NORTH COAST RESOURCE PARTNERSHIP

HEALTHY WATERSHEDS, VITAL COMMUNITIES, THRIVING ECONOMIES

Actionable Strategies for California's North Coast Region

North Coast Resource Partnership

May 16, 2018

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FIGURES

1. HISTORY & OVERVIEW

This document outlines a set of actionable, multi-benefit strategies to support the conservation of functional ecosystems and working landscapes; the enhancement of built infrastructure; and the enrichment of human community health and economic vitality in the North Coast Region of California. It discusses the integrated relationships of these three types of capital; the foundational role of these relationships in supporting viability and resilience; and the emerging opportunities for investment in a prosperous and sustainable future.

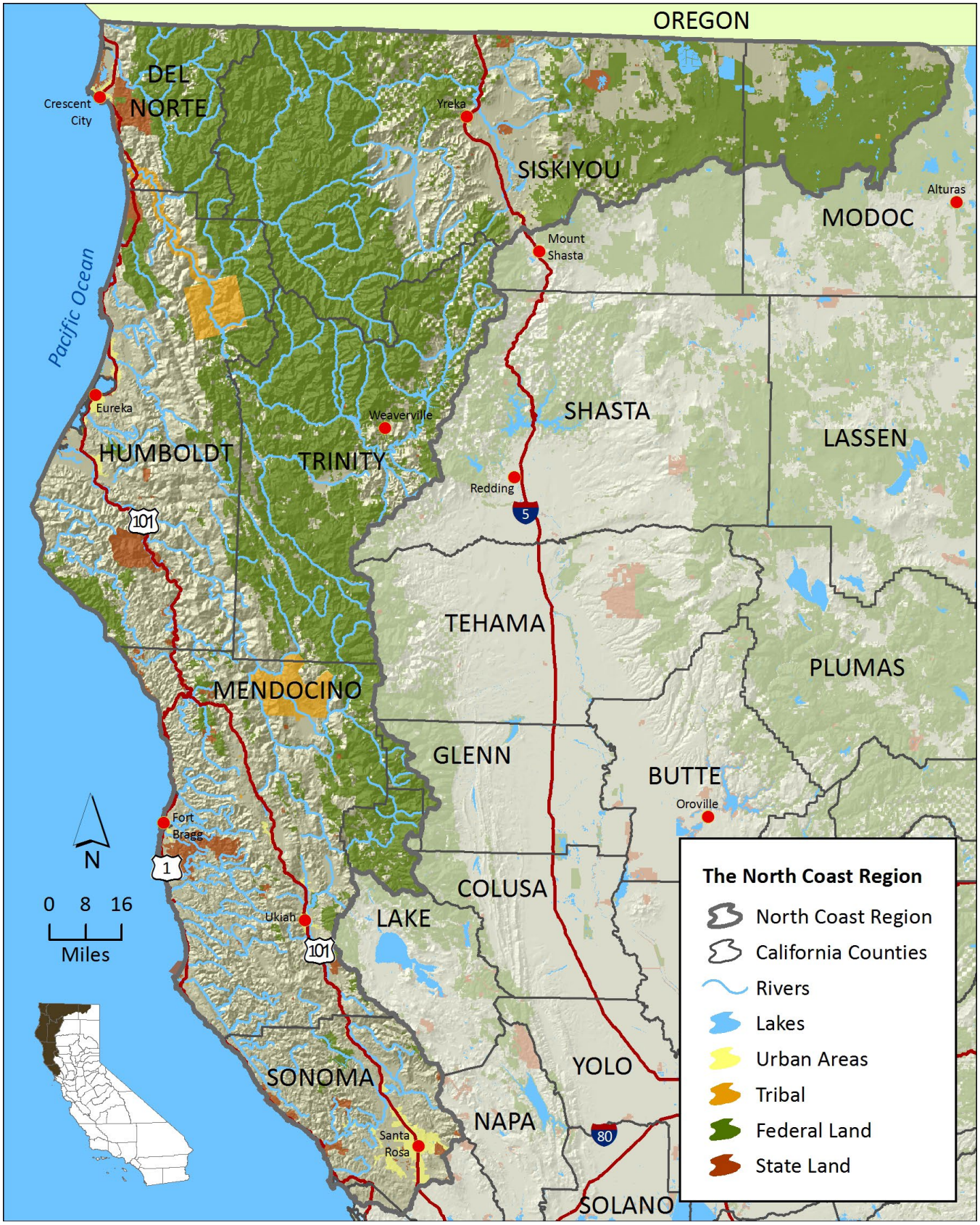
THE NORTH COAST REGION

The North Coast Region of California is a landscape of profound promise and opportunity. This 19,000 square mile hydrologic region has undergone significant changes, including local and regional modifications to land use, land cover and hydrology that have affected water quality, water supply, public health, native habitats, and wildlife. Global changes to the climate are beginning to impact coastal communities due to sea level rise, threatening the functionality of built and natural infrastructure, while extreme weather events are fueling fires, droughts and floods at an unprecedented rate. While the Region is still addressing challenges from legacy land use issues, the North Coast is largely rural, with large tracts of land in agriculture, timber, parks and open space, and has not undergone the transformative development and urbanization typical of so much of California.

The Region retains or is restoring a significant amount of its natural capital—working and natural lands that help to protect water quality and supply, sequester carbon, maintain plant and wildlife habitats and species, mediate natural disasters and climate change, and contribute to the health, economic viability and well-being of human communities. In addition to many locally experienced benefits from intact natural capital, multiple values from the North Coast source Region are also conveyed to other areas in California and the world, often with great economic benefit to areas outside the North Coast.

Many communities in the North Coast Region are economically disadvantaged, sharing the challenges of other rural areas in the United States with a history of industries based in natural resource extraction. The North Coast has some of the highest levels of failing water quality, water supply and wastewater infrastructure in California, and this degraded built infrastructure has negative impacts on human health, ecosystem health and the economic viability of the region. In addition to challenges with natural capital and built capital, there is a dearth of human capital in the Region due to a number of factors, including economic challenges and the lack of high paying and stable jobs.

Figure 1. The North Coast Region of California



THE NORTH COAST RESOURCE PARTNERSHIP

The North Coast Resource Partnership (NCRP) was formed in 2004 as a regional collaboration to bring funding, resources and focus to the 19,000 square mile North Coast Region of California. To date, the NCRP has brought over $67 million in funding to this economically disadvantaged region, with a focus on projects that enhance natural and working lands, create and maintain effective built infrastructure, and provide economic benefits in the form of jobs and local revenue. Governance and leadership is provided by elected officials appointed by Tribal councils and county boards of supervisors, with decision making supported by a technical advisory committee composed of scientists, planners and experts, as well as staff and consultants. The NCRP places a strong emphasis on using the best available science and local knowledge to inform its decision making and project prioritization process, with the intention of using limited financial resources to efficiently achieve the most important, multi-benefit outcomes on the ground. For more on the NCRP, its leadership and governance, goals, objectives and projects see http://www.northcoastresourcepartnership.org.

Figure 2. North Coast Resource Partnership Project Locations

OPPORTUNITIES & ACTION FOR THE NORTH COAST REGION

The North Coast has the opportunity to address the suite of challenges related to its natural, built, and human capital by developing and implementing an integrated, multi-benefit set of strategies and priority actions that build on the region's foundational strengths.

This document builds on data and analyses from a variety of technical reports and evaluations developed by the NCRP with funding from the Strategic Growth Council and The Department of Water Resources, as well as technical data from other sources throughout California and the nation. The document aligns with and amplifies the goals and vision of the State of California, through the lens of a rural, economically challenged region. It includes integrated strategies, priority actions and a summary of the benefits of implementing these priority actions, resulting in thriving economies, vital human communities, and healthy watersheds.

The individual strategies and integrated, multi-benefit priority actions included herein directly inform NCRP planning, project selection criteria, and project implementation moving forward—maintaining a strong focus on meaningful, lasting outcomes that benefit the region's natural, built, and socio-economic systems.

GUIDING PRINCIPLES

The strategies and priorities in this document are guided by a suite of principles. These strategies and priorities are:

- *Specific and actionable*—Clear enough to inform the prioritization of assessments, plans, and projects that result in real outcomes, on-the-ground, in communities.
- *Integrated*—Achieves multiple objectives and result in multiple benefits and economies of scope and scale.
- *Efficient and effective*—achieve substantial impact with the smallest possible investment
- *Adaptive*—Modifiable as new information becomes available and the Region changes.
- *Supportive*—Directly support multiple NCRP goals.
- *Scientifically supportable*—Built on a foundation of best available information and data from local, regional, state, national, and global sources.
- *Comprehensive*—Structured to amplify the strength and opportunities associated with the regional partnership and designed to achieve "Triple Bottom Line" goals for Environment+ Economy+ People.
- *Collaborative and cooperative*—Is a "Collective Impact" model for resolving complex problems by focusing on stakeholders' shared agendas and open communication.

2. INTEGRATED, MULTI-BENEFIT PRIORITY STRATEGIES

For over 14 years, the NCRP has been implementing integrated, multi-benefit projects that achieve myriad local, state, and national objectives. Given its status as an economically disadvantaged region, the NCRP has become adept at "doing more with less"—creatively using limited funding to attain the most benefit for its communities and landscapes. The thoughtful integration of multiple objectives and strategies allows the NCRP to achieve its goals in an efficient and effective manner, achieving economies of scope and scale by "stacking" benefits within a single initiative, action, or project.

The following section is a set of six high-priority integrated strategies ("actionable priorities") for efficiently achieving the NCRP vision of healthy watersheds, vital communities, and thriving economies. This section builds on the individual strategies for each focus area that are illustrated and summarized in Section 3. Every integrated strategy will inform the NCRP project evaluation and selection process and guidelines, ensuring that funders and project proponents have a clear understanding of the intentions and priorities of the NCRP, and that all projects achieve long-lasting multiple benefits.

NATURAL CAPITAL: HEALTHY FORESTS & WATERSHEDS

Increasingly volatile climate patterns, vegetation stress due to drought, fuel loading due to a long history of fire suppression, and increased human habitation at the wildland-urban interface has resulted in the region's forests and communities being increasingly vulnerable to catastrophic fires. Frequent and severe wildfires have obvious negative consequences for human communities and natural ecosystems throughout the Region. In addition to direct loss of life and property, the aftermath of fires can bring additional hazards (debris flows, flooding, hazard trees, sedimentation, dissolved organic carbon, blockage of water intakes, loss of habitat) and release of massive amounts of GHG emissions.

Impaired air quality due to wildfire is a public health, as well as environmental health, issue. For example, during a 45-day time period in 2017 (August 3–September 17), for twelve communities in Siskiyou and Humboldt counties (a total of 464 24-hour periods or "community days"), only 27 "community days" (5.82% of the time) had an air quality index (AQI) of "good;" 163 "community days" (35.13% of the time) had an AQI of "moderate," in which unusually sensitive individuals should consider limiting prolonged or heavy exertion, and the rest of the "community days" (274 24-hour periods, or 59.05% of the time), AQI was unhealthy, very unhealthy or hazardous for at least some community members (see Table 2.1, *45 Days of 24 hour average AQI values across NW California*; Ray Haupt, North Coast Resource Partnership Meeting Presentation, Redding, CA, April 20, 2018). Note that seventy-six (of the 464) 24-hour periods did not have data due to equipment failure or other issues. These data gaps mostly occurred in the communities of Willow Creek and Mount Shasta with Orleans, Weitchpec, and Callahan also experiencing data gaps.

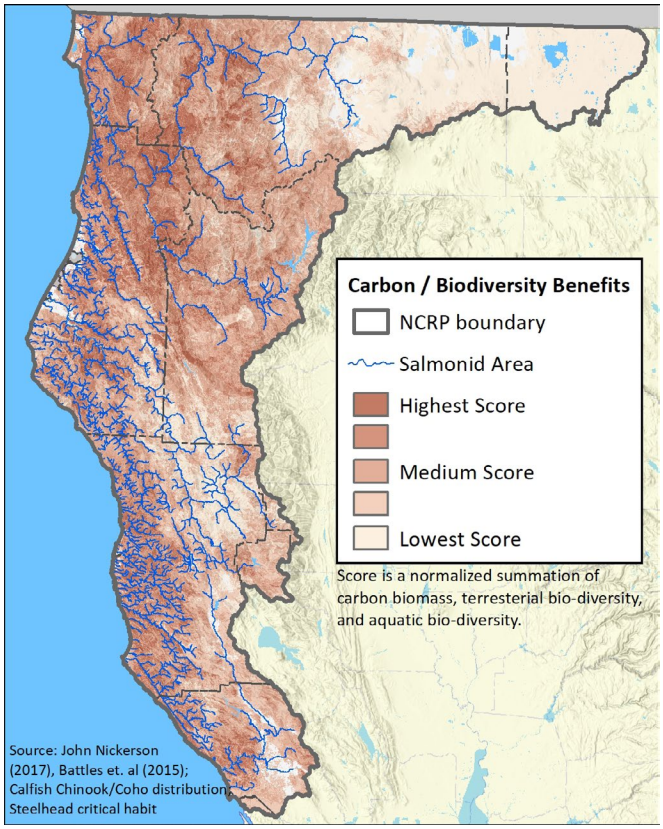
Table 2.1. Forty-five Days of 24 hour average Air Quality Index (AQI) values across NW California

AQI	# "Community Days" (24 hour periods)	Percent of time	Recommended Actions
Good	27	5.82%	None
Moderate	163	35.13%	Unusually sensitive individuals should consider limiting prolonged or heavy exertion
USG	73	15.73%	People within sensitive groups should reduce prolonged or heavy outdoor exertion
Unhealthy	111	23.92%	People within Sensitive Groups should avoid all physical activity
Very Unhealthy	53	11.42%	Everyone should avoid prolonged or heavy exertion
Hazardous	37	7.97%	Everyone should avoid any outdoor activity

In addition to impacts on vegetation, forest stress, and the resulting impacts on wildlife habitat, climate change has reduced snow pack and increased the volatility of weather patterns and extreme events: these impacts are expected to increase in magnitude in the coming years. Stream corridors are likely to experience more frequent and intense flood events, impacting fish and wildlife habitat as well as downstream communities.

The NCRP has an opportunity to address many of these challenges via an integrated strategy portfolio focused on protecting and managing North Coast forests and watersheds to maximize their value: as habitat for an array of terrestrial and aquatic species, for carbon sequestration, for water supply and filtration, to reduce fuel loading near vulnerable human development, and to create jobs and revenue for local communities. A preliminary assessment of areas in the Region that provide multiple benefits is seen below.

Figure 3. North Coast Carbon and Biodiversity Benefits



ACTIONABLE PRIORITIES I—NATURAL CAPITAL

➢ Priorities to be reflected in NCRP plans and project selection guidelines include

i. Advocate for sustainable forest management, fuel load reduction, prescribed fire, and fire management that reduces fuel loads in the understory and maximizes carbon sequestration in larger trees, while protecting wildlife habitat, aquatic ecosystems, and native plant communities.

ii. Support projects that include sustainable forest management to support local jobs and local revenue, including projects focused on bio-energy, bio-char, bio-products, cellulosic ethanol, pellets, and other forest products, including forest-based nanocelluloses and other natural-occurring nanocelluloses, that reduce carbon footprints and minimize the need for petroleum based products.

iii. Promote development of and support for state and national policies that result in sustainable forest management, fuel load reduction, prescribed fire, and fire management while enhancing opportunities for local jobs and revenue.

iv. Refine assessment of high priority areas for forest and watershed management and/ or protection, based on amount and concentration of human habitation, fuel loading and forest management status, potential for carbon sequestration, importance of area for water quality and supply, and presence of habitat for threatened and endangered species.

v. Explore acquisition of conservation easements and similar protective status designations that protect biodiversity, water quality, and water supply values of forests, while allowing for sustainable forest management to reduce fuel load and sequester carbon, improve water quality and supply, and create and maintain local jobs and revenue.

vi. Pursue partnerships with private landowners, companies, and public agencies to align, enhance, and further goals and strategies related to healthy forests and watersheds.

AQUATIC ECOSYSTEMS: UPSTREAM INVESTMENTS & DOWNSTREAM BENEFITS

The NCRP has a strong focus on salmonid recovery, given that salmonids are a primary indicator of watershed and ecosystem health, and the salmon fishery is a foundational part of the culture, economy, and historic subsistence of North Coast tribes and other more recent inhabitants. The North Coast still retains viable salmonid populations, yet these species are threatened with extinction. The factors that are important for salmonid recovery are often the same factors that influence the viability of other species and habitats, and also affect human community health and economic well-being. These factors include stream corridors, freshwater wetlands, salt marshes, estuaries, and near shore marine areas; all are critically important for supporting biological diversity, clean abundant sources of water, and for climate change resiliency and the moderation of extreme events such as flooding. Additionally, stream zones act as a terrestrial and aquatic circulation system in a watershed, creating opportunities for plant and animal populations to move and adapt in response to habitat degradation and changes in the climate. The Region is home to relatively intact aquatic ecosystems when compared to other parts of California, and it is more cost effective to protect them from degradation than to attempt to recover them after they have been damaged. Aquatic ecosystem protection and enhancement are therefore high priorities for the NCRP, given the multiple benefits that flow from these investments.

ACTIONABLE PRIORITIES II—FUNCTIONAL AQUATIC ECOSYSTEMS

➢ **Priorities to be reflected in NCRP plans and project selection guidelines**

i. Rely upon Tribal entities and indigenous people's Traditional Ecological Knowledge to ensure that Tribal understanding of ecosystems and land management are used to support positive restoration outcomes.

ii. Expand on existing natural capital documentation to quantify and monetize the multiple benefits of protecting and enhancing aquatic ecosystems, including:

- » Water quality: natural filtration, public health, benefits to aquatic organisms
- » Water supply: groundwater infiltration, forested watershed runoff
- » Recreational tourism: dependent on clean, natural systems
- » Biodiversity and economic benefits: of Tribal subsistence and cultural values, , commercial fishery, clean water
- » Avoided costs: moderation of extreme events such as flooding

iii. Protect riparian corridors and wetlands via conservation easements that protect the floodplain, allow for the long term meandering of the stream channel, and promote infiltration of groundwater.

iv. Convene aquatic ecosystem experts to prioritize aquatic ecosystems for protection based on multiple benefits and values.

v. Support restoration and enhancement projects on stream corridors, wetlands, and estuaries that use locally collected native plant materials and restore long term physical and ecological processes.

vi. Advocate for unified policy and corresponding funding for protection and restoration of North Coast aquatic ecosystems across agencies and jurisdictions.

vii. Compile existing information regarding aquatic ecosystems, identify data gaps, and prioritize assessments to fill the gaps.

viii. Assess future cost/benefit to Region of out of basin water transfer, power production, and water deliveries to the rest of state.

ix. Use a "planned retreat" approach to protecting and enhancing wetlands and estuaries along the bay and coast in response to projected sea level rise.

BUILT CAPITAL: ENHANCING INFRASTRUCTURE FOR COMMUNITIES

The North Coast Region encompasses many economically disadvantaged and severely economically disadvantaged communities. These communities are challenged by degraded or inadequate built infrastructure, including water and wastewater infrastructure, communications infrastructure (such as broadband and fiber optic networks), transportation systems, and energy transmission infrastructure. Fixing or enhancing this failing or inadequate infrastructure—as well as creating new efficient built infrastructure—has multiple benefits for the local economy, for public health, and for achieving local, state, and national goals related to emissions reductions and climate change adaptation. Additionally, many of the enhancements to this built capital can have positive impacts on natural capital in the region. For example resolving problems with failing wastewater treatment plants not only enhances human health and local economic viability and reduces energy and financial expenditures, but also avoids the contamination of North Coast streams and habitats with pollutants.

ACTIONABLE PRIORITIES III—BUILT CAPITAL

➢ **Priorities to be reflected in NCRP plans and project selection guidelines include:**

i. Develop and support projects focused on enhancing or replacing failing or inadequate water and wastewater infrastructure with a specific intent to enhance the local economy, create and maintain jobs and revenue, support public health, and protect sensitive habitats.

ii. Develop and support projects that reduce emissions and provide renewable energy generated and used within the region, with an emphasis on small scale energy generation that create and maintain local jobs and revenue.

iii. Develop and support electric car charging infrastructure at accessible locations region-wide.

iv. Create policy and messaging support for the expansion of Community Choice Aggregation models such as Sonoma Clean Power and the Redwood Coast Energy Authority, and partner with these entities where appropriate.

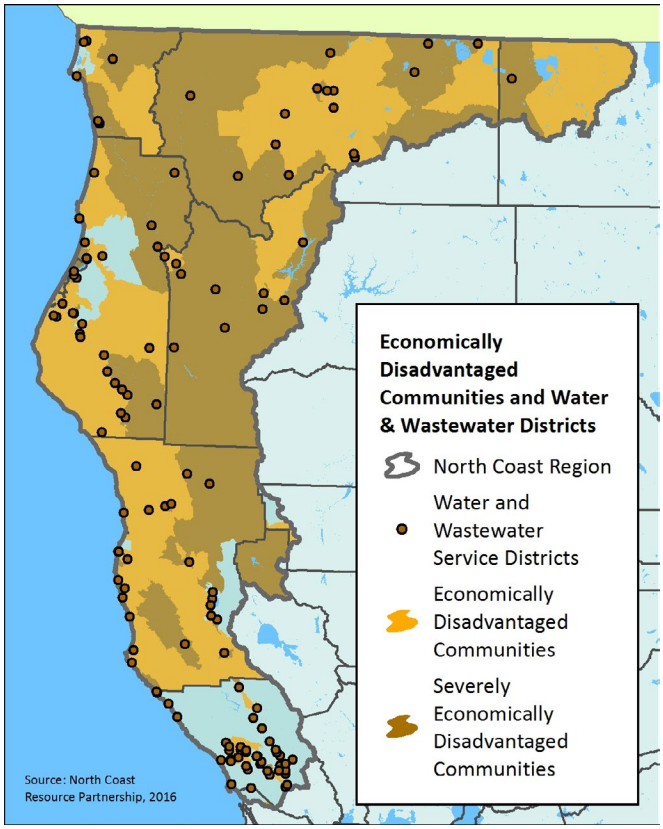
v. Evaluate all proposed built infrastructure projects based on their ability to measurably reduce emissions as a result of implementation, including water conveyance, water conservation, communications, transportation, and energy infrastructure.

vi. Evaluate and communicate the potential for built infrastructure funding mechanisms such as Enhanced Infrastructure Financing Districts, local assessments, and tax mechanisms.

vii. Explore and support infrastructure projects that enhance the ability of the North Coast to adapt to a changing climate, including localized small scale energy generation, movement of existing infrastructure, and provisions for redundancy in existing and future systems.

viii. Build on existing regional and local assessments regarding built infrastructure to evaluate the opportunities and benefits of enhancing built infrastructure.

Figure 4. North Coast Disadvantaged Communities & Water and Wastewater Service Districts

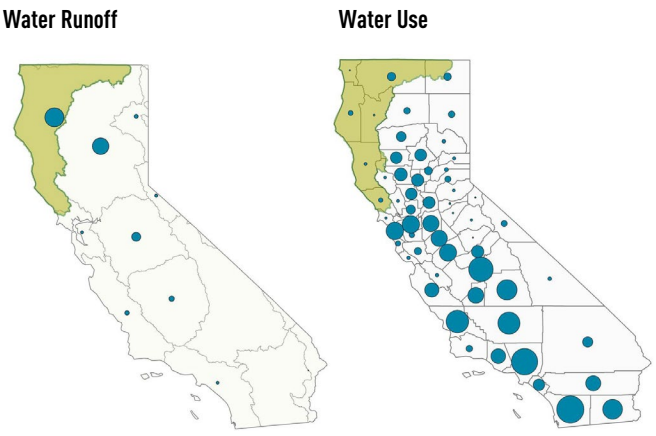


HUMAN CAPITAL: A PLACE FOR PEOPLE

Retention, recruitment, and enhancement of human capital and talent in the North Coast Region are fundamental factors in the current and future success of local communities, as well as the long term health of North Coast economies and watersheds. In both the public and private sectors, people drive success. Ensuring that public entities, local businesses, and non-profit organizations have the talent to carry on and adapt their missions over the long term is an investment that will yield positive results, not only for future residents and generations but for the landscapes, ecosystems, and natural resources that combine to make the North Coast Region a valuable and precious resource for the entire state.

As a source region, the North Coast supplies clean and abundant water, sequesters large amounts of carbon, and retains extremely high levels of biological diversity—attributes which benefit all of California and beyond. These ecosystem services are critical to the state economy and to achieving legislated climate and environmental goals. Yet these watersheds must be managed by people to ensure that these services continue to be provided to communities within and outside the region. For example, the watersheds of the North Coast supply millions of acre feet of water to other regions of California (e.g. Central Valley and Silicon Valley) and this water is translated into billions of dollars of economic value in the agricultural and technology sectors.

Figure 5. Areas of Greatest Water Runoff and Water Use in California



Very little of the revenue generated from these sectors is re-invested in the North Coast sources, so its severely economically disadvantaged communities struggle to retain a qualified and stable workforce to steward these important lands. With the increasing impact of climate change on forested landscapes, and the lack of human capital and funding resources for sustainable management, many areas are increasingly

likely to experience catastrophic fires which have the potential to negatively impact carbon stocks, biodiversity, water supply, and quality of life. Thoughtful, strategic investments in source regions—with a specific emphasis on retaining qualified people to steward these lands—is critically important to meeting the needs of Californians and the objectives of the State.

ACTIONABLE PRIORITIES IV—HUMAN CAPITAL

➢ **Priorities to be reflected in NCRP plans and project selection guidelines**

i. Identify and map current human capital assets region-wide.

ii. Develop strategies for attracting and retaining human capital.

iii. Evaluate opportunities for local job and revenue creation that are sustainable and that rely on intact natural capital.

iv. Evaluate built capital gaps that act as a deterrent to attracting human capital (e.g., failing/ inadequate transportation, communications, water and energy infrastructure).

v. Evaluate opportunities to ensure that the legalization of cannabis results in investments that restore and/ or enhance North Coast watersheds, communities, and economies.

vi. Align current human capital assets with current/ future regional/ organizational needs.

vii. Analyze and enhance current training, education, and leadership programming to reflect future needs, emphasizing jobs focused at the intersection of built and natural capital.

viii. Identify county by county opportunities to broaden the range of economic drivers to limit future boom and bust models.

ix. Assess current quality of life factors based on above; identify gaps and solutions.

FINANCING AND INVESTMENT: EXPLORING TOOLS AND STRATEGIES

The NCRP has a long track record of working in a voluntary, collaborative framework to bring funding and resources to the economically disadvantaged North Coast Region. These funds have been highly effective at enhancing watersheds and failing built infrastructure, while creating jobs and revenue. Because the NCRP is built on trust and collaboration—respecting local autonomy and acting as a "synchro" between state and local objectives—there is a high level of support for the partnership among a diversity of partners and stakeholders. This long-term trust and collaboration is foundational to the success of the NCRP as an entity that documents, integrates, and shares local priorities with state and federal agencies and other funders, while also acting as an equitable delivery mechanism for funding to the region.

The NCRP has benefitted from long term partnerships with State funding agencies—including the Department of Water Resources, Strategic Growth Council, State Water Resources Control Board and the California Energy Commission. However, these bond funded grant programs are by their nature volatile.

Many potential funding sources, particularly those emerging from recent legislation and pending voter approved bonds, promise significant potential, yet they are inherently volatile and do not provide the type of stable long-term funding needed to maintain local capacity. Emerging opportunities include Enhanced Infrastructure Financing Districts, Public Goods Charges, Regional Advanced Mitigation/Regional Conservation Investment Strategies, payments for ecosystem services, pre-disaster mitigation, carbon markets, and new approaches to private capital investment. Additional longer-term opportunities include potential tax and fee mechanisms, with significant evaluation of scale and resolution still required. Diversification and stability of base funding are important for the NCRP's continued ability to serve the North Coast region; no single funding source will provide NCRP with the stability and level of investment required to accomplish its goals and objectives—a strategy that focuses on integrating multiple funding sources holds the best potential for supplying the NCRP with a stable and long-term revenue stream.

ACTIONABLE PRIORITIES V— FINANCING AND INVESTMENT

➢ **Priorities to be reflected in NCRP plans and project selection guidelines include:**

i. Explore combinations of financing options with a focus on aggregation, integrating existing finance opportunities at the local and regional level.

ii. Develop legislation for baseline funding that can also include funding for other partners or interests in the region.

iii. Develop a regional profile/story and share it widely with the current network and other prospective funders including outreach to private sector, foundations, agency staff, and legislators to share success stories and the long term vision for the NCRP.

iv. Seek legislated funding, as the North Coast Region may have the opportunity to gain support for state legislation (and potentially federal legislation) that could provide baseline funding; potential alignment and coordination with the nine Resource Conservation Districts (RCDs) within the region, who are also seeking baseline funding, could be effective.

v. Evaluate opportunities to inform and align with the CA Forest Carbon Plan to support the State in achieving its goals for AB 32, SB 32 and SB 375.

vi. Evaluate opportunities to develop public private partnerships with private partners who have shared goals with the NCRP, including natural resource related sectors related to recreation, tourism, renewable energy, agriculture, commercial fishing, and timber.

vii. Providing regular briefings for all of the region's legislative representatives (local, state, national) to share and elevate current and past success and ensure awareness of the NCRP goals, needs, and ability to achieve state and national objectives.

Identify investment opportunities for, and co-benefits of, North Coast capital (e.g. natural, built, human).

ECONOMIES OF SCOPE & SCALE: INTEGRATING BUILT, NATURAL, & HUMAN CAPITAL

Historically, the relationship between built and natural capital has been one of conflict, with residential development, water supply, wastewater treatment, transportation, and energy infrastructure objectives having negative impacts on natural capital, thereby creating regulatory frameworks that are costly and rife with conflict. At the same time, in some sectors there has historically been a lack of appreciation for the role of working and natural lands (natural capital) in providing the foundational services that are transported or conveyed by built capital, services including clean drinking water, clean air, or renewable energy.

A substantial body of research has demonstrated that protecting and investing in natural capital and working lands while also strategically integrating built capital investments may allow our communities to achieve quality of life and local economic development goals in a more cost effective manner than if these investments were made separately. Although this new thinking presents significant "great than the sum of their parts" opportunities through unified strategic investments in natural and built capital, those investments alone will not guarantee success. Across all communities in the North Coast region, some level of change in how we manage ourselves will be required to better align with the surrounding natural environment and to secure the full potential of our communities through long term commitment to these integrated strategies and investments.

The North Coast Region has the opportunity to maintain our traditional, historic, rural quality of life, while effectively stewarding our regional lands and communities, resulting in multiple local, regional, and statewide benefits that can be enhanced for future generations. If successful in implementing this overall combined strategic investment in the people, infrastructure and natural environment, significant shared goals can be achieved. . Future success will require analysis and adaptation of the region's human capital, retention and attraction of a talented workforce, and modification of our organizational structures to ensure that our communities can demonstrate resiliency for the short and long term. Individual communities across the Region have demonstrated great creativity and innovation over the years, especially in times of crisis. As a Region we now have the opportunity to leverage that innovation while also taking advantage of the economies of scope and scale that regional collaboration can provide.

ACTIONABLE PRIORITIES VI— ECONOMIES OF SCOPE AND SCALE

➢ **Priorities to be reflected in NCRP plans and project selection guidelines include:**

i. Document the integrated outcomes related to built, human, and natural capital on every project, including summarizing this information on an ongoing basis at the individual project scale and the regional scale; quantitative cost/benefit analyses for each project; and the relationships among built/human/natural capital investments and outcomes.

ii. Identify opportunities to solve challenges facing the North Coast by strategically including and cost-effectively integrating built, human, and natural capital solutions.

iii. Evaluate land conservation strategies, working with willing participants in a voluntary, incentive-based framework to protect ecosystem services that can be integrated in a cost-effective manner with built infrastructure, and including private parties and public agencies.

iv. Evaluate opportunities to avoid sprawl, including avoiding the loss of farmland and natural habitats; plan for growth that allows

for functional built infrastructure, intact ecosystems, forests, watersheds and habitats, local agriculture, and healthy places for people to live and share information region-wide.

v. Identify and request priority financial investments in integrated natural-built-human capital projects and plans (see "Actionable Priorities: Financing and Investment" above).

3. INDIVIDUAL, REGIONAL FOCUS AREA STRATEGIES

The NCRP engages in ongoing assessments and data gathering to support planning for project implementation and outcomes on the ground, as well as other activities that benefit North Coast watersheds and communities. Using the best available science and data, and building on local, regional, and national expertise, the NCRP develops and analyzes information to ensure that funding is allocated to the highest priorities and utilized as efficiently as possible. Developed by the NCRP and its partners, including Tribes, academic organizations, state and federal agencies, NGOs, consultants and local governments, these assessments provide baseline data that are synthesized further in various documents and plans. Working across the region, the assessments are ultimately translated into actions ranging from on-the-ground project implementation to policy, legislation, funding, education, and outreach. The following individual strategies are informed by and build upon the NCRP assessments, all of which inform and support the integrated multi-benefit strategies outlined in Section 2.

This section is organized into three focus areas that reflect NCRP goals related to I) the built environment, II) the natural environment, and III) local socio-economic capacity. Each focus area details several specific strategies, one for each sector the focus area comprises. For example, focus area "natural environment" includes five strategies: aquatic ecosystems (2.1), wildlife habitat (2.2), marine area protection (2.3), forest health (2.4), and agricultural and working lands (2.5). A total of 12 strategies are presented for the three focal areas. All these strategies are informed by data and analyses commissioned by the NCRP (maps are provided where possible). These underlying technical assessments and related synthesis documents are foundational to development of these individual strategies. Technical assessment summaries and links to the full reports are included in the Appendix to this document.

FOCUS AREA: BUILT ENVIRONMENT

STRATEGY 1.1—COMMUNICATIONS INFRASTRUCTURE

INTRODUCTION

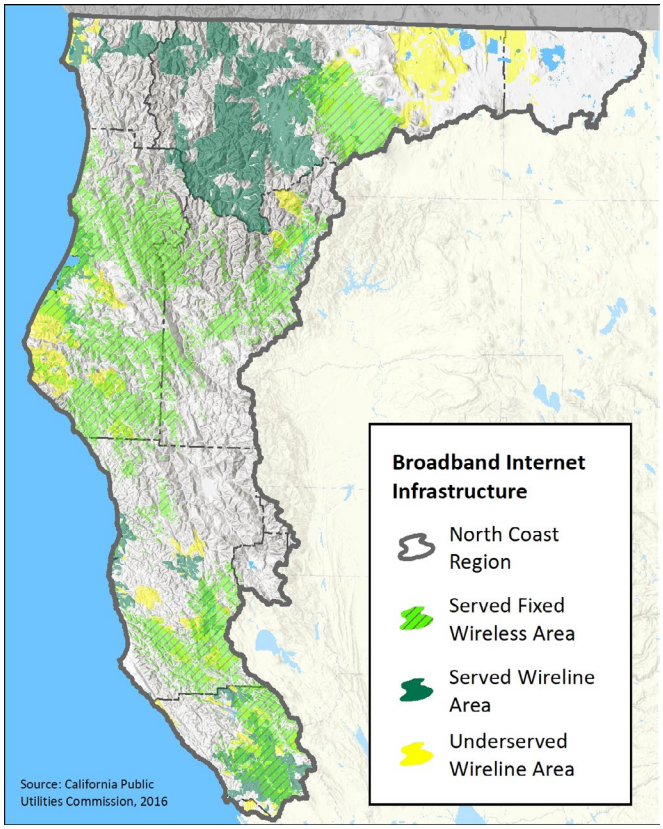
Communications infrastructure and services are increasingly important for commercial competitiveness and regional economic growth. Additionally, residents rely on telecommunication for quality of life, education, research, and access to health care and government services. Improved telecommunications infrastructure also supports public safety and emergency services by improving communications and information availability. A broadband network enables online education and work telecommuting opportunities, reducing the need for vehicle trips, and a subsequent reduction in associated emissions. Although there have been a few key recent advancements in infrastructure, The North Coast region, with its rural nature and dispersed population, lags in providing access to reliable telecommunications services relative to urban centers such as the San Francisco Bay area. Enhanced communications infrastructure could be the "leap frog" equalizer for many rural communities that are challenged with aging vehicle fleets, maintenance costs, and general capacity issues: research suggests that disadvantaged groups can benefit disproportionately from internet access (Hanak 2007). Although highly dependent on the level of engagement and knowledge of opportunities available, communities can be more engaged locally and regionally through mutual channel development, knowledge development, and resource sharing on lower-cost, higher-capacity communication networks.

