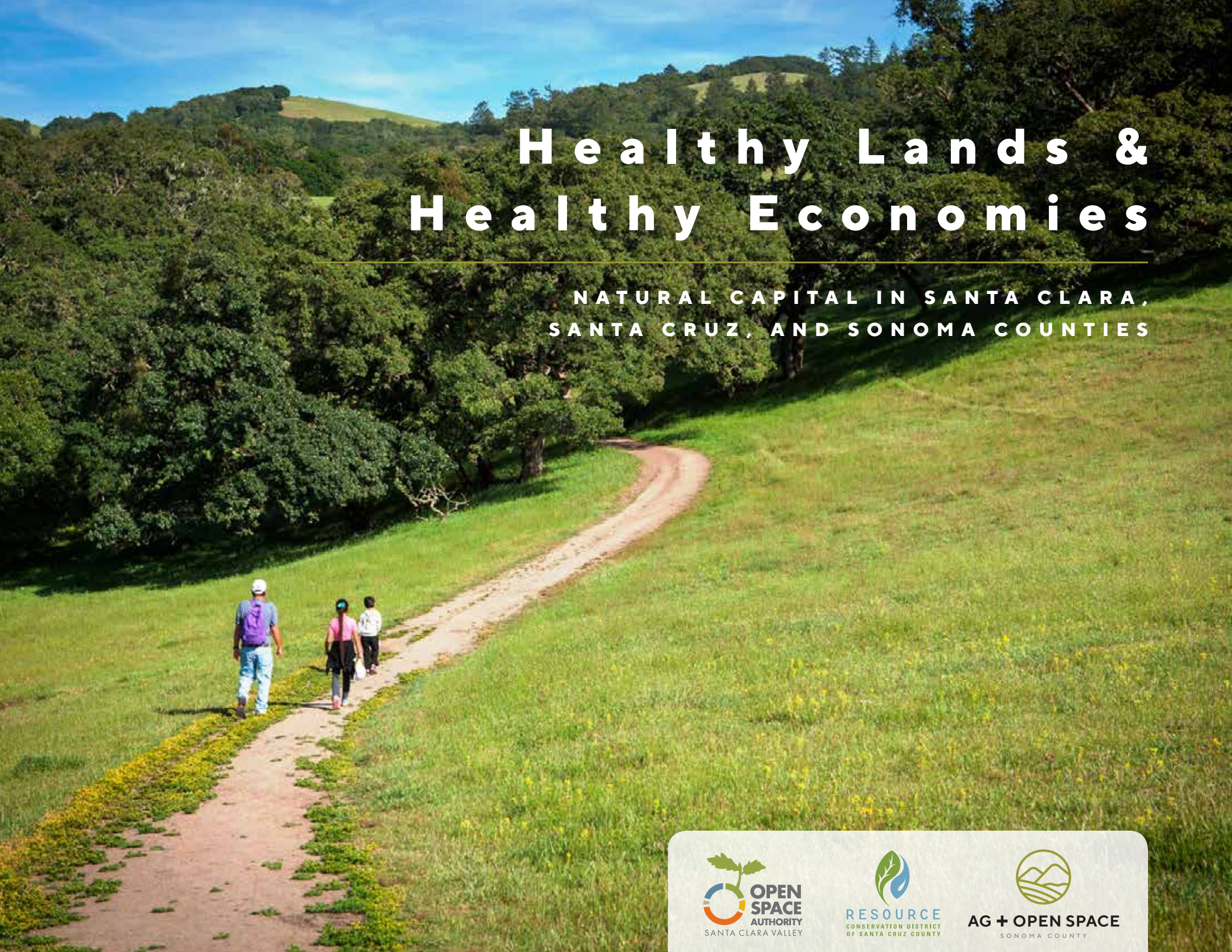

Healthy Lands & Healthy Economies

NATURAL CAPITAL IN SANTA CLARA, SANTA CRUZ, AND SONOMA COUNTIES

OPEN SPACE AUTHORITY
SANTA CLARA VALLEY

RESOURCE
CONSERVATION DISTRICT
OF SANTA CRUZ COUNTY

AG + OPEN SPACE
SONOMA COUNTY

The Healthy Lands and Healthy Economies Initiative

This report is part of the larger Healthy Lands and Healthy Economies Initiative. A joint project of the Santa Clara Valley Open Space Authority, the Resource Conservation District of Santa Cruz County, and Sonoma County Ag + Open Space, the Healthy Lands and Healthy Economies Initiative seeks to describe the economic value and community benefits of the natural and working landscapes of these three counties. This report and associated technical reports are available on the websites below. For content permission and reproduction inquiries, please contact one of the agencies below.

Santa Clara Valley Open Space Authority: www.openspaceauthority.org/HLHE

Resource Conservation District of Santa Cruz County: www.rcdsantacruz.org/healthy-lands-healthy-economies

Sonoma County Ag + Open Space: www.sonomaopenspace.org/HLHE

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OPEN SPACE AUTHORITY
SANTA CLARA VALLEY

Santa Clara Valley Open Space Authority

The Santa Clara Valley Open Space Authority conserves the natural environment, supports agriculture, and connects people to nature, by protecting open spaces, natural areas, and working farms and ranches for future generations.

RESOURCE
CONSERVATION DISTRICT
OF SANTA CRUZ COUNTY

Resource Conservation District of Santa Cruz County

The mission of the Resource Conservation District of Santa Cruz County is to help people protect, conserve, and restore natural resources through information, education, and technical assistance programs.

AG + OPEN SPACE
SONOMA COUNTY

Sonoma County Ag + Open Space

Sonoma County Ag + Open Space permanently protects the diverse agricultural, natural resource, and scenic open space lands of Sonoma County for future generations.

This Initiative is funded in part by the Gordon and Betty Moore Foundation, the S. D. Bechtel, Jr. Foundation, and the California State Coastal Conservancy.

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Overview

In the San Francisco Bay Area, we have a deep appreciation for our natural open spaces and working lands, in other words, our natural capital. We value the intrinsic scenic beauty, community character, ecosystem health, and recreational opportunities that these lands provide.

Protecting natural areas has a very real, tangible effect on our local and regional economies and the health of our communities. Open space and working landscapes provide a variety of services and benefits to our communities, including clean air, fresh water, storm and flood protection, food and fiber materials, carbon sequestration, recreation, public health benefits, and many others. The natural capital of these lands can be financially quantified to understand how our natural environment contributes services to our overall economic well-being.

The Healthy Lands and Healthy Economies Initiative is a regional collaboration, led by the Santa Clara Valley Open Space Authority, the Resource Conservation District of Santa Cruz County, and Sonoma County Ag + Open Space, that was formed to address these questions:

- What benefits and economic values are provided to the community, region, and state by natural areas and working lands?
- What is the return on investment from conservation investments to date?
- What are innovative, economically sound financing mechanisms for conservation of natural areas and working landscapes?

Funded by the Gordon and Betty Moore Foundation, the S.D. Bechtel, Jr. Foundation, and the California State Coastal Conservancy, the Healthy Lands and Healthy Economies Initiative works with economists to demonstrate how community investments in protecting agricultural and natural areas enhance the local economy and provide cost effective ways to achieve community benefits such as clean drinking water, flood control, and local food security. This multi-year project includes a broad array of local, state, and federal partners to develop a suite of tools and recommendations to help decision-makers better understand and evaluate the multiple benefits and economic value of our natural and working lands.

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What is Natural Capital?

Nature has immeasurable intrinsic value. As this report shows, it also provides services that have real, quantifiable economic values — values that are often ignored by markets and can easily be taken for granted.

Natural capital includes natural landscapes like forests, oak woodlands, wetlands, rivers and streams; working landscapes like farms, ranches; as well as urban parks and open spaces.[1] It encompasses soil, water, and air, as well as plants, animals, and microbes.

The list of services provided by natural capital is long. It cleans our water, controls floods and erosion, provides habitat for fish and wildlife, pollinates plants, controls pests, sequesters carbon, removes pollutants from the air, creates space for outdoor recreation, attracts tourists, and offers us beautiful views and scenery.

