Healthy Lands & Healthy Economies

THE MULTIPLE BENEFITS OF SONOMA COUNTY WORKING AND NATURAL LANDS

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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.

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Sonoma County has a rich and diverse landscape that sustains its vibrant communities, its rural way of life, and its vital economy. The working and natural lands of Sonoma County provide us with fresh local food, wine and other agricultural products, beautiful scenic vistas, open spaces in which to hike, ride and play, as well as amazing ecosystems that support native plants, fish and wildlife. The Sonoma County community is committed to protecting and enhancing our open space lands and our rural quality of life - whether through tribal land stewardship, private land management, the work of watershed groups and resource conservation districts, or via land conservation organizations like Sonoma County Ag + Open Space, Sonoma Land Trust, and Sonoma County Regional Parks. The Healthy Lands and Healthy Economies Initiative is an exploration of the multiple benefits and economic values that we derive from land conservation - including clean water for people and wildlife, resiliency to climate change and extreme events, and community health. As you will see, the value of this natural capital is immense, and our investments in land conservation and stewardship in Sonoma County will pay dividends for years to come - truly the "gift that keeps on giving."

JAMES GORE, CHAIR

AG + OPEN SPACE BOARD OF DIRECTORS SONOMA COUNTY BOARD OF SUPERVISORS



In Sonoma County we have a deep appreciation for our working lands and natural open spaces. While we understand the intrinsic value of these lands – scenic beauty, community character, ecosystem health, recreational opportunities, and our rural way of life – much of what we cherish most about our landscapes also has tremendous economic value. These benefits can be quantified financially to understand how our natural environment contributes to our overall economic well-being.

Protecting natural areas has a very real, tangible effect on our local and regional economies and the health of our communities. Working and natural landscapes provide a variety of services and benefits to our communities, including:

- clean, reliable drinking water;
- protection from natural hazards such as floods, fires, and coastal storm surges;
- local food production and security;
- carbon sequestration and climate change resiliency;
- recreation and tourism opportunities;
- public health benefits;
- materials for building construction and pharmaceuticals;
- and many others.

Studies from around the United States indicate that the economic values associated with the protection and stewardship of these services can be substantial. Increasingly, state and federal agencies, as well as private companies, are considering the impact to these services 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 allows the inclusion of environmental values in cost-benefit analysis for flood risk reduction projects and post-wildfire restoration projects.^{1,2}

By protecting precious open spaces, Sonoma County residents are investing in their future and achieving significant cost savings for the community. The Healthy Lands and Healthy Economies Initiative explores the multiple, long-term benefits derived from these working and natural landscapes, and provides encouraging evidence about the community's return on investment of protecting these landscapes.



WE VALUE

RESILIENT COMMUNITIES



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Protecting Sonoma County Values

The Sonoma County Agricultural Preservation and Open Space District (Ag + Open Space) permanently protects the diverse agricultural, natural resource, and scenic open space lands of Sonoma County for future generations. A special district created by the voters in 1990 and funded by a quarter cent sales tax, Ag + Open Space has protected over 116,000 acres of land in Sonoma County. Ag + Open Space goals include:

- Maintain the county's rich rural character and the unique qualities that help provide our sense of community.
- Support the economic vitality of working farms to preserve the agricultural heritage and diversity of the county.
- Protect the ridgetops, coastal bluffs, hillsides, and waterways that create the county's striking natural beauty.
- Provide connections between urban areas, parks, and natural areas throughout the county for both people and wildlife.
- Preserve diverse natural areas that provide habitat for wildlife.
- Protect the waterways and natural lands that maintain water quality and supply.
- Partner with local agencies and organizations to leverage funding for land protection, foster stewardship, and provide opportunities for recreational and educational experiences.

In order to realize the community's vision, Ag + Open Space continually advances new investments in farm and ranch preservation, greenbelts and scenic areas, the protection of native habitats and ecosystems, and parks and trails. 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.

These investments continue to provide value and quality of life benefits to the residents of Sonoma County. Included in these benefits are the beautiful, natural backdrops around Santa Rosa, Sonoma, and Healdsburg that are forever protected from development, and urban open spaces like the Windsor Town Green or Santa Rosa's Prince Memorial Greenway where families can relax and play. Recreational properties like Taylor Mountain Regional Park & Open Space Preserve provide numerous services including groundwater recharge, carbon sequestration, and beautiful hiking trails right outside of the city. Our local farms and ranches offer world class food and agricultural products as well as providing wildlife habitat, climate benefits, and protection of our streams and groundwater basins.

HOW DOES AG + OPEN SPACE WORK?

Ag + Open Space protects land by purchasing development rights and placing conservation easements on properties in order to limit development and permanently preserve working and natural lands. A highly effective conservation tool, a conservation easement is a legal agreement between a willing landowner and a land trust or government agency that permanently protects its conservation values. It allows landowners to continue to own and use their land, and to sell or pass on the property to heirs. Subsequent owners are obligated to use the land under the terms of the conservation easement since easements "run with the land" and are binding in perpetuity – in other words, forever. Ag + Open Space has worked with willing landowners and partners to preserve more than 116,000 acres of Sonoma County working and natural lands.





The Return on Investment from Conserving Sonoma County's Working and Natural Lands

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.

Many of the things that we love about our local landscapes can be quantified as natural capital: the aesthetic pleasure of the undeveloped Sonoma Coast; the health benefits of walking the trails of Montini Open Space Preserve or jogging along the West County Regional Trail; or the fact that county residents can turn on the tap and receive high-quality water from local watersheds.

Natural capital includes natural landscapes such as forests, oak woodlands, wetlands, rivers and streams, working landscapes such as farms and ranches, as well as urban gardens and parks. 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, provides opportunities for outdoor recreation, attracts tourists, and gives us beautiful views.

Unlike built infrastructure, such as a floodwall or a wastewater treatment plant, natural capital doesn't wear out or need to be upgraded. Another key difference is that while built capital is typically designed to serve a single purpose, the natural capital provided by working lands and other open spaces delivers multiple valuable services. 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 protected from development and managed well, Sonoma County's natural capital has the potential to adapt to change and continue to provide a high quality of life for our community.

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 real (and large) value of natural capital helps to ensure that those decisions are made wisely. The table at right details some of the many methods used to determine the value of natural capital.

VALUATION METHODS

The following table describes the various valuation methods employed in natural capital assessment studies.⁵

| Market Pricing | Services are valued 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 ser- vice; for instance, the premium for a house with a view of the coast, compared to a similar house without a view, provides an estimate of the view's aesthetic value. |
| Production Approaches | The value of a service is calculated based on its contribution to a measureable 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 | People are surveyed on their willingness to pay for certain services. Related methods include group valua- tion, 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. |
| Benefit Transfer | Service values are estimated by analyzing previous valuation studies that use any of the above methods on similar landscape types and applying those values to the study area. For more information on the benefit transfer method, see pages 14-15. |

The Healthy Lands & Healthy Economies Initiative

A Three County Initiative

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

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



In Sonoma County, Santa Cruz County, and Santa Clara County, the ecosystem services provided by working and natural lands are valued at up to \$11.2 billion⁴

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Focusing on Sonoma County

In Sonoma County, the community has supported a broad suite of land conservation measures and policies for decades. These include protecting land through zoning, creating urban growth boundaries, establishing community separators, taking action to mitigate and adapt to climate change, conserving water, and implementing programs to keep land in agriculture. Furthermore, Sonoma County is home to many innovative and effective land trusts, non-profits, 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 to build a unique and highly successful brand focused on sustainability.

The Healthy Lands and Healthy Economies Initiative documents the return on these investments. A countywide economic analysis considers values across the county, and a series of case studies focuses on particular geographies and themes. While many past studies have established the economic benefit of parks, preserves, and scenic lands to tourism, increased property values, business location, and quality of life, the Healthy Lands and Healthy Economies Initiative directly links open space conservation and stewardship to the economic benefits of ecosystem services.

This report offers a broad estimate of the value of working and natural lands across Sonoma County. The ecosystem services are then highlighted in ten local case studies, described at right, which each focus on a different aspect of the Sonoma County landscape.

A Countywide Valuation of Ecosystem Services in Sonoma County (PAGE 12)

The working and natural landscapes we appreciate locally provide a variety of benefits, many of which include economic value in addition to their intrinsic value. This high-level economic valuation of the county outlines the benefits provided by 12 ecosystem services and calculates their annual value on working and natural lands across Sonoma County.

The Value of Protecting the Sonoma Coast (PAGE 34)

Sonoma County has a legacy of coastal land conservation that is enjoyed by locals and visitors alike. These protected lands provide numerous ecosystem service benefits, including natural beauty and carbon sequestration.

The Value of Conserving Grasslands and Rangelands (PAGE 36)

Each year, 20,000 acres of private rangelands in California are lost to development. Conservation easements are one method of keeping these lands in agriculture and protecting the many ecosystem services they provide, including habitat, water supply and quality, and pollination services.