CURRENT CONDITIONS

Infrastructure and Service

Internet/Broadband—North Coast communities are so widespread that satellite internet (as opposed to phone line or cable connections) is often the most practical mode for those in rural areas. However, the landscape can interfere with continuous access. Mountainous terrain, proximity to the Pacific Ocean, deep canyons, weather events, and winding roads can all cause spotty satellite reception when traveling through or visiting certain parts of the region.

Figure 6. Broadband Internet Infrastructure



True high speed internet service is limited but improving throughout the region, as is connection redundancy. While the greater Santa Rosa area and most of southern Sonoma County are fairly well served, the rest of the Region varies widely with level of service and service providers, especially in more remote areas (CA-CPUC undated). Lack of adequate access is a recognized issue in the region: not only are there issues with the widespread population and challenging topographic conditions, but there are also issues regarding equitable access to broadband service. In both Mendocino and Sonoma County, a digital divide is identified, where areas with a high population density have broadband access, but other portions of the County, its population, visitors, anchor institutions, government services, and transportation corridors are underserved.

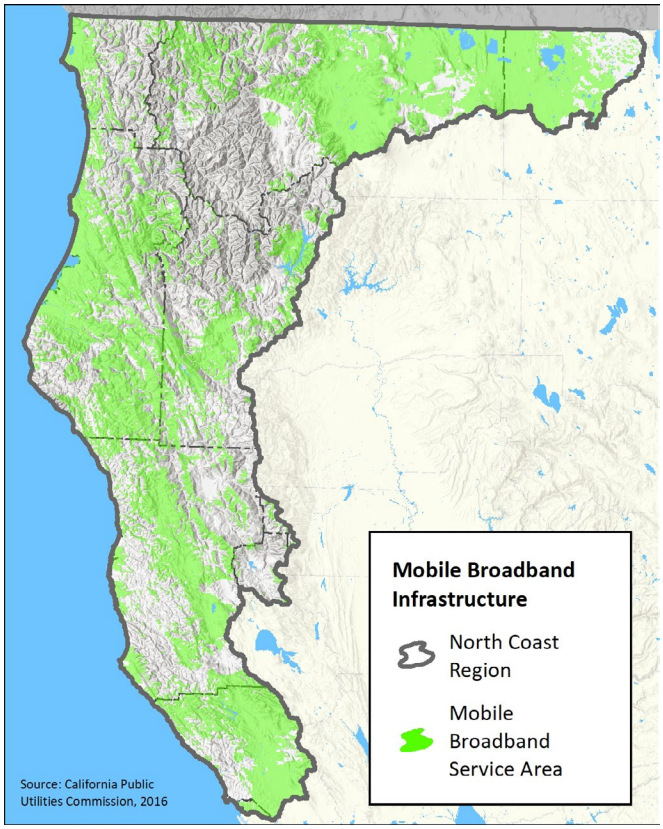
Recent infrastructure advances from remote areas of the Region include the Highway 36 fiber project, completed in 2011, which provides redundancy to Humboldt County; new middle mile service to Trinity County; Del Norte County's successful completion of a redundant fiber project in 2014; and the emergent Highway 299 project, which received needed funding and is in the midst of the planning process for build out (Hansen 2011, Hight, 2014, CA-CPUC 2017). Once these major corridors are complete, opportunities will exist for both public and private sector entities to further develop "last mile" connections to the end consumer. In some cases, the emergence of these projects has also put market pressure on current providers to expand their existing capacity and service delivery (TrinityJournalStaff 2017).

In 2010, the Yurok Tribe used grant funding from the USDA Rural Utilities Service and the California Consumer Protection Agency to bring broadband internet to its Reservation. The Tribe's Information Services Department developed *A Rural Broadband Model: A Simplified Guide to Rural Broad band Deployment* to assist others through the process. The document provides an example model for replication, equipment needs list, and technology recommendations based on site characteristics. Since its initial foray into broadband provision, the Yurok Tribe has teamed up with the Karuk Tribe to extend high-speed broadband service in Tribal lands (Woods 2018).

Collaboration by NGOs, counties, Tribes, and entities such as Community Service Districts (CSDs) will be necessary to develop suitable infrastructure for reliable, complete broadband coverage on the North Coast. SB1191 expanded CSDs'powers to include broadband service. CSDs can offer an option for broad band service for those communities too small or too remote to interest commercial providers. CSDs are trusted community organizations with billing systems and the administrative support in place to outsource broadband operations. Additionally, CSDs are government agencies that are eligible to apply for many grant funds.

Mobile Phone Infrastructure—In addition to private sector build out of mobile phone networks, some counties across the Region have also invested in infrastructure to expand access to these networks through legislation passed in 2001 (Coleman 2002). Through improved bandwidth and cell phone handset technology, a wider range of service and communication options are available in many previously unserved areas.

Figure 7. Mobile Broadband Service Infrastructure



Hardline Phones—This essential service is still the main form of communication in many parts of the Region. The distribution of "providers of last resort" overlaps with availability of hardline phone service (Map at https://goo.gl/XJL429). Although these services and infrastructure are required to be maintained in perpetuity under state law, there may be a point when technological advances make them obsolete.

Emergency Service Communications—Although public safety communications systems Region-wide are upgraded regularly, many emergency responders are equally reliant on cell phones for communication, making the propagation of that sector an important part of public safety service ability.

Ham Radio/CB Operators—Historically, these sectors have played a part in both emergency services and transportation communication. In light of advancing technology and infrastructure improvements, their role is more uncertain but is still considered valuable, especially in emergency situations when other infrastructure may fail.

Advocacy Organizations

The main communications-development advocacy organizations within the North Coast Region are composed of some combination of local and Tribal governmental entities. Redwood Coast Connect (RCC) in Del Norte, Humboldt, and Trinity Counties is an example that can act as a model for the rest of the Region (RCC 2018). RCC is an ongoing initiative to promote broadband availability to all residents in the four counties; the California Center for Rural Policy is the host of this effort. The goal of RCC is to make affordable broadband available to all rural communities through a strategy of community engagement, simplification of county and municipal policies, and tapping the ingenuity of entrepreneurs and businesses in the region. The Broadband Alliance of Mendocino County and the North Bay/ North Coast Broadband Consortium are also partnerships of local governments working towards equitable broadband access.

Regulatory Agencies

Communications entities are regulated by two main agencies, in addition to a semi-regulatory relationship with local governments. The Federal Communications Commission (FCC) regulates at the federal level and the California Public Utilities Commission (CPUC) at the state level. Local governments have a certain level of jurisdiction through franchise agreements with providers, which in most cases, are reviewed and updated on a regular basis.

LIMITING FACTORS AND CHALLENGES

Infrastructure and Service Areas Still Need Development

New infrastructure projects are challenging and costly due to a number of factors, including challenging topography, unmet environmental analysis needs, large geographic footprints, and significant cost per customer. Because of high fixed costs associated with cable broadband, areas of high population density are more profitable for broadband than rural areas (Hanak 2005). Another challenge is, in some cases, pushback from current local "low bandwidth" providers with small market monopolies.

Providers and Types of Services Provided Are In Flux

As noted above, many providers, especially in newly connected markets, are starting to offer a range of "non-traditional" services for their service areas, such as satellite, Wi-Fi and Wi-Max, a wireless technology that offers Internet connectivity over a range of one to 30 miles from a transmission tower compared to the hundreds of feet that constitute Wi-Fi's limit (Hanak 2007). As in more fully mature urban markets, it will take some time for both

consumers and providers to determine which services or combination of services best fit their specific needs.

Incomplete Knowledge and Ineffective Use of Available Tools

Provision of wide-ranging access is certainly a first step, but empowering communities with knowledge of how to fully leverage those tools is essential for any access to have a real and lasting impact. The gap in internet use between rural and urban populations has remained consistent: in 1998 28% of Americans living in rural areas used the Internet compared to 34% of those in urban areas and in 2015, 69% of rural residents reported using the internet versus 75% of urban residents. This trend remains steady over income, race or ethnicity, and educational attainment. There are likely a number of combined factors related to lack of expanded use of the internet in rural areas, but at present they remain unexplained (Goss 2016).

Cost of Access, Economies of Scale, and Limited Competition

Historically within the region, limited market competition, challenges with dispersed population (and associated high cost per customer to provide service), and other general economies of scale have significantly limited access to services at affordable rates.

Infrastructure Vulnerability and Need for Redundancy

The limited infrastructure within the North Coast Region also makes service delivery and access highly vulnerable. Although recent advances have been made, infrastructure risk and lack of redundancy continue to be significant limiting factors to service and access.

Risk of "Mobile Only" Proliferation

While mobile phone technology and capacity have advanced significantly over the last ten years, there is a risk that rural populations and leadership could "settle" for wireless-as-adequate, although for many applications, such as video meetings, mobile technology is inadequate. "Wireless internet access on mobile phones is nearly universal in both rural and urban areas, although most mobile connections aren't fast enough to meet the official FCC definition of broadband (Whitacre 2017). "

FUTURE OPPORTUNITIES, PLANNING, AND STRATEGY

Regional Standards and Policy

Regionally, North Coast counties have an opportunity to collaborate in setting standards and policy directives for broadband technology. Several counties have fully developed licensing agreements; these could be used as models for development of regional policies, standards, and licensing for newer projects and initiatives. The North Coast Resource Partnership, with its hard-won comity and string of successful implementation projects, plans, and programs since 2006 is uniquely positioned to support and promulgate regional broadband standards and policy efforts. Member counties, Tribes, and municipalities have a history of cooperation and trust through the NCRP that they may not experience in other aspects of their relationships.

Regional Knowledge Capacity

As noted above, infrastructure is not enough. Communities, individuals, local governments, and non-profits throughout the Region should develop the knowledge, skills, and motivation to use available technology and tools. Even with the current limited level of infrastructure, there is a gap between use and capabilities. Keeping abreast of new innovation and funding opportunities is vital to ensure that projects are developed using best available technology that builds upon or incorporates lessons learned from previous projects and planning initiatives. Development and distribution of regional communications tools and strategies, a particular strength of the NCRP could help communities respond proactively to future opportunities.

Public Sector Solutions for Last Mile Broadband Service

Middle-mile infrastructure, while essential for high speed connections Region wide, is not a complete solution to getting people in more rural areas connected. As with all rural infrastructure, the distance, per capita costs, and other factors of economies of scale come into play. Subsidized public-private service solutions should be sought to take full advantage of potential opportunities, with an emphasis on the multiple benefits of project implementation. For example, Del Norte County was able to achieve broadband route diversity by leveraging available funding to improve telemedicine in Oregon, achieving its goals for its own rural residents while collaborating with private industry, NGOs, other local governments, and the federal government (Hight 2014).

PRIORITY ACTIONS: POLICY AND STRATEGY RECOMMENDATIONS

Support and Enhance Efforts of Current Rural Broadband Advocates

While there are already solid teams in place advocating at the state level for infrastructure expansion, there is a need to support, enhance and strengthen efforts to obtain equitable access to broadband throughout the Region. Humboldt and Del Norte counties can serve as successful examples: Humboldt achieved Internet

route diversity in 2011 and Del Norte in 2014; both counties forged and maintained coalitions of public and private interests to leverage funding opportunities that improved reliability and Internet data capacity for their communities (Hight 2014, Woods 2018).

Work Regionally to Encourage Use and Efficacy

Development of tools and training, similar to other outreach efforts of the NCRP, such as the Water and Wastewater Service Provide Outreach and Support Program, can enhance usage and efficacy of broadband infrastructure as it continues to expand within the Region.

Include Communications Infrastructure within Future Energy Risk Assessments

As identified within *Strategy 1.3 Renewable Energy*, communications infrastructure is one of many essential public service assets potentially at risk during emergency events such as energy interruptions and natural disasters (Boudreau et al. 2016). Redundancy in communications infrastructure is vital to ensure public safety during such events.

Plan for Tiered Communications Strategies during Emergencies

There is increasing risk to power and communications infrastructure in light of more frequent and intense storms, fires, predicted through climate modeling and other natural disasters, such as earthquakes and tsunamis. Local communities should develop/update a tiered communications strategy to respond during local emergency situations.

Assess the Need for Public Entity Micro-networks

Even with the expansion of fiber optic lines in more areas of the region, private sector vendors are not always incentivized to provide viable access to remote, more dispersed populations. As with the expansion of the electric power grid, public sector support and capacity may be a viable option within the Region (Gonzalez 2018). Because the model is somewhat similar, there may be opportunities to co-locate these networks with distributed power micro-grids, with multiple benefits achieved through such combinations (Woods 2018). A report by Earth Economics (2018) suggests that wood biomass, along with wind-power and hydro-electric generation, could present an opportunity for multiple benefits when combined with data centers that provide essential information technology needs, such as wireless and optic fibers for high speed internet access.

MULTIPLE BENEFITS AND VALUES: ECOSYSTEM SERVICES AND ECONOMIC BENEFITS

- *Educational Resource Access*—With the increase in availability of low/no cost formal educational resources becoming available online the opportunities for rural communities to provide people of all ages with increased knowledge and resources can be an invaluable strength (MIT, 2018). Additionally, remote employee training, orientation and system troubleshooting would all benefit as well.
- *Opportunities for Increased Civic Engagement*—Easily access video and informational feeds for remote areas to participate in civic decisions and activities, including potential participation in state/national forums via video. "States with high percentages of rural residents who subscribed to broadband internet service showed higher levels of civic activity" (Whitacre, 2017).
- *Telemedicine Access*—Reducing the geographic barrier to adequate health services, especially for the elderly and for young families in rural areas with limited pre-natal and pediatric services (FBA undated).
- *Development of Localized Media*—Local television channels -via-web could be developed to host a variety of projects, share community information, and promote the Region to the visitors, increasing tourism and the outdoor recreation economy.
- *Reduced Need for Transportation*—Communications access (e.g. telecommuting) could support reduction in vehicle transportation miles and consequent reduced GHG output.
- *Expansion of Remote Sensing Opportunities*—This can assist natural resource monitoring and management (e.g. of trailhead, access roads, rivers, forest conditions, etc.) in addition to public safety and infrastructure response.
- Avoided Costs
  - » Reduced vehicle use and maintenance (private sector, governments, patients), resulting in lower emissions
  - » Better and quicker access to health care professionals, resulting in more cost effective and better health outcomes

Economy and Jobs

- *Employment Growth*—A strong positive relationship exists between broadband expansion and employment growth; broadband expansion causes existing businesses to expand or redistribute economic activity toward the expansion area (Kolko 2010)
- *Recruitment Opportunities*—In conjunction with a thoughtful marketing strategy, there is potential

for the recruitment of companies/individuals to broaden local economic opportunities and talent base. This could result in an increase in available jobs and local disposable income. These could have secondary positive impacts for existing businesses over time and broaden the region's economic diversity.

- *Lowered Cost of Access*—Increased infrastructure and system redundancy would likely result in decreased market rates for access due to increased possibility of local competition.

STRATEGY INTEGRATION

Strategy 1.1. Communications Infrastructure informs the multi-benefit priority strategy *Built Capital: Enhancing Infrastructure for Communities* outlined above in Section 2. It integrates the *Local Socio-Economic Capacity Focus Area*, including both general economic opportunities presented by expanded infrastructure and the potential human capital benefits and potential of local talent. The *Transportation Infrastructure Strategy* integrates with communications infrastructure in a number of ways, including potential reduced transportation needs and associated savings. Communications can also improve information delivery for road conditions for agencies and the public. The *Renewable Energy*, *Energy Transmission*, and *Natural Environment Focus Area* strategies could benefit from the remote sensing and monitoring opportunities provided by a robust communications infrastructure network.

STRATEGY 1.2—TRANSPORTATION INFRASTRUCTURE

INTRODUCTION

This Transportation Strategy is not meant to plan for every potential "transportation" issue in the North Coast Region. Rather, it is an analysis of how the transportation sector integrates with other related sector strategies, including *Strategy 1.1 Communications Infrastructure*, *Strategy 1.3 Renewable Energy*, and *Strategy 1.4 Energy Transmission*. As noted in the California State Association of Counties' policy platform on transportation and public works, balanced transportation "does not simply mean the provision of highways or public transit devices. A balanced transportation system is a method of providing services for the mobility requirements of people and goods according to rational needs. Transportation systems must be fully integrated with planned land use; support the lifestyles desired by the people of individual areas; and be compatible with the environment by considering air and noise pollution, aesthetics, ecological factors, cost benefit analyses, and energy consumption measures (CSAC 2014)." Transportation is one of the major budget items/cost centers for government entities and communities in the North Coast region. Finding ways to reduce the need for, lower costs of, and identify regional efficiencies for transportation will significantly improve quality of life and support the natural environment.

CURRENT CONDITIONS

Key Agencies and Facilities

Road Transportation—Public road transportation regulation and management is carried out by a wide variety of organizations throughout the Region. These include, but are not limited to, the Federal Highway Administration, Caltrans (Districts 1, 2, and 4), county Road Departments, Regional Transit Authorities and, in the case of Sonoma County, Regional Planning Agencies. The U.S. Forest Service Bureau of Land Management and National Park Service also manage networks of thousands of road miles within the Region.

Air Transportation—Air transportation and infrastructure is relatively limited, but still comprises a solid presence within the region. The Federal Aviation Administration, Caltrans Division of Aeronautics, and local transportation departments are the main related agencies. A multitude of small public airports and airstrips exist regionwide, with three larger commercial airports located in Arcata, Crescent City, and Santa Rosa in Humboldt, Del Norte, and Sonoma Counties respectively. Additional air travel hubs with wider service close to the Region include San Francisco, Oakland, Sacramento, Redding and Medford (Oregon).

Rail Transportation— Although more limited to the northeastern and southwestern parts of the region, rail services for passengers and freight are available and possibly expanding.

Cycling and Pedestrians—There are significant networks, infrastructure, and continued planning for bicycle and pedestrian traffic facilitation in towns and cities throughout the region. Many communities in the Region are working to expand bicycle networks and improve their safety in an effort to comply with greenhouse gas (GHG) emissions reduction targets set forth by AB32.

Public Sector Transportation Activity

Transportation is an essential part of public sector activity and also a significant part of most public agency budgets in the Region, particularly due to the large geographic area with relatively dispersed populations. Although not a comprehensive list, some of the sectors that depend on public sector transportation include law enforcement and emergency responders, mail delivery, general public agency travel,

schools, personal health services, and land/ resource management (e.g., park and open space maintenance).

Private Sector Transportation Activity

Individual and private business activity transportation uses vary widely and face challenges associated with the large geographic territory and dispersed communities of the North Coast Region. Examples of private sector transportation activity include commercial and consumer-direct shipping/receiving, local citizen traffic, visitors/ tourism, inter- and intra- regional commuting, and land/ resource management (e.g., agricultural activities).

Public Transit Service

Despite the vast geographic distances and generally constrained budgets, all of the counties in the North Coast Region offer some level of public transit. Three counties (Trinity, Humboldt, and Del Norte) have routes and schedules that provide mutual inter-county service. Mendocino and Sonoma counties also have routes and schedules that integrate. Modoc County has a connection to Redding which is linked with Trinity Transit. Both fixed route (e.g., bus service, AMTRAK) and flexible route services such as Dial-a-Ride and other community access networks geared toward seniors, the differently-abled, or children are available in scattered locations throughout the Region.

Non-Fossil Fuel Vehicles and Infrastructure

According to a 2017 report developed by the Redwood Coast Energy Authority, as of December 2016, the alternative fueling infrastructure in the NCRP Region included: 147 electric vehicle charging stations, 17 propane fueling stations, four biodiesel fuel pumps, and one hydrogen fueling stations (Zoellick 2017). Multiple plans have also been developed across the Region to expand knowledge of, infrastructure for and encourage expanded use of non-fossil fuel vehicles, especially those with an electric power component. A number of public agencies are converting specific areas of their existing vehicle fleets to one more types of non-fossil fueled vehicles and/ or hybrids (e.g., Sonoma County Water Agency). Individual consumer and private sector entities are also increasing demand for this type of infrastructure through purchases of non-fossil fuel vehicles.

LIMITING FACTORS AND CHALLENGES

Scale and Distance Increase Cost of Goods and Cost of Living

As noted above, the Region is characterized by small, dispersed population centers. Longer distances traveled equate directly to increased costs of goods, such that retail prices of food and other essential goods in rural areas can be more than double retail prices in urban areas. The lack of economies of scale for truck-delivered goods to restaurants and rural stores serving small and decreasing populations leads to these increased prices. At some point, such deliveries are no longer viable for the wholesaler or the retailer, limiting the variety of goods available to rural populations.

Vehicle and Natural Gas Fuel Delivery Has a Negative "Double Impact"

Communities in the North Coast Region are geographically widespread and often isolated; vehicle and natural gas fuel deliveries to meet local needs are accomplished through use of gasoline tanker trucks that burn fossil fuel to deliver fossil fuel. For rural areas in the Region, the long distances from major supply locations in the Bay Area or Oregon makes economic and environmental costs of fuel delivery compound quickly.

Road Infrastructure is Aging, Vast, and Vulnerable

As with other major infrastructure throughout California, the North Coast Region's transportation network is aging and much of it is in need of repair, adaption, or improvement to accommodate existing and future travel demand (Caltrans 2016). Additionally, some sites on major transportation arteries are particularly vulnerable to floods and landslides. In some extreme cases this is because current roads were developed from routes that were originally wagon roads and/ or built into unstable hillslopes. A recent example of this emergent major transportation issue has occurred repeatedly on Highway 299 when rockslides or the threat of rockslides have closed the route, causing those who regularly use it to resort to back roads through the Six Rivers and Trinity national forests to get around the slide (Braxton Little 2016).

Historic Forest Roads and Needed Decommissioning and Restoration

Due to the thousands of road miles managed by the U.S. Forest Service in the North Coast Region, travel management plans in a variety of stages have been vetted for each of the region's National Forests. Many of these roads have been need of either closure and/ or decommissioning or basic upgrades due to sedimentation into local waterways, a recognized limiting factor for salmonid species survival. Although significant work has been accomplished region-wide, historic and poorly constructed rural roads remain a significant challenge throughout much of the North Coast.

Airport Access and Consumer Choice

Competition for major airline service in rural airports is extremely high and the Region has seen multiple changes in airline service from different carriers over the last ten years. For tourists visiting the Region and local citizens

who need access to reliable air travel for business and personal needs, this remains a significant challenge.

FUTURE OPPORTUNITIES, PLANNING, AND STRATEGY

In order to support the state's efforts to reduce GHG emissions (AB 32), it is essential to collaborate regionally to reduce vehicle miles travelled and fossil fuel consumed. Potential innovative opportunities include:

- EV infrastructure (Caltrans 2016, ARB 2017)
- Increase resident ridership on public transportation (Caltrans 2016, ARB 2017)
- Rural Uber, Zip Car, Lyft, etc. E.g. Rural Uber combined with electric vehicle use are a potential municipal organization strategy; for example, an EV Special District.
- Alternative fuel vehicle implementation (especially electric) has significant potential, especially when combined with locally-produced renewable energy. This could keep transportation dollars local instead of exporting to major gas companies, and would also help communities reduce carbon footprints (Caltrans 2016, ARB 2017).
- Improvements in regional communications networks, particularly Broadband to reduce vehicle trips and costs (Caltrans 2016).

PRIORITY ACTIONS: POLICY AND STRATEGY RECOMMENDATIONS

Leverage NCRP Social, Political, and Economic Capital

- *Enhance Existing Efforts*—for the transportation sector specifically, significant analytical resources and planning are conducted on an annual basis through Caltrans, county transportation departments, and other entities. The NCRP should focus on collective actions to expand and enhance existing efforts.
- *Determine Shared Transportation Needs of Local Governments*—conduct a high level initial analysis of current spending on transportation by individual local governments, and potential for shared efforts and planning, to inform whether opportunities for cost savings/ increased quality of service delivery may be realized via regional collaboration.
- *Analyze Current and Potential Public Transit Connections and Infrastructure*—although there are a number of counties within the Region that have established cross-county public transit connections, gaps in the system still exist. Analyses should be considered to assist in closing these gaps and to determine where related infrastructure could potentially be leveraged (e.g. Zero Emission vehicle - ZEV - Infrastructure).
- *Establish/ Expand a Working Group of Regional ZEV Deployment Partners*—over the last ten years, most counties within the Region have seen an emergence and expansion of ZEV infrastructure. Trinity and Modoc Counties are developing theirs: Trinity does have three publicly available charging stations, though they are not conveniently located and two of the three are specific to a single type of vehicle (Tesla); Modoc County hosts two Tesla-specific stations. It "is critical for the NCRP Region to accelerate the deployment of alternative fueling infrastructure (Micheli et al. 2016)."
  - » Establishing key public and/ or private sector partners, regionally and the development of funding for their activity to expand infrastructure would assist in accelerating deployment. Several jurisdictions have established district taxes to fund transportation priorities, which recently have come to include advance mitigation (ECONorthwest 2017)—this may be a steady revenue stream to fund such activities.
  - » The North Coast Electric Vehicle Readiness Plan identifies the follow supporting activities as necessary to facilitate EV adoption (Woods 2018):
    - Engage with regional permitting entities to encourage the adoption of standardized and streamlined permitting and inspection processes and fee structures.
    - Produce a streamlined set of EVCS criteria to assist potential EVCS owners/operators in choosing what equipment to install and to assist contractors with adopting best practices and understanding regional permitting requirements.
    - Engage with potential site hosts for EVCS in the North Coast Region and produce preliminary engineering designs and cost estimates for 30-40 sites.
    - Install directional signage guiding drivers to at least 10 regional EVCS.
    - Promote PEV adoption through public and fleet operator outreach and education campaigns.
    - Educate and support regional municipalities on the potential

to adopt local building codes that promote PEV adoption.

- These activities are currently being implemented through a grant from the California Energy Commission.

- *Encourage Regional Advocacy to Repair/Protect Key Routes and Infrastructure*—leverage the combined strengths of the Region to assist with needed infrastructure repair, especially along major routes

Expand the Use and Safety of Bike and Pedestrian Facilities—where appropriate, support a broad range of investments to encourage corridor-wide and community-wide strategies that will increase active (non-motorized) transportation for short trips, first/last mile transit trips and school trips (Caltrans 2016).

MULTIPLE BENEFITS AND VALUES: SOCIAL SERVICES AND ECONOMIC BENEFITS

- Increased local transportation job opportunities, especially as EV infrastructure is developed
- Less expensive and more convenient transportation options
- New opportunities through collaborative delivery models
- Major issues can benefit from regionwide support for resolution
- Improved health outcomes
  - » Health benefits as more people are enabled to choose active forms of transportation
  - » Less health issues associated with fumes from fossil-fuel burning vehicles
- *Avoided Costs*—many avoided costs are associated with decreased VMT and decreased use of fossil fuels. They include:
  - » Fuel costs from fleet vehicles replaced by EVs
  - » Transportation costs associated with motorized vehicles as the use of active transportation is expanded where possible
  - » Potential reduced costs for rural businesses and governments by banding together for unified delivery and purchases
  - » Health costs associated with illnesses caused by the poor air quality associated with conventional automobile use
  - » Road maintenance costs—fewer VMT means less wear and tear on roads and highways

STRATEGY INTEGRATION

Strategy 1.2. Transportation Infrastructure informs the multi-benefit priority strategy *Built Capital: Enhancing Infrastructure for Communities* outlined above in Section 2. It integrates with the *Communications Infrastructure Strategy* with respect to potential benefits of expanded communications via video conferencing/other tools to reduce the need for travel for business. Expanded communications infrastructure could assist with remote sensing of weather, road, and traffic conditions across the region. This strategy integrates with the *Renewable Energy Strategy* in terms of the networks and options surrounding Zero Emission Vehicles. The potential reduction in emissions provides integration with the *Natural Environment Focus Area* strategies and *Local Socio-Economic Capacity Focus Area* strategies, to limit both emissions and costs of importing fossil fuels from outside of the region.

STRATEGY 1.3—RENEWABLE ENERGY

INTRODUCTION

Renewable energy production is one of the largest unrealized resources in the North Coast Region and has significant potential to improve regional ecosystems, economic conditions, and standard of living in addition to setting the standard for how rural areas across the nation can successfully organize around the potential for renewable energy development. A number of counties, Tribes, and cities in the Region have developed robust strategies and guidelines, including provisions within General Plans to assess energy efficiency, potential energy supplies, and long term strategies and planning for local energy resiliency. Energy security, lower utility rates, better quality of life, and a highly aware, well trained renewable energy workforce are all possible through this strategy. The NCRP and its member counties, Tribes, and municipalities have a significant opportunity to organize and prosper around the latent renewable energy production potential available within the Region while also retaining functional ecosystems that benefit both residents and the globe.

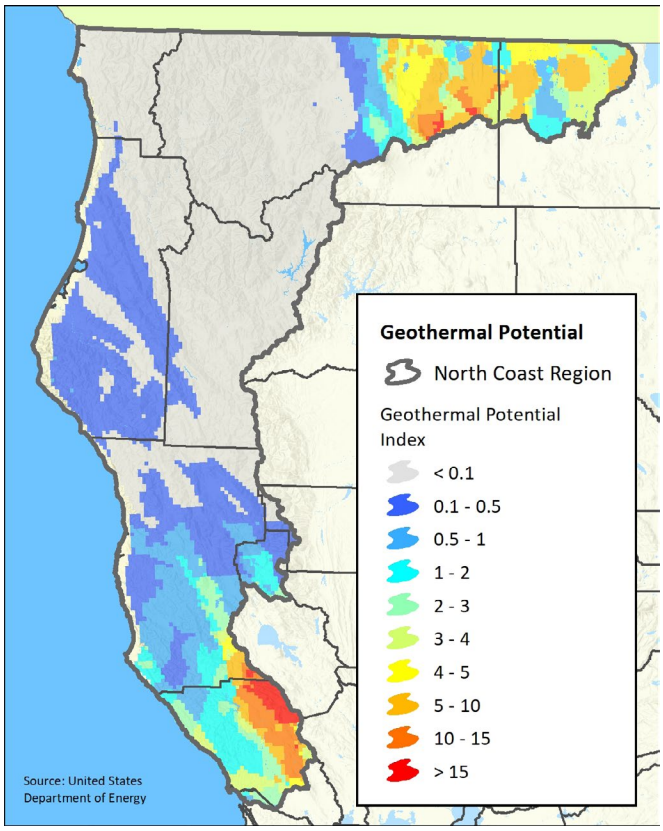
CURRENT CONDITIONS

Energy Sectors

Although annual energy production in the North Coast Region varies from year to year, generally the Region produces more renewable energy than the total energy (renewable and non-renewable) that it consumes, making the balance of that energy available to other markets. The Region contains a diverse set of power generation sources with the majority coming from renewables. Geothermal represents the largest

fraction of power plant generation, followed by hydro, natural gas, biomass, and solar respectively.

Figure 8. Geothermal Energy Development Potential



During 2015, the Region produced 5,800 GWh Hours of power from renewable sources, which equals about 35% of the current installed capacity and slightly exceeded regional energy consumption (by about 500 GWh). Even with accounting for maintenance needs and other down time, the Region still produces far below its current facility capacity. Part of this gap is related to the uncertainty of the hydro and biomass sectors, which are resource- and weather-dependent (Zoellick et al. 2017).

Energy Authorities

Over the last several years there has been a shift away from investor-owned power delivery toward community aggregation, in which local jurisdictions aggregate the buying power of individual customers within a defined jurisdiction in order to secure alternative energy supply contracts. Although still involved in infrastructure and maintenance, large investor-owned utilities such as PG&E are facing a changing dynamic in the North Coast Region. There is continued emergence and growth of both existing public utilities such as Trinity PUD and Community Choice Aggregations (CCAs), such as Sonoma Clean Power and Redwood Coast Energy Authority. It is estimated that "most of the population in the NCRP Region will be served by a CCE or municipal utility by mid-2017 (Zoellick 2017)." Smaller-capacity self-generation for individuals and organizations (i.e. distributed power) is a growing presence in the North Coast.

Energy Usage and Imports

As noted above, the North Coast Region is a net exporter of energy, with total renewable energy production alone totaling more energy than the Region consumes as a whole. Conventional (non-renewable) energy use within the Region includes imported natural gas, kerosene, heating oil, and other fossil fuel. Natural gas plays a smaller role in the overall usage portfolio with utility-provided service being "available in Sonoma, Mendocino and parts of Humboldt County. All of the natural gas consumed in the Region is imported from outside the Region with the exception of Humboldt County, where about 10% of the gas consumed comes from gas wells located within the county (Zoellick 2017). " It should also be noted that use of firewood/wood fuel constitutes over 40% of the residential primary heating fuel for Trinity and Modoc counties. Non-utility delivered (private sector) natural gas is also used throughout the region, though to a lesser extent. Data to measure this and other fuel source consumption is not readily available.

Transportation Fuel

Although overall use of transportation fuel varies by county, generally the use of transportation fuels is closely linked to the number of vehicle miles traveled (VMT), a major factor in GHG emissions. Rural counties have a higher average VMT than many more densely populated areas. Travel distances and related challenges are explored in detail in the Transportation Infrastructure Strategy.

LIMITING FACTORS AND CHALLENGES

Transmission Corridors and Capacity

Although information is readily available about where current transmission infrastructure exists, capacity levels and how they may mesh with future energy production projects is uncertain. This concept is explored more fully in *Strategy 1.4 Energy Transmission*.

Local Opportunities and Tools Need Additional Clarification and Support

Tools and information for local decision makers and the general public should be enhanced to provide pathways to future development and more energy independence. As demonstrated through the development and ongoing implementation of the goals of the *Planning Guide for Tribal Energy Sovereignty* developed for the Bear River Tribe, even small communities can accomplish energy independence when they obtain access to

adequate tools and opportunities (Redwood Energy and Freshwater Environmental Services 2016). The NCRP is uniquely positioned to continue its regional role in developing strategies for energy independence and obtaining funding for implementation projects (see *North Coast Strategies for Energy Independence, Climate Adaptation & Emissions Reduction*).

Numerous System Risk Factors

Based on existing conditions and the limiting factors and challenges stated above, there are numerous ongoing risks to the viability of the overall North Coast energy system. Long term viability of present local generation facilities is at risk due to a suite of different factors, including proximity to feedstock supply (biomass, see *Strategy 2.4 Forest Health*), potential impacts from climate change and natural disasters, the current national political climate, which favors fossil fuels, and economic and infrastructure constraints. Adequate transmission infrastructure continues to be a problem in some areas due to both current line capacity and lack of redundancy (see *Strategy 1.1 Communications Infrastructure*). Additionally, in certain sectors (e.g., reliance on electric generation from natural gas), over-reliance on a single resource makes some communities especially vulnerable to outages.