With ongoing stewardship, natural capital won't wear out or need to be upgraded — unlike built infrastructure such as a floodwall or wastewater treatment plant. While built capital is typically designed to serve a single purpose, landscapes provide multiple valuable services. A floodwall delivers only flood protection, whereas wetlands and floodplains provide flood protection, fish and wildlife habitat, groundwater recharge and filtration, and carbon sequestration.

The diversity and resilience of natural systems will be more and more important as the climate changes, with altered precipitation, temperature, and flood patterns likely. If managed well, natural capital has the potential to adapt and change, continuing to deliver substantial returns on investment from natural and working landscapes.

Critical decisions about land use and conservation are often made based on calculations — explicit or implicit — of the costs and benefits of protecting landscapes. Accounting for the economic value of natural capital helps to ensure that those decisions are made strategically and wisely.

Increasingly, state and federal agencies are considering natural capital when assessing damages from disasters such as major floods and wildfires as well as the role healthy natural systems can play in reducing the risk of such events. The Federal Emergency Management Agency (FEMA), for instance, now considers the value of the services provided by natural floodplains when conducting cost-benefit analyses of flood control proposals.[2]

Applying economics to natural and working landscapes is challenging. But more studies each year show that protecting open space is a smart investment, and that protecting the principal — our working and natural lands — will pay dividends to us and to our descendants, building an enduring natural legacy for our communities.

An example of natural capital investments at work: New York City saved residents more than $8 billion in water quality infrastructure by investing in natural capital[3]

Santa Clara County

Understanding the value provided by Santa Clara County's open spaces will be critically important as the county and cities choose how to accommodate a rapidly growing population and technology sector while it also protects and invests in its natural capital assets.

Bounded by the Diablo Range to the east and the Santa Cruz Mountains to the west, Santa Clara County encompasses a range of environments, including wetlands, fertile farms on valley floors, rolling hills, and remote mountain ranges that flow into San Francisco and Monterey bays. After decades of focused investment, public agencies and nonprofits have protected approximately 241,000 acres of open space — about 28% of the county's 825,600 acres — through land acquisition and conservation easements.[4]

Santa Clara County is also an area of extraordinary economic dynamism, home of the Silicon Valley, birthplace of the modern technology industry and some of the most valuable corporations in the world.[5] The county's population is predicted to grow from 1.8 million to 2.4 million by 2035, making it the fastest growing county in the state.[6]

"...conservation partners are positioning Santa Clara County as a leader in creating a sustainable and resilient San Francisco Bay Region"

After decades of aggressive expansion, Silicon Valley is increasingly directing its growth into existing urban areas, recognizing its natural and working lands as critical infrastructure and an important contributor to the regional economy. However, with rapid job growth and total assessed property values already in excess of $400 billion, Santa Clara County's open spaces still face high development pressure, resulting in high costs to conserve and protect these landscapes.[7]

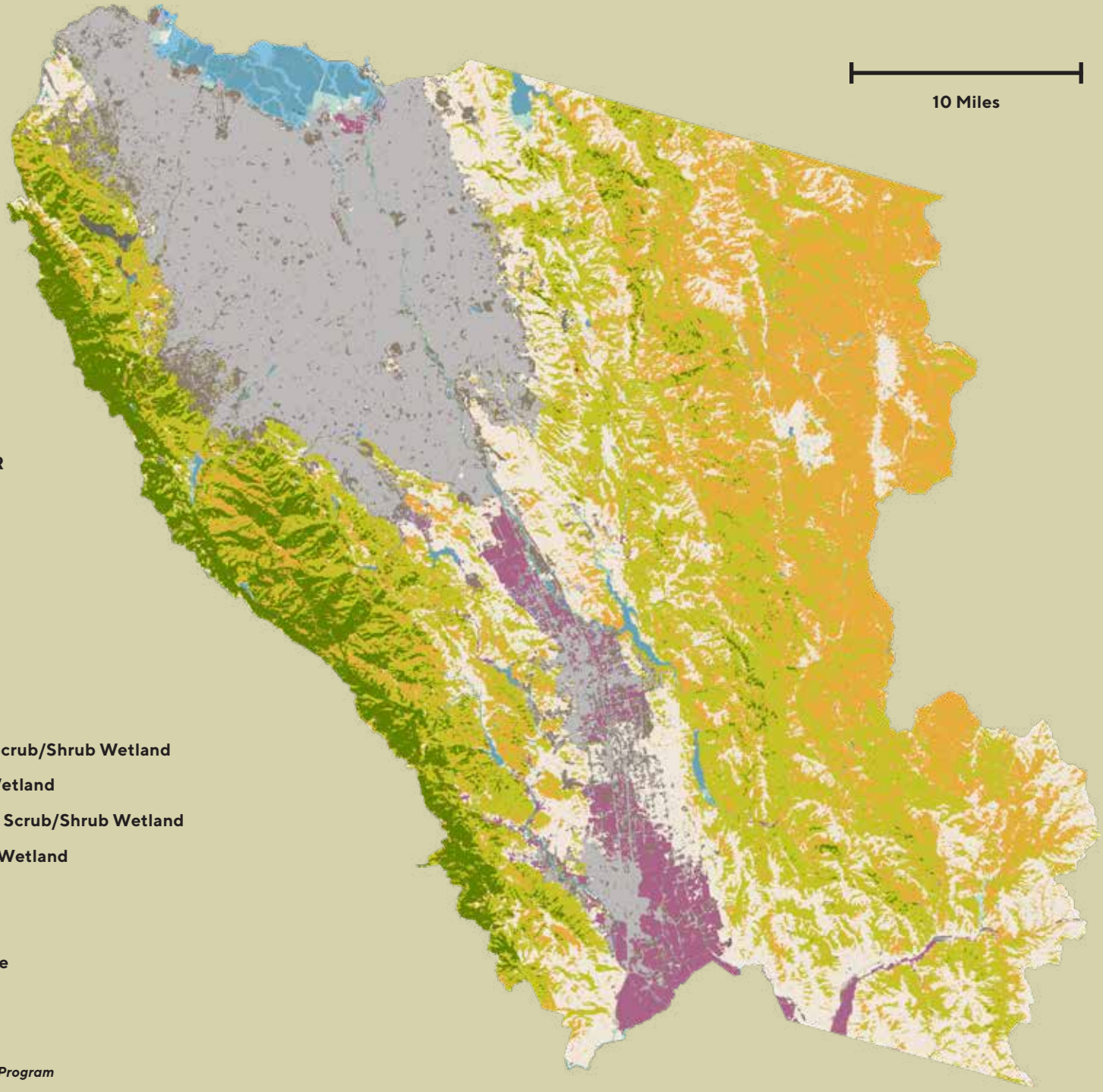
By increasing understanding of the importance and value of natural capital among the region's decision-makers, elected officials, business community, and citizens, the Santa Clara Valley Open Space Authority (Open Space Authority) and its conservation partners are positioning Santa Clara County as a leader in creating a sustainable and resilient San Francisco Bay Region.

The Open Space Authority is the first agency in California to sponsor and develop a Regional Conservation Investment Strategy (RCIS), as part of the California Department of Fish and Wildlife's RCIS Program.[8] This program is creating a new, voluntary advanced mitigation framework to promote the conservation of the county's most important species, habitats, and other natural capital assets by pooling mitigation for public infrastructure projects.

In partnership with the cities of San Jose, Morgan Hill, and Gilroy, the Open Space Authority and the County developed *The Santa Clara Valley Agricultural Plan* – a regional land use and economic development strategy that will catalyze permanent protection of the county's most important prime farmland and rangelands as a greenhouse gas emissions mitigation strategy.

The Open Space Authority and its partners are also working to create a new future for Coyote Valley, a 7,400-acre agricultural landscape that has been threatened by development for decades. A 2017 study lays the groundwork for a new vision built on investments in the area's natural capital. *The Coyote Valley Landscape Linkage* report articulates a vision to protect and restore essential areas within the valley that are vital to ensure ecological connectivity, health, and resilience to a changing climate.[9]

Innovative economic measures, policies, funding mechanisms, and smart investments are coming together in Santa Clara County to provide multi-benefit, sustainable solutions to secure healthy lands and healthy economies.