The Value of Protecting Riparian Corridors (PAGE 40)

Riparian corridors are areas of incredibly high biological diversity, and are some of the most threatened habitats in California. This study evaluates the ecosystem services provided by existing riparian corridors in Sonoma County, and then quantifies the increase in value provided if riparian corridors were restored to their fully functional extent.

The Value of Protecting a Watershed: Cooley Ranch (PAGE 44)

One of the most efficient ways to provide clean drinking water is to prevent pollution, and one way to avoid pollution is to protect natural lands with conservation easements. This study calculates the economic benefits to water quality in Sonoma County from conserving land in the Upper Dry Creek Watershed.

The Value of Urban Open Space: Exercise and Health (PAGE 46)

Research links physical activity with numerous health benefits. Urban open space provides easily accessible, free or low-cost venues for exercise which can offer significant economic savings. This study calculates the annual value of health benefits provided by Sonoma County's urban open spaces.

The Value of Protecting Rangeland: The Local Cheese Industry (PAGE 48)

In the North Bay, the artisanal cheese industry and agricultural conservation easements are helping dairies stay in business. This study analyzes the impacts of the artisanal cheese industry on the local economy and quantifies some of the ecosystem services that protected dairies in the region provide.

The Value of Protecting the Sonoma Baylands

(PAGE 52)

Tidal wetlands are critically important ecosystems that are being lost worldwide at alarming rates. San Francisco Bay has lost more than 75% of its tidal wetlands since the early 1800s. This study tallies the economic benefits of the Sonoma Baylands from carbon sequestration, wastewater treatment, moderation of extreme weather events, wildlife habitat, and recreation services.

The Value of Conserving Taylor Mountain (PAGE 54)

Recreational lands provide many benefits to Sonoma County residents. In this study, the carbon sequestration, water supply, and recreation benefits of conserving Taylor Mountain Regional Park and Open Space Preserve are quantified.

The Value of Nature-Based Education (PAGE 56)

Spending time outdoors is an invaluable experience for many children. Not only do kids enjoy getting out of the classroom, but studies have shown that naturebased education can lead to better test scores and increased focus, creativity, and confidence. This study highlights the benefits of educating children in an outdoor environment.

The Value of Land Conservation: Groundwater (PAGE 58)

As climate change continues to affect local weather patterns and droughts become more frequent, groundwater is an increasingly important resource. This study analyzes the risks of groundwater overdraft and the financial benefits of conserving land in groundwater recharge areas.

WE VALUE



BREATHTAKING LANDSCAPES

A Countywide Valuation of Ecosystem Services

Introduction

The countywide study provides a high-level valuation of 12 distinct ecosystem services provided by Sonoma County's natural capital. For each of over 100 different landscape combinations in the 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 elsewhere. Each of the studies employs one or more well-established economic methods to value the services provided by natural capital.



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. Comparable ecosystem service values were calculated in peer-reviewed primary studies through a variety of methods (see table on page 5 for examples) and the findings of these studies are applied locally and are expressed in this report at a countywide level.

Adding up the value of the services provided by every landscape type in the county shows the astonishing yield from protecting and stewarding Sonoma County's working and natural landscapes: **\$2.2 to \$6.6 billion per year.** This figure includes the annual value for all public and private working and natural lands in the county – not just those protected by Ag + Open Space.

"Natural Capital Value in Sonoma County: \$2.2 to \$6.6 billion per year"

This countywide study explores each service that contributes to this total value. The accompanying technical report provides a deeper explanation of the economic concepts that underpin natural capital valuation, documents the methods used in the study in detail, and includes a full bibliography of the 87 published studies that are the basis of the valuation.⁵

ANNUAL VALUE OF NATURAL CAPITAL

Annual value provided by natural capital in Sonoma County, in millions of 2015 dollars. The range for each service indicates the low and high values estimated using the benefit transfer method.

| Ecosystem Service | \$ Millions Per Year Countywide (low estimate) | \$ Millions Per Year Countywide (high estimate) | |
|------------------------------|---|--|--|
| Water Supply | \$9M | \$180M | |
| Wastewater Treatment | \$35M | \$117M | |
| Moderation of Extreme Events | \$82M | \$220M | |
| Urban Stormwater Management | \$0.2M | \$8M | |
| Soil Retention and Formation | \$4M | \$620M | |
| Carbon Sequestration | \$58M | \$197M | |
| Air Quality | \$19M | \$22M | |
| Pollination | \$218M | \$367M | |
| Habitat and Nursery | \$4M | \$43M | |
| Biological Control | \$8M | \$23M | |
| Natural Beauty | \$1,214M | \$4,182M | |
| Recreation and Tourism | \$500M | \$596M | |
| GRAND TOTAL | \$2,151M (or \$2.2 billion)* | \$6,575M (or \$6.6 billion)* | |

* The totals reported are based upon rounded values from individual services. For precise values, please see the original study.



Assessing the Value of Natural Capital

How it Works:

Using the benefit transfer method, Earth Economics estimated the value of the services provided by Sonoma County's natural capital at **\$2.2 to \$6.6 billion per year.** Here's how the benefit transfer method works:

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. Using a publicly available dataset from the U.S. National Oceanographic and Atmospheric Administration (NOAA), researchers classified Sonoma County's roughly 1 million acres of land into 17 land cover categories at a resolution of roughly ¼ acre⁶ (see map).

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; serving as a green buffer around towns or cities (within ¼ mile of high-density urban development or 2 miles of any urban development); or part of a contiguous area larger than 5 acres of a single land-cover type.

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 & Beaches Developed Open Space** Developed Bare Land

Source: NOAA Coastal Change Analysis Program

14 · COUNTYWIDE STUDY

10 Miles

3. MATCH STUDIES TO LAND COVER TYPES

The next step is 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 the part that is akin to using "comps" to estimate real estate values; since it isn't possible to directly study each acre in the county, the results of primary studies on similar landscapes in other locations are used instead. This process identified 106 combinations of land-cover type and spatial conditions to which at least one primary economic study applied.

Earth Economics used 87 peer-reviewed studies to estimate the annual natural capital value provided by each acre of land in the county. Each study uses one or more of the valuation methods listed on page 5; a full bibliography is in the technical report.⁷

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 economists then totaled the low estimate and the high estimates across all natural capital services and all land cover types across the county (table on page 13). The result is a range of estimates for the total value provided by the county's natural capital: **\$2.2 billion to \$6.6 billion annually.**

For full details on the methods used, including sources and data, please see the accompanying technical report.



A Countywide Valuation of Ecosystem Services

Water Supply and Quality

\$9 million - \$180 million annually

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 reliable supplies of clean water for people as well as for 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 and inadequate flows can be particularly harmful to Sonoma County's threatened coho, steelhead, and Chinook salmon populations.

Healthy watersheds provide multiple water supply services – storage, treatment, conveyance, and groundwater recharge – that would be very costly or impossible to replace with built infrastructure. The cost to replace healthy watersheds with water infrastructure and the willingness to pay for alternate sources of clean water has been measured by researchers in many studies (using the replacement cost and contingent methods detailed on page 5). Lands protected by Ag + Open Space include 18,658 acres of protected groundwater basins or natural recharge areas.⁸

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 millionacre water supply watershed in the Catskill Mountains is recognized internationally as an example of the successful preservation of natural capital – saving taxpayers millions of dollars each year while providing other values such as local food, recreation, scenic viewsheds, and wildlife habitat. Sonoma County has a similar example in the protection of Cooley Ranch in the Dry Creek Watershed (see "The Value of Protecting a Watershed" on page 44).

Wastewater Treatment

\$35 million - \$117 million annually

Wastewater and runoff from agricultural, residential, and urban lands in Sonoma County contribute substantial loads of nitrogen and phosphorous compounds to the San Francisco Bay and the Russian River.⁹¹⁰ While these nutrients are essential for plant growth, elevated concentrations in bodies of water can degrade water quality, driving blooms of photosynthetic micro-organisms and lowering the concentration of oxygen in the water, potentially harming fish populations.

Wetlands, as well as vegetation adjacent to agricultural lands, can reduce the loads of nutrients and other pollutants. 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. Numerous studies have calculated the avoided cost to users of wetlands and other pollutant-removal ecosystems and valued the willingness to pay out of pocket for these services (see "The Value of Protecting the Sonoma Baylands" on page 52). To date, Ag + Open Space has protected 2,797 acres of wetlands, primarily in the Sonoma Baylands region, where Sonoma Creek and the Petaluma River meet San Pablo Bay.