FUTURE OPPORTUNITIES, PLANNING, AND STRATEGY

Working Together to Leverage the Region's Full Potential

Additional "region-led" analysis, support, and strategy is needed to provide concise information and better communication between potential energy innovators and local government. In order to implement expanded strategies, up-to-date information and strategic support will be needed by local decision makers. The NCRP is again uniquely positioned to gather and disseminate relevant information and serve as a rallying body for regional collaboration. The NCRP is well versed in communication, including outreach to underserved or under-represented groups and has proven capabilities associated with integrating local needs with statewide priorities. The consolidation of Sonoma and Mendocino Counties into the unified Sonoma Clean Power CCA is an example of the possibilities of aggregating governance resources in a positive direction; it could serve as a model for similar aggregations.

Filling the Gap for Decommissioned or Reduced Energy Facilities

With changes in ownership, increases in maintenance cost, lack of affordable/available feedstock supply, and other factors, some historic energy production facilities are either undergoing or being planned for decommission or dramatically reducing their output. For example, the low levels of energy currently generated by the Potter Valley Project, a hydroelectric power plant straddling the Eel and Russian River watersheds, have led its owner, PG&E, to consider selling the concern (Mendo Voice 2018). Such losses of local energy generation, if they continue, will decrease regional energy independence and potentially impact the local economy. The NCRP should identify opportunities to secure support and funding from the state and power users outside the Region to finance viable, ecologically sound renewable energy development in areas losing renewable energy plants.

Alignment with State Climate Change Objectives

The communities of the North Coast have an opportunity to convince decision-makers and policy developers at the state level that energy-related investment in the North Coast Region is good business. Electric vehicles, GHG reductions, distributed power generation, cost savings for cash strapped local municipalities, incentives to keep natural resources in good ecological health, improved public health and environmental justice for disadvantaged communities are just some benefits that could be realized with additional investment in renewable energy opportunities.

Technological Advancements Can "Leap-Frog" Challenges

Technological advancements are occurring at a rapid pace within all types of renewable energy and constraints that previously existed are being overcome at seemingly ever-increasing rates. Just as batteries for electric vehicles are becoming smaller and less costly to manufacture, advances are being made in solar energy capture and storage, wind turbines, methane converters and other types of renewable energy. For example, limitations on offshore wind energy development may be overcome in the near future. "What's historically ruled the North Coast out of wind energy discussions…is that the waters off the local coast 'get too deep, too quick,' meaning the wind turbines used in shallow waters off the East Coast and elsewhere won't work off the Humboldt County coastline. But a new floating platform technology is proving to be a game changer (Greeson 2018)."

Potential to Align with, or Be Ahead of, the Regulatory Curve

With proper human capital and organizational development, the North Coast Region has the potential to position itself to be on the leading edge of energy operations for the state. A key factor is ensuring that close attention is paid to emergent and changing regulatory actions and dynamics (e.g. CPUC/CEC/FERC). Again, the NCRP, with its proven track record of

aligning local need, resources, and expertise with state goals, priorities, and funding initiatives has the power to successfully lead the Region to energy independence.

PRIORITY ACTIONS: POLICY AND STRATEGY RECOMMENDATIONS

Develop a Regional Energy Management Support Organization

The NCRP is in a strong position to take the lead (or support the establishment of a nimble, effective regional energy management consortium to take the lead) in the issues contained in this strategy. A cohesive regional group could effectively pursue:

- Regional funding for energy planning and program and project development (see *North Coast Integrated Regional Water Management Plan: Energy Independence·Emissions Reduction·Job Creation·Climate Adaptation*).
- Development of replicable demonstration projects and research into innovative technologies (see *North Coast Integrated Regional Watershed Management Plan North Coast Energy Independence, Emissions Reduction & Climate Adaptation Projects*).
- Development of opportunities where special assets in the Region distinguish, and even favor, local project development such as biomass electricity.

Generate Annual Regional Energy Report

Produce an annual regional report of renewable energy being produced, transmission system status and percentage utilization of installed capacity by county. This could include future projections on climate impacts for the hydro and biomass sectors (Micheli et al. 2016, Nickerson 2017), status of CCAs within the region, additional planning information and more.

Initiate Region-Wide Assessment of Potential Renewable Energy Projects

Although there are a tremendous number of renewable energy development opportunities throughout the North Coast Region—across many sectors including solar, wind, wave, geothermal, hydropower and biomass—solar energy development offers "68% of the total estimated renewable resource potential" and "the greatest total potential across all resources (Zoellick 2017)" within the Region. Initiating a county-by-county assessment of potential locations for renewable energy installations with a specific focus on solar installations should be a priority. Selecting ideal project locations across all renewable energy sectors (and pursuing distributed generation models) will rely heavily on regional energy transmission infrastructure (see *Strategy 1.4 Energy Transmission Infrastructure*) (ARB 2017)

Implement Biomass Specific Recommendations

- Expand upon existing NCRP biomass reports (Morris et al. 2017, Nickerson 2017) to evaluate and document the multiple benefits associated with biomass utilization in rural regions—including fuel load reduction, enhanced forest carbon sequestration, local jobs and revenue (see *Strategy 1.4 Forest Health* for a brief discussion).
- Encourage State of California, via the California Energy Commission and other relevant agencies, to adjust pricing incentives to be competitive with natural gas pricing to ensure operations and viability of existing facilities (ARB 2017).
- Advocate for subsidies for small scale development comparable to recent solar build out incentives via Cap-and-Trade program, future legislation, and other opportunities (DFW 2017, ARB 2017).
- Engage local, state, and federal agencies; private industry; and non-profits to analyze the potential of biomass in their current/future project work and look for opportunities to provide regional support for technological research and innovation in facility design (CalFire et al. 2017) Earth Economics 2018).
- Advance the idea of a Mobile Biomass Utilization Facility that can plug into the grid at strategic locations across the Region (Morris et al. 2017).

Assess Impacts of the Region Purchasing All of Power from Local Production Sources

Currently the Region simultaneously produces power and exports power, while also purchasing power and other energy source material (e.g. natural gas) from outside of the region. Assess and document the implications of the Region exclusively purchasing all of its needed power from local sources; this could incentivize development and accelerate a trajectory towards energy independence.

Conduct Risk Assessment of Strategic Public Services and Facilities

Using the example of Redwood Coast Energy Authority's "Site Resilience and Energy Assessment Process for Key Assets" report (Boudreau et al. 2016), identify key regional locations and assets that would be at risk in energy outages/ shortages.

Encourage Municipal Organizations to Take the Lead by Aggregating Regionally

In pursuit of being fiscally responsible with public dollars and to encourage leadership on these issues regionally, public sector entities have an opportunity to collaborate to improve existing renewable energy generation and seek new opportunities; the NCRP has the potential to act as the umbrella organization for these

efforts. Opportunities include: planning for, funding, and scheduling energy audits for municipal facilities; encouraging and assisting counties, cities, CSDs, and others to join existing CCAs; analyzing locations for distributed generation facilities (solar/ wind); and incorporating electric and other alternative fuel vehicles into municipal fleets via county by county assessment and aggregate funding proposals (Zoellick et al. 2017).

MULTIPLE BENEFITS AND VALUES: SOCIAL SERVICES AND ECONOMIC BENEFITS

- Potential new job base generated from construction, operations, management and maintenance of new facilities (ECONorthwest 2014)
- New tech-oriented vocational training opportunities
- Marketing opportunity for the Region to attract related/ integrated businesses (Morris et al. 2017)
- Branding opportunity for the Region as a model for energy independence
  - » Full development of regional renewable energy resources could be a significant launch factor for other industries including:
  - » Server farms in conjunction with broadband service expansion (Earth Economics 2018)
  - » Electric Vehicle (EV) hub and node transportation networks (Caltrans 2016)
- Avoided energy costs for local municipalities, saving funding for other programs
- Long term goal to reduce fossil fuel import and use yields multiple benefits including:
  - » Reduction of exporting financial capital
  - » Reduction of emissions—has an economic value determined by the state's cap and trade program (ARB 2017, ECONorthwest 2017)
  - » Health benefits

STRATEGY INTEGRATION

Strategy 1.3 Renewable Energy informs the multi-benefit priority strategy *Built Capital: Enhancing Infrastructure for Communities* outlined above in Section 2. The *Natural Environment Focus Area* strategies have an intimate relationship with renewable energy production. In some cases, like biomass, hydroelectric, and geothermal, the very essence of the natural resource (e.g., forests) is key to developing renewable energy. More generally, location siting, transportation routes and related transmission efforts will all require feasibility analysis that will need to coordinate with protection of the region's natural resources. It also integrates with the *Energy Transmission Infrastructure Strategy*. Distribution of power within local communities and the Region are a key part of the successful realization of regional energy independence and overall energy system redundancy. Ensuring that there are multiple systems and connections available, especially for key public service systems and infrastructure, is a key part of overall public safety. The *Communications Infrastructure Strategy* ties-in several ways, including remote sensing of renewable energy facilities and resources, expansion of services consumer apps (i.e. Uber electric fleet service), and the overall marketing of the Region to prospective knowledge workers who may be able to increase the region's renewable energy capacity who are also counting on a robust communications infrastructure being available to them. The *Transportation Infrastructure Strategy* connects with renewable energy, too: renewable energy development and its potential incentive to expand and improve the energy transmission infrastructure will require adequate, and potentially new, transportation routes. Also, the proliferation of potential electric vehicle adaptation by both public agencies and the private sector, especially for localized public transit, is a key part of future transportation planning. The Human Capital & Talent Strategy is functionally correlated with renewable energy: the availability and knowledge of the local workforce defines the capacity of the Region to take the needed next steps.

STRATEGY 1.4—ENERGY TRANSMISSION INFRASTRUCTURE

INTRODUCTION

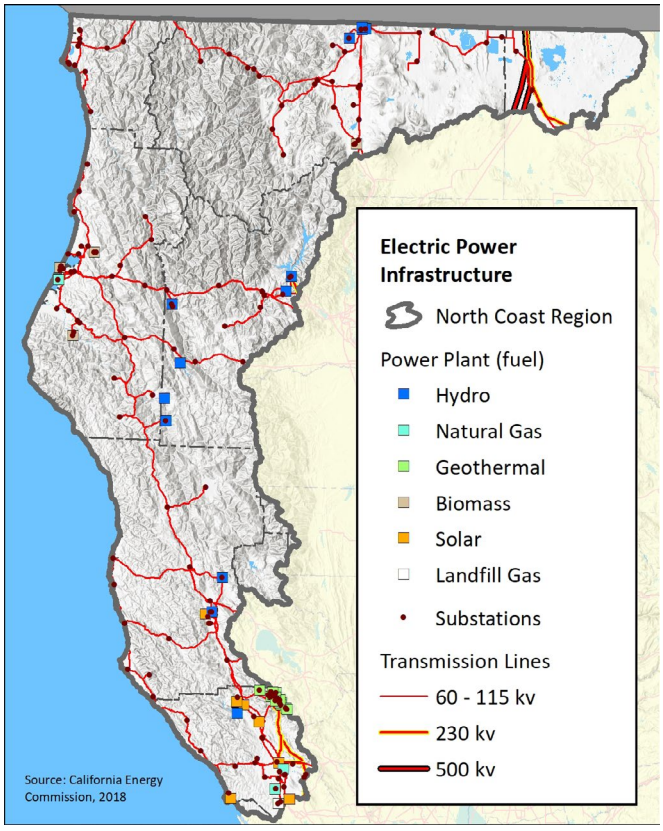
The energy transmission infrastructure network is a significant asset for the North Coast region, both providing electric power within and exporting power out of the Region for consumption across California and beyond. Understanding where this network exists, how it is used, what its carrying capacity is at any given time, and how to access and tie into this network all have significant implications for further leveraging renewable energy development, use, and authority in the region. Renewable energy has been identified by the NCRP as a key component of economic, social, and ecological stability and resilience in the North Coast and it is inextricably reliant on a robust and redundant transmission network. Regional transmission of electric energy is a key component of renewable energy development and also plays an important role in potential future revenue streams from energy exports.

CURRENT CONDITIONS

Regional Energy Transmission Network

As shown in Figure 9 (*Electric Power Infrastructure)* "the main backbone of California's electrical transmission grid runs north to south through the Central Valley, and the high voltage lines connecting us to our neighbors to the north (called the Pacific AC Intertie) comes down through Modoc and Siskiyou counties (Zoellick 2017)."

Figure 9. Electric Power Infrastructure



Current Authorities

California Energy Commission (CEC)—Although they do not manage transmission facilities directly, the CEC has a significant role in facilitating analysis and planning regarding future infrastructure and system development.

California Independent System Operator (CAISO)—CAISO manages the scheduling of power on the lines formerly managed by PG&E.

Pacificorp—Also an investor owned utility (IOU), Pacificorp operates and manages a network of transmission lines in three of the seven counties within the Region (Del Norte, Siskiyou, Modoc). A 2015 study has recommended integrating Pacificcorp transmission operations with the CalISO systems. PacifiCorp and CAISO hope to begin integrating by late 2018 or 2019 (Trabish 2015). Results of this study include:

- Showing how a combined regional power marketplace could reduce billions of dollars in costs over a 20-year span.
- By combining the two electrical grids to create a Western Region marketplace, consumers could save between $3.4 billion and $9.1 billion through 20 years.
- Both companies will need input from regulators and stakeholders as well as regulatory approval before they can combine forces.

Transmission Agency of Northern California (TANC)—the Transmission Agency of Northern California (TANC) assists its publicly-owned Member utilities in providing cost-effective energy supplies to their customers, through long-term ownership or contracts

Trinity Public Utilities District (TPUD)—Although they are a more localized utility (serving most of Trinity County, CA), the TPUD also owns its own transmission "network" of sorts. In 2010, after 30 years of transmitting a power allocation via PG&E lines from Trinity Dam, TPUD lit its own transmission lines that deliver power directly from the generation facilities at Trinity Dam.

Western Area Power Administration (WAPA)—WAPA has a separately regulated, and somewhat parallel, network of transmission lines in the central and western portions of the U.S. WAPA markets and delivers reliable, cost-based hydroelectric power and related services. They are one of four power-marketing administrations within the U.S. Department of Energy that market and transmit electricity from multi-use water projects.

Distributed Energy Resources and Micro Grids

The definitions of "distributed energy" resources vary widely as do their functionality, scale, and level of connectedness to the larger electric grid. These range from small on-site systems used for agriculture or home energy use to larger community-wide systems that are also connected to the grid. The number and nature of these within the Region is a data gap.

Existing Energy Transmission Capacity

In 2017, the CEC released a biennial Integrated Energy Policy Report that also includes a Strategic Transmission Investment Plan. From the Renewable Energy Transmission 2.0 Report: "There is currently no existing capacity available for new fully-deliverable resources from either generation in Northern California or imports from the Northwest" and "providing new capacity could require new transmission from the Oregon border to the Tracy area, at an order-of-magnitude cost of $2 billion-$4 billion."

Non-Electric Based Distributed Energy Systems

Both geothermal and biomass energy have the potential for "direct heat transmission" systems that do not use traditional wired transmission facilities to deliver heat energy to multiple facilities. There are a handful of these types of systems within the North Coast region.

LIMITING FACTORS AND CHALLENGES

Transmission Infrastructure at Capacity

As noted above, transmission capacity in the North Coast is at or near its limits. If large, utility-scale power projects are to be developed in the NCRP Region, it is necessary to assess the capability of the existing transmission system to transport the power. If the transmission system is found inadequate, there will likely be substantial additional costs incurred (Zoellick 2017).

Vulnerable Transmission Infrastructure

There is a certain, but unquantified, vulnerability of the power supply and transmission infrastructure within the Region due to storms, seismic events, or other forces. Risks to this sector should be defined and considered by the appropriate decision makers to ensure long-term durability and security of existing infrastructure (Boudreau et al. 2016).

Misperception of Adequate Transmission Capacity

With the documented reduction in certain types of renewable energy production (biomass, hydro), it is important to clarify with key decision makers at the state level that the current transmission capacity for export is still needed. Currently the North Coast Region is producing far below the installed capacity (potential production based on current facilities) (Zoellick et al. 2017). Combined with the fact that current transmission infrastructure is close to peak capacity, this raises concerns related to future energy exports from potential new production facilities.

FUTURE OPPORTUNITIES, PLANNING, AND STRATEGY

Regional Opportunity for Planning and Advocacy

Regional decision makers are in a strong advocacy position if they continue to gather locally relevant information related to transmission and energy development issues and organize regionally to participate in the ongoing planning efforts of the CEC and related entities. The North Coast Resource Partnership has proven extremely effective in effective outreach to relevant entities to mobilize planning and action that benefits all concerned; it is the logical entity to lead such an effort.

Development of Micro-grids and Distributed Generation

In lieu of increasing energy exports through what may be an "at capacity" transmission system, additional planning should focus on developing micro-grids and distributed generation throughout the Region as part of a local energy reliability planning effort and, in some cases, to provide a more economical power supply. This type of development increases the resiliency of the grid by allowing sections to remain operational in the event of a larger grid outage. Planning for micro-grids should be done as part of a local energy assurance planning effort. Critical facilities should be assessed for micro-grid suitability. In addition to providing resiliency, micro-grids can also encourage the use of distributed renewable resources, which can delay expensive transmission upgrades and provide other ancillary benefits to the grid (Woods 2018).

PRIORITY ACTIONS: POLICY AND STRATEGY RECOMMENDATIONS

Learn from Models like SCP/ RCEA

Wherever possible, follow the example of successful regional entities such as Sonoma Clean Power, Redwood Coast Energy Authority and make use of existing studies such as *RePower Humboldt, A Strategic Plan for Renewable Energy Security and Prosperity* and the NCRP's *Northwest California Sustainable Energy and Water Conservation Outreach*.

Distribute and Promote Currently-Available Tools and Resources

Energy transmission can be a fairly amorphous issue that can be taken for granted as a constant, rather than infrastructure and processes that can be modified or expanded for future needs. Distribution of existing tools such as the Planning Guide for Tribal Sovereignty (RedwoodEnergy&FreshwaterEnviornmentalServices, 2016), with a one page cover sheet about how it could apply to individual organizations/ communities, could be an easy primer to encourage decision makers to consider the options available to them. Additionally, outreach about the types of projects that enhance regional energy independence should be showcased, as on the NCRP website: *North Coast Energy Efficiency & Energy Independence Projects*.

Develop a Regional Energy Management Support Organization

As recommended in *Strategy 1.3 Renewable Energy*, the NCRP or other collaborative body acting as a regional Energy Management Support Organization would be a significant asset across many sectors in the region, including Energy Transmission.

Initiate Assessment of Regional Transmission

With limited transmission capacity, additional out-of-area export of renewable energy beyond the currently installed capacity could be challenging. Initiating a "Transmission Assessment" in conjunction with CEC would give a baseline of where capacity exists and provide a baseline condition that could be augmented with potential new production sites to manage capacity.

MULTIPLE BENEFITS AND VALUES: SOCIAL SERVICES AND ECONOMIC BENEFITS

- Increased advocacy power of a regional approach
- Job creation in association with distributed generation (Morris et al. 2017)
- Energy and community security from increased presence of micro-grids (Woods 2018)
- A county-wide switch of all of Humboldt county households to Redwood Coast Energy Authority's(RCEA) clean power from PG&E will generate $1.3 million in CO2 emissions savings (Earth Economics 2018)
  - » In addition to emissions savings this switch will provide an average of $18 per year in rate based savings per household, or about $1 million in rate-based customer savings (Earth Economics 2018)
  - » Since many customers in adjacent counties are eligible to enroll in the RCEA program, these estimates are the minimum expected (Earth Economics 2018)
  - » The RCEA also creates jobs; more than 30 positions in within the Energy Authority have been filled to date (Earth Economics 2018)
- Future potential energy independence (Zoellick et al. 2017)
- Increased service reliability/redundancy, which is key for attracting tech companies and other "constant power" user businesses to the Region (Morris et al. 2017)
- More opportunities for retention of local capital resources within the Region through reduction of power imports and other actions

STRATEGY INTEGRATION

Strategy 1.4. Energy Transmission Infrastructure informs the multi-benefit priority strategy *Built Capital: Enhancing Infrastructure for Communities* outlined above in Section 2. It integrates most directly with the *Renewable Energy Strategy*. Distribution of power within local communities and the Region is a key part of the successful realization of regional energy independence and overall energy system redundancy. Ensuring that there are multiple systems and connections available, especially for key public service systems and infrastructure, is an essential part of overall public safety.

STRATEGY 1.5—FLOOD & SEA LEVEL RISE MANAGEMENT INFRASTRUCTURE

INTRODUCTION

In the coming years, the slow but persistent rise of the oceans worldwide is expected to significantly impact a large number of people and population centers around the globe. In the United States alone, between 489 and 668 coastal communities, more than 50 of which currently have populations greater than 100,000, are expected to experience chronic coastal flooding due to sea level rise by the end of the century (Dahl et al. 2017). Because of gently sloping shorelines and high population densities along the southern and eastern U.S. coasts, many of the at-risk coastal communities are located in those regions. Despite substantial buffering from dunes and tall coastal bluffs, the North Coast Region is hardly immune to sea level rise impacts (Reza and Tinsman 2017).

Also projected is the likelihood of more intense storms, with more precipitation falling as rain, and an increase of rain-on-snow events which will speed snow melt and lead to increased sediment delivery and potential flooding in watersheds. Communities and development near watercourses will be at-risk to increased flooding. This trend will continue and given projections of stronger storms travelers should expect further impacts to local and regional travel (Medley-Daniel 2011). Planning for projected future events is a crucial task for regional communities and the benefits, mostly in avoided costs, are significant. Through the NCRP, the North Coast Region has the networks, the comity, and the local knowledge to successfully meet expected challenges.

CURRENT CONDITIONS

Flood History

The floods of 1955 and 1964 were called "the disaster of the century" and a "1,000 year event" respectively (McGlaughlin, 2014). We are still living with impacts of those events, from flooding in urban areas to the significant devastation of blown out timber road networks and the domino effect that has had on our regional ecosystems and communities. Since 1960 there have been more than twice as many severe snow and ice storms in the U.S. than occurred in the 60 years prior, and over the past century "the amount of rain falling in the heaviest downpours has increased approximately 20% on average

(Thomas and Peterson 2009)." Annual precipitation is greater in this Region than in any other part of the state and floods are a fairly regular phenomenon. Damaging floods occur relatively frequently in the Region, with particularly destructive floods documented in December 1955, December 1964, February 1986, spring 1995, and January 1997 and 2006. In the North Coast, more than 30,000 people (5% Region population) and $3 billion in assets lie within the 100-year flood zone. Some 40,000 people and over $4 billion in assets are exposed to the 500-year flood event (NCIRWMP 2014). As recently as the winter of 2017, California and the North Coast Region experienced significant flood events (Goff 2017). Significant risk to communities and infrastructure are already a factor under current conditions, and flooding is projected to increase in most places (FEMA undated).

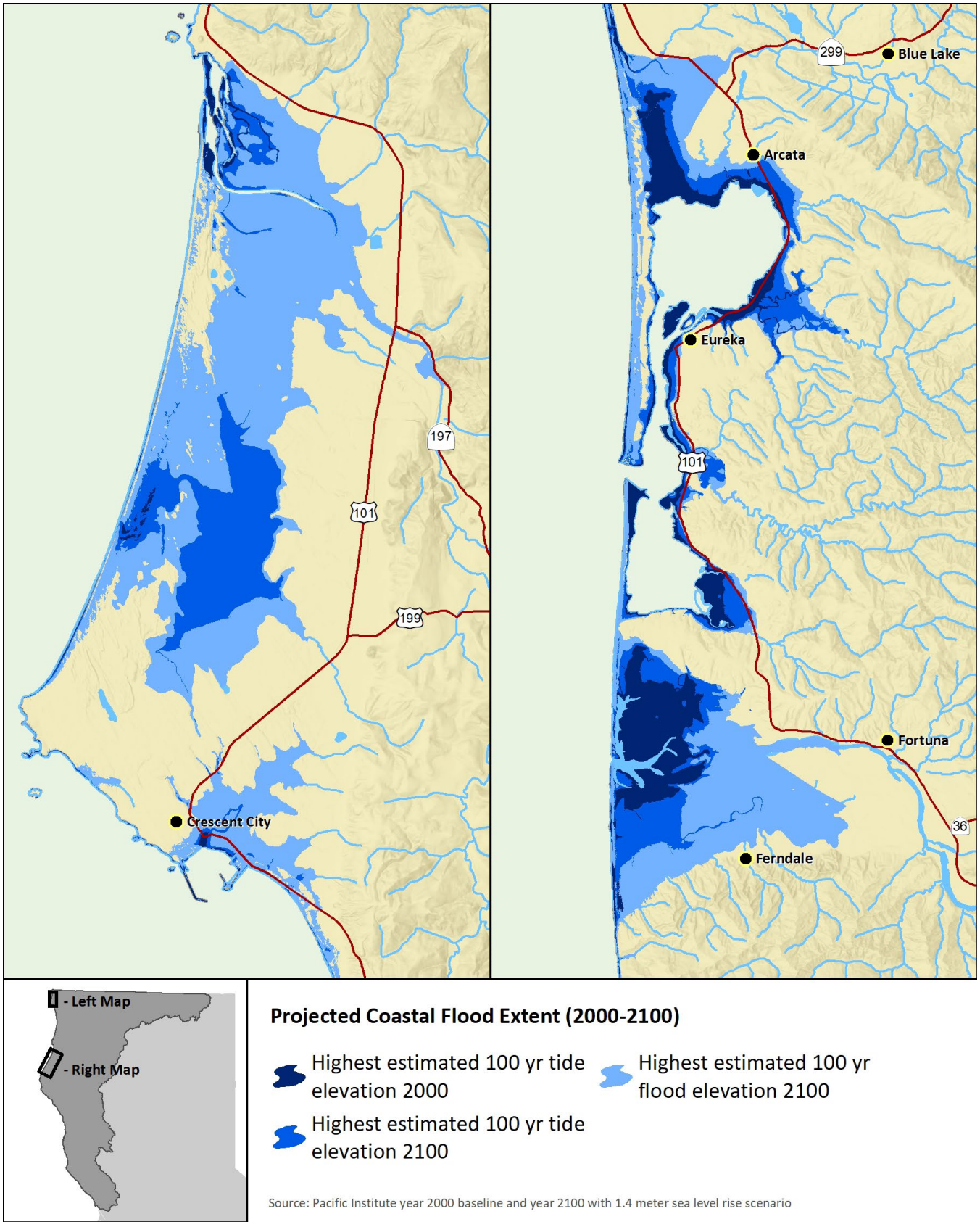
Infrastructure with High Vulnerability to Flooding

Transportation routes and low lying communities along all major waterways are vulnerable to flooding (Houston, 2017). Low lying communities, especially those in low lying coastal areas close to estuaries or at the confluence of major waterways are at particular risk. Rivers that flow directly into the ocean along the North Coast include the Russian, Eel, Mattole, Van Duzen, Mad, Klamath, and Smith Rivers. Many communities on these waterways have experienced a history of flooding. Major tributaries of these rivers, including the Trinity River (which drains into the Klamath), also have significant potential to present flood risks to communities, transportation, and other vital built infrastructure.

Infrastructure with High Vulnerability to Sea Level Rise

The North Coast Region has almost 300 miles of coastline, including lowlands. Where major rivers and the ocean meet, sea level rise and flooding could have a tremendous impact for nearby communities, infrastructure, and the environment (e.g. from land based debris and contaminants being washed into waterways). The impacts will vary within the Region and are dependent on geologic condition: "In Crescent City, for instance, the land is being uplifted via plate tectonics faster than sea level is currently rising, such that relative sea level has been falling by about 0.4 inch (0.97 mm) per year (Reza and Tinsman 2018). " The Humboldt Bay Area, in contrast, is subsiding due to plate tectonics, and relative sea level is rising faster than anywhere else in California at an average rate of 0.1 to 0.23 inch (2.5 to 5.8 mm) per year. "As a result, by the end of the century, sea levels in Humboldt Bay are expected to be 19 to 68 inches (49 to 174 cm) higher than they are today. This is clearly an issue for the communities in and around Humboldt Bay, and the cities of Eureka and Arcata (at 39 feet or 12 m and 23 feet or 7 m above sea level, respectively) and the County of Humboldt have already begun planning for the effects of sea level rise on the Region (Laird, 2015, Laird, 2016, Humboldt County, 2014a; in: Reza and Tinsman 2018)."

Figure 10. Flood and Sea Level Rise Risk: Crescent City and Humboldt Bay areas



LIMITING FACTORS AND CHALLENGES

Significant Development Already Exists in Some at Risk Areas

Resources required to respond during an emergency will be stretched thin where large amounts of development/built infrastructure exist inside a projected flood-risk area.

Transportation Routes for Evacuation/ Strategic Retreat Could Be Compromised

Many routes are already compromised during current weather events. The current inundation zones in recently updated flood maps from FEMA include significant portions of Highway 101. The Russian River is one of the most flood-prone rivers in California, routinely overflowing during wet years and impacting local as well as major transportation routes (WEF 2018). Flood exposure also occurs along the coastline, Eel River, Elk River, Scott River, around Crescent City Harbor, and Humboldt Bay (DWR 2013).

Impacts on Other Baseline Infrastructure

Depending on the proximity of infrastructure to at risk areas, disruption of transportation routes, drinking water supply, wastewater facilities (and risk of overflow), and communications facilities could occur with direct impact on evacuation/strategic retreat activities, communication, and eventual relocation efforts.

Coastline Changes Could Impact Tourism and Local Recreation

The iconic coastline of the Region is one of the hallmark attractions for the significant tourism industry and is associated with positive economic impacts.

Potential Political Resistance for Future Planning

Given the many current challenges associated with limited funding and prioritization of myriad infrastructure, social services and other community needs, it can be challenging for local elected officials and leaders to prioritize future risk planning.

FUTURE OPPORTUNITIES, PLANNING, AND STRATEGY

Infrastructure Analysis of At-Risk Waterways and Coastal Areas

Ensures reliability of baseline services and/ or needed relocation, plus potential environmental and non-vital infrastructure impacts if changes in land use and relocation efforts do not occur.

Emergency Services Awareness and Implications

Although most communities/counties have emergency plans developed, the level of analysis regarding relationship between potential events is unclear. Renewed communication with emergency service providers and teams with regard to these strategies would be beneficial.

Aggregated Planning and Strategic Efforts

Coastal urban areas and river corridor communities could aggregate their planning efforts and share strategies to increase efficacy and efficiency.

Plan for Impacts to Recreation and Tourism Options

Although the specific changes are as of yet unknown, communities and tourism related businesses should be prepared for a changing coastline and adapt their efforts accordingly.

PRIORITY ACTIONS: POLICY AND STRATEGY RECOMMENDATIONS

Use a Planned Retreat/ Green Infrastructure Approach to Adapt to SLR as Feasible

Planning for strategic retreat entails first identifying vulnerable properties and structures and then developing incentives, such as regulatory, tax, and market-based tools, to encourage and achieve realignment (Reza and Tinsman 2018).

Conduct Risk Assessments for At-Risk Waterways and Coastal Areas

- Infrastructure at risk (private and public)
- Viability of transportation routes for evacuation/planned retreat
- Potential number of evacuees and impacts on local housing
- Risk to communications infrastructure and redundancy planning
- Environmental impacts from damaged/ inundated infrastructure

Incentivize Sustainable Land Use Planning and Integrated Flood Management

To ensure that measures to protect or relocate resources and begin limitation on building in at-risk areas, explore potential mitigation funding, or other creative ways to drive the process. Planners should incorporate natural hydrologic, geomorphic, and ecological processes to reduce flood risk by influencing the cause of the harm, including the probability, extent, or depth of flooding. The general principles of integrated management include adaptation planning to embrace sustainability while

considering equitable distribution and apportionment of costs and benefits of adaptation measures, especially with regard to disadvantaged communities (DWR 2013).

MULTIPLE BENEFITS AND VALUES: SOCIAL SERVICES AND ECONOMIC BENEFITS

- Aggregated planning can ensure well-informed/ well-coordinated plans and implementation strategies, saving economic capacity and lives through loss prevention and/ or minimization
- Effective public safety planning and response, especially during emergency events
  - » Avoided human displacement
  - » Avoided injuries and/ or deaths
  - » Avoided loss of economic activity
- Additional visibility for the NCRP and the North Coast Region as state and national leaders in cross-jurisdictional regional planning and implementation for climate adaptation
- Avoided costs of additional infrastructure damage and cleanup (ECONorthwest 2014)
  - » Avoided municipal opportunity costs
  - » Avoided water quality impacts

STRATEGY INTEGRATION

Strategy 1.5. Flood and Sea Level Rise Management Infrastructure informs the multi-benefit priority strategy Built Capital: Enhancing Infrastructure for Communities outlined above in Section 2. It integrates with the Natural Environment Focus Area strategies in terms of storm events, climate, and potential future flooding impacts. It relates to the other Built Environment Focus Area strategies in terms of the impact of flooding and sea level rise on infrastructure and the need for infrastructure use (transportation, communication, etc.) to respond to floods and/ or organize strategic retreat efforts. It relates to the Water and Wastewater Strategy as there is significant potential that some of these systems could be impacted through sea level and waterway inundation. The Local Socio-Economic Capacity Focus Area strategies have a direct relationship with this strategy in that the efficacy of our regional capacity, talent, organizations, and partnerships is directly related to strategy success.

STRATEGY 1.6—WATER AND WASTEWATER INFRASTRUCTURE

INTRODUCTION

The North Coast Region is home to hundreds of water supply and wastewater treatment service providers. These systems range from well-funded large citywide water systems to extremely isolated systems that serve only a few individual connections off of a rural water source deep in the backcountry. Many of the region's water systems are impacted by inadequate, failing, or non-existent infrastructure, having been built decades ago and, in many cases, built to serve much smaller communities than they currently serve. A number of these systems are also geographically isolated, serve economically disadvantaged communities, are under-staffed, and lack current technological advancements—all these can make infrastructure improvements difficult to finance (NCRP 2016). Despite the challenges, these systems have been providing basic water and sewer services to local populations and, similar to the potential of distributed power in the energy strategy, have the potential to continue to provide service without hooking up to a "larger grid." Maintenance, updates, and modernization are vital for ensuring viability of water and wastewater infrastructure for rural communities. The NCRP has initiated its *Water & Wastewater Service Provider Outreach & Support Program* to identify and address infrastructure and other needs throughout the Region.

CURRENT CONDITIONS

Systems and Governance

Cities and Special Districts—These entities are responsible for management of the largest systems (e.g. air, water, open space) within the Region and are regulated through the State of California. Special Districts include a variety of formations, including Dependent Districts which are governed via either a city council or county board of supervisors.

Tribal Government Systems—Twenty-one Tribes on the North Coast operate water and wastewater systems that serve their communities. Tribal water and wastewater systems vary in their formation and operations, depending on the rules and regulations of each individual Tribe. Tribal government-run systems are regulated by the United States Environmental Protection Agency.

Investor Owned Utilities—A water company regulated by the CPUC is commonly referred to as an investor owned utility (which can include utilities owned by one or more people). Public water system standards apply to investor-owned utilities that serve over 25 people for more than 60 days per year.

Mutual Water Associations/Companies—A mutual water association or company is a private (usually non-profit) association created for the purpose of providing water to its shareholders or members. Companies organized for mutual purposes are generally not subject to regulation by the California Public Utilities

Commission (CPUC) unless the company delivers water for profit to persons other than shareholders.