REGIONAL LAND COVER

- Cultivated
- Pasture/Hay
- Grassland
- Scrub/Shrub
- Deciduous Forest
- Mixed Forest
- Evergreen Forest
- Estuarine Forested & Scrub/Shrub Wetland
- Estuarine Emergent Wetland
- Freshwater Forested & Scrub/Shrub Wetland
- Freshwater Emergent Wetland
- Water
- Unconsolidated Shore
- Developed Open Space
- Developed
- Bare Land

Source: NOAA Coastal Change Analysis Program

Santa Cruz County

Santa Cruz County is in many ways a refuge. Despite being bordered by one of the world's most economically active and developed regions — Silicon Valley — and on the edge of one of the world's most intensively cultivated landscapes — the Salinas Valley — the county's natural landscapes remain rich and largely intact. Redwood forest covers 61% of the county's 285,000 acres, 29 miles of beaches draw thousands of visitors daily, and habitats from mountain streams to coastal shrublands make the area a biodiversity hotspot, with 1,200 species of native plants and 350 bird species. Thirty-five of the county's plant and animal species are endemic — found nowhere else on Earth.

A strong stewardship and conservation ethic, decades of conservation leadership, and innovative land use policies have helped to protect this natural capital. Today, 37% of the county is shielded from development in perpetuity, including over 50,000 acres of state, county, and city parks with 231 miles of trails. Yet, as the county's 2011 comprehensive conservation blueprint reported, there are a number of hidden threats to the county's natural capital that drive a need for continued land stewardship and conservation.[10]

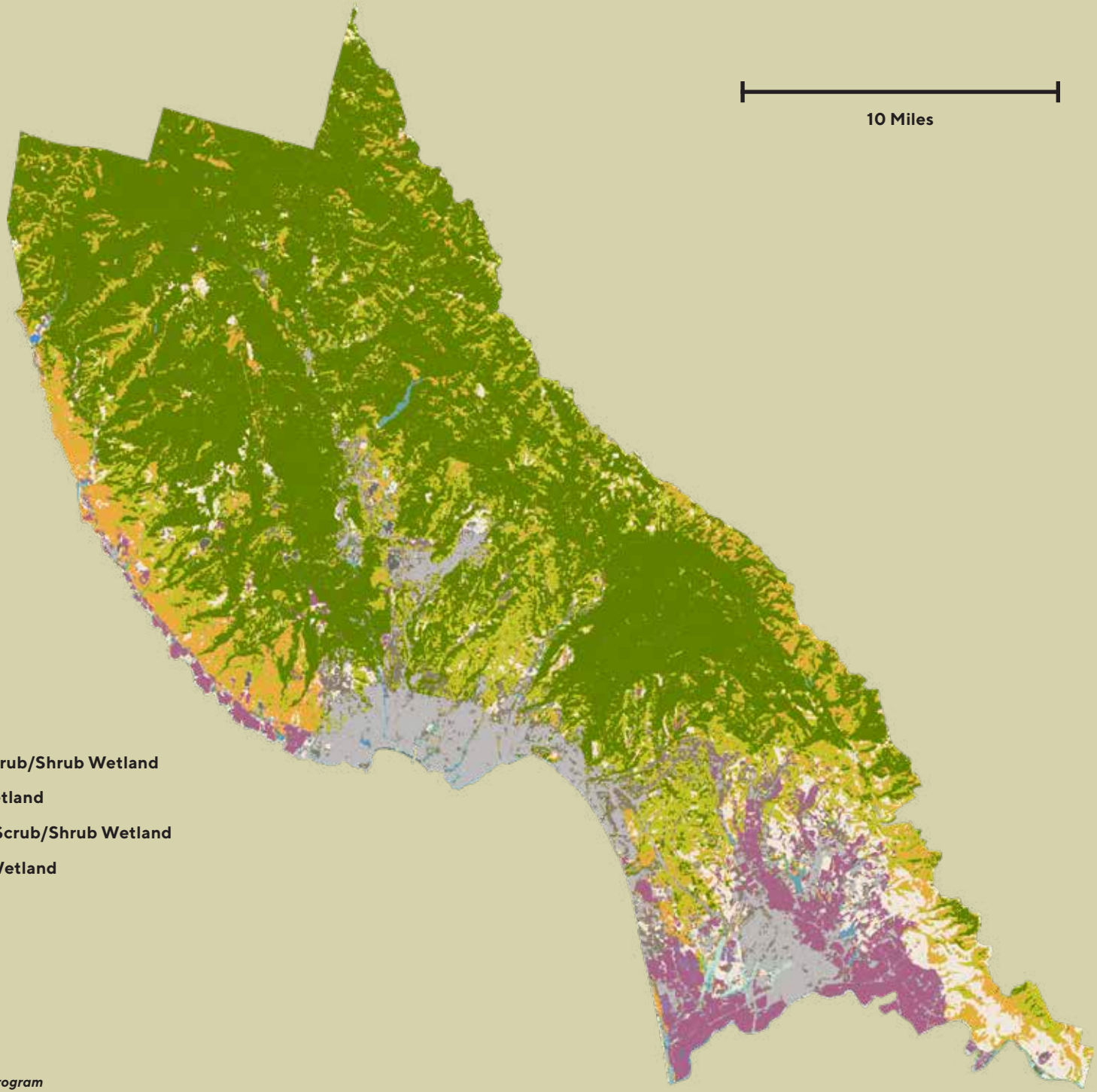
While Santa Cruz voters approved pioneering land-use policies in 1978 that have significantly limited local growth, the county continues to develop, with 17,000 new residences projected to be built by 2035. Continued growth in the four counties surrounding Santa Cruz — which are projected to reach a combined population of 4 million in less than a generation — will continue to put pressure on the region's resources.

Water resources are a major concern. Already, 18 streams and rivers in the county fail to meet the standards of the federal Clean Water Act. The county has no imported sources of water, and local aquifers — which provide over 90% of water for residents and farms — are all overdrafted.[11] These water challenges threaten the Monterey Bay National Marine Sanctuary, the quality and supply of drinking water, and the future of the county's agriculture industry. Climate change is also making the region hotter and drier, with cascading effects on water resources, plants, wildlife, and agriculture.

These challenges are significant, and the county is taking action to address them. A variety of stewardship programs and policies support improved groundwater management, habitat restoration, and conservation measures on private lands. Near Watsonville, the Bokariza Managed Aquifer Recharge Project is demonstrating how fallow land in agricultural landscapes can be used to replenish groundwater. The project channels stormwater runoff from fields and hills into a basin with soil characteristics that allow for large volumes to seep deep into the ground. This percolation, an example of the "water supply" natural capital service in action, helps to refill the depleted Pajaro Valley Aquifer, the source of 90% of the irrigation water used by the county's $600-million farm sector.

"Within a few years of investing in groundwater recharge, a community can see monetary benefits in the form of avoided costs to water supply infrastructure"

Another influential example of stewardship is the Integrated Watershed Restoration Program (IWRP), a countywide partnership effort to facilitate implementation of conservation projects that increase the quality and quantity of habitat for threatened and endangered species and improve water quality in polluted waterways. IWRP projects illustrate how investments in natural capital yield multiple benefits; conservation and restoration efforts that target habitat or water quality (or both) are designed to enhance additional services such as flood attenuation, groundwater recharge, and recreation.



REGIONAL LAND COVER

- Cultivated
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- Freshwater Forested & Scrub/Shrub Wetland
- Freshwater Emergent Wetland
- Water
- Unconsolidated Shore
- Developed Open Space
- Developed
- Bare Land

Source: NOAA Coastal Change Analysis Program

Sonoma County

Sonoma County residents recognize that protecting farmlands and natural areas is an effective way to retain the county's unique rural character. The Sonoma County community has long supported land conservation measures and policies, and in 1990 voters created the Sonoma County Agricultural Preservation and Open Space District (Ag + Open Space). Funded by a ¼ cent sales tax, the Ag + Open Space mission is to permanently protect the diverse agricultural, natural resource, and scenic open space lands of Sonoma County for future generations.