Examples of Natural Capital Investments At Work

| City, State | Population served | Watershed protection benefit |
|-------------------|-------------------|---|
| New York City, NY | 9 million | \$1.5 billion spent on watershed protection over 10 years saved at least \$6 billion in capital costs and \$300 million in annual operating costs |
| Boston, MA | 2.3 million | \$180 million (gross) avoided cost |
| Seattle, WA | 1.3 million | \$150-\$200 million (gross) avoided cost |
| Portland, OR | 825,000 | \$920,000 spent on watershed protection annually is avoiding \$200 million in capital costs |
| Portland, ME | 160,000 | \$729,000 spent on watershed protection annually has avoided \$25 million in capital costs and \$725,000 in annual operating costs |
| Syracuse, NY | 150,000 | \$10 million watershed conservation plan is avoiding \$45-\$60 million in capital costs |
| Auburn, ME | 23,000 | \$570,000 spent to acquire watershed land is avoiding \$30 million capital cost and \$750,000 in annual operating costs |

NYC'S NATURAL CAPITAL INVESTMENT

Widely regarded as a prime example of effective and beneficial investment in ecosystem services, New York City's preservation of the Catskills Mountains watershed has saved residents between **\$8-10 billion** in recent decades.¹¹ In 1992, the U.S. Environmental Protection Agency ordered the city to install a water filtration system. Instead of paying \$6 billion to install and \$250 million per year to operate a new filtration system, New York City chose to spend \$1.5 billion to preserve the watershed that was naturally filtering water for nine million residents. Over the past 20 years, the city has purchased more than 144.000 acres of watershed lands and invested in new water quality projects throughout the watershed. Without this investment, it would have taken much longer for drinking water systems to return to operation after the devastation caused by Superstorm Sandy in 2012. Not only that, but this investment in land conservation preserves many other ecosystem services besides water quality. See the table at left for other examples of water treatment cost savings.





Moderation of Extreme Events

\$82 million - \$220 million annually

Wetlands, grasslands, riparian vegetation, and forests all provide protection from flooding and other disturbances. These landscapes absorb and store large amounts of rainwater during storms, reducing the volume that flows into streams.

This flood control service is increasingly important as the climate warms, creating the potential for more severe storm events and increased fire-related flooding. 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.¹² 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.¹³

Since 2013, the Federal Emergency Management Agency's (FEMA) cost-benefit methodology has officially recognized the flood-risk-reduction services provided by natural and restored floodplains. Previously, when FEMA decided 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. Incorporating these values into such analyses is expected to inform land use and land conservation decisions, helping communities reduce repetitive damage to property, protect human life, and lower disaster expenditures.¹⁴

Urban Stormwater Management

\$0.2 million - \$8 million annually

By capturing and absorbing rainfall, particularly during heavy rains, green space in watersheds and urban areas helps to reduce the transport of pollutants from developed areas to waterways. It thus provides a water quality benefit.¹⁵



Russian River Flows at Guerneville,

July 2016-April 2017

Despite being regulated by Warm Springs Dam, flows in the Russian River can vary by a factor of more than 500 over the year. Vegetation in wetlands and upstream watersheds moderates these flows; degrading these systems would likely increase peak flood flows and associated damages, and reduce already-low summer flows.



A Countywide Valuation of Ecosystem Services

Soil Formation and Retention

\$4 million - \$620 million annually

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.

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. Soil retention provided by vegetation helps to avoid the large costs associated with erosion¹⁶ (see replacement cost method on page 5). Keeping land in productive agriculture can help protect the many ecosystem services provided by healthy soil.







Working landscapes – including farms, ranches, dairies, vineyards, orchards, and timberlands – are major economic contributors to the variety of products that feed, house, and clothe the community - locally and internationally. Additionally, keeping land in agriculture, along with good conservation practices by high-quality water downstream by minimizing development and impervious surfaces in a watershed. Streams that run through private lands have been shown to save downstream communities expenses associated with flooding and water treatment. In addition, studies have shown that California rangelands contribute up to **\$2.4 billion** to the economy by maintaining habitat for pollinators.¹⁷



Carbon Sequestration

\$58 million - \$197 million annually

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

Unlike the other natural capital services presented in this report, the carbon sequestered by some types of working and natural lands is actively traded on various markets, setting 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 around \$13 per tonne carbon dioxide equivalent (tCO₂e).

However, a large body of research suggests that such market prices understate the long-term value to society of sequestering carbon. The measure known as the "social cost of carbon" assesses the marginal increase in long-term, global, climate-change-related economic damages associated with the emission of one additional tCO₂e in a given year. The U.S. Environmental Protection Agency estimates the social cost of carbon emitted in 2020 to be roughly \$42 per tCO₂e, assuming a 3% discount rate; many published estimates are much higher.^{18,19} For consistency in this report, Earth Economics generated the range of values for the carbon sequestration service with the same benefit transfer approach used throughout.

Several recent studies have quantified the carbon benefit – in terms of carbon dioxide stored, rather than dollars – provided by Sonoma County landscapes.

The Climate Action Through Conservation project, detailed at right, estimated total carbon sequestration throughout the county and evaluated the emissions savings of the conservation of Buckeye Forest – approximately 1 million tCO₂e. This is equivalent to the greenhouse gas emissions from over 200,000 passenger vehicles for one year.

A review of the benefits provided by Sonoma County's estuarine wetlands found that this landscape type sequesters between 0.6 and 3.5 tCO₂e per acre each year.²⁰

Another study assessed the carbon impact of Ag + Open Space's work to preserve the land that is now Taylor Mountain Regional Park and Open Space Preserve. Had the land been developed intensively for housing, more than 100 tCO₂e per acre would have been lost to the atmosphere. The findings of this study are summarized in the "The Value of Conserving Taylor Mountain" case study on page 54.



QUANTIFYING LANDSCAPE CARBON

The Climate Action Through Conservation project²¹ - a collaboration between Ag + Open Space and The Nature Conservancy - evaluated the emissions impact of the conservation of Buckeye Forest, a remote 19,000-acre property in northwestern Sonoma County that was slated for residential development. Conservation organizations purchased the land, and Ag + Open Space acquired a perpetual conservation easement over 18,000 acres, thereby averting development of 53 homesites and providing for sustainable forest management. The study found that this conservation action will deliver, between 2010 and 2030, a net climate benefit of roughly **1 million tCO**₂**e** by preventing the conversion of high carbon sequestering forests to other land uses which sequester less carbon.

The Climate Action Through Conservation project also estimated total carbon sequestration by all of the county's working and natural 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 tCO2e from 1990 to 2010, primarily due to increases in forest cover and forest biomass.





A Countywide Valuation of Ecosystem Services

Air Quality

\$19 million - \$22 million annually

Human exposure to air pollutants can be a serious public health concern. Vegetation in populated areas helps to mitigate concentrations of a number of air pollutants.

A number of studies have evaluated the air quality benefits provided by urban trees. 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.

These services provide a direct public health benefit and can also contribute to avoiding the cost of other measures to address air pollution.





Two medium-sized, healthy trees can supply the oxygen required for a single person for a year²²



VALUE

LOCALLY FARMED FOOD

Pollination

\$218 million - \$367 million annually

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. There is no practical replacement for the pollination services provided in natural systems by wild pollinators.

Pollination services also contribute to yields for many cultivated crops, enhancing the basic efficiency and economic value of agriculture.²³

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

Habitat and Nursery

\$4 million - \$43 million annually

Sonoma County landscapes provide a rich variety of habitats: streams, redwood forests, oak woodlands, grasslands, freshwater and estuarine wetlands, coastal scrub, and more. Wild species of fish, birds, mammals, and reptiles cannot survive, let alone thrive, without intact habitat. This habitat is especially important for the survival of endangered species. Many surveys have shown that natural habitats and the wildlife they support are valued for a variety of reasons – for birdwatching, hunting and fishing, or simply the knowledge that they exist.²⁴

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 5).

Ag + Open Space has conserved large expanses of multiple habitat types in Sonoma County – 76 miles of salmon streams, 33,579 acres of redwood forest, 58,853 acres of native oak woodland and forest, and 2,797 acres of wetlands. These protected areas include over 5,800 acres of habitat for threatened and endangered plants and animals.

Ag + Open Space, Sonoma Land Trust, and other conservation partners understand the value that natural lands provide as habitat, and have protected thousands of acres to keep those services viable. The Sonoma Baylands, wetlands along the San Pablo Bay, are one example of critical habitat protection. The Baylands 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 the salt marsh harvest mouse. More than one million birds and waterfowl stop in the Sonoma Baylands during their annual migration (see "The Value of Protecting the Baylands are returning habitat and nursery services to human-altered lands.

Biological Control

\$8 million - \$23 million annually

Natural areas support animals that help to control populations of pests – from rodents to insects to soil organisms – that cause plant diseases. Native predators, such as owls, help manage populations of "pest" species, such as rats, that can negatively affect agricultural operations and urban life.