Other Systems—In addition to the common water system organizational types described above, there are water systems operated by private companies. These include restaurants and hotels; retail, commercial and industrial facilities; RV parks; and private campgrounds, camps, and retreats. There are also additional water systems that supply water to small communities but they may not be officially organized as a legal entity.

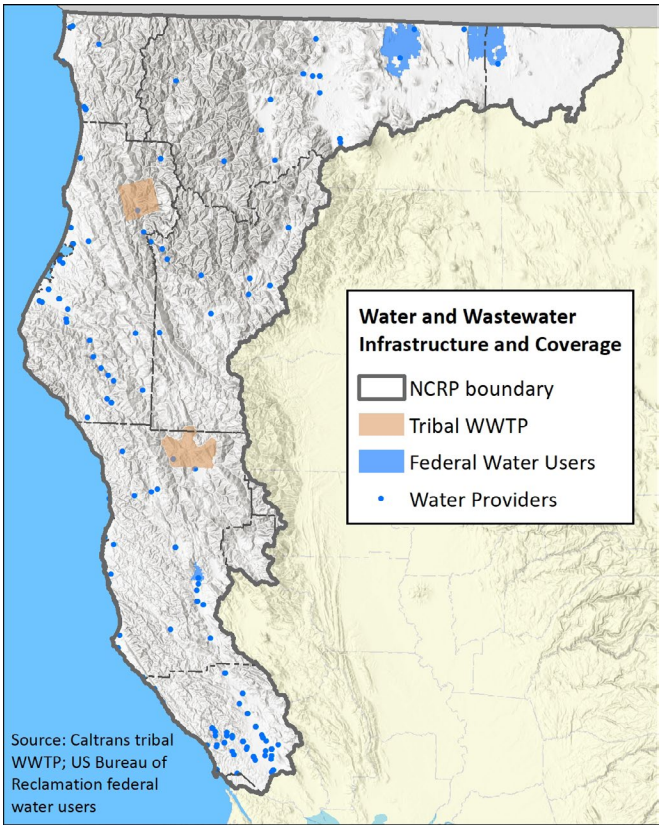
Types of Source Systems

Although municipal systems serve the most citizens and connections in the region, at least 60% of the existing systems are smaller community-based systems. Seventy-six percent of total systems in the Region are sourced from groundwater that is not under the direct influence of surface water (e.g., protected wells) (SWRCB 2018). Additionally, the number of privately held small water systems, regulated or unregulated, is not well quantified.

Wastewater Infrastructure

In almost all instances across the North Coast region, wastewater collection and treatment systems are owned and operated by local agencies: either cities or special districts. These are regulated by the State of California. Additionally, there are large numbers of individual homes that use individual septic tanks. Over the last few decades a number of communities have aggregated multiple homes previously served by individual septic systems into more formalized waste water systems. The number and capabilities of these systems is a significant data gap for the region.

Figure 11. Water and Wastewater Infrastructure



LIMITING FACTORS AND CHALLENGES

Stacked Challenges

Respondents to a *2014 NCRP Water & Wastewater Provider Survey* overwhelming identified "aging or failing infrastructure" as the most significant infrastructure problem. Many systems face "stacked challenges" of aging pipe network, contaminants in the water supply, and capacity issues around regulatory compliance.

Lack of Capacity to Manage Regulatory Requirements

Across many water and wastewater systems, meeting state standards is challenge, especially so for drinking water. Funding, sampling, and testing procedures; training requirements, paperwork, and reporting requirements; and fee fulfillment are all significant challenges. This is especially true for smaller systems because they do not have reserve capital or capacity to respond to changing regulatory requirements.

Human Capital Challenges

General capacity challenges can be exacerbated by the lack of succession planning and availability of trained personnel. Some communities struggle to secure professionals with adequate experience

and required operating licenses and training, while board leadership and employee rosters for many organizations are skewed towards older individuals nearing retirement. Recruitment for talent in both arenas can be challenging (CA DOF 2017).

Additionally, with changing demographics and water availability, historic intercounty and out-of-basin water transfers may warrant revisiting and/ or modification depending on community and natural resource needs versus projected future supplies (Houston 2017).

Projected Low Precipitation Amounts Will Limit Water Supply

In years when demand by water users remains stable and rainfall is abundant, only local water quality issues and the need for improvements to aging and failing water-related infrastructure will limit future water supply reliability. In years of scarce rainfall, surface water supplies will be stressed and several years of drought will likely produce more water supply-related conflicts (NCRP 2016).

Protecting and Managing Watersheds

Natural capital assets within a watershed (e.g. forests, wetlands, and rivers) perform critical functions such as capturing, storing, conveying, and filtering rainfall and produce goods such as potable water for communities or services such as reduced flood risk. Healthy watersheds may be the cheapest and highest quality sources of clean water (Fletcher and Soares 2016). Beyond the ongoing legacy impacts of historic timber extraction, road building, and related sediment issues, additional risks to watersheds/water sources have emerged over the last decade. These include both trespass (public lands) and private land cannabis grows, the impacts of which can include sediment inputs from grading, timber clearing, and poor road building; chemical contaminant inputs from pesticide use; and significant water diversions (see *Strategy 2.4 Forest Health*). Climate-induced changes in runoff patterns and runoff volume will compound many or all existing impacts (Micheli et al. 2016).

FUTURE OPPORTUNITIES, PLANNING, AND STRATEGY

Proactive Analysis of Management Consolidation

A number of communities have multiple districts, mutual water companies, and other operating systems that all face similar challenges. Defining where the opportunities exist to aggregate management of these systems can avoid the need to do so in conjunction with a system failure or other crises event. The recently completed NCRP project: Lewiston Valley Drinking Water Intertie Pipeline provided water security to the community's two water supply systems through construction of an intertie that allows the systems to share water supplies during drought, fire, or other emergencies, providing increased water supply reliability for the entire community. Multiple such opportunities exist throughout the North Coast; with additional funding, the NCRP will be able to continue this type of assistance to local communities.

Regional Aggregation of Regulatory Compliance Assistance

Including training and development of licensed operators, providing a regional "help desk" for regulatory compliance, and additional services to fill shared operational gaps. The *NCRP Small Community Toolbox* provides online resources to assist small communities to approach management of local water and wastewater infrastructure in a systematic fashion. Although it is not a substitute for professional assistance and guidance, it is an important first step to help small utilities understand options, budgeting, and where to find further assistance.

Analyze Potential for Distributed Generation Solar Facilities

Include water system operators (especially municipalities and CSD) in planning for and facilitating distributed generation solar operations at existing water facilities.

Analyze and Map Watersheds and Water Supplies for Each System

Survey systems within the North Coast Region to review water sources and water supplies in the context of future climate condition, possible impacts on specific watersheds, and future off stream storage (water banking) needs.

Continue Regional Support for Updating Systems of Most Vulnerable Communities

NCRP's support for the updating of water and wastewater systems within the Region has made a significant positive impact for the communities of the North Coast. Continued activity in this regard is essential.

PRIORITY ACTIONS: POLICY AND STRATEGY RECOMMENDATIONS

Protect Water Supply and Security

- Define watershed(s) for all water systems and their level of protection.
- Analyze future climate impacts on watersheds and water sources (Micheli et al. 2014).
- Engage system operators in water conservation and long-term plans for water security (NCRP 2013)
- Protect high value recharge zones and maximize subsurface storage in aquifers (Micheli et al. 2014)

- Find innovative ways to capture winter precipitation, storm water runoff, and peak flows for use during dry seasons and recycle wastewater streams (Micheli et al. 2014, CDFA et al. 2016.

Coordinate and Collaborate with Watershed and Land Management Entities

- Increase moisture holding capacity of soils where feasible through vegetation management or soil amendments (CDFA et al. 2016, ARB 2017)
- Consider vegetation monitoring for stress and mortality, particularly during drought events, in locations identified with high vegetation vulnerabilities (Micheli et al. 2014)
- Seek vegetation management tools and treatments capable of reducing accumulated fuel loads and associated fire risks (Micheli et al. 2014, CalFire et al. 2017)
- Develop plans for post-fire management that address strategies for native vegetation resilience and mitigation of impacts to watershed runoff (CalFire et al. 2017)
- Coordinated action across entities and jurisdictions to enforce water diversion and trespass activity laws and regulations(CalFire et al. 2017)

Aggregate/ Consolidate Management to Ensure Operational Security

- Regional support, assistance, and management of common management gaps (NCRP 2013)
- Local consolidation of management and operations, where appropriate (DWR 2013)
- Assistance using technological innovations (e.g., remote sensing technology) as a means to improve operational capacity (DWR 2013)

Continue to Address Long Term Infrastructure Funding Issues

- Explore the possibility of a Public Goods Charge for water/ wastewater systems (ECONorthwest 2017)
- Explore cap and trade/watershed protection funding that can be leveraged (ARB 2017, ECONorthwest 2017)
- Explore development of additional funding sources associated with federal public land management within the Region and other opportunities through state programs (ECONorthwest 2017, DWR 2013)

MULTIPLE BENEFITS AND VALUES: SOCIAL SERVICES AND ECONOMIC BENEFITS

- Cost savings and operational capacity increases due to regional management assistance and/ or aggregation—this monetary benefit is difficult to estimate, but would include the avoided costs associated with shortages and water quality impacts related to failing infrastructure, especially catastrophic failures and the revenue associated with providing water to new customers
- Increased water supply reliability has an estimated monetary benefit of between $19–$27 per household per month
- Avoided cost of projects (ECONorthwest 2014)
  - » Avoided costs of emergency repairs to water treatment operations
  - » Avoided costs of water quality impacts of failing wastewater treatment plants
  - » Avoided costs associated with water shortages
- Increased efficacy and compliance with state/ federal regulations will lead to monetary benefits associated with avoided fines and other penalties
- Potential increased health security for vulnerable populations
  - » Avoided costs of health problems associated with poor drinking water quality
  - » Improved quality of life associated with high quality drinking water

STRATEGY INTEGRATION

Strategy 1.6. Water and Wastewater Infrastructure informs the multi-benefit priority strategies *Aquatic Ecosystems: Upstream Investment and Downstream Benefits* and *Built Capital: Enhancing Infrastructure for Communities* outlined above in Section 2. It is closely integrated with the *Natural Environment Focus Area* strategies, in that the health of the ecosystem has a direct impact on both water supply and also water quality. Negative impacts to the natural systems will result in direct cost increases, operational challenges and potential supply shortage for communities regionwide. Other related strategies include those of *the Local Socio-Economic Capacity Focus Area;* these relate to the ability for the Region to adapt to the changing demographics, climate, and regulatory needs of operating these systems. As part of that dynamic, the *Communications Infrastructure Strategy*, especially where it pertains to remote sensing (system monitors) will be key to ensuring that our operational capacity within the Region can increase its efficacy without having undue impacts on system operators and overhead costs.

FOCUS AREA: NATURAL & WORKING LANDS

STRATEGY 2.1—FUNCTIONAL FRESHWATER ECOSYSTEMS

INTRODUCTION

Freshwater ecosystems occur throughout the North Coast Region and consist of three types: lotic, lentic, and wetland ecosystems. Lentic ecosystems contain slow moving water (e.g. pools, ponds, and lakes); lotic ecosystems are faster moving (e.g. streams and rivers); and wetlands are ecosystems in which soil is saturated or inundated with water at least part of the year (e.g. freshwater marsh, vernal pools). Closely related to lotic systems and addressed in this section are riparian ecosystems. For the purposes of this section, we define riparian areas as the land area encompassing the river channel and its potential floodplain. The riparian zone is characterized by unique physical attributes that distinguish it from the surrounding landscape. These include river flooding, rich and productive soils, and a relatively shallow near-stream water table—attributes that, when coupled with weather events and fluvial conditions, create a wide variety of growing conditions and subsequent heterogeneity of structural forms (e.g. forests, shrublands, wetlands, meadows, grasslands) that support a greater diversity of wildlife than any other habitat type (Riparian Habitat Joint Venture 2009).

When fully functional, these aquatic-based systems provide vital services to communities in the North Coast, such as water supply, nutrient transport, water quality, fish production, flood attenuation, health benefits, and water-dependent recreational opportunities. Many of these benefits are recognized as having tangible monetary value. The abundant freshwater ecosystems in the Region also provide essential habitat for anadromous fish and other aquatic species as well as a majority of terrestrial wildlife.

The existence and functionality of the region's aquatic ecosystems is fundamentally based on regional water inputs and outputs. From an ecosystem perspective, two main environmental water sources for the North Coast are in snowpack and in precipitation runoff/ groundwater recharge. Major changes are expected in the availability of water for aquatic ecosystems, as both snowpack/ melt and recharge/ runoff are projected to decline and climatic water deficits are projected to increase.

Figure 12. Historical and Projected Average April Snowpack

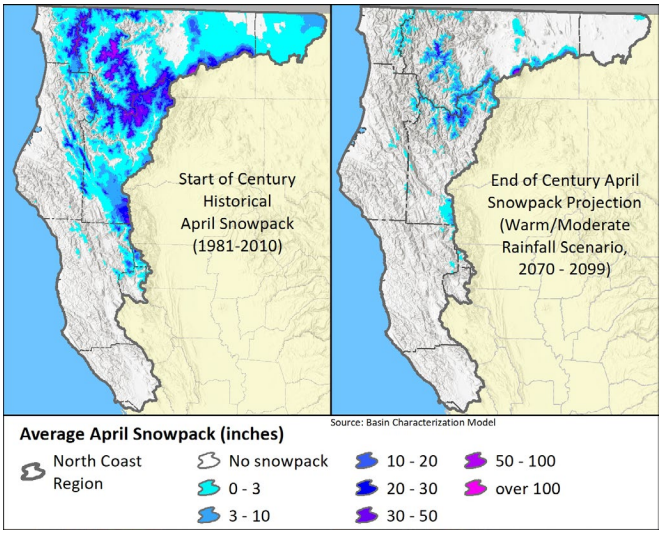
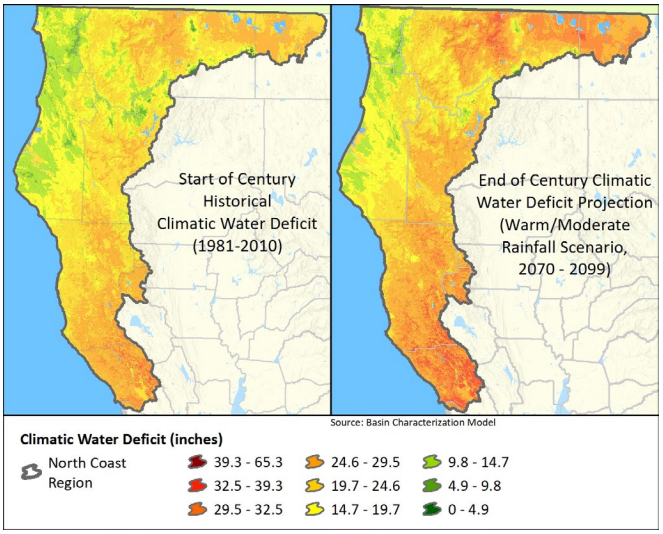


Figure 13. Historic and Projected Climatic Water Deficits

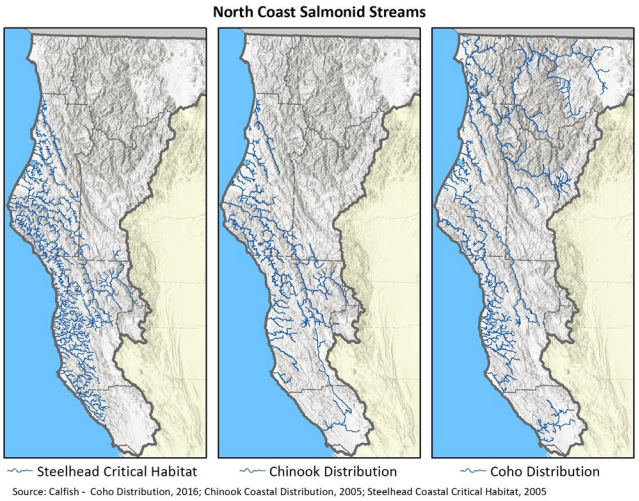


CURRENT CONDITIONS

Lotic and Riparian Ecosystems

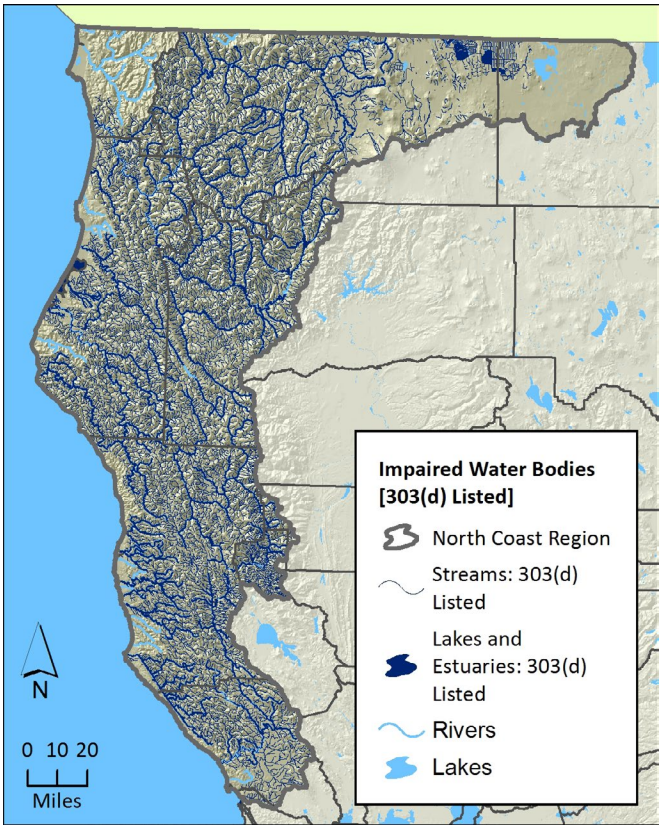
River, creek, and stream ecosystems in the North Coast contain a complex of rich biological and economic resources. They provide shelter and forage for diverse wildlife, including endangered salmonids protect instream water quality through pollutant filtration and nutrient sequestration; sequester greenhouse gasses; temper flooding and sediment transport; and contain substantial commercial timber, agricultural, and other economic resources.

Figure 14. North Coast Salmonid Streams



The North Coast Region is recognized as having some of the most pristine river systems in the state. With the passage in 1972 of the California Wild and Scenic Rivers Act, much of the North Coast Region (e.g. Smith River and tributaries, Klamath River and tributaries, and the Scott, Salmon, Trinity, Eel, and Van Duzen Rivers) was designated as "protected." However, the North Coast has many riparian ecosystems and waterways that are mildly to severely impacted by historic and current land use practices. Water bodies that drain approximately 85 percent of North Coast streams (32,677 km in 2007) are listed as impaired under Section 303(d) of the Clean Water Act; most of these impairments are due to sediment and temperature (NCRP 2014).

Figure 15. Freshwater Ecosystem Conditions



Lentic Ecosystems and Wetlands

While the North Coast is rich in riparian systems and contains several manmade reservoirs, significant natural freshwater bodies (apart from rivers and estuaries) are scant. Large natural freshwater bodies in the North Coast include the remnant Meiss Lake in Siskiyou County, the Laguna de Santa Rosa in Sonoma County, and historic Tule Lake in Modoc County and Howard Lake in Mendocino County. Meiss Lake and Tule Lake, as well as managed reservoirs in the northeastern part of the region, are important for migratory waterfowl and serve as critical links in the Pacific flyway. Sonoma and Mendocino counties have vernal pools, some of the most ecologically important and distinctive habitats in California. Vernal pools are depressions in the landscape with a hard underground layer that prevents precipitation from draining into the subsoils. Rains fill the pools in winter and spring and the pools evaporate during summer's heat. These conditions have created plants and animals specifically adapted to this habitat; species such as Sebastopol meadowfoam (*Limnanthes vinculans*), Sonoma sunshine (*Blennosperma bakeri*) occur nowhere else and it is considered essential habitat for the California tiger salamander (*Ambistoma californiense*) and important habitat for the California red-legged frog (*Rana aurora draytonii*). The Laguna

de Santa Rosa in 2011 was recognized through the Ramsar Convention on Wetlands as a Wetland of International Significance due to the rare and endangered species it sustains, its high biodiversity values, and the presence of unique vernal pool environments.

LIMITING FACTORS AND CHALLENGES

Land Management Practices

Some of the river systems in the North Coast Region still possess intact fluvial geomorphic processes and the habitats that form in response to them, but many of these systems have been impacted to at least some extent by timber harvest, mining, invasion of non-native plant species, or other stressors. In some locations, natural processes have been impaired by land use changes including channelization, road development, agricultural activities, gravel mining, and dam construction. The implementation of Best Management Practices (BMPs) for forest management, agricultural enterprises, construction activities, and other land uses, and regulations requiring riparian setbacks have lessened negative impacts, and habitat restoration projects by Tribes, RCDs and conservation groups have helped to protect and enhance these stream systems. However, timber harvest, road construction, agricultural activities, urban development, gravel extraction, and other human activities continue to cause habitat degradation. Forest management for timber harvest by both industrial and nonindustrial landowners has become a contentious issue with regard to how logging practices and road building impact watershed resources via sedimentation, and other cumulative effects.

Erosion and Sedimentation

Ten of the 14 hydrologic units in the Region include water bodies impaired by excess sediment (DWR 2013). Some of the most sensitive beneficial uses are impacted by sediment. Those uses are associated with migration, spawning, reproduction, and early development of cold water fish such as coho salmon (*Oncorhynchus kisutch*), chinook salmon (*O. tshawytscha*), and steelhead trout (*O. mykiss*). Sedimentation is a naturally occurring process, and, when it is generated at natural levels, it is an important component in the aquatic environment. Sediment levels are naturally elevated during times of high rainfall and runoff and aquatic organisms possess life history strategies that have adjusted to the natural timing, duration, and levels of sediment. However, land use activities in the North Coast Region have accelerated erosion processes and altered the timing, duration, and amount of sediment delivery to levels significantly outside the natural range. Excess sediment has led to infilling of streams, which adversely impacts drinking water supplies, and causes degradation of salmonid habitat. Accelerated rates of erosion from land use practices impact the migration, spawning, reproduction, and early development of cold water anadromous fish.

Additional problems associated with excess sediment include:

- Decrease in the complexity of aquatic plant communities by decreasing light penetration
- Reduction in Dissolved Oxygen flow to and waste removal from salmon redds (nests)
- Decrease in the ability of juvenile fish to avoid predation
- Irritation of salmonid and other fish gills and destruction of the protective mucous that covers eyes and scales making fish more susceptible to infection and disease
- Unnatural aggradation of stream beds which contributes to creating barriers to migration of fish, and causes increased flooding
- Decrease in the availability of refugia—isolated habitats that retain environmental conditions that were once widespread
- Physical scouring of plants, insects, and other invertebrates from the streambed, thereby reducing food sources for fish
- Transportation of sediment-adsorbed chemicals, such as pesticides, from land to water
- Interference with disinfection of drinking water
- Interference with the delivery of water supplies by added wear on water pumps

Water Quality and Quantity

Legacy land use practices continue to impact water quality. Historic timber harvest methods caused extreme sedimentation and loss of canopy cover and agricultural practices led to clearing riparian vegetation, polluted runoff, and draining of wetlands. These, combined with other legacy road and infrastructure construction activities resulted in many aquatic and riparian ecosystems that were once suitable habitat becoming marginal or unusable.

Residential development and urban and suburban areas also have a large impact on nonpoint source pollution and water demand. Low density, exurban residential development is the fastest growing land use in the United States and the zone of exurban development is much larger than the combined footprint of urban and suburban development (Newburn and Berck 2011). It is particularly prevalent in areas of high amenity value surrounding protected areas, a description which covers much of

the North Coast Region. Residential development of any type has a large impact on aquatic ecosystems because there is little to no regulation on use of pesticides, fertilizers, or other pollutants such as cleaning supplies, automobile products, or other home and garden products. Improper or excessive use of these environmental contaminants can lead to serious impacts to the Region's waterways that are difficult to diminish or ameliorate.

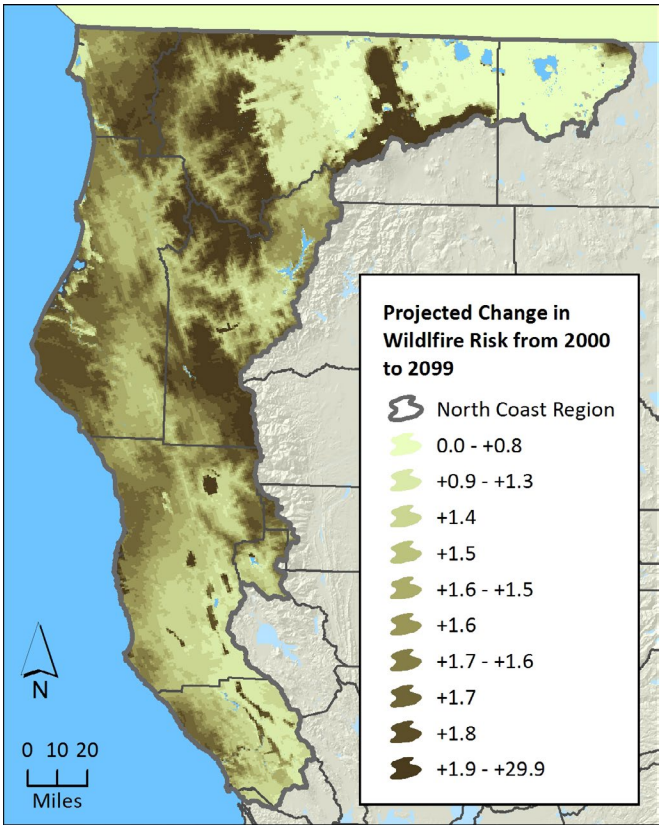
In addition to land use practices, channel modifications for flood control and water diversions for crop irrigation and drinking water supply have radically changed water quality conditions in many water bodies in the region. Ranney collectors—horizontal wells adjacent to or under the bed of a stream—provide the drinking water for many of the northern communities in the region. These collectors are actually collecting surface water, which decreases the amount of surface water available for other beneficial uses. Reduced natural flows from both Ranney collectors and instream diversions can result in increased temperature, decreased capacity to dilute contaminant concentrations, and decreased dissolved oxygen.

The state's legalization of medical and recreational cannabis has drastically increased cannabis cultivation in the North Coast, especially in the "Emerald Triangle"—Humboldt, Mendocino and Trinity counties. Unregulated (illegal) marijuana grows are ongoing problems in federal and state lands where creeks and streams are diverted, often running dry, and cultivation techniques involving fertilizer, insecticides, rodenticides are improperly conducted, leading to contamination of both waterways and the food chain. In many coastal watersheds throughout the region, significant, localized water diversions via riparian right have impacted listed salmonids region-wide, and affected water supply security for rural water users, communities, and small municipalities. These watersheds are approaching a population threshold where population is large enough to create water supply problems and aquatic ecosystem impacts, but too small to create community-scale water systems.

Climate Change Impacts

Climate change is expected to exacerbate and compound the challenges facing functional aquatic ecosystems. Increased heat, decreased rainfall, and increased frequency and intensity of precipitation events are expected to add to existing impairments (e.g. increased water temperature, decreased dissolved oxygen, and increased pollutant load) and threaten the survival of endangered salmonids and other aquatic and terrestrial wildlife as well as the continued viability of those dependent on high quality instream water supplies such as farmers, ranchers, and water dependent recreation purveyors. Fire risks are projected to increase across the region, increasing the probability of a "fire within the next 30 years" on average by 40% end of century (Micheli et al. 2016). In Del Norte County, a summer temperature increase of 3° F is projected by 2050, increasing to as much as 6° F by 2100; this temperature is expected to increase the fire risk by 250% by the end of the century (Earth Economics 2018). Following wildfires, watersheds experience increased landslides and sediment loading to streams, diminishing water and habitat quality. Sea level rise is projected to affect low lying coastal areas adjacent to the ocean and streams, especially during extreme high tides, winter storm events and episodes of large ocean swells. This increases potential for saltwater intrusion in coastal groundwater basins; but given the adequate coastal basin recharge that occurs, saltwater intrusion is not generally expected to be problematic in the North Coast (2ND Nature 2013).

Figure 16. Projected Change in Wildfire Risk



The North Coast Climate Vulnerability Analysis (2NDNature 2013) found an increased risk of water conflicts between urban, agriculture, and environmental beneficial uses of water due to expected changes in rainfall coupled with increased heat events: this is of concern because the Region has already been struggling with conflicts between water users. For example, the Klamath Project has been extremely controversial; to maintain adequate instream fishery flow to ensure the

survival of endangered salmonid populations, water to farms has at times been cut off to prevent harm to the fisheries, resulting in extreme controversy and conflict.. Likewise, environmental groups in the Eel River watershed are opposing relicensing of the Potter Valley Project, which diverts the Eel River into the Russian River watershed, providing irrigation water for farmers in the Potter Valley and downstream in the Russian River and also providing some electricity through a hydropower plant. Such controversies will be exacerbated if water availability decreases while demand increases as is projected by most climate models.

FUTURE OPPORTUNITIES, PLANNING, AND STRATEGY

Use Existing Information and Resources

There are many opportunities to reverse impacts from historic land use practices, reduce impacts of current practices, and avoid impacts from future practices. These include habitat restoration, habitat enhancement, invasive species removal, and changes to water management, or geomorphic structure that restore natural fluvial processes. The North Coast contains numerous groups working to restore existing aquatic and riparian habitats to their former structure, composition, and function. These include Tribal entities, Land Trusts, NGOs, cities, and counties, the State of California, as well as community members from a diversity of backgrounds, professions, and economic status. Foresters, farmers and ranchers have ever-increasing opportunities to practice agricultural lands stewardship and improve forest health; improved management practices are constantly being developed and refined. Partners such as Resource Conservation Districts (RCDs), Land Trusts, the US Forest Service Research Stations, University of California Cooperative Extension Service and Rural Community Assistance Corporation provide technical and financial assistance. Additionally, social and environmental value programs such as Fish Friendly Farming, the Sustainable Forestry Initiative, and the Forest Stewardship Council provide certification for goods produced using practices that use sustainable practices to ensure forest and agricultural lands health and protect fisheries, increasing their value, and thus providing an incentive to participate in use of beneficial BMPs. Several regional RCDs promote LandSmart®, a collaborative program that helps land managers meet natural resource management goals while supporting productive lands and thriving streams.

Continue Integrated Water-Land Planning and Management

Through the NCRP, multiple planning and implementation models have been developed with respect to freshwater ecosystems. For example, the Trinity County water planning tool contains recommended water policy changes to protect and enhance freshwater resources. The Yurok Tribe's Land Use and Residential Water Policies document provides a template for water resource-related goals, policies, and implementation measures, all designed with sustainable aquatic ecosystems in mind. The Yurok Tribe's Environmental Program contains a "Community and Ecosystems Division, which focuses on the interactions between environmental conditions and community health. The Hoopa Tribe developed a management model for decentralized wastewater treatment system planning, which enables small communities to review their options related to wastewater, including the introduction of cluster systems, which are generally more cost effective than treatment plants and offer benefits to individual septic systems with respect to water quality and land use. This model will help smaller communities to make feasible choices that will protect aquatic ecosystems. Humboldt County Resource Conservation District has developed a North Coast Irrigation Water & Fertigation Management Plan, which is an Excel workbook-based tool to inform producers of optimal water and fertilizer use for enhanced management of farm resources, maximization of crop production, and protect freshwater quality through minimization of fertilizer runoff.

The North Coast IRWMP synchronizes statewide planning priorities with local planning efforts to protect and enhance coastal resources; these efforts include Integrated Coastal Watershed Management Plans, which emphasize a programmatic approach and have specific objectives related to reducing pollution in impaired waters and sensitive habitats including CCAs, MPAs and ASBS. The four ICWMPs in the North Coast Region are: Russian River and Salmon Creek Integrated Coastal Water Management Plans and the Mattole, and Trinid-Westhaven Coastal Watershed Management Plans.

PRIORITY ACTIONS: POLICY AND STRATEGY RECOMMENDATIONS

Reduce Non-Climate Stressors

- Protect functional aquatic ecosystems from habitat loss, invasive species, and pollution, via land conservation, habitat restoration and public-private partnerships (CDFA 2013, DWR 2013, NCRP 2014, DFW 2016a,
- Prioritize aquatic systems providing habitat for known threatened, endangered, and special status species and native salmonids.
- Protect high value recharge zones and maximize subsurface storage in aquifers (DWR 2013, NCRP 2014, Micheli et al. 2016)

Plan for Projected Climate Change Impacts

- Make use of available climate and hydrology projections to determine optimal aquatic ecosystems for restoration, enhancement, and protection (Micheli et al. 2016)
- Seek vegetation management tools and treatments capable of reducing accumulated fuel loads and associated fire risks (Micheli et al. 2016)
- Develop plans for post-fire management that address strategies for native vegetation resilience and mitigation of impacts on watershed runoff (Micheli et al. 2016)
- Diversify local water supplies (CDFA 2013, DWR 2013, OPR 2018)
  - » Find innovative ways to capture winter precipitation, storm water runoff, and peak flows for use during dry seasons and recycle wastewater streams (Micheli et al. 2016)
- Adopt wetland and riparian area protection policies (DFW 2016a)
- Improve conservation planning alignment on policies and regulations between government agencies (DFW 2016a)

Evaluate and Improve Agricultural Lands and Forest Health Stewardship, and other Land Use Activities

- Broaden watershed focus by integrating working groups; engage Tribal groups and landowners in projects to understand land values to benefit water quality (DFW 2016a)
- Focus on agricultural and forest health stewardship activities (DWR 2013, DFW 2016a, DFW 2016b)
  - » Consider alternative irrigation and water efficiency techniques to conserve water and energy (DWR 2013, OPR 2018)
  - » Increase soil moisture holding capacity of soils where feasible through vegetation management or soil amendments. (CDFA et al. 2016, Micheli et al. 2016, OPR 2018a)
  - » Consider cultivation of plant and tree species likely to be suited for projected environmental conditions (CDFA 2013)
- Encourage low-impact development (CDFA 2013, DFW 2016a)
- Develop easement strategies with multiple objectives (DFW 2016a)

MULTIPLE BENEFITS AND VALUES: ECOSYSTEM SERVICES AND ECONOMIC BENEFITS

- *Conveyance and Delivery of Water Supply*—Functional aquatic ecosystems in the North Coast provide an abundance of water for human and environmental beneficial uses.
- *Effective Conveyance of Flood Waters*—Riparian vegetation and vegetated floodplains attenuate flood waters and trap large debris, protecting built infrastructure and facilitating groundwater infiltration.
- *Maintenance of Water Quality*—Living rivers improve water quality via biological processing of pollutants and physical filtering of sediments and organic material.
- *Wildlife Habitat and Regional Migration Corridor*—Vegetated floodplains provide wildlife cover/forage during migration; functional instream habitat provides habitat and migration routes for threatened/endangered salmonids and other aquatic organisms.
- *Recreational Benefits*—Functional aquatic ecosystems will provide the basis for water dependent recreation such as fishing, swimming, boating, eco-tourism, and other recreational opportunities.
- *Spiritual, Historic, Cultural, and Artistic Resources*—Functional aquatic ecosystems can serve as the basis for spiritual renewal, focus of folklore, symbols of group identity, motif for advertising, and enhances quality of life.
- *Increased instream flow for environmental, agricultural, and municipal purposes*: $80–120 per acre-foot per year (ECONorthwest 2014)
- *Increased water supply reliability*: $19–27 per household per month (ECONorthwest 2014)
- *Riparian habitat restoration*: $120 per acre per year (ECONorthwest 2014)
- *Wetland habitat restoration*: $2,000–4,000 per acre per year (ECONorthwest 2014)
- *Water-dependent recreation* is valued at:
  - » $65 per fishing day
  - » $52 per motorboating day
  - » $102 per non-motorized boating day (Rosenberger et al. 2017).
- *Avoided Costs*: Functioning aquatic ecosystems slow and spread stormwater, increasing groundwater infiltration; groundwater infiltration increases

water supply and lessens impacts to built infrastructure: this reduces costs of damaging flood events. The dollar value of this benefit is dependent upon the location and severity of the storm event and flooding (ECONorthwest 2014).