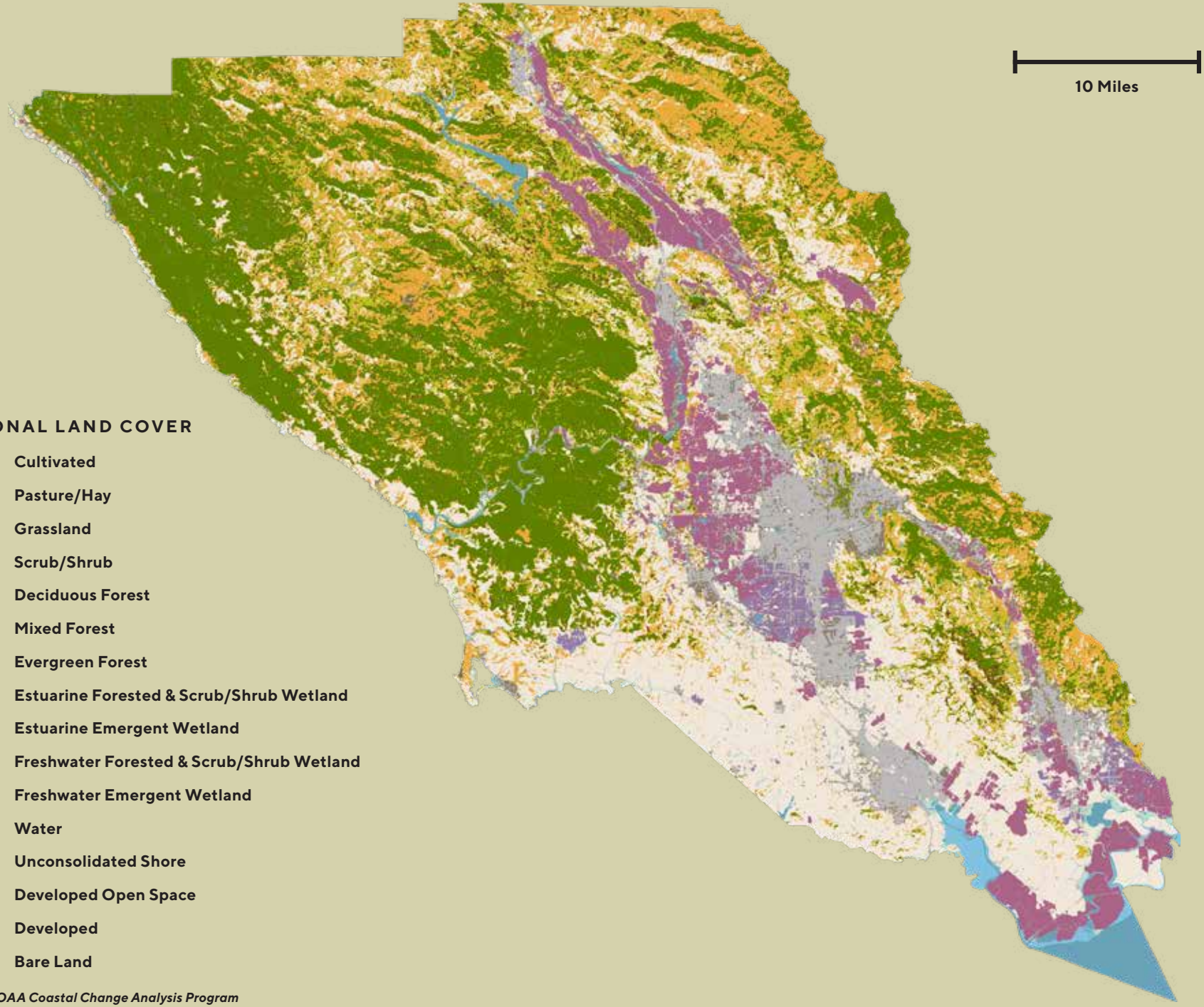
Working in a voluntary framework — with willing sellers and in collaboration with a wide variety of organizations — Ag + Open Space and its partners have translated $303 million in sales tax dollars into over 116,000 acres of land protected to date — over 11% of this million-acre county. As of today, these lands include 239 conservation easements (112,000 acres) and 17 properties that Ag + Open Space owns outright (4,400 acres). Conserved areas include Sonoma County working lands, scenic viewsheds, mountains, greenbelts, community separators, natural ecosystems, watersheds, wildlife habitats, parks, trail systems, and urban open space.

In addition to its proactive land use and land protection strategies, Sonoma County is home to innovative and effective land trusts, non-profits, local tribes, resource conservation districts, park districts, and community-based organizations. These bodies conserve, steward, and restore land via the generosity of the local community; through the commitment of their members, staff, and boards; and by channeling investments from regional, state, and national agencies and foundations. Complementing their public agency and non-profit counterparts, Sonoma County landowners, ranchers, farmers, and business owners follow environmental and conservation best practices, an approach that has helped local producers build a unique and highly successful brand focused on sustainability.

Ag + Open Space continues to work to realize the community's vision. Each year new investments in parks, trails, farm and ranch preservation, greenbelts and scenic areas, and the protection of native habitats and ecosystems are executed or advanced. Every day, the people of Sonoma County – and thousands of visitors from the broader Bay Area and beyond – are able to see, touch, and experience the fruits of these efforts.

"Ag + Open Space land protection along the Sonoma Coast alone yields ecosystem service benefits valued at more than $3.5 million per year[12]"

These investments continue to pay dividends and provide multiple benefits — from the beautiful natural backdrops around Santa Rosa, Sonoma, and Healdsburg that are protected from development; access to the parklands of the Sonoma Coast or Taylor Mountain and urban open spaces like the Windsor Town Green or the Prince Memorial Greenway; to the incredible agricultural goods produced by local farms and ranches. By choosing to tax themselves, Sonoma County residents are protecting these quality of life benefits for future generations.



Source: NOAA Coastal Change Analysis Program

Ecosystem Service Valuations

The Healthy Lands and Healthy Economies Initiative quantifies the ecosystem services provided by natural and working lands in order to demonstrate how community investments in land conservation contribute to the local economy, provide cost effective alternatives to built infrastructure, and achieve a variety of community benefits. This report provides a high-level valuation of 12 distinct services provided by natural capital in Santa Clara, Santa Cruz, and Sonoma counties.[13]

For each of dozens of different mapped landscape classifications in each county, Earth Economics, a non-profit organization that specializes in natural capital valuation, identified published studies estimating the value of the natural capital services provided by similar landscape types — either locally or, more often, elsewhere. Each of these studies employs one or more well established economic methods to value the services provided by natural capital (see table on page 13).

This approach to valuation is known as the "benefit transfer method." In concept, it is similar to the familiar real estate practice of estimating the value of a property by identifying comparable properties ("comps") that have sold recently. In most cases, Earth Economics found multiple estimates for the value of the services provided by a given landscape type. As a result, the results of the study are expressed as a range of values rather than a single number. While the benefit transfer method is scientifically validated for use at a regional scale to inform land conservation and land use decisions, the wide variety of primary studies used limit its use for site level land use decisions.

"Natural capital value across all three counties = $4.6-12.6 billion per year"

Adding up the value of the services provided by every landscape type in each county shows the astonishing yield from protecting and stewarding natural and working landscapes:

- **Santa Clara County: $1.6 to $3.8 billion annually ($1,900 to $4,600 per acre)**
- **Santa Cruz County: $0.8 to $2.2 billion annually ($2,800 to $7,700 per acre)**
- **Sonoma County: $2.2 to $6.6 billion annually ($2,200 to $6,500 per acre)**

This summary report details each service that contributes to this total value. The accompanying technical reports and individual county reports provide a more thorough explanation of the economic concepts that underpin natural capital valuation and the methods used in this analysis, as well as deeper context for conservation activities in each county.

ANNUAL VALUE OF NATURAL CAPITAL

Annual value provided by natural capital in Santa Clara, Santa Cruz, and Sonoma counties, in millions of 2015 dollars. The range for each service indicates the low and high values estimated using the benefit transfer method. The values of services are related to the amount of land – in general, the larger the amount of land, the higher the value.