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.²⁶



Natural Beauty

\$1.2 billion to \$4.2 billion annually

Sonoma County has a remarkable diversity of beautiful landscapes. From the Pacific coastline to redwood forests, dairy pastures, rolling oak woodlands, and river valleys, the county's landscapes have classic, universal, and irreplaceable appeal.

People value this beauty immensely. In the analysis by Earth Economics, the aesthetic benefit provided by the county's working and natural lands had the highest value of any single service.

This aesthetic value contributes to increased property values because people will pay extra for a view of, or proximity to, beautiful open space. Natural beauty likely contributes significantly to the county's \$72 billion (in 2014) total assessed property value (see hedonic pricing method description on page 5).²⁷

Many studies show that people are willing to pay to preserve aesthetic amenities.²⁸ 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.

Recreation and Tourism

\$500 million - \$596 million annually

The county's 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. Since its founding, Ag + Open Space has helped to substantially expand recreational open space in Sonoma County, leading the creation of 32 new parks, preserves, and public spaces – a total of 11,969 acres of publicly accessible open space. Ag + Open Space has also been a partner on 52 urban open space projects; its matching grant program leveraging \$32 million to open 426 acres of urban parks, trails, and greenways to public use.

Sonoma County draws an estimated 7.5 million tourists each year who spend an average of \$389 per person — a total of nearly \$3 billion annually. In a study of Sonoma County's tourism economy, 90% of visitors ranked the scenery provided by the local landscapes as "important" or "extremely important" to their decision to visit.²⁹ These expenditures from visitors from outside the county translate into roughly one quarter of the Ag + Open Space revenue from sales taxes.

PARKS AND OPEN SPACE: A PRESCRIPTION FOR COMMUNITY HEALTH

The Centers for Disease Control and Prevention (CDC) has documented that the sedentary lifestyle of most Americans is contributing to an increased incidence of obesity-related diseases, such as high blood pressure, diabetes, congestive heart failure, and stroke. In 2000, expenses resulting from conditions related to obesity totaled **\$117 billion** and were responsible for over 300,000 premature deaths per year.³⁰ To address this, the CDC has called for more parks and playgrounds, as studies have shown that people exercise more when they have access to parks. More information is available in "The Value of Urban Open Space: Exercise and Health" case study on page 46.
The value of the recreation and tourism ecosystem service is generally measured using travel cost as a proxy – on the assumption that a landscape must be worth as much to a visitor as the money spent to get there – and through willingness-to-pay surveys.

In a 2018 study using business surveys, instead of travel cost, the Sonoma County Economic Development Board calculated that the outdoor recreation industry adds \$731 million a year to the economy.³¹

Recreational use of the county's 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.³² Many healthcare providers now write "parks prescriptions" to encourage patients to engage in some form of physical activity and develop outdoor exercise habits.³³ By supporting public health in these and other ways, open space contributes to reducing illness-related productivity losses and healthcare costs.

The growing Sonoma County agritourism sector is an excellent local example of the multiple benefits of conserving working landscapes. Parcels protected by Ag + Open Space include 39 farms producing local food and wine which, in many cases, offer tastings and tours. Conservation easements have had a particularly important role in launching the county's renowned artisanal cheese sector, which now includes roughly 30 producers. As of 2011, more than two-thirds of the farmstead cheese operations in Marin and Sonoma counties had sold agricultural conservation easements and used the proceeds to invest in their businesses, which in turn have become significant employers and tourism destinations for the region. The Value of Protecting Rangeland: The Local Cheese Industry case study on page 48 provides more information on the natural capital benefits of these partnerships.



WE VALUE

30 · COUNTYWIDE STUDY

CLEAN, CLEAR WATER

Sonoma County Working & Natural Lands

The countywide evaluation of natural capital benefits provides a high level understanding of the value and multiple benefits of our working and natural lands. While an efficient way to estimate natural capital values over a large area, this approach is not intended to document specific conservation values in particular geographies. To further refine the countywide valuation, Ag + Open Space worked with partners to identify specific case studies that would illustrate the multiple benefits of protecting working and natural lands across Sonoma County's varied landscapes.

The ten case studies in this report provide a detailed look at how natural capital operates in specific landscapes in Sonoma County — including coastal landscapes protected from development, watersheds that supply clean abundant drinking water, scenic mountains that support community health, and rangelands that sequester carbon and provide local food and fiber. These case studies were identified in collaboration with multiple county partners and conducted by a range of researchers using unique valuation approaches - each focusing on a different aspect of the local landscape. Each case study summary in this report provides the highlights of a longer technical report prepared by consulting firms and/or academic researchers. The full reports are available as links at the end of each case study.

Together, the countywide report and the case studies illustrate the immense value of protecting natural capital and the benefits of using natural capital valuations to inform choices about land use and conservation in Sonoma County.





The Value of Protecting the Sonoma Coast

CONTEXT

Since 1990, Ag + Open Space and its partners have protected over 18,000 acres of coastal landscapes in Sonoma County. These lands are rich natural capital resources that provide many services, including natural beauty, carbon sequestration, recreation, soil retention, and wildlife habitat. Had these lands been developed rather than conserved, substantial natural capital would have been lost. California and Sonoma County have a legacy of strong coastal protection, but many areas around the world do not, and it is important to recognize the impact of policies on development outcomes.

Counting only natural beauty and carbon sequestration services, the consulting firm Abt Associates estimated that conservation of Sonoma County's coastal landscapes has preserved natural capital worth up to **\$3.5 million** annually.

The coastal parcels conserved by Ag + Open Space provide a number of other natural capital services besides natural beauty and carbon sequestration. These services are outlined in the table at right.



FINDINGS

Value: NATURAL BEAUTY

The undeveloped Sonoma Coast provides aesthetic value that residents and thousands of visitors enjoy each year, and land conservation by Ag + Open Space has played a major role in preserving these views. In fact, Ag + Open Space protected land accounts for 25% of the land visible from the coastal region's major scenic corridors. Based on an estimate of the number of sightseeing trips to the coast each year, and figures from previous studies of the value of pristine views to tourists, the researchers estimated that Ag + Open Space protected land provides up to **\$2 million** in yearly value.³⁴

Value: CARBON SEQUESTRATION

Clearing land for residential development releases carbon stored in soils and woody vegetation and prevents future sequestration when lands are covered by pavement or buildings. The result is a net addition of climate-warming gases to the atmosphere. The researchers estimated how much carbon would have been released under three different scenarios of residential development on the parcels conserved by Ag + Open Space, and then estimated the value of avoiding those carbon emissions. The result: more than **\$44 million** through 2050.

Quantified Ecosystem Services

| Natural Beauty | Up to \$2 million per year. |
|----------------------|-------------------------------|
| Carbon Sequestration | Up to \$1.5 million per year. |

Ecosystem Services not Quantified

| Recreation | 12 Ag + Open Space properties in the coastal region are actively used recreation destinations. |
|------------------------------|---|
| Moderation of Extreme Events | The protected properties include two estuary areas which help to protect shorelines from storm surges and rising sea levels. |
| Habitat and Nursery | Properties with less development and that are adjacent to other protected parcels preserve large intact habitat areas, which is known to have a positive impact on biodiversity. |
| Soil Retention | Undeveloped land helps to hold soil in place, reducing erosion, and helping to preserve habitat in streams for salmon and other fish. |
| Other Services | Other services of potential value include water quality, water supply, food production, and air quality. |

 FULL REPORT: Abt Associates. 2015. The Economic Value of Natural Capital on the Sonoma Coast. Report prepared for Sonoma County Ag + Open Space.

 AVAILABLE AT: www.sonomaopenspace.org/HLHE
 RESEARCH BY: Abt Associates - www.abtassociates.com

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Sonoma County rangelands support local productive agriculture, including dairying, hay, silage, wool, milk and cheese production and myriad other agricultural products. These rural open space lands support our local economy and community by providing local food, jobs, and revenue. Grasslands are critical to agricultural production in the state, providing **75% of California's livestock forage**.³⁵ In addition to their contributions to agricultural productivity and the Sonoma County economy, these rangelands provide other important ecosystem services that provide benefits and values to the larger community. For example, research shows that in many cases ranches provide the best remaining habitats for threatened and endangered species, including wintering birds and waterfowl, invertebrates, and mammals.³⁶ Protecting rangeland is one of the many benefits that the voters of Sonoma County sought to protect when they created Ag + Open Space in 1990. Since then, Ag + Open Space has worked with willing landowners across **more than 200 properties** in Sonoma County to conserve **almost 33,000 acres** of grassland throughout Sonoma County.