STRATEGY INTEGRATION

Strategy 2.1. Functional Freshwater Aquatic Ecosystems informs the multi-benefit priority strategies *Aquatic Ecosystems: Upstream Investments and Downstream Benefits* and *Natural Capital: Healthy Forests and Watersheds* outlined above in Section 2. The Functional Freshwater Aquatic Ecosystems strategy also integrates with the *Water and Wastewater Infrastructure Strategy* and the *Flood and Sea Level Rise Management Infrastructure Strategy*. The former is directly dependent on this strategy because functioning aquatic ecosystems improve both water conveyance and water quality; the latter depends on restoration of riparian habitat and floodplains to slow and absorb floodwaters, reducing damage to infrastructure from flooding events. The *Local Socio-Economic Capacity Focus Area* strategies also interact with this strategy: functional aquatic ecosystems provide multiple benefits that improve quality of life for all residents in the region. Likewise, social and economic factors influence the implementation of this strategy. The society must value functional aquatic ecosystems to approve of such projects and it must have the economic resources to accomplish them.

STRATEGY 2.2—NATIVE HABITAT & WILDLIFE CORRIDORS

INTRODUCTION

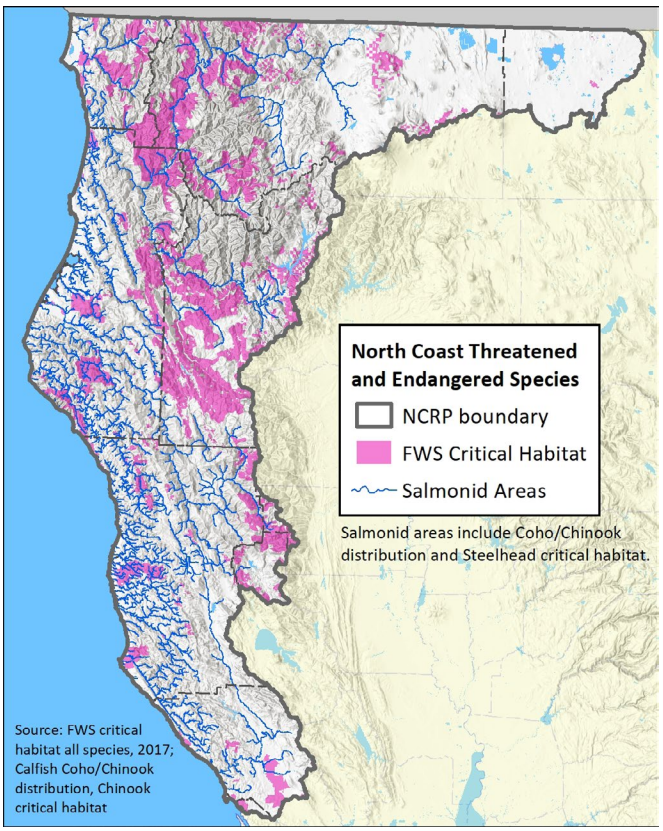
In the face of measurable changes to weather patterns induced by the changing climate, land conservation and habitat restoration are more important than ever to protect biodiversity. Wildlife species will need to migrate to access suitable habitat as habitat shifts occur due to changes in soil moisture, weather events, and temperature increases. The more habitat that is available, the more likely that each wildlife species will be able to successfully locate habitat conducive to its unique forage, shelter, and reproductive needs.

CURRENT CONDITIONS

The North Coast region's environmental resources serve as habitat for a large number of plant and animal communities and large corridors of undeveloped land allow for migration, dispersal, and genetic exchange between locations.

The Region contains many species of concern, including thirty federally endangered plant species, four federally endangered fish species (including salmonids), four federally endangered bird species, and seven federally endangered mammals (see *NCIRWM Plan Appendix H, Table 27*; NCRP 2014). Additionally, the region's mountains, valleys, forests, and grasslands are home to deer (*Odocoileus hemionus*), common garter snake (*Thamnophis sirtalis*), elk (*Cervus elaphus*), Vaux's swift (*Chaetura vauxi*), bear (*Ursus americanus*), southern torrent salamander (*Rhyacotrition vareigatus*), mountain lion (*Puma concolor*) and many other animal species.

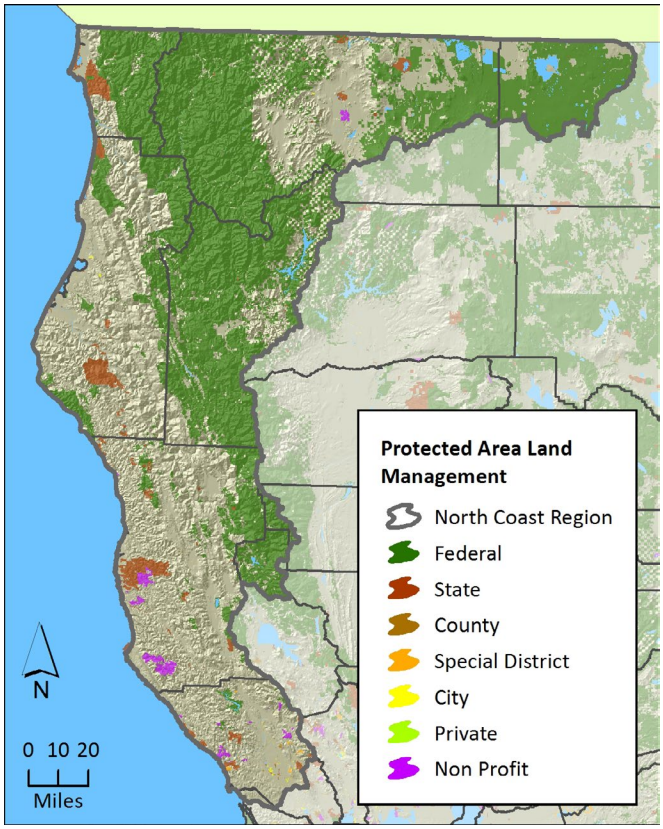
Figure 17. North Coast Threatened and Endangered Species Habitats



Approximately 49% of the North Coast Region land is permanently protected by public agencies (e.g. federal, state, local), private entities, or non-profit organizations. The North Coast IRWMP lists nearly 300 protected areas including parks, preserves, reserves, recreation areas, national/ state forests, private lands, and other sites in the North Coast Region (see Appendix H, Table 19; NCRP 2014). Conservation easements offer one means through which public agencies and non-governmental organizations (NGO) can sell parcels and keep them protected while retaining private or NGO management. Conservation easements comprise approximately 100,000 acres in Sonoma County alone. Functionally, "protection status" for these lands varies, depending on a number of factors, including how lands are managed. Extractive

and recreational uses may be permitted on some public and private "protected lands," depending on the specified management status and protections afforded thereby; other protected lands are managed to mimic natural disturbance regimes and maximize biodiversity.

Figure 18. North Coast Protected Lands Distribution



LIMITING FACTORS AND CHALLENGES

Land Use Practices

Land use practices that involved removal of riparian vegetation, channelization, dam construction, and other practices that led to channel incision, excessive sedimentation, increased stream temperature, and loss of migratory passage in stream channels led to a steady decline in salmonid populations. Sedimentation, increased water temperature, and chemical and biological pollution can reduce habitat viability and negatively affect at least some stages of the salmonid life cycle. Spawning salmon are known to require adequate surface flows in order to return upstream to their natal streams and clean, appropriately sized gravel in which to spawn; juveniles need intact complex habitat (a matrix of pools, riffles, large woody debris, and riparian vegetation) to provide shelter, food, cool water temperatures, and other factors necessary for survival; and smolts seek intact, unpolluted estuarine habitat to physiologically adjust to the saline environment prior to outmigration to the ocean.

Historically, habitat has been fenced off, native vegetation removed, movement corridors interrupted, and ecological function of many systems was destroyed or severely impacted. For example, buildup of fuels due to fire suppression has led to changes in composition and structure of forest and shrub land ecosystems; accumulated fuel has caused catastrophic canopy fires in systems such as oak woodlands that were formerly more open and frequently experienced ground fires that prevented fuel accumulation. Post-fire, lack of groundcover can lead to increased sedimentation and in extreme cases, landslides, when the rainy season occurs, exacerbating existing instream water quality issues and lengthening recovery time for the burned system.

Agriculture and Resource Extraction

Today, the major land uses in the Region that impact wildlife habitat are resource extraction (e.g. fisheries, timber harvest, and aggregate mining) and agriculture (e.g. vineyards, rangeland, dairies, row crops, and marijuana cultivation). Agricultural lands use significant volumes of water and a large portion of the water supply: irrigated agriculture accounts for about 80% of the developed uses of water supplies in the Region. Additionally, activities associated with agriculture, including grazing, fertilization, and soil disturbance can impact water quality through sedimentation and nutrient loading.

In addition to impacting water quality, agricultural lands also provide forage and habitat for wildlife (NCRWQCB 2011), and it is important to note that agricultural and rangelands protect habitat from urban development and provide connectivity between wildland parcels. A 2002 study of vineyards in Sonoma County found that while large predators were more likely to use native habitat, their numbers and activity levels were next greatest in vineyards adjacent to core habitat, underscoring the importance of the agricultural buffer and suggesting that riparian corridor restoration is important on these lands (Hilty and Merenlender 2004). For further discussion of issues and benefits associated with agriculture, please see Section 2.5, Agriculture and Working Lands Strategy.

Aggregate mining (in-stream and upland types) is the mechanical removal of aggregates (i.e. sand, gravel, and cobble) from the Region's river systems. Aggregates are used to make concrete and asphalt, and as road base/ sub-base and drain rock. Gold mining in streams also occurs. Sediment suspension and changes to channel morphology from aggregate and/ or gold mining has degraded salmonid habitat and impaired water quality.

In recent years, the timber industry has declined as a result of economic issues, changes in international markets, and the expansion of environmental regulations (NCRP 2014). Regulations regarding timber harvest

currently moderate sediment and temperature impacts to water bodies, but significant legacy effects from past practices are still present. Failure to manage national forests by thinning and harvesting has caused an unnatural massive buildup of biomass that has reduced water available to streams by canopy interception of snow and evapotranspiration in addition to setting the stage for catastrophic wildfires.

Urban, Suburban, and Exurban Development

Exurban development affects both agricultural and natural lands by fragmenting them as it "leapfrogs" beyond incorporated areas into unincorporated areas. Impacts from all types of residential development include loss of migratory/movement corridors, and stressors on water supply, water quality, air quality, and vegetative community composition in surrounding habitat as native plants are outcompeted by invasive landscape plants and weeds associated with increased human traffic.

Exurban development has been identified as the fastest growing land use in the United States (Wildlife Conservation Society, 2018). It is particularly prevalent in areas of high amenity value surrounding protected areas, and while not always visually obtrusive, it is one of the more consumptive development patterns with significant impacts to biodiversity and landscape cohesion due to fragmentation caused by roads and driveway networks as well as the development itself. Studies have shown a significantly reduced survival of native species with a corresponding increase in nonnative species in areas of exurban development. Additionally, exurban development was found to have a larger overall impact on sediment levels in salmonid spawning streams due to the tendency to "leapfrog" into watersheds with intact habitat (Lohse et al. 2008).

Climate Change Impacts

Added to the existing stressors on native habitats and wildlife in the North Coast are projected stressors associated with climate change. These include warmer temperatures, greater hydrologic variability, greater evapotranspiration and the associated increased water demand for landscapes and agricultural crops, variable runoff and groundwater recharge, increased wildfire risk, and shifts in natural vegetation types (Micheli et al. 2018). The shifts in vegetation patterns due to changing abiotic conditions will force wildlife to move to continue to live in habitat conducive to its needs. If such vegetation no longer occurs in protected areas, the wildlife dependent on that habitat may have nowhere to survive.

FUTURE OPPORTUNITIES, PLANNING, AND STRATEGY

The North Coast Region is fortunate to contain multiple entities that recognize the threats that land use, current development patterns, and climate change pose to native habitats and wildlife and who are studying how to address these issues. The Pepperwood Preserve in Sonoma County and other Bay Area and regional organizations are sharing their work with local resource managers as data sets and case studies featured on the California Climate Commons, which was established by the multi-jurisdictional California Landscape Conservation Cooperative. The Pepperwood Preserve's Terrestrial Biodiversity Climate Change Collaborative (TBC3) is leading development of empirically-based high-resolution climate-hydrology projections designed to support site-specific conservation solutions.

PRIORITY ACTIONS: POLICY AND STRATEGY RECOMMENDATIONS

Promote Legislation and Policy

- Promote legislation and policies that incorporate climate change planning into conservation lands planning, acquisition, and design (OPR 2018b).

Utilize Data-Based Planning and Management

- Modify existing conservation and open space management priorities to buffer species from the effects of climate change (Micheli et al. 2016).
- Several sources for climate and hydrology projections for conservation lands are available. Land managers are encouraged to use proven data and tools to determine optimal lands for protection (Micheli et al. 2016).
- Identify multi-benefit conservation values that include other land use priorities for management purpose (DFW 2018b)

Implement Comprehensive Monitoring

- Expand and improve monitoring programs to better understand ecosystem dynamics (DFW 2016b).
- Consider vegetation monitoring for stress and mortality, particularly during drought events, in locations identified with high vegetation vulnerabilities (Micheli et al. 2016).
- Tailor program to specific local/regional setting and define potential threats as specifically as possible to ensure usefulness of data collected (OPR 2018b).
- Collect and collate data about wildlife corridor use (e.g., roadkill, radio tracking, genetics) in and around agricultural areas to ascertain

management and other protection measures to ensure or enhance such uses (CDFW 2016e)

Practice Adaptive Management

- Reduce non-climate stressors, such as habitat loss, invasive species, and pollution, by continuing current management practices, such as habitat restoration and invasive species removal. Less-stressed systems will be more resilient to climate change impacts (DFW 2016b, OPR 2018b).
- Keep abreast of current research in climate adaptation and management techniques to preserve native habitat and wildlife corridors (Micheli et al. 2016)
  - » Prioritize preservation of landscape units with high topographic heterogeneity to allow for climate shifts over shorter distances, increasing the likelihood of overlap between current climate and future climate within a landscape unity and therefore increasing the likelihood of successful species migration and survival within that unit (Heller et al. 2015).
- Assist landowners to develop wildlife friendly practices on their working lands that can be sustained and co-exist with agricultural operations; the Wildlife Conservation Board accepts grant applications for habitat restoration projects on a continuous basis (WCB 2018).

Foster Innovation

The list of potential management actions to anticipate, respond to, slow, or facilitate climate-driven ecosystem change is rapidly expanding. Examples include (Micheli et al. 2016):

- Ensure genetically appropriate seed collection, propagation and ecological restoration that takes into consideration projected shifts in conditions due to climate change
- Species translocations
- Reevaluation of invasive species risks
- Re-creation of historical water flows (DFW 2016a)
- Facilitated ecosystem transformations

MULTIPLE BENEFITS AND VALUES: ECOSYSTEM SERVICES AND ECONOMIC BENEFITS

Recommended actions will improve, protect, and create native habitat and wildlife corridors while enhancing ecotourism and recreation, which are relatively new industries in the past couple decades, supporting and strengthening the existing North Coast economy. Economic benefits also accrue from the ecosystems services mentioned above (including water filtration, carbon sequestration, pollination). In fact, redwood forests were recently recognized as setting global records for biomass, leaf area, and carbon sequestration (Van Pelt et al., 2016).

- *Water Filtration*—Conservation lands, in addition to providing critical wildlife habitat and linkage corridors, are essential for maintaining and improving water quality.
- *Pollination*—Conservation lands support insects that facilitate the pollination of native plants as well as agricultural crops.
- *Wildlife Habitat*—Conserving wildlife habitat with an eye towards climate change may prevent species extirpation or extinction. Improved corridor linkages provide habitat for economically important fish and wildlife.
- *Carbon Sequestration*—New and enhanced conservation lands will produce oxygen and sequester carbon from the atmosphere, helping to ameliorate GHG emissions.
- *Recreation*—Enhanced conservation lands can provide the basis for outdoor sports, eco-tourism, and other recreational opportunities such as birding.
- *Spiritual, Historic, Cultural and Artistic Resources*—Conservation lands enhancement can serve as the basis for spiritual renewal, focus of folklore, symbols of group identity, motif for advertising, and enhances quality of life.
- Quantifiable monetary amounts associated with these benefits include (Fletcher and Soares 2016):
  - » Coniferous forests (including redwood forests) on average, provide about $2,628 in benefits per acre per year
  - » Mixed forests on average provide about $2,484 in benefits per acre per year
  - » Deciduous forests on average provide about $2,625 in benefits per acre per year
  - » Freshwater herbaceous wetlands on average provide $10,649–51,978 in benefits per acre per year depending if in agriculture, coastal, riparian, or urban areas
  - » Grasslands on average provide $168–29,814 in benefits per acre per year depending on whether they occur in agriculture, coastal, riparian, or urban areas
  - » Saline herbaceous wetlands provide about $18,823 in benefits per acre per year

» Shrublands provide $ 146–18,600 in benefits per acre per year depending on whether they occur in agriculture, coastal, riparian, or urban areas

STRATEGY INTEGRATION

Strategy 2.2 Native Habitat and Wildlife Corridors informs the multi-benefit priority strategy *Natural Capital: Healthy Forests and Watersheds* outlined above in Section 2. It integrates with and supports other Natural Environment Focus Area strategies in this document. For example, it directly supports the *Forest Health Strategy* by conserving forested lands within the landscape matrix. It also integrates with the *Near Shore Marine Areas Protection Strategy* through fishery habitat protection/enhancement; and water quality improvement. By protecting processes at the landscape scale, this strategy will safeguard and restore high quality instream flows to estuaries and protect natal habitat, enhancing the likelihood of salmonid species survival.

STRATEGY 2.3—NEAR-SHORE MARINE AREAS PROTECTION

INTRODUCTION

The estuarine and near-shore environments along the North Coast Region are extremely important to many species of waterfowl and shore birds, for feeding and nesting, and for anadromous salmonids, which use estuaries as a staging area to physiologically adapt to changes in salinity. Offshore coastal rocks are used for resting and reproduction by marine mammals and as nesting areas by many species of seabirds.

CURRENT CONDITIONS

Regional Distribution of Marine Areas

The North Coast region's nearshore marine environment exhibits high productivity and exceptional biodiversity due to persistent upwelling along the coast that brings cold, nutrient-rich water to the surface. These waters support blooms of phytoplankton, which form the foundation of a complex food web. The coast also contains many estuaries and littoral environments that are very significant, providing important habitat for a variety of terrestrial and aquatic organisms and are strongly affected by freshwater outflow. Examples include Lake Earl in Del Norte County, Humboldt Bay and northern lagoons, and Bodega Bay. Also in this category are the often extensive estuarine environments of many waterways, including the Smith, Klamath, Ten Mile, Noyo, Albion, Big, Navarro, Gualala, Mattole, and Russian Rivers and smaller waterways such as Redwood Creek.

Types of Marine Managed Areas

Legislative protection has been assigned to many of the region's estuarine, marine, and terrestrial coastal resources that are considered to be environmentally sensitive and in need of protection or improvement by federal, state, and/ or local government actions. In the mid-1990s, the California Coastal Commission began to identify coastal watersheds that deliver polluted runoff to coastal waters with recognized high resource value; in 2017, there were 23 Critical Coastal Areas (CCAs) in the North Coast Region. In 1999, the Marine Life Protection Act was passed; this act establishes a statewide network of protected areas identified by the California Department of Fish and Wildlife. These Marine Managed Areas (MMAs) include Marine Protected Areas (MPAs), State Water Quality Protection Areas (SWQPAs), and Areas of Special Biological Significance (ASBSs).

- *Marine Protected Areas*—MPAs are established for conservation and management of the natural marine resources and allow specific recreation and commercial activities. MPAs are primarily intended to protect or conserve marine life and habitat.
- *State Water Quality Protection Areas & Areas of Special Biological Significance*—ASBS are a subset of SWQPAs, which, like MPAs, are a subset of MMAs. ASBS are designated and monitored by the SWRCB through its water quality control planning process. In ASBS, water quality conditions are maintained to protect against impacts to marine aquatic life. A SWQPA is a non-terrestrial marine or estuarine area designated to protect marine species or biological communities from an undesirable alteration to natural water quality. In a SWQPA, point source waste and thermal discharges are prohibited or limited by special conditions in discharge permits. Nonpoint source pollution (NPS) is controlled to the extent practicable but no other use is restricted.

LIMITING FACTORS AND CHALLENGES

Water Quality

Inland water quality directly affects near shore water quality in the marine environment; where freshwater rivers are impaired, the estuarine ecosystems that receive their outfall are likewise impaired. Additionally, land use activities meant to improve inland conditions can have a detrimental effect. For example, consider the Redwood Creek estuary, where the summer water quality is poor. Degradation of water quality in this estuary is related to the construction of the Redwood Creek Federal Flood Control Project. While these levees provide beneficial flood protection to Orick, they have significantly impacted estuary function by altering

the physical setting of the estuary and sloughs. The condition of this estuary has been considered a major limiting factor to anadromous salmonid production in the Redwood Creek watershed (CWPAP & NCWAP 2006). Humboldt Bay is rimmed with multiple historic and abandoned industrial sites that require monitoring to ensure that contaminant plumes do not pollute the important Humboldt Bay oyster beds. Recent actions at the federal level have supported opening California's coasts to oil drilling. Impacts from the drilling activities as well as pollution from spills or accidents threaten all North Coast estuarine and nearshore ecosystems.

Sea Level Rise

Higher sea levels can inundate low-lying coastal areas, accelerate erosion of bluffs, beaches, and other coastal features; flood areas near the mouths of rivers and streams; increase the potential for levee failures; alter estuarine and aquatic habitats; and stimulate the intrusion of saltwater into estuaries and freshwater aquifers. A recent report by the Ocean Protection Council indicates that as climate change accelerates over the course of the century and the rate of freshwater input from the major ice sheets increases, sea levels are expected to rise faster along the California coast than elsewhere in the United States (Griggs et al., 2017). When storms, winds, and high tides cause storm surges, increases in sea level that appear inconsequential at other times may lead to substantial damage to shorefront properties and infrastructure, and increase the probability of injury and death. Where land is rising due to tectonic lift, the rate of sea level rise may or may not be exceeded by the rate of coastal uplift. For example, at Humboldt Bay's North Spit, sea level is rising by 18.6 inches per century (4.73 millimeters per year), the highest rate in California. At Crescent City, 80 miles north, sea level is dropping relative to the coastline by 2.5 inches per century. The shoreline at Humboldt Bay is subsiding, whereas Crescent City's coastline is rising (DWR 2013).

FUTURE OPPORTUNITIES, PLANNING, AND STRATEGY

The designation of Marine Management Areas serves to protect water quality and important ecosystems from further degradation, enhancing habitat and allowing for its recovery. Data from areas with pre-existing, long-established MPAs have shown increases in biomass and abundance of targeted fish species (CDFW et al. 2017). State and federal legislated protection has been assigned to many of the North Coast's significant estuarine, marine and terrestrial coastal resources. The State of California is actively working to protect its coast from potential oil drilling activities proposed by the federal government; this issue will be working its way through the court systems for the foreseeable future. Additionally, coastal counties are initiating and/ or supporting measures to deter drilling along the California coast. As sea level rise impacts increase throughout the nation and the world with respect to increased coastal flooding events, more focus has been placed on adaptation to sea level rise. Many resources for coastal managers are now available: these include planning models and documents, and general policy and ordinance templates. Additionally, monitoring data will be available through a publicly available interactive dashboard that serves as an online platform to learn about existing conditions and connect with the MPA monitoring community. Funding is available at the federal and state levels and through private foundations for adaptation planning and implementation; those communities that act quickly will be best prepared for storm surges and other impacts from rising seas. It is vital to take advantage of pre-disaster mitigation funding in particular.

Because local governments largely determine the future of coastal development through implementation of local land use plans and regulations, city and county general plans and ordinances can play a significant role in sea level rise adaptation. However, despite information on adaptation planning being available, many local governments lack the resources and guidance to assist them in integrating adaptation strategies into existing plans and regulations. Furthermore, in developing new regulations, the new and amended land use plans and ordinances must be able to integrate with existing local regulations as well as comply with existing state and federal laws. To this end, the State of California's recently updated its General Plan Guidelines to include guidance on incorporating climate change adaptation into local general plans. However, there are currently still no state-specific "best practices" examples for local governments to model sea level rise ordinances on. Nevertheless, the legal framework for doing so is explained in Herzog and Hecht (2013).

PRIORITY ACTIONS: POLICY AND STRATEGY RECOMMENDATIONS

Improve Water Quality Inputs

Mitigation of the water quality issues impacting North Coast Region freshwater aquatic ecosystems will directly improve the quality of waters draining into near-shore marine areas. Refer to *Strategy 2.1 Freshwater Ecosystems* for recommendations related to water quality.

Plan and Implement Strategic Retreat

Strategic retreat (also called planned retreat, managed realignment, managed retreat, set back, and de-embankment) entails establishing thresholds to trigger removal and relocation of development threatened by rising sea levels. As part of this process,

actively maintained defenses against storm surge and sea level rise will most likely need to be adjusted over time, typically further inland and to higher ground, in response to encroaching waters. Planning for strategic retreat entails first identifying vulnerable properties and structures and then developing incentives, such as regulatory, tax, and market-based tools, to encourage and achieve realignment. Strategic retreat options include the following (Reza and Tinsman 2018):

- Refined assessments of assets at risk
- Preservation and enhancement of coastal wetlands
- Transfer of development rights
- Purchase of development rights
- Zoning and development standards
- Rolling easements
- Fee-simple acquisitions
- Preservation of Open Space
- Infrastructure relocation

Conservation Activities

- Support Community MPA Collaboratives to ensure that local and regional expertise informs management decisions (DFW 2016d)
- Facilitate the distribution of publications to local communities and partners about MPA regulations, resources, and monitoring results (DFW 2016d)—be proactive in presenting science-based information to the general public and engage the community frequently with opportunities to ask questions and participate as volunteers in data collection, invasive species removal, and native species planting (Judge et al. 2017)
- Encourage marine resource assessments and monitoring on areas/ species, such as rocky intertidal, marine birds, marine mammals and eelgrass (DFW 2016d)
- Engage partners on the ground in data collection both on their own land (for buy in) and on their partners' land (to increase understanding of landscape level processes)
- Encourage coastal monitoring consistent with the State's Wetland and Riparian Area Monitoring Plan (DFW 2016d)
- Improve fish passage through use of estuary enhancement data (DFW 2016d)
- Consider development of a list of marine restoration options such as eelgrass, native oyster and salt marsh restoration, land purchases for habitat restoration to buffer from sea level rise, and other activities that would directly benefit MPAs and marine resources in general (DFW 2016d)
- Consider wildlife needs in management of water and floods in estuaries and wetlands (DFW 2016d)

MULTIPLE BENEFITS AND VALUES: ECOSYSTEM SERVICES AND ECONOMIC BENEFITS

- *Wildlife Habitat*—Estuarine environments are areas of high primary productivity and thus critical to the support of marine and coastal biodiversity. Coastal and estuarine habitats are critical for many species of waterfowl and shore birds, which feed and nest there. Intertidal areas throughout the Region are used extensively as nursery habitat for many types of marine organisms, including shellfish and fishes. Salmonids require estuaries as a staging area to physiologically adapt to environmental changes in salinity; many estuarine environments have been identified as critical habitat by NOAA.
- *Carbon Sequestration*—Coastal wetland systems have been recognized for the past decade as ecosystems that hold significant amounts of organic carbon in biomass compared to other terrestrial ecosystems.
- *Recreation*—Enhanced, protected estuaries and coastal wetlands will provide the basis for outdoor sports, recreational fishing, eco-tourism, and other recreational opportunities.
- *Spiritual, Historic, Cultural and Artistic Resources*—Estuary and coastal wetlands protection and enhancement can serve as the basis for spiritual renewal, focus of folklore, symbols of group identity, motif for advertising, and enhances quality of life
- Recommended actions will assist in protecting the region's coastal environments and fisheries resources, while enhancing ecotourism and recreation, which are relatively new industries in the past couple decades, supporting and strengthening the existing North Coast economy. Economic benefits also accrue from the ecosystems services mentioned above. These include (Fletcher and Soares 2016):
  - » *Bay/estuary ecosystems* provide about $13,091 per acre per year
  - » *Marine ecosystems* provide about $5,342 per acre per year
  - » *Saline herbaceous wetlands* provide about $18,823 per acre per year

» *Recreation* revenues per user per day are approximately $27 - $102 for sightseeing, swimming, hiking, boating, or fishing; $42 - $53 for picnicking or wildlife viewing; and $29.11 for camping (Rosenberger et al. 2017)

» *Community Vitality*—Coastal communities on the North Coast benefit from estuarine ecosystem health in the form of livelihoods, recreation, and the aesthetic, intrinsic , and dollar value of protected coastlines. Several North Coast communities, including Albion, Bodega, Crescent City, Eureka, Fort Bragg, McKinleyville, and Trinidad have been identified by NOAA as communities "substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs (NOAA 2007)." Commercial fishing makes up only 1% of the region's total business income; however, it generates multiplier effect jobs in the form of bait, ice, fuel, repair, and support for maintenance of marina and port infrastructure (CDFW et al. 2018).

STRATEGY INTEGRATION

Strategy 2.3. Near-Shore Marine Areas Protection informs the multi-benefit priority strategies *Aquatic Ecosystems: Upstream Investments and Downstream Benefits* and *Natural Capital: Healthy Forests and Watersheds* outlined above in Section 2. It integrates with *Functional Freshwater Ecosystems Strategy* ensures that clean freshwater is being delivered to coastal wetlands and estuaries. The *Native Habitat and Wildlife Corridors Strategy* protects fishery habitat and enhancement and improves water quality, safeguarding and restoring high quality instream flows to estuaries and protect natal habitat to enhance the likelihood of salmonid species survival. It also enhances the *Human Capital and Talent Strategy*.

STRATEGY 2.4—FOREST HEALTH

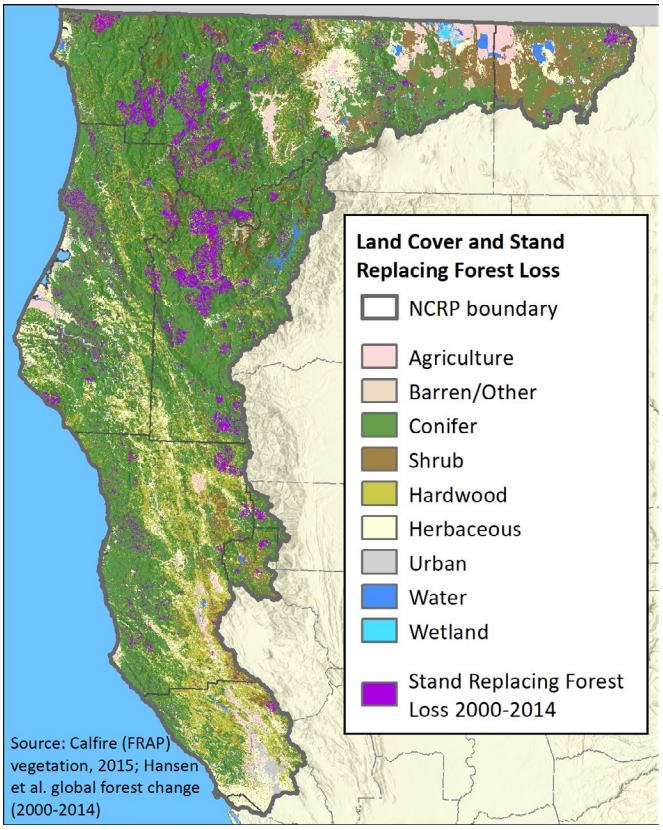
INTRODUCTION

Forested watersheds in the North Coast Region have significant ecological and economic importance. Resource extraction has historically been the major land use in the Region and timber harvest, which was more widespread historically, is still an important industry today. Watersheds covered in functioning, healthy forested landscapes provide important ecosystem services and support the region's economy in a number of different ways including recreation, tourism, generation of renewable energy, and the more traditional timber extraction based economic drivers.

CURRENT CONDITIONS

Forest is the dominant vegetation type in the North Coast Region. Approximately 3.5 billion hectares, or almost 70% of the Region is forested (Nickerson 2017). Though historically much more widespread and prevalent, timber harvest and thinning remains an important economic driver in the North Coast region. Much of the region's land is identified as national forests, state and national parks, under the jurisdiction of the US Forest Service, Bureau of Land Management, National Park Service and State Park agencies, in addition to Native American lands such as the Hoopa Valley and Round Valley Reservations. Large corporations, Native American Tribes, and smaller, family-owned companies conduct timber harvest operations. In the past few decades, the timber industry has declined as a result of economic issues, changes in international markets, and the expansion of environmental regulations to protect resources and ecological function.

Figure 19. Land Cover and Stand-replacing Forest Loss



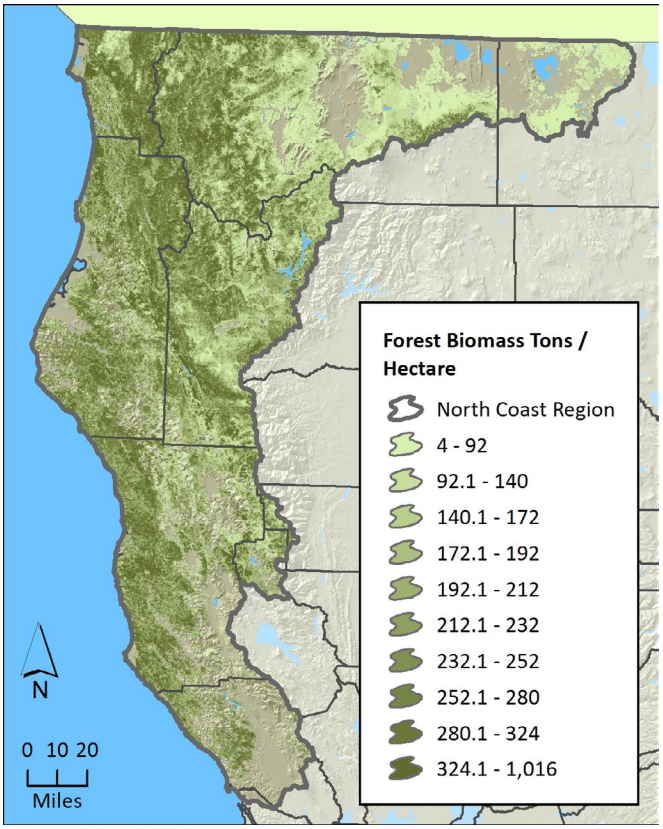
Increased regulations have also created new opportunities for foresters in the Region with respect to the carbon sequestration and the Cap-And-Trade Program. Natural and working lands are a key sector in the State's climate change strategy (ARB 2017, CalFire et al. 2017). Storing carbon in trees, other vegetation, soils, and aquatic sediment is recognized as an effective way to

remove carbon dioxide from the atmosphere (ARB 2017). Forests contain nearly 90% of terrestrial based carbon stores in the Region, or almost 4 gigatonnes of CO2e. The carbon densities in forests within the Region are among the highest in the United States (Nickerson 2017).