Ecosystem Service	Santa Clara (825,600 acres)		Santa Cruz (284,800 acres)		Sonoma County (1,008,640 acres)	
	Low	High	Low	High	Low	High
Water Supply	$66M	$156M	$2M	$42M	$9M	$180M
Wastewater Treatment	$33M	$93M	$17M	$36M	$35M	$117M
Urban Stormwater Management	$0.3M	$14M	$0.1M	$4M	$0.2M	$8M
Moderation of Extreme Events	$59M	$134M	$50M	$73M	$82M	$220M
Soil Retention and Formation	$3M	$309M	$0.6M	$60M	$4M	$620M
Carbon Sequestration	$65M	$125M	$8M	$50M	$58M	$197M
Air Quality	$13M	$17M	$12M	$14M	$19M	$22M
Pollination	$88M	$146M	$39M	$103M	$218M	$367M
Habitat and Nursery	$2M	$18M	$2M	$9M	$4M	$43M
Biological Control	$4M	$9M	$3M	$7M	$8M	$23M
Natural Beauty	$917M	$2,308M	$415M	$1,473M	$1,214M	$4,182M
Recreation and Tourism	$357M	$444M	$249M	$284M	$500M	$596M
GRAND TOTAL	$1,607M Or $1.6B	$3,773M Or $3.8B	$798M Or $0.8B	$2,155M Or $2.2B	$2,151M Or $2.2B	$6,575M Or $6.6B

Please see the accompanying technical reports for more information, as found on each organization's website.

Assessing The Value Of Natural Capital

The benefit transfer method is a well-established approach that environmental economists use to develop estimates of natural capital values over large areas in cases where detailed studies would be impractical. Here's how it works, and how it was applied to this study:

1. IDENTIFY LAND COVER TYPES

The natural capital value of a given acre of land depends in part on its ecosystem type — evergreen forest, grassland, cultivated land and so on. Earth Economics used a publicly available dataset from the U.S. National Oceanographic and Atmospheric Administration (NOAA) to map 17 land cover categories at a resolution of roughly ¼ acre.[14]

2. REFINE THE LAND COVER TYPES

A parcel's natural capital value can be influenced substantially by its proximity to certain land-cover types or landscape features. For instance, pollination services stand to have a greater dollar value if they are provided adjacent to agricultural land rather than to a natural area. Therefore, the researchers refined the county land cover map by distinguishing land that is: within 50 feet of a stream channel; within 3 miles of farmland; within ¼ mile of high-density urban development (areas where buildings and pavement account for more than 80% of land cover); within 2 miles of any urban development; or part of a contiguous area larger than 5 acres of a single land-cover type.

3. MATCH STUDIES TO LAND COVER TYPES

The next step was to identify published studies that quantify natural capital services for the land cover types identified in steps 1 and 2: evergreen forest, evergreen forest adjacent to a stream, evergreen forest areas greater than five acres, and so on. This is similar to the real estate industry's use of comparable sales, or "comps", to estimate real estate values: since it is prohibitively expensive and time consuming to directly study each acre in the county, the results of studies on similar landscapes in other locations are used instead.

For our studies, Earth Economics used 87 published studies to estimate the annual natural capital value provided by each acre of land in each county. Each reference study uses one or more of the valuation methods shown in the table at right to estimate the value of similar land cover types found elsewhere. These values were then applied to the land cover types in our three counties.

In most cases, multiple estimates for the value of the services provided by a given landscape type were found. The low and high estimates (minimum and maximum estimates of the annual dollar value of the service) for each landscape type were recorded.

4. ADD UP THE NATURAL CAPITAL VALUES ACROSS THE COUNTY

The final step is simple arithmetic. For each land cover type and each natural capital service identified in the county, the number of acres of the land cover type was multiplied by the low and high per-acre value estimates for the natural capital capital service. Adding up the results of all of those calculations yielded low and high estimates of the total value provided in the county by each type of natural capital service (the table on page 11).

For full details on the methods used, including sources and data, please see the accompanying technical reports.[15]

VALUATION METHODS

The following table describes the various valuation methods employed in the natural capital assessment studies used through the benefit transfer method in this report.

Market Pricing	**Services are evaluated based on their demonstrated market value.**
Travel Cost	**For land used for recreation, the value of the recreation service is assumed to be at least equal to the cost of traveling to the site.**
Hedonic Pricing	**A service is valued based on the price difference between properties with and without access to that service; for instance, the premium for a house with a view (its value over a similar house without a view) provides an estimate of the dollar value of the view.**
Production Approaches	**The value of a service is calculated based on its contribution to a measurable economic output; for example, an increase in the commercial value of a salmon fishery may be attributed to an improvement in watershed health.**
Replacement or Substitute Cost	**A service provided by nature is valued based on the cost to provide the same service through human-made means; for instance, a water filtration plant (which has known construction and operating costs) and a healthy watershed may provide similar water-quality services.**
Avoided Cost	**Well-functioning natural systems can reduce or eliminate costs that would have been incurred in the absence of those systems; the value of that service is estimated as the avoided cost of replacing with built infrastructure.**
Contingent Valuation	**People are surveyed on their willingness to pay for certain services. Related methods include group valuation, which uses group discussion to arrive at a willingness-to-pay figure; and conjoint analysis, which asks people to state preferences based on a range of options.**

Countywide Assessments

Water Supply and Quality

The total economic yield in each county from the ecosystem service of water supply and quality is:

Santa Clara County	**$66 million–$156 million annually**
Santa Cruz County	**$2 million – $42 million annually**
Sonoma County	**$9 million – $180 million annually**

Please see the accompanying technical reports for more information, as found on each organization's website.

When rain falls in a watershed, some of it runs off into streams, some is absorbed into the soil where it can be used by plants, and some percolates into aquifers.

Healthy, unpolluted watersheds provide clean water for people as well as fish and wildlife. Degraded or polluted watersheds tend to deliver polluted water that requires more treatment, often at great cost, before people can use it. Impaired water quality can be particularly harmful to fish, such as the threatened salmon populations in Santa Clara, Santa Cruz, and Sonoma counties.

Healthy watersheds provide multiple water supply services — storage, treatment, and conveyance — that would be very costly or impossible to replace with built infrastructure.

Protecting the watersheds that provide municipal water supplies can provide large savings compared with allowing watershed degradation and then building a treatment plant to clean the water. New York City's investment to protect its million-acre water supply watershed in the Catskill Mountains is recognized internationally as an example of the successful preservation of natural capital that has saved taxpayers millions of dollars while providing other benefits such as agricultural preservation, recreation, and wildlife habitat.

Santa Clara, Santa Cruz, and Sonoma counties each have powerful examples of the value of protecting local watersheds.

In the Santa Clara Valley, groundwater overdraft from the late 1800s to the 1960s resulted in widespread land subsidence, buckling roads, breaking pipes and leaving almost 11,000 acres of land adjacent to San Francisco Bay below sea level. Over decades, a sustained commitment by the Santa Clara Valley Water District to water conservation, groundwater monitoring, and aquifer recharge has halted subsidence and largely restored the region's water table. Upstream, a focus is on protecting portions of the 204,800-acre Coyote Creek Watershed, which supplies water to the Coyote and Anderson reservoirs and includes the Coyote Valley, the largest remaining undeveloped recharge area for the groundwater basin that serves Silicon Valley.[16]

Santa Cruz County relies entirely on water that originates in the region's mountains, making the health of streams, wetlands, and groundwater recharge areas key to both water quality and water supply. Over 90% of the county's annual water demand is met with water pumped from local aquifers, all of which are currently overdrafted. Through an initiative called the Community Water Dialogue, the Resource Conservation District of Santa Cruz County (RCD), local water providers, landowners, University of California researchers, and other stakeholders are collaborating on a range of efforts to conserve local watersheds and support sustainable groundwater management. In the Pajaro Valley, for example, UC Santa Cruz professor Andy Fisher, the RCD, and the Pajaro Valley Water Management Agency are developing innovative approaches to local groundwater management. One facet of this project is "net metering" for water, where farms that use their land

to capture and infiltrate runoff from winter storms receive a credit against their groundwater extraction charges during the dry season.[17]

In Sonoma County, Lake Sonoma is the primary source for domestic water, providing clean, naturally filtered drinking water to over 600,000 people in Sonoma and Marin counties. The 83,276-acre Upper Dry Creek Watershed supplies the reservoir.