Eighty-eight percent of grasslands in California are privately owned, and they are being converted to other land uses at a high rate. Each year, **20,000** acres of private ranch land in California are lost to development, with 10% of private lands fragmented into parcels of less than 20 acres.³⁷ When grasslands are converted or developed, we lose important agricultural lands and the ecosystem services they provide, including protection of our water supply, soil retention and formation, carbon sequestration, pollination, and habitat for rare and endangered species. In addition, fragmentation and conversion to non-ag uses can make it more difficult for neighboring ranchers to stay in business, creating a snowball effect where development and conversion leads to increased development and conversion, and the loss of supporting services that make working agriculture viable.^{38,39}

Statewide, grasslands are a critical component of the state's biodiversity, providing habitat for **90%** of state-listed rare and endangered species, while also regulating water flow and water quality, and storing carbon.⁴⁰ By providing habitat for native pollinators and honeybees, the rangelands surrounding California's croplands provide an estimated **\$2 billion** worth of pollination services alone.⁴¹ Grasslands are also habitat for the animals that provide biological control of pest organisms, and contain habitat and migratory corridors for large mammals, birds, reptiles, and amphibians, including rare and endangered vernal pool species.⁴²

Grazed rangelands can provide enhanced ecosystem service benefits, including a reduction in invasive species and reduced fuel loading.⁴³

A recent study completed in Sonoma County estimated that the ecosystem services provided by grasslands, including carbon sequestration, water quality and supply, pollination, biological control, and habitat, total up to **\$2.4 billion per year.**⁴⁴



Ag + Open Space has protected over 33,000 acres of rangeland in Sonoma County

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Research has demonstrated that rangeland owners who have conservation easements are more motivated to manage their land in a manner that protects and enhances the ecosystem services that rangelands provide.⁴⁵ Ag + Open Space works with Sonoma County's agricultural community: farmers, ranchers, and organizations such as the Farm Bureau and the Farmer's Guild/Community Alliance with Family Farmers, to support the economic vitality of working farms and to conserve productive agricultural land throughout the county. Statewide, other organizations such as the California Rangeland Trust and the California Rangeland Conservation Coalition are working in partnership with ranchers to conserve both the agricultural heritage of the state and to conserve these important grassland ecosystems and the services they provide for future generations.

The University of California Cooperative Extension (UCCE) examined the conservation value of Ag + Open Space protected land through an analysis using InVEST, an open-access software package developed by the Natural Capital Project. Using this tool, they quantified biophysical values for carbon storage, sediment retention, nutrient retention, and water yield on land protected by Ag + Open Space conservation easements, compared to adjacent private and public lands. They found that for all four services measured, Ag + Open Space protected land had a higher conservation value than similar unprotected land in the county.

These results suggest that land protected by the taxpayers of Sonoma County via Ag + Open Space conservation easements provides ecosystem services that benefit all county residents. As we develop more sophisticated tools to analyze the conservation value of available land, we will continue to improve our ability to identify those conservation opportunities that will provide the highest possible ecosystem services for all the residents of Sonoma County. Our understanding of the values provided by rangelands and their risk of conversion allows us to continually evaluate and improve our land conservation efforts, ensuring that taxpayer dollars are used to protect properties that retain land in productive agriculture while providing returns on the community's investment.

FULL REPORT: Butsic, V, Shapero, M, Moanga, D, Larson, S. 2017. Using InVEST to assess ecosystem services on conserved properties in Sonoma County, CA. UC Cooperative Extension. AVAILABLE AT: www.bit.ly/2Q4u7oo

RANGELAND CONSERVATION IN CALIFORNIA

California is fortunate to have many organizations working to protect our grasslands and rangelands. The California Rangeland Conservation Coalition brings together over 100 organizations who are interested in preserving ranching as a way of life and the landscapes required to do so. The California Rangeland Trust conserves rangeland throughout the state - over 318,000 acres since 1998.46 Organizations like these ensure that the ecosystem services provided by rangelands throughout California will continue to benefit future generations.

Stream ecosystems are areas of incredibly high biological diversity – home to myriad plant communities and critically important habitat for aquatic, terrestrial, and avian wildlife. Over three-quarters of the amphibians and half of the reptiles in California rely upon these systems for a substantial part of their life cycle, and these areas are foundationally important for threatened and endangered aquatic species including freshwater shrimp, steelhead trout, coho, and Chinook salmon. Resident and migratory bird species are dependent on riparian areas – some traveling from Central and South America to overwinter in California streamside forests. Salmonid species use these connected habitats to move up and downstream during spawning and outmigration, while a wide variety of terrestrial species – including bears, mountain lions, bobcats, foxes, and coyotes – use stream corridors for shelter, food, and movement through increasingly developed landscapes.

Intact riparian corridors are also important for human well-being - helping to ensure clean and abundant supplies of drinking water, minimizing downstream flood impacts, supporting the commercial and recreational fishery, sequestering carbon, enhancing climate resiliency, maintaining cultural and spiritual values for a community, and contributing to scenic beauty and recreational enjoyment.

Because floodplains are often ideally suited for high value human land uses such as roads, residential and commercial development, or agriculture, over 95% of the floodplain riparian habitat in California has been removed.⁴⁷ Preliminary studies in Sonoma County point to trends similar to the rest of the state, with increasing impacts to floodplain riparian areas.

Ag + Open Space is tasked with protecting natural lands (including riparian corridors), agricultural lands, scenic areas, and greenbelts. One strategy that Ag + Open Space uses to accomplish this goal is to work with private landowners through a voluntary, incentive based approach to protect stream systems, such as a riparian easement. Riparian easements can protect existing riparian habitat as well as degraded habitat in the floodplain that can be restored to a fully functional state.

Based upon this analysis, the estimated value provided by current riparian areas is **\$61.3 million to \$85.0 million** annually. If fully restored to their functional potential, riparian corridors could provide up to **\$116.3 million** per year. Since numerous services were not included in this study (including natural beauty, water supply, pollination, and pest control services, among others), this value is likely an underestimate of the true value of Sonoma County riparian corridors.

METHODS

This analysis is based on a review of published studies evaluating the effects of riparian corridor protection, and building on a multi-year technical collaboration with Tukman Geospatial, Dr. Joan Florsheim, and O'Connor Environmental, among others, to identify the most important riparian corridors in Sonoma County to prioritize for protection.





Over 95% of floodplain riparian habitat in California has been lost⁴⁸



FINDINGS

Value: WATER QUALITY

Toxic algae blooms, polluted runoff, high water temperatures, and altered sediment levels negatively impact Sonoma County's water quality. Highly functioning riparian ecosystems can assimilate pollutants, reduce stream temperature, and decrease erosion thereby improving water quality through-out the watershed and avoiding costly water treatment infrastructure. Previous studies have shown that households are willing to pay on average \$45 per year to improve water quality through riparian restoration. In Sonoma County, this is equivalent to **\$8.5 million** per year for the benefits provided by riparian corridors in their current state, and **\$17 million** per year if all riparian corridors in Sonoma County were restored to a fully functional state.

Value: MODERATION OF EXTREME EVENTS

Floods are the most frequent natural hazard in Sonoma County.⁴⁹ Naturally vegetated riparian areas can reduce the force, height, and volume of floodwaters by slowing waters and allowing water to spread out across the floodplain. Natural riparian areas thus help save lives, prevent costly property damage, and reduce the need for flood control infrastructure. By analyzing the value of buildings and infrastructure at risk from large flood events, the researchers estimated that current riparian areas contribute up to **\$59.5 million** annually in flood protection benefits. Increasing the area of riparian corridors would provide more room for floodwaters to spread out, and would likely decrease the amount of damage caused by flooding in Sonoma County.

Value: HABITAT AND NURSERY

In a recent survey, 78% of respondents in Sonoma County indicated that preserving a diversity of habitat for wildlife is extremely important or very important. Riparian areas are relied on by many species – 11 of the county's 28 threatened and endangered species rely on riparian zones as their primary habitat. By approximating that Sonoma County households would be willing to pay \$35 per year for habitat and nursery benefits, the researchers estimated that riparian areas in their current state would provide at least **\$6.6 million** annually.

Value: CARBON SEQUESTRATION

Carbon is stored in riparian vegetation and in riparian soils in the form of organic matter. In Sonoma County, current riparian areas are estimated to sequester aboveground approximately 1.84 million tCO₂e, and, with additional restoration, could increase to 3.1 million tonnes aboveground CO₂e. Using the most conservative estimate of the social cost of carbon at \$15 per tCO₂e, the value of aboveground carbon storage in Sonoma County's riparian areas is **\$27.6 million**, and the potential value of a fully functional system would be **\$46.5 million**. The range in values for the social cost of carbon is very wide; using the least conservative estimates, the value of aboveground carbon storage in Sonoma County riparian areas is **\$489 million**, and the carbon values associated with fully restored riparian corridors exceeds **\$820 million**.

Value: RECREATION

Nearly 75% of our nation's outdoor recreation – including fishing, hiking, and viewing wildlife – takes place within one-quarter mile of streams or other bodies of water.⁵⁰ Sonoma County residents make approximately 907,000 trips a year to fish or view wildlife that are supported by riparian corridors. This benefit can be valued at approximately **\$45.3 million to \$54.4 million** annually. Enhancing our current riparian areas or allowing riparian areas to expand over time would likely provide for a greater recreational value to Sonoma County residents.