In addition to utilizing California's forests for carbon sequestration, the Air Resources Board (2017), in response to ARB32, the California Global Warming Solutions Act, recommends use of forest biomass to advance statewide objectives for renewable energy and fuels. Available biomass varies throughout the region: Humboldt and Mendocino counties have the highest forest biomass with the majority of land ownership as private (timber) companies. Siskiyou and Trinity counties also have high woody biomass availability, with different species and terrain. Trimmings from vineyards can potentially be a significant source of biomass for Sonoma County. In Del Norte County growth productivity is extremely high, but is mostly on public lands used for preservation/ recreation. Modoc County offers an opportunity to utilize a significant amount of biomass (i.e. western juniper being removed from 400,000 acres of sage grouse habitat). The annual supply of biomass for the Region is estimated at 2,337 MWs of operating capacity, assuming a 90% capacity factor. Given today's energy pricing that translates to annual revenues of $ 1.84 billion. Four facilities exist within the North Coast Region, with the majority of these being located in Humboldt County. In the past two years, two of them have stopped operations and a third is operating at partial capacity (Morris et al. 2017).

The NCRP has determined that sustainable harvesting of forest biomass/timber waste may provide a viable, low-GHG emission source of local energy, independence, and revenue when undertaken to provide multiple benefits to ecosystems and communities of the North Coast, a position echoed by CalFire in the California Forest Carbon Plan (2017), which promotes biomass utilization as an "innovative solution" to support ongoing forest management activities.

Figure 20. Forest Biomass



Finally, the recreation value provided by the forested landscapes of the North Coast Region continues to emerge as a stronger and stronger economic driver. For 2016 alone, overall travel spending in the Region totaled over three billion dollars with related tax receipts of over 256 million (VisitCalifornia, 2016). Managing forests for recreation continues to make good economic sense.

LIMITING FACTORS AND CHALLENGES

Salmonid Declines and Status

Although a multitude of factors have been identified as responsible for the continued decline in salmon numbers and distribution, sedimentation and loss of canopy cover have been identified as major impacts to streams where reproduction and rearing of juveniles occurs. Inadequate streamflow, impaired water quality (both sedimentation and increased water temperatures), and loss of access to upstream habitat are recognized as major causes of poor juvenile survival, which in turn affects reproductive success and ultimately, leads to continued population declines.

Timber Management

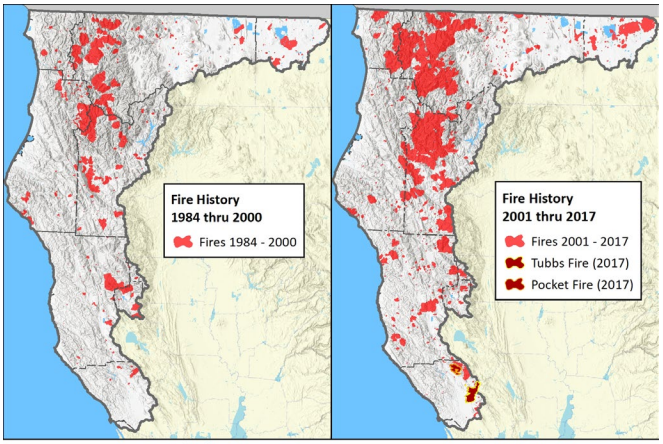
Management of timber lands by both industrial and non-industrial landowners has been a contentious issue with regard to how logging practices and road

building impact watershed resources, sedimentation, and cumulative effects of land use. The implementation of Best Management Practices (BMPs) and regulations requiring riparian setbacks have lessened these negative impacts, however, timber harvest, road construction, and related activities continue to cause habitat degradation to a more limited extent. Failure to manage some forests, especially by thinning and harvesting has caused an unnatural massive buildup of biomass that has reduced water available to streams by canopy interception of snow and evapotranspiration; this has contributed to the potential for extremely hazardous fire events.

Fire Management

California's forests were historically managed by Native Americans, who used low-intensity fire to favor desirable plant and animal species. Upon European conquest, a nearly comprehensive exclusion of fire on the landscape occurred; this loss caused forests that had typically experience fire frequently (as often as every 10 years in some cases) to miss fire cycles, known as Fire Return Intervals (FRIs). As more FRIs were missed, dead material began to accumulate and fire adverse species began to increase. Multiple missed FRIs resulted in overly dense stands composed of smaller trees and in some areas, a species shift, impacting habitat suitability, creating a homogenous forest landscape with few available niches, which respond similarly to disturbance. This phenomenon led to a homogeneous post-disturbance landscape, which varied greatly from historic conditions. With respect to carbon, more of the carbon in fire-suppressed forests is in vulnerable smaller trees and in the "dead pool," not in large pine trees. Limited resource availability stunts growth and reduces annual carbon sequestration and disturbance events (e.g., fire, drought, insect, disease) mobilize significant portions of forest carbon back into the atmosphere (CalFire et al. 2017). Over the last few decades, wildfires in California's conifer forest have grown bigger and have exhibited larger and larger uniform patches of severe fire. Fire severity has been increasing as well: in the 1800s, large tree death from fire was an uncommon experience, and by the 1980s, 20% of forests were severely burned (CalFire et al. 2017).

Figure 21. Historic and Projected Wildfire Extent



Source: CalFire Fire Perimeters v17_1 (2017)

The enormous costs expended on fire suppression have gutted many programs that include components of fire prevention. For the U.S. Forest Service, predictions are especially dire: "By 2025, two-thirds of the agency's expenses are likely to be tied up in firefighting, according to federal estimates" (Alexander, 2015). Thankfully, the recently passed Omnibus Bill (March 2018), includes an agreement that "creates an emergency pot of money for the U.S. Forest Service to use when it exceeds its fire-suppression budget, so federal agencies no longer have to dip into money earmarked for firefighting and prevention (Burton, 2018)."

Climate Change Impacts

Impacts to forests from climate change include warmer, drier growing seasons that increase risk of catastrophic wildfire and milder winter temperatures that increase risk of damage from insects and disease (2ND Nature 2016). Increased evapotranspiration rates are projected to increase climatic water deficit, a measure of drought stress, by approximately 10–19% by mid-century and 16-32% by end-century, while snowpack is projected to shrink from 60% of the Region during 1951–1980 to 29% of the Region by mid-century and to only 11% of the Region by end-century. These projected conditions are likely to favor drought-adapted species, potentially promoting expansion of chaparral and shrublands at the expense of woody species (Micheli et al. 2014), or favoring invasive species, which are generally able to thrive under a wider range of conditions than native species (Reza and Tinsman 2018).

Although tree mortality from bark beetles and cycles of drought are a part of the natural forest cycle, the recent drought and warmer temperatures have intensified the mortality. Conifer mortality tends to increase when annual precipitation is less than about 80% of normal and trees stressed by inadequate water are weakened to the point that they are highly susceptible to insect damage.

Areas with high tree density or trees ill adapted to the site are very susceptible to high levels of mortality and the extent to which that mortality occurs in influenced by stand dynamics (already heavily impacted from decades of fire suppression) and weather patterns. Thus dense stands are susceptible to bark beetle attacks because of stress caused by constant competition for limited resources, stressed trees are suitable hosts for more bark beetles, and successful colonization results in more beetles, and high levels of mortality. According to a USDA Forest Service risk assessment, California is at risk of losing at least 25% of its standing live forests to insects and disease over 5.7 million acres, or 12% of the total forested area in the state (CalFire et al. 2017). Modoc National Forest is among those expected to be hardest hit: 39% of its forests are considered at risk of mortality due to insects and disease. As drought becomes more severe and prolonged, the number of dead trees, and therefore fire risk, grows.

Although several factors affect the size and frequency of wildfires, the progressively warmer temperatures and associated drought stress projected for the Region are expected to contribute to an increase in wildfire size and frequency that models predict will worsen over time (Krawchuck and Moritz, 2012). Micheli, Dodge, and Flint (2016) note that the probability of fire over a 30-year period is expected to increase across the Region on average by 40% by the end of the century. Fourteen of California's 20 largest wildfires over an 86-year period have occurred since 2000 (CalFire 2018), leading some to conclude the combined effects of increased heat and drought are already contributing increased wildfire risk in California (Krawchuck and Moritz, 2012).

For foresters, an awareness of how these environmental stresses will impact individual tree vigor and stand dynamics is critical. Some of the most difficult climate change impacts to address are those that progress slowly and are therefore more difficult to recognize. Due to the long cycles involved in forestry harvests, this phenomenon is particularly relevant. Shifts in forest health and invasive species spread can have detrimental impacts on biodiversity, wildfire frequency—and harvest. Without careful monitoring, changes in forest composition and/ or structure may be missed during the early stages of forest succession.

Trespass Cannabis Growing

The ongoing impacts from unregulated and, in many cases trespass oriented, growing of cannabis, especially on public lands, has had a considerable impact on forest, wildlife and watershed health. A 2015 study in four northwestern California watersheds found that in the least impacted watershed, there was an estimated streamflow reduction of up to 23% of the annual seven-day low flow, while the in the other three watersheds, water demand for cannabis cultivation exceeded streamflow during the low-flow period. This diminished streamflow is likely to have lethal or sub-lethal effects on aquatic wildlife including state and federally listed salmonids and sensitive amphibian species. In addition to depletion of streamflow, many cannabis grows are managed with little regard for environmental impacts: forests are cleared and hilltops graded improperly to provide enough light for the crop, crops are cultivated on unstable slopes, pollutants (e.g., sediment, petroleum products, fertilizers, herbicides and pesticides) are used without precautions to prevent their spread into the surrounding forest, and BMPs to protect riparian and stream habitat are virtually nonexistent. Additionally, the grows are spread throughout the landscape in an attempt to avoid detection, converting forests to bare slopes and fragmenting once contiguous habitat with improperly constructed roads and poorly graded and maintained cultivation sites (DFW 2013).

Between 2011 and 2015 in California, more than 8,000 illegal outdoor grow sites were detected and eradicated with most of them on federally managed land; many of the sites are made up of several acres linked together by networks of poorly constructed, unauthorized trails and irrigation lines. In addition to pollutants from cultivation, grow sites contain human detritus: everything from tents to utensils to human waste is left out at the sites. Although progress to detect and clean up these sites is slowly being made through locally driven partnerships with federal and state agencies, significant impacts to the environment and public safety continue to be prevalent factors (USFWS, 2018).

Authority, Jurisdiction, and Capacity

For some parts of the region, the governance authority for forest management resides almost exclusively within the jurisdiction of federal agencies. The capacity of these agencies, their ability to work together collaboratively, and their ability to respond to community priorities all factor into the level of management efficacy. Although there are areas and instances of highly successful management and collaboration, generally this has been a challenge and gap in most of the affected areas. Additionally, even where collaboration has had some success, changes in agency personnel, budget limitations, shifts in nationally set priorities and other factors have reduced the full potential of these efforts.

FUTURE OPPORTUNITIES, PLANNING, AND STRATEGY

When implemented with watershed health and function in mind, many forest harvest activities have the potential to positively affect the beneficial uses of our surface

waters, forest, watershed, and community health, and climate change goals. Timber harvesting and forest fuels reduction operations provide an opportunity to decommission, replace or reconstruct legacy roads that are chronic sources of sediment inputs to surface waters. Fuels reduction projects can assist in reducing wildfire severity and thus can reduce post-fire sediment discharges and release of terrestrial carbon into the atmosphere. The multiple benefits associated with well-planned fuel management are discussed below.

Manage Forest Density for Multiple Benefits

Density management is the practice of thinning stands to favor the growth of a smaller number of commercially valuable trees; however, thinning provides multiple benefits with respect to ecosystem health, fire ecology, and alternative revenue streams.

Forest Health

Thinning forests makes them more resistant to insects and pathogens and selective harvest leaves habitat and movement corridors intact, protecting native wildlife. When specifically practiced for threat reduction management, includes "sanitation" harvests to remove biotic threats such as insects and disease and integrated pest management to minimize risks associated with invasive plants and animals. Mitigation and restoration work associated with thinning and selective harvest can provide opportunities for addressing legacy erosion sites and removal of fish migration barriers, which enhances salmonid recovery and provides local employment. Thinning can also be used to increase summer water yield by creating a balance of stand openings and ground shade to maximize snow accumulation on the forest floor. While this treatment can be used at all elevations and aspects, to increase summer water yield it is most effective between 4,000 feet and 6,000 feet elevation on northwest to east facing aspects (5C 2017).

Wildfire Risk Reduction

Thinning and fuels reduction activities reduce ignition sources and the associated risk of severe, landscape-level wildfires, protecting watershed function, wildlife habitat, and the associated economic benefits that local communities derive from intact forests. As discussed above, the recent trend has been toward more frequent, severe fires that completely destroy forests; however, a 2012 study of the Klamath, Mendocino, Shasta-Trinity, and Six Rivers National Forests found that, although wildfire size and frequency have been trending upward, the severity of wildfires has not been (Miller et al., 2012). The authors concluded that, under appropriate conditions, fire could be more extensively used in the Region to achieve management objectives. The Governor's Office of Planning and Research also recommends restoring and protecting forest ecosystem function by reintroduction of fire where appropriate (OPR 2018c).

Energy Production

The use of selective harvest and thinning of forests to produce biomass energy holds significant promise for enhancing current conditions and long-term resilience and stability of local rural economies. Biomass energy has higher, longer-lasting, and more localized economic impacts than most other renewables in that it is labor intensive to collect, process, and convert to power, contributing to greater energy independence while diversifying employment opportunities (Morris et al. 2017, Earth Economics 2018). Morris et al. (2017) found that biomass energy holds significant promise for enhancing both the current condition and long-term resilience and stability of local rural community economies along with the broader regional economy, and the state's California Forest Carbon Plan calls for biomass utilization to support sustainable forest management (CalFire et al. 2017). According to a model developed for Trinity County forests, thinning of 2,280 acres in the assessed areas would retain approximately 15 tonnes of stored CO2e per acre (12,500 tonnes total) that could otherwise be released when fire burns through the stands (5C 2017). Thinning of forests as part of ongoing efforts to restore fire resiliency and overall forest health will also provide a significant stream of biomass, which may be useful to a regional effort to develop biomass energy systems (Morris et al. 2017). Biomass energy systems could present an opportunity for multiple benefits for rural communities when combined with data centers that provide essential information technology needs (Earth Economics 2018).

Carbon Sequestration

Selective harvest and density management will favor the growth of large, resilient trees that store carbon over the many smaller trees that currently comprise most of the Region's forests. "A primary goal of the Forest Carbon Plan is to transfer stocks from many small, fire-vulnerable trees into resilient large trees (CalFire et al. 2017)." Without considering biomass utilization benefits from excess biomass removed during treatment, a recent Sierra Nevada study found that prescribed fire combined with mechanical understory treatments resulted in stands that sequestered within ten years the equivalent of carbon that had been removed during treatment. Additionally, the stands experienced positive net ecosystem productivity. These results show that such treatments shift carbon from smaller trees into larger, more resilient trees which had enough access to resources (e.g., soil nutrients, water, light) to grow into healthy forest stands (CalFire et al. 2017). California's climate objective for natural and working lands is to maintain them as a carbon sink, and to this end, the

Air Resource Board has developed a compliance offset program. As mentioned above (*see Existing Conditions*), the Region's forests contain nearly 4 gigatons of CO2e; as forest health stewardship improves, this amount is likely to increase. These forests represent an economic opportunity for revenue generation through "Carbon Offsets" sold in the California Cap-and-Trade market.

Tools are being developed to enable communities to analyze local carbon sequestration and GHG emissions levels based on existing and future projections of land use and land cover in order to make wise decisions regarding land use and conservation planning. The Conservation Carbon Accounting Tool (C-CAT) is a GIS model that estimates how changes in land use, land management and land cover affect landscape carbon sequestration and conservation values over time and helps to identify areas where conservation goals are aligned with emissions reduction potential. Developed for Sonoma County, it could be applied to counties elsewhere in California and throughout the US (TNC & SCAPOSD 2015).

Collaborative, Integrated, Regional Approach

The California Forest Carbon Plan promotes multiple strategies that protect and enhance forest carbon and the broader range of ecosystem services for California's forests. It calls for regionally-based efforts to identify the areas that pose the greatest threat to forest health and offer the best opportunities to restore resilience and urges landscape- or watershed-level collaboration with leadership by federal agencies such as the USDA Forest Service and Bureau of Land Management (CalFire 2017). The North Coast is fortunate to contain several Native American Tribes that possess both Traditional Ecological Knowledge and a strong scientific understanding of ecosystem processes and habitat restoration. Most of these Tribes are active members of the NCRP; their participation will greatly enhance any such collaborative endeavor.

PRIORITY ACTIONS: POLICY AND STRATEGY RECOMMENDATIONS

Practice Adaptive Management

- Careful management can maintain economic value, watershed function, and biodiversity (DFW 2016e, OPR 2018c).
- A monitoring program that is tailored to regional needs allows for responsive management of these systems and enables identification of areas where insects and disease, invasive species, and/ or tree mortality levels are high or increasing (Micheli et al. 2016).
- Manage forests for climate adaptation by considering potential climate effects, the spatial scale of response, timing and prioritization of adaptation efforts.
- Consider forests at the landscape scale to aid in prioritizing site and stand level actions to reduce threats to forest health and forest-based economies (Micheli et al. 2014).
- Manage forest composition by altering management regimes are altered to favor species that have characteristics suited to projected environmental conditions.
  - » There is uncertainty about how native vegetation may respond to changing climate conditions; long-term monitoring is need to better inform models with an improved understanding of mechanisms and trajectories of potential change (Micheli et al. 2014)
  - » Results from model simulations could inform planting choices to maximize timber harvest, carbon sequestration, and drought tolerance (Micheli et al. 2014)
  - » Development of mixed-species forests decreases risks associated with pest outbreaks and promotes greater genetic diversity and resilience (CalFire et al. 2017)
- Use tools such as C-CAT to provide analytical support for investments in landscapes from the State's Greenhouse Gas Reduction Fund through California's cap-and-trade program (TNC & SCAPOSD 2016)

Manage Forest Density for Forest Health, Wildfire Risk Reduction, Energy Production & Carbon Sequestration

- Practice density management; to increase summer water yield, thin stands between 4,000 and 6,000 feet in elevation on northwest to east facing slopes (5C 2017)
- Forest managers should seek vegetation management tools and treatments capable of reducing accumulated fuel loads and associated fire risks (Micheli et al. 2016).
- Fuel load reduction can also provide a significant stream of biomass, which may be useful to a regional effort to develop biomass energy systems (DFW 2016e, Morris et al. 2017, Woods 2018)
  - » When evaluating potential for biomass energy systems, scale is vital: the average biomass feedstock haul mile distance vs. the amount of total energy expended reached a threshold of diminishing returns at around 60 miles; the authors recommend

45 miles. To meet the goal of both reducing emissions and lowering energy use overall, a smaller geographic sphere of influence should be considered (Morris et al. 2017).

- "Managing forests in California to be healthy, resilient net sinks of carbon is a vital part of California's climate change policy (CalFire 2017)." The California Forest Carbon Plan calls for increasing the pace and scale of forest and watershed improvements on nonfederal forest lands, fuels reduction, invasive species removal, road improvements, prevention of forest land conversions through easements, acquisitions and land use planning, biomass utilization, and continued research and data management, including development and dissemination of tools to assist landowners.
  - » Carbon offsets offer a mechanism for private landowners to receive market-based incentives for maintaining and enhancing forest health. The California Air Resources Board issues carbon offset credits to projects meeting requirements in its Cap-and-Trade Regulation (ARB 2017).
- Post-fire management plans should be developed to address strategies for native vegetation resilience and mitigation of impacts on watershed runoff (Micheli et al. 2016).

Align Governance Priorities

- Managers of both public and private forests should expand collaborative approaches to landscape-level vegetation management and treatments (Micheli et al. 2014). With the vast majority of the forested lands in the Region being managed by federal agencies, alignment among agencies and collaboration with local communities is essential for successful implementation of these strategies (DFW 2016e).
- The policy and strategy recommendations above enact and help to accomplish the objectives of the State's climate change program, including increasing the use of renewable electricity (state goal of 50%), protecting and managing natural and working lands, and providing a strong natural resource foundation for a successful Cap-and-Trade program (CAB 2017).
  - » Assistance and collaboration from state agencies in aligning these efforts can help ensure the effectiveness of these efforts and serve as a model for other regions of California and the United States.

MULTIPLE BENEFITS AND VALUES: ECOSYSTEM SERVICES AND ECONOMIC BENEFITS

- *Water filtration*—Forested lands also maintain and improve water quality (specifically, drinking water quality). According to the Trust for Public Lands (in Ernst et al. 2004):
  - » For every 10% increase in forest cover in the source area (up to about 60% cover), water treatment costs decreased approximately 20%
  - » About half the variation in operating treatment costs may be explained by percent forest cover (the rest by facility and management practice variation)
- *Pollination*—Healthy forest systems support insects that facilitate the pollination of native plants as well as agricultural crops.
- *Wildlife Habitat*—Functioning uplands and riparian forests provide both terrestrial and instream habitat. Improved streamflows from proper management will provide habitat for economically important fish and wildlife.
- *Carbon Sequestration*—Forests store almost 4 gigatonnes of CO2e, or 90% of the carbon within the Region (Nickerson 2017). New and enhanced forest lands will produce oxygen and sequester carbon from the atmosphere, helping to mitigate GHG emissions. A recent carbon inventory for the North Coast found that the highest concentrations of above-ground carbon is stored within the redwood belt, particularly in state and national parks as well as Jackson State Demonstration Forest (Nickerson 2017).
- *Recreation*—Enhanced forests will provide the basis for outdoor sports, water-dependent recreation such as sport fishing, swimming and boating, eco-tourism, and other recreational opportunities.
- *Spiritual, Historic, Cultural, and Artistic Resources*—Upland and riparian forest enhancement can serve as the basis for spiritual renewal, focus of folklore, symbols of group identity, motif for advertising, and enhances quality of life.
- *Research Opportunities*—Parts of the region, especially in the Klamath Mountains, sit on the edge of climactic regions and also host incredible amounts of biodiversity. Research opportunities and centers, like the Klamath Bird Observatory (Oregon), UC Hopland Research and Extension Center (Mendocino County), Pepperwood Preserve (Sonoma County), and others can use these natural laboratories to study climate's effect on a multitude of species and ecologic processes.

- Recommended actions will generate a number of outcomes, including outputs for the local timber industry, enhancements for local ecotourism and recreation and local jobs through fire prevention and related activities, all while protecting key watersheds and ecological systems. Together, these can provide a diverse and thoughtful portfolio of economic engines that can support and sustain the communities of the North Coast region. Economic benefits also accrue from the ecosystems services mentioned above (including water filtration, carbon sequestration, provision of raw materials). These include the following (Fletcher and Soares 2016):
  - *Coniferous forests* on average, provide about $2,628 in benefits per acre per year (Fletcher and Soares 2016)
  - *Mixed forests* on average provide about $2,484 in benefits per acre per year (Fletcher and Soares 2016)
  - *Recreation* revenues per user per day average about $63 (Rosenberger et al. 2017)
  - *Carbon sequestration—existing*—In the counties that make up the North Coast of California, eight carbon offset projects have been completed which registered over $5 million in offset credits. Another 24 projects are planned, for another $12 million in registered offset credits (Earth Economics 2018).
  - *Carbon sequestration—potential*—Existing carbon credits sold in the North Coast are just a small fraction of the total carbon sequestration assets in the Region—nearly 4 billion tons of CO2e are stored in North Coast forests alone (Nickerson 2017); there is great potential in the Region for further use of carbon offset credits as a revenue source.

STRATEGY INTEGRATION

Strategy 2.4. Forest Health informs the multi-benefit priority strategy Natural Capital: Healthy Forests and Watersheds outlined above in Section 2. It integrates with the *Native Habitat and Wildlife Corridors Strategy* by recommending practices that manage the landscape for wildlife movement and habitat heterogeneity. Managing forests to minimize pest outbreaks and catastrophic fire events will lead to more open canopies and uneven-aged stands, which provide more diverse habitat for both aquatic and terrestrial wildlife. By protecting upstream forests from clearcutting and other improper practices, this strategy supports the *Function Freshwater Ecosystems Strategy*. Managing forests to increase the amount of snow that reaches the ground will increase infiltration to groundwater basins, increasing the cold water flow to important instream habitat and increasing water supply for both human and environmental Beneficial Uses. It will contribute to the *Near Shore Marine Area Protection Strategy* through fishery habitat protection and enhancement and water quality improvement. By providing high quality instream flows to estuaries and improving natal habitat conditions, this strategy will enhance likelihood of salmonid species survival. There are also significant links to the *Renewable Energy Strategy*, especially surrounding the potential sustainable utilization of forest biomass and biomass energy production. Links to the *Human Capital and Talent Strategy* cannot be overstated: with forests as the majority landscape cover for the North Coast region, forest watershed health has a direct impact on the quality of life, quality, and quantity of water supply and potential job and economic opportunity base.

STRATEGY 2.5—AGRICULTURE & WORKING LANDS

INTRODUCTION

Agriculture and working lands are an important part of the North Coast Region's economy, history, and identity. Agriculture as defined by the California Department of Agriculture includes crops, ranching, silviculture, and fisheries; however this section will address only cultivated crops and rangeland. Silviculture is addressed in *Strategy 2.4: Forest Health*, and fisheries are addressed in *Strategy 2.1: Functional Freshwater Aquatic Ecosystems* and Strategy *2.3: Near-Shore Marine Area Protection.*

Although not a geographically-large part of the Region's area (herbaceous rangeland covers 7.26 %; cultivated agriculture covers about 3.57%), agriculture looms large in the Region's identity: the southern part of the Region, "Wine Country," is known for its vineyards and fine wines, fresh organic vegetables, and artisanal cheeses while further north along the coast are dairies, ornamental flowers, and bulb production. Pasture, orchards, alfalfa, grain, and potato production accounts for much of the major inland agricultural enterprises. The Region is also home to the "Emerald Triangle," portions of Trinity, Humboldt, and Mendocino counties where conditions are favorable for cannabis cultivation, which was legalized in California in 2018.

CURRENT CONDITIONS

Water Supply

According to DWR (2013), irrigated agriculture in the North Coast uses most of the Region's developed water supplies (81% of non-environmental water

use), while municipal and industrial use comprise only about 19%. Approximately 422,300 acres in the Region are irrigated (3.4 %), and approximately 65% the Region's irrigated agriculture is in the Middle and Upper Klamath River basins (including Scott, Shasta, and Butte valleys and Tule Lake), above the confluence of the Salmon and Klamath rivers.

In the past twenty years, the acreage of orchards has declined and the acreage planted in vineyards has increased. Most of the newer grape vineyards use drip irrigation systems for irrigation allowing plantings in areas previously unavailable (i.e., sloping hillsides). This places a greater demand on the available water resources requiring surface water infrastructure improvements or reliance on groundwater (DWR 2013). There is also substantial water use occurring from cultivation of cannabis, much of which continues to be illegally grown on public lands; with respect to water supply, this can result in the complete diversion of streams which provide natal habitat for endangered salmonids or provide food and shelter for other wildlife.

Municipal recycled water is provided by 15 public and private water suppliers in the North Coast Region; about 8,700 acre-feet were provided for agricultural irrigation by nine recycled water suppliers, including several cities in Sonoma County and the California Department of Corrections and Rehabilitation at Pelican Bay. Use of municipal recycled water for agriculture is one way that the NCRP members implement the DWR's Resource Management Strategy of matching water quality to use. For the most part, agriculture can usually utilize lower quality water than most urban users, but some crops will be sensitive to certain constituents such as boron, and there may be perception issues with using treated wastewater for some applications (e.g. irrigating crops meant for human consumption or high end products like wine), although this backlash is diminishing as drought conditions continue.

Water Quality

Although agricultural lands stewardship has improved significantly in the past twenty years, there are still environmental impacts associated with agricultural activities. Agricultural activities are associated with sedimentation, nutrient loading, increased water temperatures, and decreased Dissolved Oxygen in the Region's waterways; however, they are not the only source of these contaminants. Silviculture, urban, suburban, and exurban development, and other land use activities also contribute to water quality impairments.

Land Conversion

The trend for agricultural land in the past few decades has been one of land consolidation to form larger holdings and the conversion of prime agricultural land to urban and suburban growth. Exurban development occupies about 14% of the land area in the US and it has been found to pose a greater threat to farmland loss than urban or suburban development (Newburn and Berck 2011). Trends toward larger holdings and conversion is thought to be a result of low crop values, the lack of additional inexpensive surface water, and the ability to use only the most economically developable groundwater (DWR 2013). The cost of environmental regulation and uncertainty of continued water supply for irrigation also contribute to decisions to convert or sell farmland.

Socioeconomic and Environmental Factors

Agricultural enterprises in the Region are valued by most North Coast residents for a variety of reasons not always associated with the wide array of food produced. Many of the cities, particularly in the southern part of the Region, use zoning regulations to protect agricultural lands in order to maintain pastoral viewsheds and the recognized environmental benefits these lands provide (see below for further discussion). Agricultural lands also serve as a type of corridor between large habitat patches and often provide a buffer between natural lands and urban or suburban development.

LIMITING FACTORS AND CHALLENGES

Many of the current conditions of agriculture in the North Coast that are described above could also be considered limiting factors and/ or challenges. These are addressed below through the lens of the newly (state) legalized cannabis industry and projected changes in climate.

Trespass Cannabis Growing

Although cannabis cultivation is now legal in California (since January, 2018), regulation and enforcement on this crop is in its early stages and it is likely that many growers will continue—at least in the short term—with unsustainable cultivation practices, which include stream diversion (up to 100% of flows), use of rodenticides that accumulate up the food chain and harm apex predators such as Pacific fisher, marten and spotted owl, sedimentation from improperly developed roads, and pollutants from fertilization, generator fuel spills/ leaks, and pollutants from campsites used by those who tend the crops. The water supply and quality impacts associated with illegal cultivation of marijuana are not well quantified, but anecdotal evidence from local experts indicates that these impacts are substantial and growing (for more information, see North Coast

Integrated Regional Water Management Plan Section 6.3.1: *Issues for North Coast WMAs*; for information about how cannabis cultivation effects forested lands in the Region, see *Strategy 2.4 Forest Health*). The amount of unregulated marijuana grow sites has "exploded" since 2007, with hilltops leveled to make room for the crop and the sites steadily increasing in size (Barringer, 2013).

Climate Change Impacts

Findings from the NC Vulnerability Assessment (Climate Change Vulnerability Assessment for the North Coast IRWMP, 2NDNature, 2013) suggest that agriculture has a moderate-high vulnerability to projected climatic/ hydrologic conditions expected from climate change. The impacts of potential climate change on agriculture (particularly viticulture suitability in the Region) are "substantial," leading to possible conflicts between land use and freshwater ecosystems (Hannah et al. 2012). Projected conditions associated with climate change that are expected to impact agriculture include higher temperatures, which will lead to higher evapotranspiration rates and longer growing seasons and therefore higher agricultural water demand. Increased climate variability is a given under all climate projection models: these variations year-to-year and within a growing season will have a disproportionate effect on agriculture, particularly for perennial crops where there is one opportunity per year, and a short window, for flowering, pollination and/ or fruit set. The major impacts of expected climate patterns on agriculture in the North Coast are described below; nearly all of these impacts can be ameliorated to some extent by improved agricultural lands stewardship.

Crop Type Changes and Geographic Pattern Shifts

Climate is likely to become unsuitable for high value crops such as grapes, fruits and nuts. Zones of suitability for fruits and nuts, especially wine grapes, will be reduced with rising temperatures and the associated loss of chill hours. New or modified farming techniques may mitigate the need to change growing locations to some degree, and it is possible that some types of crops grown in certain areas could benefit from projected climate and hydrologic changes, but this would be the exception rather than the rule.

Additionally, weeds are likely to migrate northward and become more difficult to combat as many respond to increased atmospheric CO2 with increased growth rates (Roberts 2009). Likewise, crop diseases and insects are expected to expand their ranges northward and may be more difficult to combat due to wetter springs and/ or warmer winters.

Enhanced Forage Production but Reduced Forage Reliability in Drought Years

Cattle ranching is one of the top 5 grossing agricultural industries in 6 of the 7 North Coast counties that depend on reliable forage production. Complex interactions of enhanced CO2, temperature increases, and hydrologic changes contribute to uncertainty of changes.

Longer Growing Season with Shift toward Longer Summers

While many crops in the Region are affected by this impact, growers can adjust to changes simply by planting earlier in the season, developing and/ or using heat resistant varieties, and improving irrigation efficiencies.

Increased Wine Grape Yields but Reduced Wine Grape Quality

Climate changes will alter the economics and distribution of vineyard and wine producing regions; Willamette Valley in Oregon is projected to have a climate in 2050 similar to Sonoma County's present climate. Exposure to this impact is based on economic importance of these crops. Growers can adapt with developing and/ or using heat resistant varieties, but a climate that will be as warm as Sonoma and Mendocino counties are projected to be in 2050 would be more likely to be a table grape Region rather than the fine wine varietals for which the Region is currently known.

Increased Irrigation Water Demand in Summer

Hotter, longer summers will mean that that most crops will require more water. Current water demands for crops and ecosystem services are the key existing stressors that will be exacerbated with projected climate changes. Conservation practices or crop type changes contribute to adaptive capacity.

Increased Risk of Field Damage from Flooding in Coastal Low-lying Areas

The greatest increase in the risk of damage due to floods is in coastal low lying areas. Land use maps indicate that much of the agriculture in the Region occurs in coastal lowland areas such as Arcata and Crescent City with some degree of exposure to flood damage, but is a small percent of land use in the Region. As sea level rises, progressive flooding and inundation of low-lying areas as well as increased cliff and bluff erosion is expected. The DWR (2013) conducted a risk assessment of flooding based on the rate and magnitude of expected sea level rise; according to their analysis about 25% of agricultural crops will be exposed to 100-year flood events and about 26% of agricultural crops will be exposed to 500-year flood events. The value of the exposed crops

is estimated to be $84.0 and $87.7 million respectively. Flooding damage will also dependent on rainfall pattern changes which are less certain than sea level rise.

Sea Level Rise

With respect to sea level rise, it is anticipated that there will be a reduced viability of coastal agriculture due to increased soil salinity.

Vegetation Water Needs

Expected moisture deficits in non-irrigated agriculture, landscaping, and natural systems will lead to increased agricultural irrigation demand to avoid crop losses at a time when it is likely there will be increased urban water demand. Climate change has the potential to drive changes in viticulture that will impact the Region's ecosystems and threaten native habitats: damage to freshwater habitats is generally highest where water is already scarce (Vorosmarty et al. 2010). Changes in viticulture practices could affect land use (e.g. establishment of vineyards at higher elevations, leading to conversion of upland areas) and/ or water use (e.g. increased water use for irrigation and crop protection, leading to freshwater conservation conflicts). Damage to freshwater habitats is generally highest where water is already scarce (Vorosmarty et al. 2010).

GHG Emissions and Carbon Sequestration

Agricultural operations are both a source of greenhouse gasses and a carbon sink. Agricultural soil management practices are the main source of GHG in agriculture with 68% of emissions coming from soil management; most of these emissions are N2O, the worst of the GHG in terms of global warming potential. Other direct emissions sources include production and application of fertilizers, pesticides and other chemicals and animal manure and associated gasses. Indirect sources include fuel for pumping water, running equipment, heating greenhouses and energy used for packaging, processing, storage and distribution. Agriculture also holds much potential for carbon sequestration and it is estimated that improved land management could offset as much as 25% of fossil fuel emissions (Sherr and Sthapit 2009), with soil carbon sequestration alone offsetting as much as 15% of fossil fuel emissions (Lal 2004).