In 2001, Ag + Open Space purchased a conservation easement that permanently protects a core piece of the watershed, the 19,132-acre Cooley Ranch. The easement limited significant development in the watershed that could have impaired water quality by adding to the nitrogen load in the watershed and increasing runoff from paved surfaces.

Countywide Assessments

Wastewater Treatment

The total economic yield in each county from the ecosystem service of wastewater treatment is:

Santa Clara County	**$33 million–$93 million annually**
Santa Cruz County	**$17 million–$36 million annually**
Sonoma County	**$35 million–$117 million annually**

Please see the accompanying technical reports for more information, as found on each organization's website.

Runoff from farmland, degraded open lands and forests, and urban lands contributes substantial loads of nutrients (primarily nitrogen and phosphorus) and sediment (which clouds water and is often a vehicle for nutrients and chemical pollutants) to waterways in the three counties and to San Francisco and Monterey bays. These pollutants can impair water quality, harming fish and other aquatic species, as well as increasing the cost of treating water to drinkable standards. Nitrate (a nitrogen compound) also readily percolates into the ground, polluting aquifers; this is a particularly serious problem in Santa Cruz County.

"More than 70% of historic wetlands in the San Francisco Bay have been lost, leading, in part, to increased water quality issues in the bay[18]"

Wetlands, as well as vegetation adjacent to agricultural land, can reduce the loads of nutrients and sediment in waterways and reduce nitrate flows into aquifers. Plant and microbial activity in these natural systems takes up or converts nutrients to gaseous forms, removing them from water flows. In addition, natural landscapes can trap substantial amounts of sediment, a vehicle for a variety of water pollutants from agricultural and urban sources.

Treatment plants to remove water pollutants are very costly to build and operate; as a result, the similar pollutant-removal services performed by healthy natural landscapes are highly valuable.

Countywide Assessments

Urban Stormwater Management

The total economic yield in each county from the ecosystem service of urban stormwater management is:

Santa Clara County	**$0.3 million–$14 million annually**
Santa Cruz County	**$0.1 million–$4 million annually**
Sonoma County	**$0.2 million–$8 million annually**

Please see the accompanying technical reports for more information, as found on each organization's website.

Stormwater runoff from the built environment — streets, rooftops, driveways, sidewalks, parking lots, landscaping — is one of the main contributors to water quality impairment in the United States, as well as in the three counties profiled here. In addition to washing chemicals and microbial contaminants (such as fecal matter from cats and dogs) into lakes and streams, urban stormwater often poses a physical hazard to aquatic habitats and stream function due to large increases in water velocity and volume as water runs off impervious surfaces and is concentrated in gutters and drains, emptying into waterways.[19]

By capturing and absorbing rainfall, particularly during heavy rains, green space in urban areas helps to reduce the transport of pollutants from developed areas and lower the speed and size of water flows. It thus provides benefits to both water quality and aquatic habitats.[20]

Moderation of Extreme Events

The total economic yield in each county from the ecosystem service of moderating extreme events is:

Santa Clara County	**$59 million–$134 million annually**
Santa Cruz County	**$50 million–$73 million annually**
Sonoma County	**$82 million–$220 million annually**

Please see the accompanying technical reports for more information, as found on each organization's website.

Wetlands, grasslands, riparian vegetation, and forests all provide protection from flooding, fires, and other disturbances. For example, wetlands and streams may provide a physical buffer around urban communities during floods and fires, and can also store and filter water into aquifers which is of critical importance during droughts. These landscapes absorb and store large amounts of rainwater during storms, reducing the volume that flows into streams. This service is increasingly important as the climate changes, creating the potential for more severe storm events, and increased flooding or landslides after high intensity wildfires.

Structures in floodplains, such as houses, businesses, and wastewater treatment plants, all depend on the flood protection services provided by upstream landscapes. The retention of natural, permeable land cover and the restoration of floodplains and wetlands helps to reduce the risk of flood and avoid the major costs of flood damage, as affirmed recently in a major report by the National Wildlife Federation, the global insurance company Allied World Assurance, and Earth Economics.[21] In some cases, the flood control service provided by such "green infrastructure" can reduce or eliminate the need for levees and other costly engineered flood-control structures.[22] Such projects also often have a variety of co-benefits, including improved habitat, groundwater recharge, and recreation.

Since 2013, FEMA's cost-benefit methodology has officially recognized the flood risk-reduction services provided by natural and restored floodplains.[23] Previously, when the agency was weighing whether to purchase a land parcel in a floodplain for the purpose of reducing exposure to flood risk, it was unable to fully account for the flood-control and other services provided by a restored floodplain system. Without these substantial benefits on the ledger, it was often difficult or impossible to justify the cost of acquiring such land. Incorporating these values into such analyses is expected to reduce repetitive damage to property, protect human life, and lower disaster expenditures.

THE VALUE OF RETAINING FLOOD PROTECTION SERVICES IN THE UPPER PAJARO VALLEY

In the Upper Pajaro Valley (Santa Clara and San Benito counties), the Santa Clara Valley Open Space Authority, the Nature Conservancy, the U.S. Army Corps of Engineers, and other partners are demonstrating the importance of upstream open space and wetlands to flood management downstream in Santa Cruz County. Their work has found that the protection of Upper Pajaro Valley landscapes — including Soap Lake and its associated wetlands, and floodplains in the Gilroy area — provides critical flood protection for the downstream communities of Pajaro and Watsonville as well as high value farmland.[24] 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.[25]

Countywide Assessments

Soil Formation and Retention

The total economic yield in each county from the ecosystem service of soil formation and retention is:

Santa Clara County	**$3 million–$309 million annually**
Santa Cruz County	**$0.6 million–$60 million annually**
Sonoma County	**$4 million–$620 million annually**

Please see the accompanying technical reports for more information, as found on each organization's website.

Soil is the basis of plant life and the foundation of agriculture.

Soil is created slowly from rock by natural processes over millions of years. The weathering of rock by water and wind creates the parent material. Then animals, plants, and the multitude of species that live in the soil work to slowly build organic matter, nutrients, and porosity. The result is a valuable resource: healthy, fertile soil that can hold water and support life.

Stable soil supports the infrastructure of civilization — farms and food, homes, businesses, schools, industry, roads, bridges, and more.

"Soil ecosystem services are the foundation for resiliency in economically valuable agricultural systems"

Water and wind erode bare soil. Vegetation holds soil in place, slowing or stopping erosion and helping to stabilize the banks of streams and rivers. In coastal areas, wetlands absorb the energy of waves, reducing their erosive power; as sea level rises, this service is increasingly important.

Without these soil retention services, erosion can damage or destroy built structures and eat away at shorelines and riverbanks. It can also carry off the fertile soil that supports both natural vegetation, and cultivated and grazing lands. In addition, the soil particles washed away by erosion tend to end up in waterways, where they can impair water quality for aquatic species and for human uses. Fine sediment is arguably the most significant water pollutant in waterways in Santa Cruz County.[26] Soil retention provided by vegetation helps to avoid the large costs associated with erosion (see replacement cost method on page 13).[27]

RE-ENVISIONING COYOTE VALLEY: WATER RESOURCE BENEFITS IN SANTA CLARA COUNTY

Coyote Valley, a "Last Chance Landscape" south of downtown San Jose, is being re envisioned as a 21st century greenbelt to serve as essential natural capital for the South Bay region.

The Santa Clara Valley Open Space Authority, in partnership with other agencies and conservation organizations, has developed a new vision for Coyote Valley that highlights the benefits provided by conserving and investing in open space. Building on the work of the Healthy Lands and Healthy Economies Initiative, the Open Space Authority has developed a vision for Coyote Valley that seeks to restore and maintain many of the landscape s provisioning, regulating, supporting, and cultural services.

The vision establishes a strong relationship between restoring hydrologic function and Coyote Valley s ability to support sustainable gains in ecosystem services. Work is now underway with the Santa Clara Valley Water District, the City of San Jose, and other conservation and technical partners to quantify how leveraging Coyote Valley s vast undeveloped areas can help reduce flooding for downstream areas; improve water quality; increase groundwater recharge; and provide a suite of climate smart co benefits for a resilient South Bay region.