FULL REPORT: Sonoma County Ag + Open Space and Highland Economics. 2018. The Multiple Benefits and Values of Sonoma County Riparian Corridors. Report prepared for Sonoma County Ag + Open Space. AVAILABLE AT: www.sonomaopenspace.org/HLHE | RESEARCH BY: Highland Economics - www.highlandeconomics.com

CASE STUDIES · 43

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The most cost effective way to provide clean water is to prevent it from becoming polluted in the first place. Conserving watersheds does just that.

The 83,276-acre Upper Dry Creek Watershed drains into Lake Sonoma, which in turn provides water for more than 600,000 people in Sonoma and Marin counties.

Cooley Ranch, in northern Sonoma and southern Mendocino counties, is a 19,132acre parcel that makes up 23% of the land that drains to Lake Sonoma. In 2001, Ag + Open Space purchased a conservation easement on the land, which had been in rancher Crawford Cooley's family since 1910. The easement extinguished 93 of the 97 development rights that were available at the time of acquisition.

The preservation effort averted what could have become a large-parcel residential development. About three-quarters of the property - a mix of chaparral, stream corridors, forest, and grasslands that supports bald eagles, black bears, mountain lions, and rare plant species - will remain as undeveloped wild habitat in perpetuity. In addition, cattle are still allowed to graze almost 17,000 contiguous acres, and up to 1,000 acres of vineyard are permitted.

In addition to conserving habitat, scenic, and agricultural values, protecting Cooley Ranch preserved a critical natural capital service of the watershed – providing clean water to Lake Sonoma.

Development can impair water quality, primarily by increasing the amount of sediment and nitrogen that washes into waterways. These contaminants can increase treatment costs for water providers by millions of dollars; they can also degrade aquatic habitat and recreational uses, harming fish and amphibians and limiting swimming, fishing, and other activities in reservoirs and estuaries. Many communities around the country have found that protecting the watersheds that provide drinking water is an excellent investment that avoids major costs associated with new water treatment infrastructure (see table on page 17).

This study, conducted by Earth Economics in partnership with Ag + Open Space and Sonoma Water, assesses some of the natural capital values preserved by protecting Cooley Ranch.



FULL REPORT: Earth Economics. 2017. The Economic Value of Land Conservation in Sonoma County: A Case Study Focused on Upper Dry Creek and Cooley Ranch. Report prepared for Sonoma County Ag + Open Space. AVAILABLE AT: www.sonomaopenspace.org/HLHE RESEARCH BY: Earth Economics – www.eartheconomics.org

Cooley Ranch is an important part of Sonoma County's water supply system, enhancing water quality for 600,000 people

FINDINGS

Value: AVOIDED NITROGEN POLLUTION

Had Cooley Ranch not been protected, it likely would have been developed for large-parcel residences. By comparing existing conditions to a conservative development scenario that included 56 home sites, the researchers were able to analyze some of the water quality impacts that development could have caused. Using data on the nitrogen flows generated by residential septic systems and other land uses, the researchers estimated the avoided nitrogen pollution benefits associated with protecting Cooley Ranch at \$164,000 per year. This value does not reflect any other water quality benefits of preserving land, including avoided phosphorus inputs, minimized sediment runoff, and other avoided pollutants associated with development.

The Value of Urban Open Space: Exercise and Health

CONTEXT

A significant body of research documents the links between physical activity and health – from maintaining healthy body weight to reducing the incidence and severity of a wide range of illnesses, including depression, anxiety, heart disease, diabetes, and several types of cancer. Healthcare providers across the U.S., including here in Sonoma County, are now writing "parks prescriptions" to encourage patients to engage in some form of physical activity and develop outdoor exercise habits.⁵¹

Urban open spaces provide free or low-cost venues for exercise. In addition, recent studies show that the presence of nearby open spaces helps to improve motivation to exercise in the first place – increasing the rate at which people exercise.

Sonoma County's **140 miles** of regional trails and nearly **300 parks** include a large variety of urban open spaces. A recent report commissioned by the County of Sonoma Department of Health Services recommended increased access to parks as a key place-based intervention that would benefit the health of Sonoma County residents overall.⁵²

METHODS

To assess the value of the health benefits associated with exercise in Sonoma County's urban open spaces, the consulting firm Earth Economics considered the number of residents who exercise regularly in these open spaces, and the average annual costs associated with physical inactivity.

Total annual healthcare and lost-productivity costs associated with physical inactivity among adults in Sonoma County was estimated at **\$274 million** annually, or \$699 per person (\$267 associated with health care costs, \$402 associated with lost productivity) in a 2009 study.⁵³ The total value of health benefits from parks and trails was calculated by multiplying the estimated number of individuals who exercise in parks, approximately 10% of the urban population, by the estimated costs associated with physical inactivity for adults, seniors, and children.



 FULL REPORT: Earth Economics. 2017. Urban Open Space: Essential to Physical and Mental Health. Report prepared for Sonoma County Ag + Open Space.

 AVAILABLE AT: www.sonomaopenspace.org/HLHE

 RESEARCH BY: Earth Economics – www.eartheconomics.org

FINDINGS

Value: HEALTHY LIVING

By exercising in urban parks, Sonoma County residents avoid a total of **\$17.5 million** in health care and lost-productivity costs each year. Not only do urban parks provide open space for Sonoma County residents to improve their physical health, numerous studies have shown that urban parks can improve mental health by decreasing anxiety and reducing symptoms of depression. A recent study showed that living near an urban park can result in the same mental health benefits as a decrease in local unemployment by 2%.⁵⁴

By exercising in urban parks, Sonoma County residents avoid a total of \$17.5 million in health care and lost-productivity costs each year⁵⁵

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The Value of Protecting Rangeland: The Local Cheese Industry

CONTEXT

Rangelands in Sonoma and Marin counties are home to agricultural operations that support a wide variety of products, including beef, lamb, and goat meat, as well as hay, silage, milk, yogurt and cheese. The locally produced artisan and farmstead cheese market has emerged as an important economic driver in northern Marin County and southern Sonoma County. In this coastal agricultural area, over **330 people are employed** directly in cheese-making or fermented dairy production, and there are up to **600 additional jobs** in related sectors.⁵⁶ In total, the value of milk production in Sonoma and Marin counties in 2017 totaled over **\$170 million**.⁵⁷ A 2010 study showed that local farmstead and artisanal cheese production alone is a **\$119 million** industry,⁵⁸ and has helped this region become a world class producer of artisanal and farmstead cheese, and a prime destination for agricultural and food tourism.

However, due to fluctuations in markets and land prices, regulations, and competition from outside areas, dairying has become increasingly challenging.

These challenges can result in dairy closures and land use changes, including the conversion of land from agriculture and food production to rural residential or other uses. Between 1984 and 2008, over **480,000 acres** of California rangeland were converted to other uses, most commonly commercial and residential development.⁵⁹

In addition to the values associated with productive agriculture, the coastal rangelands in Sonoma and Marin counties also encompass important groundwater basins, scenic vistas and open spaces, wildlife corridors, and habitat – including several streams that are home to the endangered coho salmon. Coho are under intense pressure due to land use change, climate shifts and ocean conditions, with development being a major driver of impacts to their habitat.



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In 2016, all but one artisan cheesemaker in Marin operated on land conserved with an easement⁶⁰



Rangeland agriculture and wildlife - including coho salmon - have co-existed for hundreds of years, and the protection of private rangelands and habitat holds promise for the continued existence of both. In fact, research shows that in many cases ranches provide the best remaining habitats for threatened and endangered species, including wintering birds and waterfowl, invertebrates, and mammals.⁶¹ There are 75 plant and animal species associated with California grasslands that are listed as threatened or endangered under the Endangered Species Act.⁶² Land conservation – whether through private stewardship, public and private investment of dollars into conservation easements, or via Williamson Act provisions - keeps land in agricultural production while providing many other benefits to the local and regional economy and community. In Sonoma and Marin counties, there are nearly 47,000 acres of dairy land, and of these, over 18,400 acres are protected by a perpetual conservation easement - most commonly held by Ag + Open Space or the Marin Agricultural Land Trust. In addition to perpetual conservation easements, other tools play an important role in protecting rangeland. For example, in Sonoma County over 17,600 acres of dairy land are protected by the Williamson Act - a state program that provides short term protection of agricultural land.

In addition to the revenue and jobs that are provided to the local economy from artisanal cheese production and other agricultural uses, these privately stewarded lands help our community to protect biodiversity, sequester carbon, avoid greenhouse gas emissions associated with rural residential subdivisions, adapt to climate change, and protect drinking water supplies by keeping lands over groundwater basins open and supporting flows in stream corridors.