FUTURE OPPORTUNITIES, PLANNING, AND STRATEGY

Agricultural enterprises in the North Coast contribute to the Region's high quality of life through provision of fresh, local, food, and employment, providing scenic and physical barriers to urban and suburban development, and maintaining the Region's historic economic foundation. There are many opportunities to address challenges and limiting factors in agriculture and improve agricultural lands stewardship. These include increasing value-added food based manufacturing in order to retain agriculture businesses, expand the manufacturing sector, and capture the agriculture profit leakage that occurs when bulk crops are exported out of the Region. Planning for expected conditions associated with climate change makes evaluation and cultivation of different varieties or types of crops an important strategy as well as a new opportunity.

PRIORITY ACTIONS: POLICY AND STRATEGY RECOMMENDATIONS

- Improve Agricultural Lands Stewardship: The NCRP report *Climate Change and Agriculture in the North Coast of California* (Roberts 2009) identifies project-level agricultural BMPs that will reduce GHG emissions and increase soil carbon sequestration and economic incentives and policy specific to agriculture. These include:
  - » Carbon farming, the practice of applying compost to rangeland soils, which increases carbon in soils and water and nutrient holding capacity (CAN 2015, CDFA et al. 2016, Woods 2018) (https://www.marincarbonproject.org/carbon-farming).
  - » Organic farming operations provide multiple opportunities to reduce agricultural GHG emissions and sequester carbon; a twelve year study in California showed a 36% increase in carbon sequestration with the use of organic practices such as green manures and animal manures despite increased tillage compared to the conventional system (CAN 2015).
  - » Farmscaping describes a broad range of agricultural practices that incorporate perennial and annual flora into agricultural production to benefit both farm productivity and the environment; these practices include hedgerows along farm margins, riparian buffer zones and winter cover crops (CAN 2015).
  - » Methane digesters and on-farm electrical generation (ARB 2017) (https://www.epa.gov/anaerobic-digestion/farm-digester-projects). In an analysis conducted specifically for the North Coast Region, The Watershed Research and Training Center found that together with forest products, agricultural based biomass resources could support the development and operation of appropriately scaled biomass energy systems (Morris et al 2017). (http://www.northcoastresourcepartnership.org/resources/)

  - » Switch to alternative irrigation techniques to use less water and less energy; in some cases conversion to alternative irrigation techniques can be funded as offsite mitigation of GHG emissions as part of a project's CEQA review. Local jurisdictions can support alternative irrigation techniques through partial or full coverage of cost and/ or technical support (CAN 2015, Reza and Tinsman 2018).
  - » California Climate and Agriculture Network (CalCAN) Cap-and-Trade. CalCAN's goal is to secure revenue to incentivize agricultural practices that mitigate climate change (DFW 2016 c, ARB 2017)(http://calclimateag.org/cap-and-trade/).
  - » Soil Best Management Practices (DFW 2016c, ARB 2017) (http://agwaterstewards.org/practices/soil_management/).
  - » Habitat Restoration (DFW 2016c) (https://wcb.ca.gov/programs/agricultural-lands).
  - » Surface storage: rainwater catchment for agricultural uses has increased in the North Coast in the past decade as water balance analyses have shown that the Region receives adequate rainfall to support all beneficial uses of water, but that the timing of the rainfall is out of step with water demand, which is high for all beneficial uses during the summer dry season. The North Coast Regional Water Quality Control Board is supportive of efforts to provide off-channel storage for summer agricultural use as an alternative to summer instream withdrawals to protect salmonid populations (NCRWQCB 2011) and California's Healthy Soils Action Plan (CDFA et al. 2016) promotes on-farm water storage for soil health.
  - » Diversify crop choices and take advantage of local microclimates to enhance resilience to changing climatic conditions (OPR 2018d).
  - » Diversify potential sources of farm income, including value-added products, agricultural tourism, roadside stands, organic farming and farmers' markets (Reza and Tinsman 2018).
- Evaluate, identify and map locations within the Region that have ideal characteristics for soil carbon sequestration and water infiltration to improve soil health, food production and resilience to climate change impacts and drought (CDFA et al. 2017).
- Policy and economics as incentives: local governments can institute new ordinances, zoning laws, pricing policies, and land use practices that support agriculture and limit conversions of wildlands, incentivize carbon sequestration, generate energy from biogas, improve agricultural water efficiency, and use conservation easements to protect agricultural operations and land.

MULTIPLE BENEFITS AND VALUES: ECOSYSTEM SERVICES AND ECONOMIC BENEFITS

- Agriculture provides an array of benefits, such as maintaining local food sources for Californians, enhancing biodiversity and wildlife habitat, carbon sequestration, water filtration and groundwater recharge. Protecting agricultural lands is one of the ways that North Coast municipalities and counties can implement the DWR's "Recharge Areas Protection" Resource Management Strategy (DWR 2013).
- Additionally, research suggests that conserving farmland at the urban edge slows the spread of sprawl and reduces transportation-related GHG emissions (Wassmer, 2008). These agricultural lands around urban areas may help to cool the "heat island" effect created by albedo in cities and other developed areas. This cooling would help offset impacts associated with increased temperatures (Weare 2009, Wildinson 2002). Finally, a study based in California suggests that ecosystems adjacent to farmland provide enhanced ecosystem service benefits due to this proximity (Chaplin-Kramer et al. 2011).
- Some of the economic values of ecosystems services provided by agricultural lands include (Fletcher and Soares 2016):
  - » Cropland in the North Coast Region provides an estimated benefit of between $46,246,075 and $ 147,464,689 per year
  - » Pasture in the North Coast Region provides an estimated benefit of between $63,567,976 and $ 80,868,886 per year

STRATEGY INTEGRATION

Strategy 2.5. Agriculture and Working Lands informs the multi-benefit priority strategies *Aquatic Ecosystems: Upstream Investments and Downstream Benefits*, *Natural Capital: Healthy Forests and Watersheds*, and *Human Capital: A Place for People* outlined above in Section 2. The *Agriculture and Working Lands Strategy* also integrates with the *Water and Wastewater Infrastructure Strategy*, because functioning irrigated agricultural lands require water conveyance and water quality and it also supports the water supply and quality through provision of groundwater filtration and recharge. The *Renewable*

Energy Strategy is supported by specific actions taken by agricultural landowners such as m Methane digesters and on-farm electrical generation. The *Human Capital & Talent* Strategy also interacts with this strategy: functional agricultural lands provide multiple benefits that improve quality of life for all residents in the region. Likewise, social and economic factors influence the implementation of this strategy. The society must value functional agricultural land to approve of such projects and it must have the economic resources to accomplish them.

FOCUS AREA: LOCAL SOCIO-ECONOMIC CAPACITY

STRATEGY 3.1—HUMAN CAPITAL & TALENT

INTRODUCTION

Despite historically economically challenged communities and a series of boom and bust economic cycles, the communities of the North Coast Region continue to approach their future with a remarkable level of tenacity and optimism. The North Coast Resource Partnership is recognized statewide for its ability to organize and leverage this energy—and uses this momentum to help to support and guide the Region towards a more resilient future. Creating, nurturing, and retaining human capital and talent in the North Coast Region is a critical factor in current and future success of local communities and the region. Human capital and talent—the social resources of the Region—are as important to its future as its natural and built infrastructure. Identifying, empowering, and tapping into existing social capital is vital to leverage and multiply human potential to continue on a path towards a resilient and viable North Coast Region.

CURRENT CONDITIONS

Local socio-economic conditions are described for the portion of each county that occurs in the North Coast hydrologic region, except for Siskiyou and Modoc Counties, where conditions are described for the entire county.

Demographics

Population—With a projected 2018 population of 803,324 (ACS 2016) trends indicate that the North Coast Region will only grow by another 140,000 residents by 2060. The majority of that growth will be absorbed by Sonoma County, with Mendocino County accommodating the next-largest population increase (Demographic Research Unit, 2018). Most counties will see modest increases. Modoc County is the only county in the Region expected to lose population over this same time period.

Age—The median age of the Region is 43.54 years of age with Trinity County being the oldest (50.6 years) and Humboldt being the youngest (37.6 years) (ACS 2016). This is older than the statewide average of 36.

Income, Economic Status, Poverty, and Employment—Median household income varies widely, with Sonoma County being the highest at $66,833 and Trinity County being the lowest at $35,270. Other counties range from $38, 524 to $43,510 (ACS 2016). In total, 24% of the Region's population and 33% of its geographic area (4,132,912 acres) are considered economically disadvantaged. An additional 20% of the Region's population and 45% of its area (5,536,820 acres) are considered severely economically disadvantaged (combined: 44% of the population and 78% or 9,669,731 acres of its area) (Reza, 2018).

The North Coast Region's poverty status is generally higher than the rest of the state's rate of 11.8% of individuals living in poverty (CA DOF 2017a). Of the seven NCRP counties, Sonoma (7%), Modoc (8.4%), and Humboldt (11.2%) exhibit poverty rates below the state average. For the other counties, poverty rates are as high as 16.7%(Del Norte County).

Modoc and Sonoma counties have unemployment rates (6.8% and 7% respectively) lower than that of the state as a whole (8.7%), while Del Norte (10.4%), Humboldt (9.5%), Mendocino (11%), Siskiyou (11.7%) and Trinity (9.9%) have larger unemployment rates in keeping with their high poverty status and large number of Economically Disadvantaged Communities (Reza 2018). Modoc County is an apparent anomaly; these statistics may suggest that while similar percentages of inhabitants are employed in Modoc and Sonoma County, Del Norte employees are paid less for similar work, or that the work they do, and related industries, are less profitable.

Health Insurance Coverage—There are approximately 90,516 individuals in the North Coast who are not covered by health insurance. Although Trinity County has the highest percentage of its population uninsured (16.4%), Sonoma County has the highest number of uninsured individuals (48, 872)—over half of the region's uninsured (ACS 2016). Combined with low wages and existing poverty levels, this conditions is a significant impediment to developing potential human capital and talent.

Education—Regionwide, approximately 87.59 % of the population has graduated from high school (or equivalent) and 5.96% of the population has a BA degree or higher. The Region is slightly above the California average for high school completion and slightly below the average for college completion. Trinity is an interesting anomaly in this data set with high marks of 90.7% for high school graduation but on the lower end for college graduation (20.1%).

Resilience of Individuals and Organizations

Although the populations of the North Coast Region have weathered multiple boom and bust economies and demographic challenges over the course of their history, they are also remarkably resilient. There are many examples of communities and organizations working together in creative ways to achieve desirable goals. These include Redwood Coast Energy Authority (RCEA) (Humboldt County) and Sonoma Clean Power (Sonoma and Mendocino counties). Of particular note are the examples of Tribal communities within the region. Although subject to near extermination by emigrating settlers in the 1800's, a number of Tribes have re-emerged as science-based innovators and political leaders in fire management, river restoration, renewable energy, and other disciplines (e.g. Yurok Tribe, Karuk Tribe, Hoopa Tribe). The entire Region can benefit and learn from the incredible resilience of North Coast Tribal communities.

Major Economic Drivers

The economies of the North Coast Region are concentrated mainly around two overlapping sectors: government employment and the service sector (education, health, and social services), which together comprise 30% of the employment base. Government employment alone is 20% of Del Norte County's economy. The remaining 60% of the economic base is surprisingly diversified, with a wide combination of other sectors each representing 8-10% of employment (ACS 2016).

LIMITING FACTORS AND CHALLENGES

Disparities between Region and State

As a Region, the North Coast is older, less affluent, less racially diverse, and less educated than the California average. Although these factors represent significant challenges, there are also many shared values, such as an appreciation for the Region's astounding natural beauty and widespread support of its agricultural heritage, that compensate. Additionally, for over a decade, the NCRP has proven that individuals and communities with widely different lifestyles and/ or beliefs are able to find common ground; through the Integrated Regional Water Management process, the Region has made great gains in creating a shared vision for the North Coast.

Changing Economic Conditions

Over the past 100 years, the North Coast evolved from mainly extractive activities (fur, gold, timber, agriculture) to more stewardship-based and service-oriented activities (outdoor recreation, education, sustainable forestry) today. At every step along the way, natural capital assets have been foundational to these economic sectors with human innovation and strong institutions also playing an important role. From computer technology to cattle genetics, that dynamism continues. While extractive industries remain, they can now be augmented and influenced by changing market values and opportunities that improve local economic health while also ensuring the long-term health of local natural resources and the communities that are dependent upon them. Moving forward, the North Coast economy of the 21st century is poised to further advance value-added goods and services. The diverse economy and ecology that exists across the Region requires an economic vision for the future that takes advantage of the value provided across every economic sector (Earth Economics 2018).

Limited Job Opportunities and Regional Loss of Human Capital

Retention (and re-attraction) of talent is a challenge for the region. As noted in the NCIRWM Plan (NCRP 2014), in Modoc and Siskiyou Counties "younger non-migrant residents continue to leave the area." The present lack and modest projected increases of population age 25 and younger is indicative of locations that are unable to provide living wage jobs that retain local youth (CA DOF 2017b). Although there are a few nascent initiatives underway (e.g. in community groups and churches) and the Region continues to do well in educating its population through high school, the Region does not capitalize on that investment to secure these graduates returning. This is due in large part to the lack of wage parity and paucity of employment opportunities. Additionally, in a number of interviews, the lack of access to high speed internet is identified as a significant deterrent for younger workers who might want to stay in the region, but expect the ability to work remotely. The dearth of young professionals, and their families also impacts succession planning in both private and public sectors, resulting in an aging population of entrepreneurs, elected officials, and administrative staff. Also, falling school enrollment with resulting budget and capacity implications is a challenge for many of the more rural school districts.

Aging Population and Succession Planning Needs

The state's estimated median age has increased slightly from 33 to 36, while the median ages in the six main counties in the North Coast Region are estimated to approach the mid-40s (CA DOF 2017a). While the Region's overall birthrate continues to decline, estimates point toward an increasingly aging Region population. Increasingly, retirees are settling in the North Coast as they value the area's rural quality of life and high standard of living. Modoc, Trinity, and Siskiyou Counties have the largest proportion of residents age 65 and over (25%, 23%, and 21% respectively) (Pederson 2018). This may lead to an increase in the demand for health-

related services and related construction of retirement, healthcare, and other facilities in these remote areas.

Especially in the more rural areas of the region, the lack of younger populations, the continued exodus of high school graduates, and wage competition from communities outside of the Region all lead to the aging of organizations, elected bodies, and private sector leadership. For some public organizations this means board members are continuing to serve well into their 80's and, many of these elderly leaders have unparalleled levels of knowledge and institutional memory that is extremely valuable. Unfortunately, without the use of/skill for electronic archiving or transferring this knowledge to new leadership, it disappears when the leader ends their tenure.

Potential Loss of Infrastructure, Knowledge, and Talent

The North Coast region, during the transition from a resource extraction based history to a more sustainable and diversified economic portfolio, risks the potential loss of existing talent and infrastructure. As an example, traditional timber industry knowledge, human talent, and infrastructure will still be needed in a climate adaptive/forest restoration scenario. It is important to ensure that the current assets that could help with a future industry are not lost as a result of economic dips occurring within that transition period. Future activities and opportunities are likely to be more expensive and time consuming if new facilities and talent need to be developed from the ground up (Morris et al. 2017).

FUTURE OPPORTUNITIES, PLANNING, AND STRATEGY

Regional Knowledge and Talent Development

With the recent merging of the Northwest and Northeastern California Small Business Development Center (SBDC) Offices, there is an opportunity to work with this and similar organizations to enhance region-wide knowledge, workforce training, and other programming.

Vocational Training Programs to Fill Specific Technical Sector Gaps

Although the Region does have some highlights in vocational and technical training (e.g., the College of the Redwoods and College of the Siskiyous both received accolades for programming in 2017), there remains a significant opportunity to improve other North Coast programs.

Leveraging Previously "Exported" Human Capital and Related Networks

In spite of the current demographic challenges of the region, there are networks of people elsewhere that have some type of connection (family, education, recreation) to the Region and may be willing to participate in a defined North Coast assistance program. Alumni and fans of the Region include leaders in tech, forestry, renewable energy, recreation, and the entertainment industry, among others.

PRIORITY ACTIONS: POLICY AND STRATEGY RECOMMENDATIONS

Analyze Regional Training, Leadership and Recruitment Programs

- Engage regional SBDC and other organizations in conversations about identified gaps and needs in relation to the Priority Actions for other areas of this document.
- Engage private sector regarding the need for, and viability of, a regional intern program.
- Engage public sector organizations in civics leadership and sector governance and policy knowledge development (energy, natural resources, communications, transportation).
- Inventory the current offerings from local colleges and universities and integrate those into the three points above.
- Invite and engage current leadership in serving as mentors and training their replacements.

Source High Visibility Regional Alumni and Supporters

- Identify and contact high-visibility alumni and supporters of the Region to bring their resources, expertise and visibility to assist long term in supporting specific programs, goals, and initiatives.
- Integrate these contacts into regional training, leadership, and recruitment programs listed above, as appropriate.

Analyze a "Recruit Back" Strategy to Re-attract Talent Developed in the Region

Similar to recruitment strategies for rural health care, develop student loan repayment programs and other incentives to bring back locally developed talent after they have completed their formal educations. Additionally, in job recruitment efforts, engage the alumni list mentioned above to assist with "recruit-back" strategies.

Identify, Engage, and Support Current Emergent Leaders

Support and assist the current leadership to strengthen their commitment and demonstrate to future leaders that they will be stepping into supportive businesses, jobs, and elected positions.

MULTIPLE BENEFITS AND VALUES: ECOSYSTEM SERVICES AND ECONOMIC BENEFITS

- *Secure Community Leadership Succession*—In both the public and private sectors, people drive the success of our communities. Ensuring that our public entities, local businesses, and non-profit organizations have the talent the carry on and adapt their missions for years to come is an investment that can yield multiple positive results as leaders see tangible, positive outcomes of their actions for the communities they serve.
- *More Robust and Adaptive Workforce*—Developing human capital in the North Coast Region in the context of changing conditions, adaptive governance solutions, and more nimble entrepreneurial environment has the potential to create a more robust, talented, and adaptive workforce. Although specialization will be needed (e.g. solar energy technicians), generalists who specialize in organizational management and broader system development will be required as environmental conditions, infrastructure technology, and societal needs change.
- *Enhanced Capacity and Performance across All Organizations*—Productivity and time are more often than not unanalyzed resources within organizations, be it a community, a local government, or a private business. Enhanced capacity and talent can be the margin of success for the region.
- *Unknown Innovation Opportunities*—Over time, resources of talent and innovation can have a multiplier effect in terms of catalyzing new ideas and solutions. Ramifications of this potential future dynamic in the North Coast Region are as of yet unknown (and even the potential for the talent itself is speculative) but the opportunity exists.

STRATEGY INTEGRATION

Strategy 3.1. Human Capital and Talent informs the multi-benefit priority strategies *Human Capital: A Place for People* and *Financing and Investment: Exploring Tools and Strategies* outlined above in Section 2. It integrates with the *Renewable Energy Strategy, Communications Infrastructure Strategy*, and *Natural Environment Focus Area* strategies, which have the greatest potential for growth and change and will rely on human capital and talent to reach their full potential.

4. FINAL THOUGHTS

"As guardians of our ancestral land we are obligated to support practices that emphasize the interrelationships between the cultural elements and physical dimensions of ecosystems.

We support natural diversity as the key means of stabilizing the cultural and ecological components of natural forest, grassland, and aquatic ecosystems. We strongly adhere that recovery of ecological systems are the context for management and not just special or economic interests.

We believe that sustainable ecosystem land management incorporates the best information that is available including scientific, indigenous knowledge, and integrated adaptive management lessons."

—Karuk Tribe Department of Natural Resources
Eco-Cultural Resources Management Plan

Frederick Law Olmstead—the designer of Central Park—was a farmer and a conservationist who was very interested in the integration of function, beauty and natural landscapes. He envisioned a time when the rural farmlands of what is now New York City would be overrun by urbanization and was an advocate for protecting natural landscapes for people and wildlife, from California to the East Coast. His recognition that the future may be very different from the past is instructive in thinking about how to best plan for the North Coast Region of California to retain its rural nature, working lands, healthy forests, thriving ecosystems, and quality of life.

The North Coast Region has the opportunity to learn from the experiences of other areas in California and to proactively plan for the protection and enhancement of its watersheds and communities, while creating and maintaining new sources of revenue and jobs. There is increasing understanding of the values of natural capital and ecosystem services, and the recognition that investments need to be made in regions like the North Coast that supply so many benefits to the region, the state, the nation, and, indeed, the world—including carbon sequestration, clean abundant water, biological diversity, and more.

The North Coast Resource Partnership has organized regionally to synchronize the goals, objectives, capacity, and knowledge of North Coast communities with state and federal objectives related to watershed and community health and economic vitality. Moving forward, the NCRP will use its assessments, strategies, and integrated plans referenced herein to achieve enduring outcomes that ensure healthy watersheds, vital communities, and thriving economies throughout California's North Coast region.

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APPENDIX: NCRP TECHNICAL ASSESSMENT SUMMARIES

ECOSYSTEM SERVICES VALUATION (NORTH COAST REGION)

TITLE: Technical Report for the North Coast of California—Ecosystem Services Valuation

AUTHORS: Angela Fletcher and Jared Soares of Earth Economics (2016)

FULL REPORT: http://www.northcoastresourcepartnership.org/resources/

REPORT SUMMARY

PURPOSE/ OVERVIEW

Like a road, building, or other built capital asset, the goods and services produced by the landscape of California's North Coast Region are also economic assets: they comprise its *natural capital* assets. Just as the value of built capital assets can be measured, so too can natural assets be quantified in economic terms. This report provides a framework for calculating ecosystem services value (ESV), and uses it to quantify the valuable contributions to the economy that the working lands and natural systems of California's North Coast provide. This ESV calculates both *annual valuation* (a point in time) and *asset valuation* (over the course of time, i.e. 100 yrs) across the entire North Coast and for its landcover types, watershed management areas (WMAs), and counties.

Natural capital is an extension of the traditional economic notion of capital. Economies depend on built, financial, human, social, and natural capital, and a robust and resilient economy requires that all these forms of capital are healthy and work productively and synergistically. Natural capital has specific ecosystem functions that provide the economy with a diverse flow of goods and services. Ecosystem goods and services are the end product of natural capital and ecosystem functions, and are defined as the benefits people derive from nature.

If natural assets were appraised like a business, based on the value of the goods and services they provide, how much would they be worth? According to the report, the dollar equivalent of the region's functioning ecosystems (distinct from the dollar value of its extracted resources) is in the billions each year, with trillions in value to be realized over time.

Many would argue that the ecosystems within a landscape are "priceless." Pricelessness may not be a practical value when it comes to making decisions about development and natural resource extraction. On the other hand, the natural landscape provides real value, and as demonstrated here, this value can be quantified using ecosystem valuation techniques. The identification and monetary valuation of environmental goods and services provides evidence of the economic importance of the North Coast region's operational landscape.

This report reveals significant financial value in ecosystem services. While some services, such as oxygen production, soil regulation, and storm protection, either are not, or cannot be, sold in markets, the markets for some other ecosystem services are possible and slowly growing (water temperature trading and carbon sequestration markets are examples). Established and emerging markets in ecosystem servicing can provide financial incentive to maintain and improve intact, functioning ecosystems in the North Coast region.

This analysis represents a conservative baseline for understanding and measuring the substantial value of the North Coast's extensive natural assets. Further research and data gathering both locally and throughout the greater United States will help to fill gaps and improve our understanding of the full value of the region's natural capital and its complex interactions with the local economy.

METHODOLOGY/ DATA

The methodology for calculating ESVs in this report is three-part: land cover analysis, valuation calculation, and asset (over time) valuation calculation. These are summarized here.

First, land cover acreage for the North Coast Region was derived from the U.S. Forest Service's CALVEG spatial data using GIS software. The GIS data were modified in several ways to enable a more detailed description of the natural capital of the study area. Then, spatial attributes were constructed to describe unique locations of ecosystems within the landscape. In this analysis, authors considered four spatial attributes that affect ecosystem service values: proximity to agricultural areas, and the location of land covers within coastal, riparian, or urban zones. Table 3 [last page this summary] (Appendix C) describes how each spatial attribute was derived and the datasets involved in calculating the boundaries of each spatial attribute.

The valuation approach of this report involves using benefit transfer methods (BMT) to assign values to land cover types based on the context of their surroundings. This is analogous to having your home appraisal extrapolated from the value of neighboring houses with similar features. BMT results are somewhat rough, but quickly yield values appropriate for policy work and analysis.

Certain BMT criteria were applied to ensure the source literature/primary studies (and values in them) are applicable and transferable to this study of the North Coast. These are: 1) Similarity of ecosystem goods and services, 2) similarity of land cover types, 3) methodologically-sound literature, 4) transferability of ecosystem services, and 5) similar demographics and cultural attitudes. Criteria validated a total of forty-five studies that form the basis of the benefit transfer analysis. They are included in the report as an Annotated Bibliography (Appendix B) with each cited and categorized to landtype, ecosystem service, and valuation method; the study location and brief description are provided.

The following data were pulled from the criteria-approved literature: 1) total per-acre-per-year values for each land cover, 2) ecosystem service, and 3) spatial attribute combinations. One to ten ecosystem services were valued for each land cover type. A total of 240 land cover/spatial attribute combinations were valued for the North. These per-acre-per-year values were multiplied by the number of acres fitting the combination, yielding the annual value representing the flow of ecosystem service value provided for each land type in question.

These annual values were then summed across all land cover types in the North Coast Region to produce a total ecosystem service value (asset value aka net present value, NPV) for the entire study area for 100 years. To perform asset valuation, a discount rate must be used. However, experts disagree on the appropriate discount rate for natural capital benefits. One solution is to use a declining discount rate. decision makers act in terms of declining discount rates rather than constant rates for project planning. To account for uncertainty in the use of discount rates, the authors utilize both a constant 3% discount rate and a declining discount rate

KEY FINDINGS

The annual value of the ecosystems of the North Coast Region is approximately $15 billion to $45 billion each year, with an average of $27 billion. (Tables 11, 12, and 13 show the annual values for the entire study area by land cover type, and by WMA and by county, respectively.) The annual values show the variety and levels of benefits that the North Coast's ecosystems provide.

The asset value (NPV) of the ecosystems of the North Coast Region averages $861 billion to $1.3 trillion. (Tables 14, 15, and 16 show the range and average NPV over the entire study area, by WMA, and by county, respectively.) Asset values provide a measure of the expected benefits flowing from natural capital over time.

The values presented in this study represent a broad screening-level appraisal of the natural capital assets of the North Coast of California. Results show the significant amount of economic benefits provided by the North Coast. Yet, these numbers are still an underestimate since many ecosystem service and land cover combinations could not be valued.

Land cover of each ecosystem type was determined. Very little of the North Coast is urban or agricultural; less than half a percent is developed, and only 4% is designated as cropland or pasture. The vast majority of the North Coast is forested (75%). Herbaceous land covers (grassland and shrubland) are the second most common at 18% of total land cover.

While forests provide the greatest annual value due to their prevalence, throughout the North Coast region, beaches (e.g. $543,121 per acre), freshwater wetlands ($51,978 per acre), and open water sources (e.g. reservoirs $12,506 per acre) provide high per-acre values. [per-acre values are in the full report, Table 11] The valuation in this report assumes no change to ecosystem service for 100 years: If steps are taken to ensure the natural capital of the North Coast Region is not degraded or depleted, the annual flow of ecosystem services will continue into the future.

The diversity of goods and services, with corresponding economic benefits, that can factor into economic valuation is presented in Table 1. The subset of 15 ecosystem services applied to the North Coast analysis are in Table 7 (with corresponding land types) and below:

- Aesthetic information
- Air quality
- Biological control
- Climate stability
- Disaster risk reduction
- Food
- Habitat
- Navigation
- Recreation & tourism
- Soil formation
- Soil quality
- Soil retention
- Water capture, convey & supply
- Water quality
- Water storage

OPPORTUNITIES/ CONSTRAINTS

Opportunities

With better data and emerging valuation methods, it is very likely that the values here represent only a fraction of nature's true contribution to the economy. Even in this early stage, these values can immediately be used to educate stakeholders, improve decision-making, and structure funding mechanisms. Here are four specific opportunities to apply these results:

Educating the public and policy-makers

For many decades, nature has largely been assumed to provide 'free' services to the local economy. However, whether through supplying water or carrying away waste products, nature provides critical services. Because we have come from a time of natural resource abundance, people and their accounting systems have valued these services at zero. This view is starting to change, and the values in this report can be used to convey a clear and detailed message that nature is critical to the economy and does indeed have a dollar value. This is the first step in changing policy and practice.

Estimating economic rates-of-return for conservation projects

The spatial data, economic values, and methods described in this report can be used to estimate a rate of return on conservation investments such as easements, open space acquisitions, and stewardship/restoration activities.

Scaling investments in natural capital to the size of the asset

Combining an understanding of the scale of natural capital asset value in the North Coast with an understanding of the potential return on natural capital investment can be used to inform future investments and determine the appropriate scale of conservation activities.

Encouraging investment in natural capital and its stewardship

The information in this report can incentivize and enable private and public investment in natural capital stewardship. Values can be used to show how payments for ecosystem services or investment in natural assets can support jobs, conserve biodiversity, build resiliency, and provide high returns on that investment to a broad spectrum of beneficiaries.

Constraints

The presentation of study results clearly displays the range of values and their distribution. The final estimates are not precise (however, it is better to provide estimates than to assume that ecosystem services have zero value or even infinite value). The limitations on calculating a precise value are discussed in the report (Appendix A), and summarized below. If these limitations were addressed, the result would most likely be a narrower range of values and significantly higher values overall.

- ***General Limitations***: *Static Analysis* (analysis is a static, partial equilibrium framework that ignores interdependencies and dynamics); and *Increases in Scarcity* (underestimates shifts in relevant demand curves as sources of ecosystem services become more limited).
- ***GIS Limitations***: *GIS Data* (demands reliance on precision/ accuracy of land cover maps in the benefits transfer analysis); *Scale and Resolution* (low resolution data sources provide inadequate data for high value ecosystem units); *Ecosystem Health* (identified ecosystems might in fact provide higher or lower values than expected); *Spatial Effects* (assessment assumes heterogeneity within an ecosystem but this is never the case, with unknown results); *Database Limitations* (technical limitations of the Farmland Mapping & Monitoring Program, FMMP, used to calculate the spatial attributes require use of adjusted CALVEG data).
- ***Benefit Transfer/ Database Limitations***: *Incomplete Coverage* (that not all ecosystems have been valued or studied well is perhaps the most serious issue, because it results in a significant underestimate of the value of ecosystem services); *Selection Bias* (choosing valuation studies introduces bias as with any appraisal methodology).
- ***Primary Study Limitations***: *Price Distortions* (in the current prices used for ESV calculation, resulting in underestimates of true values); *Non-linear/ Threshold Effects* (values assume smooth/ linear responses, without thresholds or discontinuities which can cause higher values); and *Sustainable Use Levels* (limiting use of ecosystems to sustainable levels imply higher values for services as the effective supply would be reduced).

Figure 1 illustrates the relationship between natural capital, ecosystem functions, and the production of ecosystem goods and services.

Figure 1. Goods and services flow from natural capital

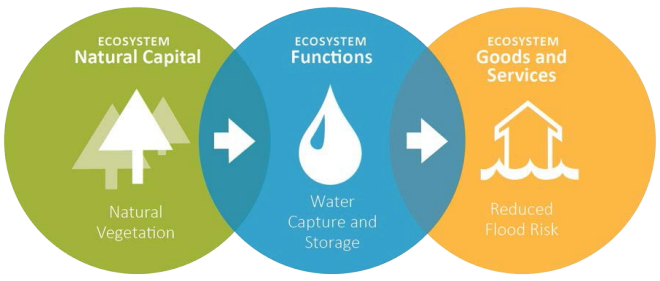


Table 1 (below and Appendix C) defines the four categories and 21 distinct ecosystem services used in Earth Economics' framework.

Table 1. Framework of ecosystem goods and services

Good/Service	Economic Benefit to People
Provisioning Services	
Food	Producing crops, fish, game, and fruits
Medicinal Resources	Providing traditional medicines, pharmaceuticals, and assay organisms
Ornamental Resources	Providing resources for clothing, jewelry, handicrafts, worship, and decoration
Energy and Raw Materials	Providing fuel, fiber, fertilizer, minerals, and energy
Water Storage	The quantity of water held by a water body (surface or ground water) and its capacity to provide water supply reliability.
Regulating Services	
Air Quality	Providing clean, breathable air
Biological Control	Providing pest and disease control
Climate Stability	Supporting a stable climate at global and local levels through carbon sequestration and other processes
Disaster Risk Reduction	Preventing and mitigating natural hazards such as floods, hurricanes, fires, and droughts
Pollination and Seed Dispersal	Pollination of wild and domestic plant species
Soil Formation	Creating soils for agricultural and ecosystems integrity; maintenance of soil fertility
Soil Quality	Improving soil quality by decomposing human and animal waste and removing pollutants
Soil Retention	Retaining arable land, slope stability, and coastal integrity
Water Quality	Improving water quality by decomposing human and animal waste and removing pollutants
Water Capture, Conveyance, and Supply	Providing natural irrigation, drainage, groundwater recharge, river flows, drinking water supply, and water for industrial use.
Navigation	Maintaining water depth that meets draft requirements for recreational and commercial vessels
Supporting Services	
Habitat and Nursery	Maintaining genetic and biological diversity, the basis for most other ecosystem functions; promoting growth of commercially harvested species
Information Services	
Aesthetic Information	Enjoying and appreciating the presence, scenery, sounds, and smells of nature
Cultural Value	Using nature as motifs in art, film, folklore, books, cultural symbols, architecture, media, and for religious and spiritual purposes
Recreation and Tourism	Experiencing the natural world and enjoying outdoor activities
Science and Education	Using natural systems for education and scientific research

Table 3 (below and Appendix C) describes how each spatial attribute was derived and the datasets involved in calculating the boundaries of each spatial attribute.

Table 3. Definition of spatial attributes and datasets used

Spatial Attribute	Dataset	Definition	Justification
Riparian	United States Geological Survey National Hydrography Dataset - 24k	Within 75 feet of stream channel flowlines that have either perennial status or Geographic Name Information System identification number.	In California, most riparian buffers range from 50 feet to 100 feet.
Urban	California Department of Conservation Farmland Mapping & Monitoring Program	Within 1,500 feet of an FMMP Urban/Built- up designated area that is either within an urban service area of is over 300 contiguous acres.	Effects on real estate prices by environmental amenities are generally realized within the first 1500 feet of the amenity source.
Coastal	Coastal Zone Boundary (CCC)	Within 1,000 yards inland from the mean high tide water line.	California's coastal zone generally extends 1,000 yards inland from the mean high tide line.
Agriculture	California Department of Conservation Farmland Mapping & Monitoring Program	Contiguous land cover cells which are directly adjacent to FMMP Prime Farmland, Farmland of Statewide Importance, Unique Farmland, or Farmland of Local Importance designated areas that are over 40 contiguous acres in size.	A study based in California suggests that ecosystems adjacent to farmland provide enhanced ecosystem service benefits due to this proximity.