Countywide Assessments

Carbon Sequestration

The total economic yield in each county from the ecosystem service of carbon sequestration is:

Santa Clara County	**$65 million–$125 million annually**
Santa Cruz County	**$8 million–$50 million annually**
Sonoma County	**$58 million–$197 million annually**

Please see the accompanying technical reports for more information, as found on each organization's website.

By capturing and sequestering carbon, natural and working landscapes help to regulate atmospheric carbon dioxide, the most important driver of climate change. The forests, oak woodlands, shrublands, grasslands, and wetlands of the three counties all contribute to this benefit, primarily by storing carbon in woody biomass — trees and shrubs, and their roots — and in soil.

"From 1990-2010, Sonoma County natural and working lands stored an amount of carbon equivalent to the annual emissions from 2.9 million cars[28,29]"

California policy recognizes the potential for natural and working lands to sequester carbon. The Healthy Soils program, launched in 2016, uses proceeds from the state's carbon emissions trading (cap-and-trade) program to provide incentives for land management activities that increase carbon storage in soils.[30]

Unlike the other services presented in this report, the carbon sequestered by some types of natural and working lands is actively traded on various markets, where it has a clear price. For instance, California power plants can buy forest carbon offsets — generated by forestry projects that yield documented increases in carbon storage — to help satisfy their emissions-reduction requirements under the state's cap-and-trade program. In recent years, the price has been approximately $13 per ton carbon dioxide equivalent (tCO_2e).[31]

However, for consistency, Earth Economics generated the range of values presented for the carbon sequestration service using the benefit transfer method employed throughout this report — identifying value ranges on a per-acre basis, based on literature references available for each land cover type.

QUANTIFYING LANDSCAPE CARBON IN SONOMA COUNTY

The Climate Action Through Conservation project,[32] a partnership of Ag + Open Space and The Nature Conservancy, quantifies carbon sequestration by Sonoma County landscapes and analyzes the greenhouse gas emission implications of conserving those lands.

One element of the study evaluated the emissions impact of the conservation of Buckeye Forest, a 19,000 acre property in northwestern Sonoma County that was slated for residential and vineyard development. Ag + Open Space worked with a collection of other conservation organizations to purchase a conservation easement on the land, averting development and providing for sustainable forest management and agricultural use. The study found that this conservation action will deliver, from 2010 to 2030, a net climate benefit of roughly 1 million tonnes of carbon dioxide equivalent (tCO_2e).

The Climate Action Through Conservation project also estimated total carbon sequestration by all of the county s natural and working landscapes, based on historical land cover and soils data from several sources. The study estimated that the county s forests, shrublands, and grasslands collectively sequestered more than 15 million tCO_2e from 1990 to 2010, equal to the yearly emissions of 2.9 million cars.

Countywide Assessments

Air Quality

The total economic yield in each county from the ecosystem service of air quality is:

Santa Clara County	**$13 million–$17 million annually**
Santa Cruz County	**$12 million–$14 million annually**
Sonoma County	**$19 million–$22 million annually**

Please see the accompanying technical reports for more information, as found on each organization's website.

Human exposure to air pollutants can be a serious public health concern and when those pollutants settle onto the land and water, they can lead to significant natural impacts. Poor air quality can have negative fiscal consequences, due to medical costs, lost productivity, or damage to our working and natural lands.Vegetation in populated areas helps to mitigate concentrations of a number of air pollutants and offset some of the physical and fiscal impacts.

A number of studies have evaluated the air quality benefits provided by urban trees.[33] Leaves can absorb ozone and nitrogen oxides and also trap airborne particles. The combination of shading and tree transpiration reduces air temperatures, which in turn helps to reduce concentrations of key air pollutants, including ozone and volatile organic compounds.

"Urban trees can reduce fine particles in the air in their immediate vicinity by as much as 25% [34]"

Countywide Assessments

Pollination

The total economic yield in each county from the ecosystem service of pollination is:

Santa Clara County	**$88 million–$146 million annually**
Santa Cruz County	**$39 million–$103 million annually**
Sonoma County	**$218 million–$367 million annually**

Please see the accompanying technical reports for more information, as found on each organization's website.

Pollination is critical to wild and cultivated plants and plays an important role in ecosystem and agricultural productivity.

Many plant species, and the animals that rely on them for food, would go extinct without animal- and insect-mediated pollination. There is no practical replacement for the pollination services provided in natural systems by wild pollinators.

"California rangelands contribute up to $2.4 billion by maintaining habitat for pollinators[35]"

Pollination services also contribute to yields for many cultivated crops, enhancing the basic efficiency and economic value of agriculture.[36] In Santa Clara County, the annual value of pollinator-dependent crop production was estimated in 2003 at $24 million.[37]

The loss of forests, riparian areas, and shrubs reduces habitat and limits the capacity of wild pollinators to perform these services.

Habitat and Nursery

The total economic yield in each county from the ecosystem service of habitat and nursery is:

Santa Clara County	**$2 million–$18 million annually**
Santa Cruz County	**$2 million–$9 million annually**
Sonoma County	**$4 million–$43 million annually**

Please see the accompanying technical reports for more information, as found on each organization's website.

Natural and working landscapes provide a rich variety of habitats: streams, redwood forests, oak woodlands, freshwater and estuarine wetlands, coastal scrub, and more. Wild species of fish, birds, mammals, and reptiles cannot survive without habitat. Preserving biodiversity and intact habitats has for decades been a key focus of conservation efforts in all three counties. Many studies show that people value natural habitats and the wildlife they support for a variety of reasons — for birdwatching, hunting and fishing, or simply for the knowledge that they exist.[38]

The Habitat and Nursery service provides an estimate of the value provided by these wild species and the lands that support them through contingent valuation (see page 13).

One example: the Sonoma Baylands, wetlands along the shore of San Pablo Bay, are home to and provide migratory habitat for hundreds of species of waterfowl, shorebirds, fish, and other wildlife, including endangered species such as the Ridgway's rail and salt marsh harvest mouse. More than one million birds and waterfowl stop in the Sonoma Baylands during their annual migration.[39]

Biological Control

The total economic yield in each county from the ecosystem service of biological control is:

Santa Clara County	**$4 million–$9 million annually**
Santa Cruz County	**$3 million–$7 million annually**
Sonoma County	**$8 million–$23 million annually**

Please see the accompanying technical reports for more information, as found on each organization's website.

Natural areas, and working landscapes that are managed to enhance biodiversity, support animals that help to control populations of pests — from rodents to insects to soil organisms — that cause plant diseases. These beneficial species — birds, bats, snakes, insects, soil microbes, and others — collectively provide a service that would be difficult and costly to replace with pest management measures.[40]

Humans have always used biological controls to help address common pests in agriculture. However, in the past century many of these natural methods of biological pest control have been replaced by chemical pesticides, often resulting in a decrease in the ecosystem service provided by beneficial species. In addition to a variety of ecosystem services that these species provide, they are often recognized as healthier, cheaper alternatives to pesticides.

Countywide Assessments

Natural Beauty

The total economic yield in each county from the ecosystem service of natural beauty is:

Santa Clara County	**$0.9 billion–$2.3 billion annually**
Santa Cruz County	**$0.4 billion–$1.5 billion annually**
Sonoma County	**$1.2 billion–$4.2 billion annually**

Please see the accompanying technical reports for more information, as found on each organization's website.

Santa Clara, Santa Cruz, and Sonoma counties have a remarkable diversity of beautiful landscapes. From Pacific coastlines to inland estuaries, redwood forests, rolling oak woodlands, farms, ranches, and river valleys, the counties' landscapes have classic, universal, and irreplaceable appeal.

People value this beauty a great deal: in each county, the aesthetic benefit provided by natural and working lands had the highest value of any single service valued in this study.

This aesthetic value contributes to increased property values because people will pay more for a view of, or proximity to, beautiful open space. Many studies show that people are willing to pay to preserve the aesthetic amenities provided by natural and working lands.[41] Natural areas that are close to urban areas are especially valuable. Because they provide an aesthetic benefit to many people, the collective value of such areas to the community can be tens of thousands of dollars per acre each year (see the hedonic pricing method on page 13).