Additional economic benefits include the well-documented contribution of scenic agricultural lands, and local cheese and other food production, to the over \$2.52 billion in annual tourist spending in Marin and Sonoma counties - driving \$1.1 billion in local business and employee income.⁶³

FINDINGS

Value: AGRITOURISM

More than **2.4 million** visitors participated in agritourism at California farms and ranches in 2008.⁴⁴ A 2015 survey of Sonoma County tourism businesses found that **44%** thought that agritourism was a good market opportunity for Sonoma County, and **69%** thought culinary tourism with locally sourced food was a good market opportunity.⁶⁵

Value: JOBS RELATED TO CHEESE-MAKING

332 people are employed directly in cheese-making or fermented dairy production in Sonoma and Marin counties, and there are up to **600 jobs** in related or supportive sectors.⁶⁶

Value: CARBON SEQUESTRATION

In Sonoma County alone, approximately **25,292** metric tons of aboveground carbon is stored on the 6,510 acres of dairylands protected by a conservation easement. With an average value of carbon storage at \$60/ tonne or greater, carbon storage on these properties is equivalent to **\$1,517,520** in avoided global climate change costs.

Value: NATURAL BEAUTY

Rangelands provide scenic and open space value. Scenic value varies considerably from location to location, but one study found that the public may value the natural beauty service at more than **\$130 per acre per year**.⁶⁷

Value: WATER QUALITY & SUPPLY

Well managed grazing combined with the natural capacity of rangelands to mitigate microbial pollutants provides for clean water. ⁶⁸ Per acre of rangeland, there is approximately 1.25 to 2 acre-feet per year of groundwater recharge, which may be valued at approximately **\$100 to \$1,000** per acre-foot, based on Sonoma Water analysis of groundwater recharge projects.⁶⁹

Value: HABITAT AND NURSERY

Rangelands provide migration corridors and habitat for diverse species, including threatened or endangered species. Grazing has been shown to enhance California's unique habitats such as vernal pools by controlling exotic annual plants and enhancing herbaceous plant diversity which can benefit a diversity of species, including endangered species such as the California tiger salamander.⁷⁰ Habitat value varies considerably from location to location, but one study found that the public may value the wildlife habitat benefits of enrolling an acre of terrestrial in a conservation reserve program at **\$87.50 per acre per year.**⁷¹





ACKNOWLEDGEMENTS: Thank you to Ms. Ellie Rilla, formerly of the UC Cooperative Extension, and Ms. Sue Conley, the founder of Cowgirl Creamery, for their invaluable guidance and insight during the development of this case study.

MORE INFORMATION: Conservation Strategy Fund. 2016. Artisanal Cheese and Land Conservation in the Milkshed of Sonoma and Marin Counties. Report prepared for Sonoma County Ag + Open Space and the Marin Agricultural Land Trust.

Rilla, E. 2011. Coming of Age: The Status of North Bay Artisan Cheesemaking. UC Cooperative Extension. Available at: **www.bit.ly/2MSNio9**



At the south end of Sonoma County, the Petaluma River and Sonoma Creek meet San Pablo Bay in an expanse of tidal wetlands – the Sonoma Baylands. Wetlands protected by Ag + Open Space total almost 3,000 acres, much of which is connected to the Baylands.

San Francisco Bay once included more than 200,000 acres of tidal marsh and wetlands. Less than a quarter of that remains, making large, relatively intact areas like the Baylands and the adjacent Napa-Sonoma Marsh especially precious.

Tidal wetlands are among the world's most vigorous ecosystems. They store carbon, remove pollutants and excess nutrients, provide habitat and nursery services for waterfowl and aquatic species, and support hunting, fishing, and birdwatching in the region.

METHODS

The researchers conducted a literature review of natural capital services provided by wetlands. They cited local studies where possible, supplementing those references with information from studies conducted in other locations as well as from review papers, which integrate information from a number of published studies on wetlands. Additional detail and all references are available in the full report.

"Restored areas of tidal marsh can reduce wave action on the coast and help levees provide flood protection at a lower cost⁷²"



FINDINGS

Value:

CARBON SEQUESTRATION

Tidal wetlands in and near the San Pablo Bay sequester 0.6 to 3.5 tCO₂e per acre per year.⁷³ At current prices on California's carbon market, this carbon storage would be worth \$8 to \$46 per acre each year. Another common measure, the social cost of carbon – an estimate of the long-term costs that the release of each ton of climate-warming emissions imposes on global society – would put the annual value much higher, at up to **\$147 per acre.⁷⁴**

Value:

WASTEWATER TREATMENT

Wetlands take up nitrogen, a common water pollutant with both agricultural and urban sources. Based on a representative figure for nitrogen removal of 29 kilograms per acre per year,⁷⁵ and an economic value for nitrogen removal of \$14.27 per kilogram,⁷⁶ the nutrient removal service provided by each acre of the Sonoma Baylands can be valued at roughly **\$400 per year**.

Value:

MODERATION OF EXTREME EVENTS

As sea level rises, storm surges are more likely to cause flooding along the shores of San Francisco Bay. Studies along San Pablo Bay have found that tidal wetlands attenuate the energy of waves, providing flood protection at a lower cost than levees alone.⁷⁷ In this way, wetlands serve as "natural infrastructure" for flood protection.

Value:

HABITAT AND NURSERY

The Sonoma Baylands are part of a habitat complex that supports hundreds of species of waterfowl, shorebirds, and fish. The area is a major stop on the Pacific Flyway, with more than one million birds stopping in the Sonoma Baylands during their annual migration. A case study in San Francisco Bay estimated the value of wetlands that support food and nurseries for halibut, rockfish, and striped bass at **\$21 to \$27 per acre per year**.⁷⁸

Value:

RECREATION AND TOURISM

The Sonoma Baylands provide recreational opportunities for hunting, fishing, and birdwatching, all of which bring economic activity. The average birdwatcher spends about \$850 on trips and equipment each year, for instance.⁷⁹ Annual spending on waterfowl hunting in the Bay Area has been estimated at more than **\$4 million**.²⁰

FULL REPORT: Earth Economics. 2017. Illustrative Story: The Value of the Sonoma Baylands. Report prepared for Sonoma County Ag + Open Space. **AVAILABLE AT:** www.sonomaopenspace.org/HLHE | RESEARCH BY: Earth Economics – www.eartheconomics.org

Taylor Mountain Regional Park and Open Space Preserve is 1,100 acres of grasslands, oak woodlands, and creeks adjacent to the city of Santa Rosa, and within walking distance of several schools and economically disadvantaged communities. Between 1996 and 2011, Ag + Open Space invested \$26 million to lead the conservation of the land, a property with 38 development rights, that was at high risk of residential development. In 2013, Ag + Open Space transferred the land to Sonoma County Regional Parks, creating the park and preserve.

With 5.5 miles of trails, a disc-golf course, picnic areas, and a variety of wildlife habitats, Taylor Mountain provides many opportunities for recreation. The park is

within easy reach of Sonoma County's largest city, drawing more than **100,000 visits** in 2014, only the second year of public access. In addition, the Taylor Mountain landscape sequesters carbon that would have otherwise been lost through residential development, and provides open space that facilitates natural groundwater recharge.

Researchers from Sonoma State University and Conservation Strategy Fund assessed the value of three of the natural capital services provided by the protected lands: carbon sequestration, water supply, and recreation. Other valuable services provided by the landscape – such as natural beauty, air quality, habitat, and soil retention – were not quantified in the study.

FINDINGS

Value: CARBON SEQUESTRATION

Clearing land for residential development results in substantial releases of the carbon stored in soils and woody vegetation⁸¹ and prevents future sequestration by forests and grasslands. The analysis showed a clear carbon benefit from conserving the land, though with a wide range of estimated values – from 14 to 120 tonnes of carbon dioxide equivalent (tCO₂e) per acre. The value of this natural capital service depends on how much avoided emissions are worth. Based off of U.S. Environmental Protection Agency standards, a range of \$5 to \$100 per tCO₂e for the value of emissions combined with the range of estimated carbon benefits from conserving Taylor Mountain was used. This yields an estimated total carbon sequestration value for Taylor Mountain of more than **\$12 million**.

Value: WATER SUPPLY

The open spaces on Taylor Mountain provide for rainwater percolation that replenishes local groundwater at an estimated rate of 81 acre-feet per year.^{e2} Providing that same service with an engineered water infiltration system would cost \$200,000 to \$400,000 for construction, plus operation and maintenance costs of roughly \$5,000 per year.

Value: RECREATION

The researchers estimated Taylor Mountain's total recreation value at **\$1.55 million** per year. That's equivalent to a net present value – the value of the recreation amenity in perpetuity, assuming a 3% discount rate – of \$51.8 million. Survey data also showed that the median household income of visitors to the park is similar to that of Sonoma County as a whole, suggesting that the park is enjoyed by a representative cross-section of residents.