Recreation and Tourism

The total economic yield in each county from the ecosystem service of recreation and tourism is:

Santa Clara County	**$357 million–$444 million annually**
Santa Cruz County	**$249 million–$284 million annually**
Sonoma County	**$500 million–$596 million annually**

Please see the accompanying technical reports for more information, as found on each organization's website.

The three counties' landscapes are a major draw for tourists and provide recreation opportunities for residents and tourists alike.

The aesthetic values of open space and natural areas contribute to the recreation and tourism value, as do opportunities for a variety of activities — hiking, running, cycling, fishing, swimming, bird watching, agritourism, and more. Clean water, abundant wildlife, and other characteristics of healthy natural landscapes help to make these areas attractive places to visit.

Recreational use of open spaces has valuable indirect benefits as well — notably to public health. Access to open space has been linked to mental health benefits, including reductions in anxiety, depression, and stress levels.[42] Healthcare providers now write "parks prescriptions" to encourage patients to engage in some form of physical activity and develop outdoor exercise habits.[43] By supporting public health in these and other ways, open space contributes to reducing illness-related productivity losses and healthcare costs.

SANTA CRUZ BEACHES

Beaches are California s most popular tourist attraction, accounting for more than 72% of state park visits and drawing 20 times the attendance of the state s amusement parks. Santa Cruz County s 29 miles of beaches are a big part of the region s draw for visitors. Iconic breaks like Steamer s Lane and Pleasure Point inspired surfing pioneer Jack O Neill to develop the neoprene wetsuit here in the 1950s. The wetsuit and clothing company he founded, O Neill, is still headquartered in Santa Cruz. Each fall, the O Neill Coldwater Classic surf competition draws the world s top surfers and more than 10,000 visitors to the county.[44] In support of their coastal ecosystem services, a host of non profit organizations focused on ocean protection, including Save the Waves Coalition, the Surfrider Foundation, and Save Our Shores, have helped protect coastal zones in Santa Cruz County and around the world through education and activism, including working to support the establishment of the Monterey Bay National Marine Sanctuary, designated by Congress in 1992.

Recommendations

The previous pages have provided a starting point for the value of natural capital across Santa Clara, Santa Cruz, and Sonoma counties. Properly accounting for this value will help to ensure that decisions about land use and conservation are made with the full complement of environmental and financial factors. The following recommendations provide a beginning for local, state, and federal agencies, utilities, and private funders to fully integrate the value of natural capital into planning and decision-making in Santa Clara, Santa Cruz, and Sonoma counties. More county-specific recommendations are included in each of the county valuation reports.

Recommendations for Planning

- Consider ecosystem services in planning processes, including those focused on mitigation, open space conservation, land use policy, as well as water supply, watershed, and transportation planning.
- Coordinate investments for land conservation, habitat, water supply, groundwater recharge, and flood mitigation and integrate with investments in infrastructure.
- Map county ecosystem service provisioning areas.
- Quantify the economic benefits of ecosystem services, replacement services (if lost), and avoided costs in land use planning, land conservation, mitigation, and infrastructure investments.
- Establish partnerships for achieving integrated water resources management outcomes.
- Develop spatial decision support tools for optimizing public investment in natural resources, water resources, floodplain protection, and restoration.
- Include the protection and maintenance of natural capital and ecosystem services in updates to county and city general plans.
- Adopt measurable environmental metrics to monitor the health of natural capital and evaluate continued flow of value from ecosystem services.

Recommendations for Policy Implementation

- Introduce statewide legislation to recognize, protect, and maintain/improve ecosystem services and the region's key natural and agricultural lands.
- Prioritize water supply, water quality, and flood control investments that include multiple ecosystem benefits and protect and restore natural capital.
- Account for ecosystem services, carbon sequestration, and climate change benefits resulting from protecting and stewarding open space and agricultural lands adjoining cities when implementing AB 32 and SB 375.
- Support funding opportunities from local, state, federal, and private organizations to continue to protect agricultural lands and support stewardship of open space and working lands.
- Incentivize conservation and stewardship actions that enhance ecosystem services in coordination with county planning departments, agricultural commissioners, resource conservation districts, conservation non-profits and land trusts, private landowners, and other agencies and stakeholders.
- Develop Regional Advanced Mitigation Programs (RAMPs) to pool investments into high-impact resource conservation projects.
- Apply ecosystem services valuation data with benefit-cost analysis to achieve triple bottom line (Economy, Environment, Equity) outcomes.

Recommendations for Funding and Investment

- Develop natural capital investment strategies and priority conservation actions funded through bonds, AB 32 revenues, transportation and land use funding (SB 375), and other mechanisms.
- Initiate new funding mechanisms which provide income to the provisioners of ecosystem services.
- Integrate natural capital valuation into funding allocation decisions for water and natural resources, incentivizing investment in natural infrastructure solutions that appreciate over time and provide multiple benefits.
- Include the protection and improvement of natural capital assets as eligible expenditures in local open space, water, and transportation funding measures and on county balance sheets.
- Promote public/private partnerships utilizing innovative funding mechanisms such as micro-financing.
- Work with private landowners and funders to develop pilot projects to evaluate and implement incentive programs that encourage stewardship of natural capital assets on private lands.
- Explore partnerships with tribes, foundations, non-profits, and agencies to develop funding mechanisms to protect ecosystem services.

CLOSING STATEMENT

Dividends for Future Generations

While the natural and working lands across each county have immeasurable intrinsic value, the Healthy Lands and Healthy Economies Initiative provides an initial estimate of the value of the many services that natural capital provides. This estimate was developed with well-established, peer-reviewed economic tools, and an innovative approach to considering the many benefits in local and regional contexts. Peer reviewed natural capital studies have been performed by numerous researchers around the world and are increasingly being used to inform land use and natural resource management decisions.

Locally, the results show clearly that the value of natural capital is tremendous —

SANTA CLARA COUNTY:

- $1.6 billion to $3.8 billion annually ($1,900 to $4,600 per acre annually)

SANTA CRUZ COUNTY:

- $0.8 to $2.2 billion annually ($2,800 to $7,700 per acre annually)

SONOMA COUNTY:

- $2.2 to $6.6 billion annually ($2,200 to $6,500 per acre annually)

For the three counties involved, the Healthy Lands and Healthy Economies Initiative continues an important, local conversation about the true value of natural capital. Santa Clara, Santa Cruz, and Sonoma counties will continue to work to refine the values calculated in this study and to capture the wide range of benefits provided by our natural systems.

Using the values calculated here and in other studies, better decisions can be made about the protection and stewardship of working and natural lands, and how the ecosystem services provided by these lands can complement built infrastructure. These tools provide a more complete view of our economy by integrating the services that natural and working lands provide.

Santa Clara, Santa Cruz, and Sonoma counties are fortunate to have incredible landscapes, and to have landowners and organizations to protect the land and the benefits it provides. Recognizing these benefits - both intrinsic and economic - is essential to ensuring that these lands will continue to provide dividends for generations to come.

Footnotes

For more detail on the findings summarized in this report, please see the individual county reports:

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- Sonoma County Ag + Open Space. (2018). *Healthy Lands & Healthy Economies: The Multiple Benefits of Sonoma County Working and Natural Lands*. Santa Rosa, CA. Available at: www.sonomaopenspace.org/HLHE

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13. Note: More detailed reports are available for each of the three counties (see inside cover for web addresses). Also note: Some additional natural

capital services — beyond the 12 covered in this report — are evaluated in the individual county reports. The 12 included in this report are the ones that were adequately documented for all three counties.

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THE HEALTHY LANDS AND HEALTHY ECONOMIES INITIATIVE

A joint project of the Santa Clara Valley Open Space Authority, the Resource Conservation District of Santa Cruz County, and Sonoma County Ag + Open Space, the Healthy Lands and Healthy Economies Initiative seeks to describe the economic value and community benefits of the natural and working landscapes of these three counties and their stewardship activities.

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A JOINT PROJECT OF:

OPEN SPACE AUTHORITY
SANTA CLARA VALLEY

RESOURCE
CONSERVATION DISTRICT
OF SANTA CRUZ COUNTY

AG + OPEN SPACE
SONOMA COUNTY

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