METHODS

To calculate the carbon sequestration value of preserving Taylor Mountain, the researchers evaluated the amount of carbon that would have been released if Taylor Mountain had been developed by comparing the estimated carbon content in Taylor Mountain's 1,100 acres – based on satellite land cover data – with similar parcels elsewhere in the county that had already been developed.

For the water supply value, annual average water percolation on Taylor Mountain was estimated by Sonoma Water using a groundwater flow model developed for the region by the U.S. Geological Survey.⁸³ The cost for an alternative engineered system was provided by Sonoma Water based on real costs for similar systems built in residential neighborhoods. Lastly, for the recreation value, the researchers surveyed 439 Taylor Mountain visitors to develop a travel-cost analysis – a valuation based on the principle that the recreation services provided by a landscape must be worth at least as much as the costs that visitors incur to travel to the site. From the survey data, the researchers calculated the average travel cost associated with visiting Taylor Mountain at \$14.39 per person per visit. Multiplying that figure by the number of visits each year yielded a figure for the park's total annual recreational value. Increased usage of the park and preserve since the survey data was collected has likely increased the total recreational value from the original estimate.



FULL REPORT: Hanauer M, Reid J, Heisler A and Vasquez F. 2016. Economic Value of Taylor Mountain Regional Park and Open Space Preserve. Report prepared for Sonoma County Ag + Open Space.

AVAILABLE AT: www.sonomaopenspace.org/HLHE

RESEARCH BY: Conservation Strategy Fund: **www.conservation-strategy.org** in collaboration with Merlin M. Hanauer, Associate Professor of Economics, Sonoma State University.



Sonoma County's natural landscapes provide extraordinary learning experiences for the region's children. Through field trips, extracurricular activities, and outdoor programs, Sonoma County's nearly **300 parks** and open spaces provide an outdoor classroom for thousands of students. In 2016, on Ag + Open Space properties alone, nearly **5,000 students** participated in 287 educational programs and outings.

"78% of educators believe that children who regularly play outdoors are better able to concentrate and perform better in the classroom⁸⁴"

These experiences simply can't be replicated in built-up areas. Multiple studies have found that nature-based education – education that uses the natural environment as a context for learning to complement classroom-based instruction – supports and enhances classroom learning in measurable ways, from higher test scores to enhanced critical thinking skills and increased motivation.

The county's 175 public schools utilize the region's natural capital through a number of outdoor education programs. Ag + Open Space sponsored trip destinations include Healdsburg Ridge Open Space Preserve, the Laguna de Santa Rosa, Montini Open Space Preserve, Petaluma Marsh, Taylor Mountain Regional Park & Open Space Preserve, and many more.

 FULL REPORT: Earth Economics. 2016. Nature-based education in Sonoma County. Report prepared for Sonoma County Ag + Open Space.

 AVAILABLE AT: www.sonomaopenspace.org/HLHE

 RESEARCH BY: Earth Economics – www.eartheconomics.org

METHODS

This study was based on a review of published studies that investigated the effects of nature-based education on various aspects of student learning and well-being.



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FINDINGS

Value: BETTER TEST SCORES

In California, a curriculum model called "Environment as an Integrating Context" (EIC) combines hands-on experiences with collaborative instruction, community-based investigation, and cooperative learning in local natural and community surroundings. Studies conducted for the state department of education compared 16 demographically similar elementary schools, half with EIC programs and half without. In **42% of cases**, EIC students scored significantly better on standardized reading, math, language, and spelling tests than students in the control group. The control group students scored better in 4% of cases, and in 54% of cases there was no significant difference.⁸⁵

Another study, of 77 pairs of demographically similar schools in Washington State, found that students in schools with an environmental education curriculum had statistically significant higher test scores in math, reading, and writing compared with traditional schools.⁸⁶

Value: FOCUS, CREATIVITY, AND CONFIDENCE

In a 2010 study, 78% of 1,900 educators surveyed believed that children who spend regular time in unstructured outdoor play are better able to concentrate and perform better in the classroom.⁸⁷ Moreover, 75% said students who spend regular time outdoors tend to be **more creative** and **better able to problem-solve** in the classroom. The EIC study cited above also noted increases in cooperation, leadership, and confidence for students in English as a second language programs.

A controlled 2004 study on more than 400 high school students in Florida found enhanced critical thinking skills in those who had received naturebased education.⁸⁸

A nationwide survey of parents of children with attention-deficit hyperactivity disorder (ADHD) concluded that green outdoor settings reduced ADHD symptoms across a wide range of activities.⁸⁹



Aquifers are a critical and irreplaceable source of water for homes, businesses, and farms in Sonoma County and throughout California. The California legislature acknowledged the importance of aquifers when it passed the Sustainable Groundwater Management Act (SGMA), which established a new structure for managing California's valuable groundwater resources. Locally, the importance of aquifers is exemplified by the Santa Rosa Plain Aquifer – one of the four major groundwater basins in the county – which, in an average year, provides more water to residents than Lake Sonoma.

Land conservation is essential to maintaining the recharge of high-quality groundwater that keeps these aquifers healthy. Aquifers are replenished by water that percolates into the ground, and water can't percolate into paved landscapes.

To date, Ag + Open Space has protected 18,658 acres of groundwater basins and natural recharge areas.⁹⁰ Natural areas – whether grasslands, chaparral, pastures, oak woodlands, or conifer forests – all contribute to groundwater recharge by providing space for rainwater to seep deep into the earth.

This study assesses some of the many values provided by the Santa Rosa Plain Aquifer, which lies in part beneath the county's most populated and developed areas. Figures on water volumes and prices were provided by Sonoma Water.

RISKS: AQUIFER DEPLETION, SALTWATER INTRUSION

The Santa Rosa Plain Aquifer lost roughly 120,000 acre-feet* of water from storage between 1976 and 2010 due to pumping. Available data suggests that water levels in the shallow aquifers in the Santa Rosa Plain have remained stable, while many of the deeper aquifers (which do not recharge as quickly) have declined.⁹¹

An acre foot of water is the amount of water needed to cover an acre one foot deep in water, or 325,851 gallons.

Aquifer depletion near a saline water body can lead to contamination of freshwater aquifers with salt water. In southern Sonoma County, which is adjacent to San Pablo Bay, groundwater levels have dropped more than 100 feet. In some areas, saltwater intrusion has created areas of brackish water that are no longer suitable for agriculture or require additional treatment.

Sonoma Water has been proactive in managing the region's groundwater. The Santa Rosa Plain Watershed Groundwater Management Plan, released in 2014, outlines a suite of strategies for sustainably managing the aquifer, including through new groundwater recharge projects and the protection of natural recharge areas.⁹²

"The market value of clean groundwater pumped from the Santa Rosa Plain is at least \$28 million annually⁹³"

METHODS

This study was based on a literature review as well as discussions with Sonoma Water, which plays an important role in groundwater management in the region.

FULL REPORT: Earth Economics. 2017. The Value of Aquifers in Sonoma County. Report prepared for Sonoma County Ag + Open Space. **AVAILABLE AT:** www.sonomaopenspace.org/HLHE

RESEARCH BY: Earth Economics – www.eartheconomics.org

FINDINGS

Value: WATER SUPPLY

The Santa Rosa Plain Aquifer provided an average of 42,000 acre-feet of water annually to all water users between 2004 and 2010. Based on water rates used by Sonoma Water (\$672.03 per acre-foot), the market value of this water is at least **\$28 million** annually.⁹⁴

The water stored in aquifers also serves as a critical backup supply during drought. One way to value this safeguard is by asking people how much water supply reliability is worth to them. One survey in Northern California found that households were willing to pay an additional \$21 to \$28 per month (in 2017 dollars) on their water bill to avoid water shortages.⁹⁵ That's an implied value of at least **\$24 million** per year for every 100,000 households.

WEVALUE

PLACES TO PLAY



Dividends for Future Generations

The Healthy Lands and Healthy Economies Initiative provides an initial estimate, developed with wellestablished economic tools, of a range of values for the many services that natural capital provides in Sonoma County. The results show clearly that this value is substantial — in the range of **\$2.2 to \$6.6 billion** annually. Properly accounting for this large value will help to ensure that decisions about land use and conservation are informed by the best available information. National and global studies have demonstrated that investments in the long term protection of our working and natural lands may in some cases be more cost effective for our society than short term investments in built infrastructure.

Ag + Open Space is working on a series of additional studies that will analyze conservation efforts and the economic value they create in our local, regional, and state economies. These studies include a closer look at artisanal cheese production, riparian corridor conservation, and the role of working and natural lands play in community resiliency to extreme events such as floods, fires, drought, and climate change.

Sonoma County is fortunate to have visionary citizens and leaders who value our working and natural lands, and are committed to protecting them – ensuring that these investments in our natural capital will continue to provide dividends for generations to come.

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