Valuation Tables (results by entire region, by WMA, by county, and by landcover type; see text and Appendix C for explanation)

Table 14. Total asset value of the North Coast

Discount Rate	Low Estimate	Average Estimate	High Estimate
3%	473,271,275,369	835,386,881,868	1,369,815,088,346
Declining Discount Rate	702,154,434,213	1,239,396,164,345	2,032,284,206,525

Table 15. Total asset value by WMA

WMA	3%			Declining	Discount	Rate
	Low	Average	High	Low	Average	High
Eel	92,800,723,319	161,992,819,780	264,266,001,534	137,680,951,218	240,335,686,189	392,070,160,278
Humboldt	40,202,831,324	69,958,546,606	119,317,742,605	59,645,699,521	103,791,855,257	177,022,114,823
Klamath	148,305,960,370	280,785,073,258	471,931,825,925	220,029,596,372	416,578,175,160	700,167,201,065
North Coast	81,773,944,267	146,156,047,625	241,003,673,425	121,321,408,162	216,839,944,168	357,557,719,565
Russian Bodega	30,048,441,032	55,631,986,577	90,872,168,173	44,580,449,332	82,536,693,208	134,819,709,435
Trinity	81,295,073,720	146,201,594,442	242,113,304,113	120,610,946,539	216,907,518,307	359,203,989,155

Table 16. Total Asset Value by County

County	3%			Declining	Discount	Rate
	Low	Average	High	Low	Average	High
Del Norte	29,743,519,216	53,714,520,781	89,201,553,950	44,128,061,417	79,691,903,801	132,341,153,804
Glenn	2,440,570,979	4,285,996,907	7,070,071,195	3,620,878,393	6,358,788,057	10,489,294,614
Humboldt	106,729,462,666	183,420,816,502	302,535,007,206	158,345,898,795	272,126,677,313	448,846,798,591
Lake	6,863,297,281	12,671,892,796	22,092,413,249	10,182,520,829	18,800,265,682	32,776,732,357
Marin	190,239,199	376,409,570	611,646,938	282,242,562	558,448,531	907,451,249
Mendocino	87,757,521,790	156,678,982,677	256,600,701,024	130,198,759,712	232,451,974,502	380,697,771,920
Modoc	14,818,519,510	30,782,761,119	52,099,216,075	21,985,042,667	45,669,900,841	77,295,406,440
Siskiyou	113,348,748,325	214,879,167,519	362,289,190,867	168,166,399,253	318,798,896,417	537,499,263,264
Sonoma	26,047,123,628	48,411,835,091	79,663,981,690	38,644,017,302	71,824,736,566	118,191,026,800
Trinity	86,487,971,439	155,503,685,325	257,340,933,581	128,315,230,212	230,708,280,578	381,795,995,284

Table 17. Valuation Results of the North Coast ESV—Subtotals by Landcover [Adapted from Table 11]

Landcover	Acres	Low	Average	High
Bay/Estuary	863	11,250,667	11,293,121	11,335,574
Beach	4,109	502,522,512	508,610,105	526,536,357
Coniferous Forest	7,749,987	11,678,362,932	20,598,317,806	34,108,544,763
Cropland	264,982	46,246,075	96,855,382	147,464,689
Deciduous Forest	1,539,355	2,293,583,612	4,098,252,297	6,551,326,468
Fresh Herbaceous Wetland	47,484	64,496,417	554,722,793	1,216,833,872
Grassland	1,003,970	120,408,033	228,525,611	348,239,990
Lake	82,796	8,274,419	557,593,225	1,106,912,030
Marine	225	1,198,922	1,202,364	1,205,805
Mixed Forest	626	957,547	1,997,447	3,425,542
Pasture	246,482	63,567,976	72,218,431	80,868,886
Reservoir	20,259	17,517,160	253,353,855	816,104,948
River	32,636	163,389	181,544	199,698
Saline Herbaceous Wetland	3,177	12,278,250	60,181,198	119,388,832
Shrubland	1,241,897	193,204,029	195,805,134	200,670,685
TOTALS	**12,238,847**	**15,014,031,940**	**27,239,110,313**	**45,239,058,140**

ECOSYSTEM SERVICES VALUATION & ECOLOGY/ HYDROLOGY (TRINITY COUNTY)

TITLE: Trinity County Forest Ecology, Watershed Hydrology, and Economic Valuation of Natural Capital and Economic Analysis for Trinity River Water

AUTHORS: Northwest California Resource Conservation & Development Council's Five Counties Salmonid Conservation Program (5C) (2017)

FULL REPORT: http://www.northcoastresourcepartnership.org/resources/

REPORT SUMMARY (part 1 of 2): Trinity County Forest Ecology and Watershed Hydrology (followed by ecosystem services valuation summary)

PURPOSE/ OVERVIEW

Water is a valuable resource of Trinity county. Since 1964 storage of snow melt water from the portions of the Alps and the Eddy Mountains upstream of Trinity and Lewiston Reservoirs has been an important source of economic wealth in the State of California. For instance, approximately 50% of the runoff from the Trinity Alps and Eddy Mountains (upstream of Lewiston) is diverted into the Sacramento River to annually generate hydroelectric power, irrigation, and water for towns and cities reliant on the California Water Project and the federal Central Valley Project.

Declining snow packs, unreliable precipitation patterns, and climatic changes over the past 50+ years have impacted water supply reliability for communities and habitat viability for endangered species. Additionally, the explosive growth of wildfire since 1987 has caused concerns and opportunities for forest management that must be considered in any effort to influence water yield.

Trinity Dam operations and water diversions impact local economics, disrupt traditional Tribal cultural practices, and contribute to other social concerns. For these reasons residents and Tribes in the watershed are vigilant regarding the management of the Trinity River flows. There is a strong interest within the watershed to look at management options that can restore flow in the river while improving local economic conditions.

This project developed a new model to estimate the effect of thinning practices on water yield. The model is based on a combination of natural forest mortality, wildfire occurrence, harvest management options, climate trends, and other factors that was used to estimate changes in forest composition and project changes in water yield, along with a gross estimate of the cumulative effects of these changes.

Results show thinning of some stands can improve snow depth and contribute to longer spring and summer runoff. However, thinning is not suggested throughout the watershed as the past 30 years of wildland fires have created risks of negative cumulative watershed impacts. This information will be used by local and regional leaders and stakeholders to evaluate different forest management approaches and water management efforts.

METHODOLOGY/ DATA

The scope of the report is the Trinity River Watershed Management Area (TRWMA) in Trinity County. The TRWMA is approximately 2,900 square miles of high elevation largely steep mountain terrain, which is predominantly under federal landownership. The focus of the report is two-fold: 1) forest ecology as it relates to water yield and 2) the use of Trinity River water, with attention to the current out of basin water export.

The assessment examines watershed level GIS fire history, forest stand data, and aerial photography of the Trinity River Watershed within Trinity County to assess stand conditions. By overlaying fire histories, topography and elevation factors with existing research on snow water yield, climatic patterns, and stand management, this assessment estimates potential increases in spring and summer snow melt water yields from thinning dense conifer stands with specific characteristics.

Based on selective criteria (*Figure 20 illustrates criteria—last page this summary*] a total of 118,278 acres were identified as conceptually suitable for thinning to meet water yield, fire reduction, and carbon storage objectives. A 10,715-acre subset of these stands was then selected for detailed assessment to estimate the water yield changes from a hypothetical thinning.

Sites selected for detailed assessment (Coffee Creek, Burnt Ranch, South Fork Mountain) share a number of desirable characteristics: they are accessible, incorporate a mix of National Forest and private ownerships, are accessible, represent the diversity of stands in the watershed, and that have not burned in the past 30+ years. [*Figure 21 maps these areas—last page this summary*].

An estimate of carbon release from fires was done by sampling 735 ARB Forest Protocol compliant carbon inventory plots in 2013. In 2015 about 65% of these plots were burned in a series of wildland fires. The burned areas had ~35% low intensity fire effects, 33% moderate intensity effects and 32% had high intensity effects (killing all trees and understory). Plots within the burn areas were then remeasured in 2015/2016. The resulting results were used to estimate the CO2e emitted.

KEY FINDINGS

Application of selection criteria described in the full report identified 118,278 acres from the total 1.63 million acres within Trinity County as theoretically suitable for thinning to improve water yield. The majority of the acreage is concentrated in the Mt. Eddy area and the headwaters of the South Fork Trinity River.

Based on the assumptions in the model, low and high water yield estimates were generated over the 16-year period of effect [*Figure 32 graphs results—last page this summary*]. Thinning of dense conifer stands by 20% of basal area (20-40 ft2/acre) and light thinning 10% of conifer basal area within mixed Hardwood-Conifer stands will yield an average of 0.22 AF of additional water per year per acre based on the aggregate stands of the three assessment areas examined.

Under two sets of assumptions on water yields the subsample area would yield an additional 1,086 to 3,019 acre feet of runoff from thinning 2,280 acres. Expanding that analysis to all 118,278 acres of potentially treatable lands would result in a theoretical maximum increase of approximately 18,000 acre feet to 36,000 acre feet while increasing snow water equivalent and snow melt in late spring and summer.

Thinning of 2,280 acres in these assessment areas over a ten-year period would yield an average 130 acre feet of additional water per year [*Figure 33 graphs results—last page this summary*]. Greater water yields would be achieved by increasing the acres treated per year or extending the period of active thinning.

Thinning 2,280 acres would retain approximately 15 tonnes of stored CO2e per acre (12,500 tonnes total) that could otherwise be released when fire burns through the stands.

Two supplemental Deliverables (A Lancaster 2017) accompany the full report, providing detailed methods, data, and assumptions of the model (see "Assessment to Improve Late Spring/Summer Stream Flows, Reduce Fire Intensity and Fire Related Carbon Emissions in the Trinity River Watershed") and photographic support (see "Appendix A: Photo Log—Fire Affected Stands in the Trinity River Basin")

LAW AND POLICY

Planning

Numerous management measures, plans, and regulatory strategies on the federal, state, and local levels have been developed that affect water management, fisheries, and water quality in the Trinity River and the North Coast region. Over the past 20 years, major state and federal actions or plans have identified impacts to water and aquatic resources in the Trinity River. However, several conservation groups are actively working to restore and enhance watershed conditions. The Bureau of Reclamation's Trinity River Restoration Program has targeted sediment reduction, habitat creation, and fish passage over the past several years in its long-term effort to address the adverse impacts to the Trinity River salmonid populations created by the construction of the dams and diversion of water to the Central Valley.

Policies

In 2015 the Trinity County Board of Supervisors and Planning Commission began holding public hearings on changes in policies within the Zoning and Subdivision Ordinances to protect beneficial uses of water. In July 2016, the Trinity County Grand Jury published findings that supported the findings of the 2014 study.

Under AB 2480 (2016) source watershed financing, a number of forest ecosystem restoration and conservation activities would be eligible for funding including, "projects with a demonstrated likelihood of increasing conditions for water and snow attraction, retention, and release under changing climate conditions."

Climate change management is outside of the short term control of land managers but carbon storage and sequestration within the watershed are important climatic benefits and priorities of the state's Carbon Cap and Trade Program and Global Warming Solutions Act (AB32, 2006 and SB32, 2016).

RECOMMENDATIONS

Authors recommend that policy makers look at forest thinning of stands at sufficient elevation and favorable aspect to improve late spring and summer water yield.

Strategic forest stand thinning can reduce sublimation, open canopies to extend the length of the spring/summer snowmelt, and modify forest fuels to reduce fire intensity without triggering adverse watershed effects due to past fire activity.

Thinning can create the right balance of stand openings and ground shade to maximize snow accumulation on the forest floor. At the same time thinning combined with pruning and fuels reduction can create shaded fuel break conditions. While this treatment can be used at all elevations and aspects, to increase summer water yield it is most effective between 4,000 feet and 6,000 feet elevation on northwest to east facing aspects.

Where water is stored in reservoirs, increased winter runoff may be beneficial if it is captured for summer use. However, capture of winter runoff and storage behind Trinity Dam is limited due to dam safety criteria that does not allow the lake maximum pool storage to exceed 80% of capacity before April 1st of each year.

Thinning to increase SWE water yields and reduce the intensity of wildland fires, could also reduce the carbon released from wildfires. As noted in the previous section approximately 2/3 of all burn acreage in the past decade has been of moderate to high severity with associated tree loss.

Salvage logging could capture or store some of the potential CO2e release and a case could be made that the standing dead and belowground dead will not be emitted soon because the char associated with the burned trees is not readily lost back to the atmosphere.

Coffee Creek: Increased water yield at Coffee Creek would benefit Trinity Reservoir and downstream river users, but will not significantly affect cold water or endangered fisheries because of the Trinity dam. Fuels reduction programs could have a significant positive effect on Wilderness values.

Burnt Ranch: Increased water yields in at Burnt Ranch would primarily benefit downstream domestic uses, including the community of Burnt Ranch. Increased flows there would not significantly benefit endangered fisheries in tributaries due to steep gradient migration barriers within most tributary streams. Increased cold water flows to the Trinity River would have some benefit fisheries and domestic uses in the river.

South Fork Mountain: Increased water yields at South Fork Mountain would primarily benefit downstream domestic uses, including the community of Burnt Ranch. Increased flows in this area would not significantly benefit endangered fisheries in tributaries due to steep gradient migration barriers within most tributary streams. Increased cold water flows to the Trinity River would have some benefit fisheries and domestic uses in the river.

Figure 20. Criteria Used to Select Areas for Detailed Assessment

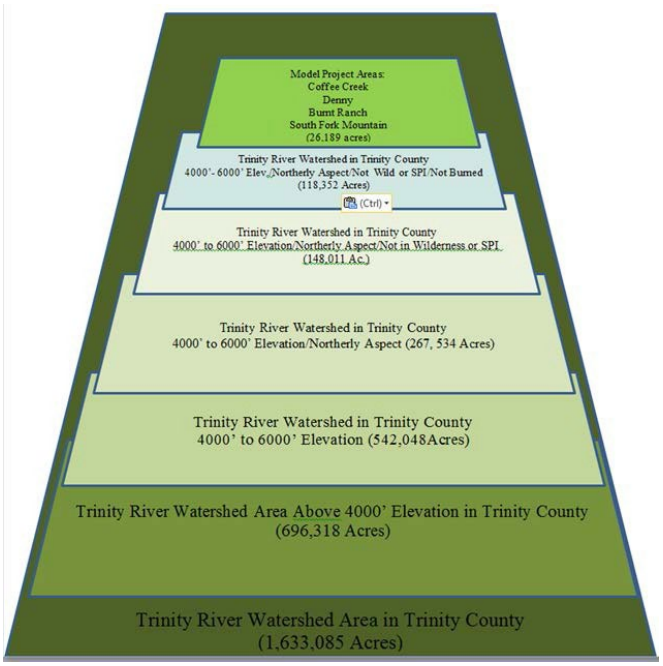


Figure 21. All lands meeting criteria of elevation, aspect, and unburned since 2006.

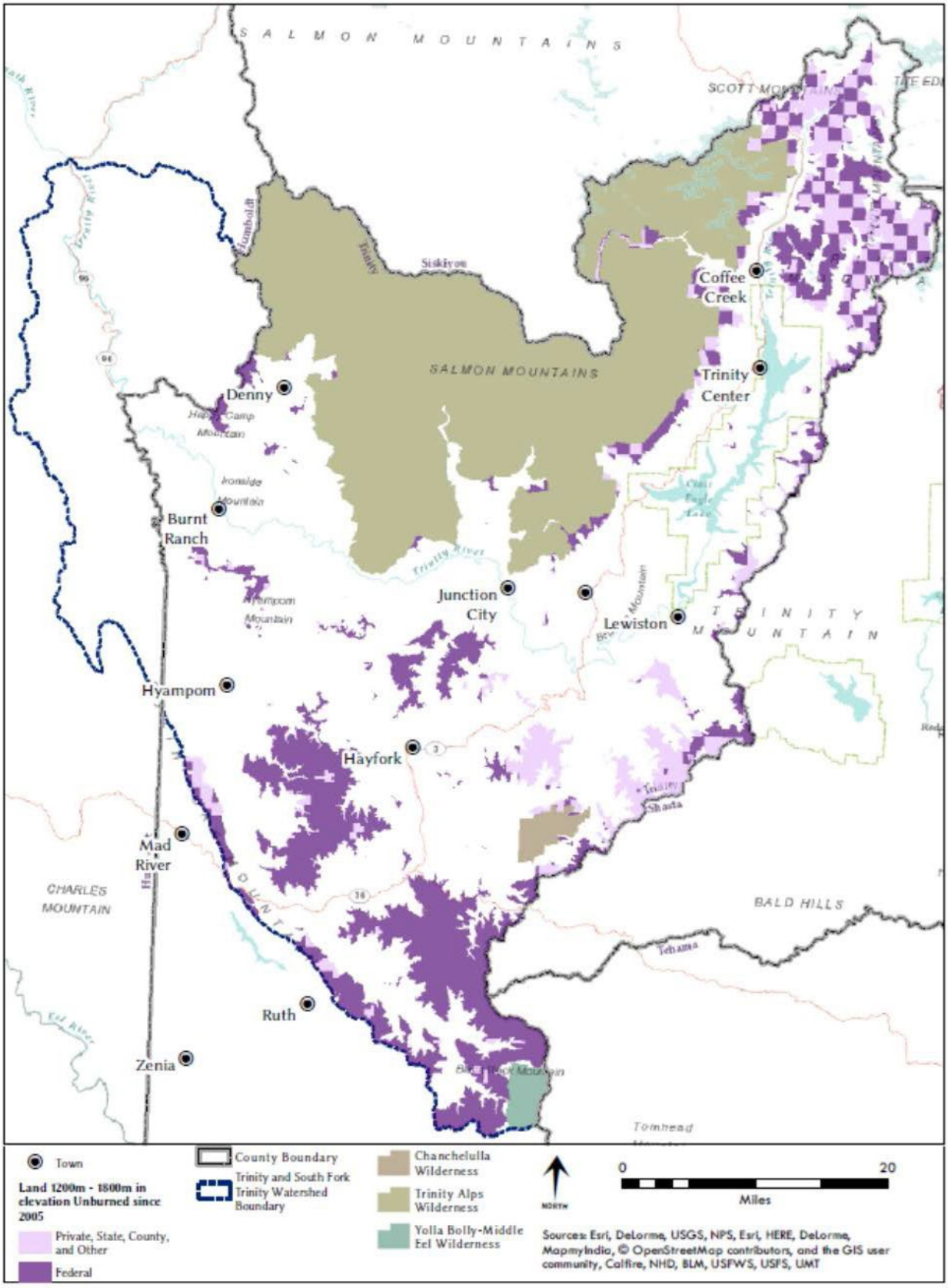
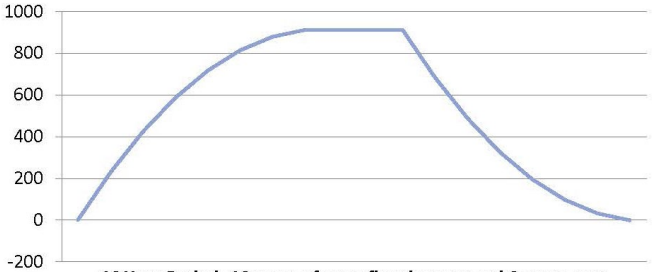


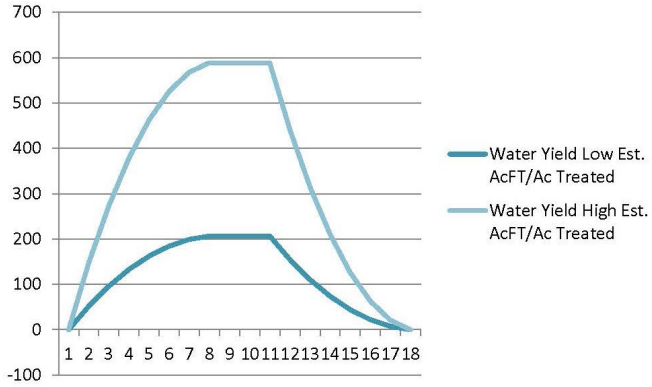
Figure 32. Harvest Change over Time

Shows the equivalent annual acres of thinning for an even flow thinning regime of 228 acres harvested per year for a 10-year perioud and a 7-year period before the thinned biomass is replaced (assuming a linear growth response in crowns and understory of thinned stands.)



16 Year Period- 10 years of even flow harvest and 6 years post harvest period as canopy closes and understory growth responds

Figure 33. Acre Feet of Annual Water Benefit from Thinning Targeted Stands



REPORT SUMMARY (part 2 of 2): Trinity County Ecosystem Services Valuation (ESV)

PURPOSE/ OVERVIEW

The benefits of Trinity River water to the state and agricultural industry has long been documented by well-resourced interests. What has been lacking is a more balanced picture that includes ecosystem services value of the watershed: its "natural capital." Local leaders have long expressed an interest in exploring the concept of assessing the value of the various benefits derived from the Trinity River. The intent of this focal study of Trinity water is to provide local decision makers with information that can facilitate discussions about local resource management. The identification and monetary valuation of environmental goods and services provides evidence of the economic importance of Trinity water in the operational landscape.

In 2016, Earth Economics performed an assessment of the value of natural capital in the North Coast Region [*see full summary in this series*]. Natural capital is an extension of the traditional economic notion of capital and, just as the value of built capital assets can be measured, so too can natural assets be quantified in economic terms. Natural capital has specific ecosystem functions that provide the economy with a diverse flow of ecosystem goods and services. Ecosystem goods and services are the end product of natural capital and ecosystem functions, and are defined as the benefits people derive from nature. The Earth Economics report provides a framework for calculating regional ecosystem services value (ESV) that can also be applied at the local (e.g. county or watershed) level.

The goal of this analysis is to provide ecosystem service values for the natural areas of the Trinity River watershed. This report summarizes the methodology and findings of the ESV that was performed for one portion of the North Coast region: The Trinity Watershed Management Area (WMA) in Trinity County. The Trinity water ESV uses the Earth Economics methodology (modified with additional studies) to calculate the value of "Trinity water," both its *annual valuation* (per-acre value at a point in time) and its *asset valuation* (over the course of time, i.e. 100 yrs) across the entire watershed and for its constituent landcover types. The results indicate $4.3 billion in annual ecosystem service value.

The report begins with a brief summary of results from a local perspective. Then, the bulk of the report details the Earth Economics ESV methods and findings, including: literature review (including additional studies identified by Trinity stakeholders), detailed methods, and Trinity River WMA ESV results (annual and asset value); it also discusses identified gaps in data, limits of methodology, and the additional economic benefits from non-ecosystem service sources. All this technical information is available in the Trinity report appendix ("Deliverables"—"Study Summaries" text and "Value Summary" tables).

METHODOLOGY/ DATA

To complete a coarse, initial economic valuation of natural capital and economic analysis for Trinity River water, existing studies presenting quantified data on the value of goods and services produced within and outside of the Trinity River basin that are directly supported by Trinity River water were compiled and synthesized, along with other non-local studies of similar uses. Earth Economics was retained to perform the economic analysis of these studies.

The first step was to assess the extent of natural areas in the Trinity River Watershed by determining the spatial extent of land cover types using Geographic Information System (GIS) software and U.S. Forest Service's CALVEG spatial data; four spatial attributes were constructed to describe unique locations of ecosystems within the landscape (proximity to agricultural areas, and

the location of land covers within coastal, riparian, or urban zones). Next, the benefit transfer method (BTM) was used to determine dollar-per-acre values for ecosystem services identified from the literature. Last, these two datasets were combined to estimate the total value of economic benefits provided by the Trinity River Watershed. Caveats and constraints related to these methods are presented later in this summary.

Total per-acre-per-year values for each land cover, ecosystem service, and spatial attribute combination were selected from the literature. These were then summed to provide a total dollar-per-acre-per-year value for each land cover type. These per-acre-per-year values were multiplied by the number of acres of that land cover type. The result was an annual value representing the flow of ecosystem service value provided for each land type in question. These flows were then summed across all land cover types in the Trinity River to produce a total ecosystem service value for the entire study area. The end result is an estimate (average, range) of the value of Trinity water assets, assuming unchanged conditions for 100 years. [*see Table 3 this summary*]

The authors also provided Earth Economics with several local and regional studies and reports on various beneficial uses of Trinity River water. Earth Economics then reviewed, and substituted where appropriate, data from these local studies into the overall valuation summary, if they met various criteria. Once valuations from local studies were added to the base framework, overall "adjusted" valuations were derived for Trinity River water.

The report categorized every value recorded from the literature review by land cover type and ecosystem service. This process allowed comparison of these new values with the values already included in the ESV and identify and exclude land cover and ecosystem service combinations that would result in double counting. When choosing additional studies to enhance the ESV, the authors followed the previously criteria outlined and lent preference to primary valuations.

KEY FINDINGS

Land Cover Acreage

The total land area of the Trinity water study area is 1,900,760 acres [*Table 1 this summary*]. Most of that is coniferous forest (82.3%) with shrubland (7.0%) and deciduous forest (6.8%) as the next-most-common landcover types. Wetlands, reservoirs, and lakes each occupy less than 1% space, but their value per acre is orders of magnitude more than the common landcover types. This is due to the critical water-related ecosystem services they can provide.

Initial Annual Valuation

The initial annual valuation of Trinity water was determined in the full ESV for the North Coast Region (Earth Economics 2016). There, the annual ecosystem service value provided by the Trinity River Watershed was estimated at $2.6 billion to $7.7 billion (average $4.6 billion). [*Table 2 this summary*]. Table 2 also lists average dollar values per acre of each landcover type. Highest-scoring landcover types include fresh herbaceous wetland ($29,509/acre), reservoirs ($12,506/acre), and lakes ($6,735/acre).

Adjusted Annual Valuation

The results in Table 2 do not include the addition of local studies to the literature review. The following values were added to adjust the ESV, and are described in the full report: cultural value (between $172 million and $1.6 billion annually), river recreational value ($21 million annually), irrigation water supply ($47 million to $5.4 billion), food crops ($105,192 to $2 million) and hydroelectric energy ($75 to $106 million). Adjustment increased the initial annual valuation total (above) to $11.0 billion to $22.7 billion, with an average of $13.4 billion. This amounts to an increase of about $8.8 billion on average. This can still be considered an underestimate in ecosystem service value, as data gaps still remain.

Total Asset Valuation

The total asset valuation of Trinity water over the course of 100 years (assuming conditions do not change and using a 3% discount rate) is on average $424 billion (ranging $348 to $717 billion) [*Table 3 this summary*]. This value includes adjustment by use of additional literature/ data as described for "adjusted annual valuation."

Data Gaps

There are large gaps in knowledge of the non-market benefits of regulating services; habitat for species including, but not limited to, salmon; and aesthetic values provided by the river [*see Table 4 this summary*] Local resource managers should find this list useful in pursuing a more complete assessment of the value of Trinity River water. Additional primary valuations conducted in these areas would greatly benefit ecosystem service estimates for the Trinity River.

Non-Ecosystem Service Economic Benefits

The Trinity River provides economic benefits beyond the ecosystem services values presented here: the watershed also directly stimulates and supports local economic development. Ecosystem-related manufacturing, sales, tourism, and events inject cash into local economies, so in addition to providing valuable ecosystem service benefits, the Trinity River also directly supports local economies. Several studies from the literature review estimate the

number of jobs and the amount of economic activity that are dependent on natural ecosystems. This initial analysis shows that the Trinity River could support millions in local economic activities and hundreds of local jobs. Again, these estimates should be regarded as underestimates as the Trinity River likely provides inputs into other economic sectors besides commercial fishing and recreation.

LAW AND POLICY

AB 2480 (Bloom 2016) supports natural capital valuation. The bill makes maintenance and repair of source watersheds eligible for the same forms of financing as other water collection and treatment infrastructure and would specify that the maintenance and repair activities that are eligible are limited to specified forest ecosystem restoration and conservation activities. Other projects with a demonstrated likelihood of increasing conditions for water and snow attraction, retention, and release under changing climate conditions are also eligible.

OPPORTUNITIES/ CONSTRAINTS/ RECOMMENDATIONS

Opportunities

Water is a key resource of the county. A significant amount of the Trinity River flow (approximately 50% or more) is diverted just upstream of Lewiston to the east and south to the federal Central Valley Project administered by the U.S. Bureau of Reclamation. This is one of the state's largest out-of-basin water transfers. It has been speculated that the cool, clean water from the Trinity River is an important element in maintaining habitat and water temperatures for Delta smelt and salmonids in the Sacramento River watershed. The diversion is also used to generate electrical power at several hydroelectric facilities along its course.

Local policy makers have expressed concern that federal management of this wealth is often done without their input. It is anticipated that this initial assessment of ecosystem services value will likely be utilized beyond specific economic benefit characterizations, providing a tool with which the County can better evaluate its resource management concerns, resource management strategies, and policy discussions. Trinity County's interests in investigating the economic benefits of natural areas are especially motivated by the fact that the county is not compensated for any of its exported water (though does receive reduced electric rates for its sparse population). These preliminary economic valuations are expected to help them navigate and better understand the benefits of the various uses of the water.

Constraints

There are several caveats that constrain development of the Trinity water ESV, including:

1. The receipt of subsidies for irrigation water, crops, and electricity by Westlands Water District.
2. The financial viability of the hydropower produced by the Central Valley Project diversion as it begins to become uncompetitive with renewable sources of energy that are gaining a foothold in the state's energy market.
3. Other factors that make maintaining dams and water delivery infrastructure cost- prohibitive.
4. The absence of valuations for local cannabis cultivation; given the exponentially greater profit margin of this crop (by acre or plant) than that of the traditional food crops that are represented in these valuations, this omission may be significant.
5. Unique values and uses likely not captured through the use of Earth Economics' database. For example, the dollar-value of the spiritual and cultural services provided by the Trinity River are significant; they also are difficult or impossible to quantify.
6. Data gaps persist and constrain determination of ESV. [*see "Recommendations" below*]

These caveats should enter into the discussions of how these results should be considered and how to weigh the benefits of the water and consider its future management.

Recommendation: Fill Remaining Data Gaps

The literature review identified many studies valuing existence and recreation benefits in the Trinity River, but values for many ecosystem services are still missing. [*see Table 4 this summary*]. Primary valuations conducted in these areas would greatly benefit ecosystem service estimates for the Trinity River. Local resource managers should find this useful in pursuing a more complete assessment of the value of Trinity River water. Perhaps some of the project metrics and data reported by NCRP projects can be compiled and analyzed to help fill in some of these gaps over time.

Table 1. Land Cover Acreage within the Trinity River Watershed

Land cover Type	Acres	Percent of WMA
Barren	30,184	1.59%
Coniferous Forest	1,564,335	82.30%
Cropland	865	0.05%
Deciduous Forest	129,136	6.79%
Grassland	19,797	1.04%
Lake	17,379	0.91%
Pasture	735	0.04%
Reservoir	25	0.00%
River	2,337	0.12%
Shrubland	131,845	6.94%
Urban	1,721	0.09%
Mixed Forest	116	0.01%
Fresh Herbaceous Wetland	2,282	0.12%
Total	**1,900,760**	**100.00%**

Table 2. Annual Valuation Results for the Trinity River Watershed [*not adjusted; see report text*]

Land Cover	Attribute			Acres	$/acre/ year (Min)	$/acre/ year (Ave)	$/acre/ year (Max)	$/year (Min)	$/year (Ave)	$/year (Max)
	Agriculture	Riparian	Urban							
Coniferous Forest				1,507,787	1,503	2,628	4,339	2,266,638,587	3,962,102,947	6,542,159,226
			*	1,216	1,827	5,372	10,016	2,222,219	6,533,392	12,181,659
		*		55,020	1,503	2,628	4,339	82,711,341	144,580,107	238,728,295
		*	*	8	1,827	5,372	10,016	14,628	43,006	80,186
	*			292	1,504	2,628	4,340	439,513	768,114	1,268,159
	*	*		12	1,504	2,628	4,340	17,728	30,982	51,151
Cropland	*			770	175	366	557	134,373	281,423	428,473
	*		*	70	175	366	557	12,149	25,443	38,738
	*	*		25	175	366	557	4,425	9,267	14,109
Deciduous Forest				121,662	1,481	2,625	4,190	180,159,277	319,371,134	509,803,667
			*	1,563	1,805	3,953	6,529	2,819,755	6,176,011	10,201,960
		*		4,524	1,481	2,625	4,190	6,698,473	11,874,486	18,954,927
		*	*	119	1,805	3,953	6,529	215,515	472,035	779,740
	*			1,262	1,482	2,626	4,191	1,869,833	3,313,976	5,289,468
	*	*		6	1,482	2,626	4,191	9,555	16,935	27,030
Fresh Herbaceous Wetland				1,988	240	10,649	24,395	476,820	21,172,483	48,501,810
		*		294	18,025	29,509	44,330	5,295,503	8,669,388	13,023,482
Grassland				18,685	66	168	264	1,228,933	3,137,244	4,927,921
			*	145	509	611	707	73,612	88,376	102,229
		*		944	66	168	264	62,106	158,544	249,038
		*	*	0.4	509	611	707	226	272	315
	*			22	66	168	264	1,433	3,659	5,748
	*	*		1	66	168	264	59	149	235
Lake		*		17,364	100	6,735	13,369	1,735,349	116,941,015	232,146,681
		*	*	7	100	6,735	13,369	733	49,425	98,117
	*	*		7	100	6,735	13,369	733	49,425	98,117
Mixed Forest				58	1,414	2,484	3,674	82,732	145,282	214,905
			*	36	1,659	3,983	7,487	60,511	145,286	273,067
		*		1	1,414	2,484	3,674	1,573	2,762	4,086
		*	*	0.4	1,659	3,983	7,487	738	1,772	3,330
	*			20	1,415	2,485	3,675	28,011	49,178	72,739
Pasture	*			728	218	253	289	158,966	184,512	210,058
	*	*		8	1,823	1,858	1,893	13,786	14,051	14,316
Reservoir		*		25	865	12,506	40,284	21,922	317,061	1,021,318
River		*		2,266	5	6	6	11,345	12,606	13,867
		*	*	68	5	6	6	340	377	415
	*	*		3	5	6	6	17	19	20
Shrubland				128,882	146	146	146	18,834,565	18,834,565	18,834,565
			*	14	146	146	146	1,983	1,983	1,983
		*		2,938	224	413	767	656,886	1,212,532	2,251,907
	*			12	146	146	146	1,788	1,788	1,788
Total				**1,868,855**				**2,572,718,037**	**4,626,793,013**	**7,662,078,845**

Table 3. Total Asset Value over 100 Years of the Trinity River WMA Using a 3% Discount Rate

Low	Average	High
347,885,735,423	423,964,337,026	716,916,714,923

Table 4. Gaps in Ecosystem Service Values for the Trinity River Watershed

Ecosystem Service	Coniferous Forest	Cropland	Deciduous Forest	Fresh Herbaceous Wetland	Grassland	Lake	Mixed Forest	Pasture	Reservoir	River	Saline Herbaceous Wetland	Shrubland
Aesthetic Information	*		*				*					
Air Quality	*		*	*	*		*					*
Biological Control	*	*	*		*		*	*				*
Climate Stability	*	*	*	*	*		*	*			*	*
Cultural Value										*		
Disaster Risk Reduction				*	*		*				*	*
Energy & Raw Materials										*		
Food	*	*	*	*	*	*	*	*				
Habitat				*				*			*	*
Navigation												
Pollination & Seed Dispersal	*	*	*		*		*					
Recreation & Tourism	*		*	*	*	*	*		*	*	*	*
Soil Formation	*	*	*		*		*					
Soil Quality	*	*	*				*					
Soil Retention	*	*	*		*		*					*
Water Capture, Conveyance, & Supply	*		*	*	*		*			*	*	
Water Quality	*		*	*	*		*				*	
Water Storage						*				*		

CLIMATE & NATURAL RESOURCES ANALYSIS & MAPPING

TITLE: Climate and Natural Resources Analysis and Planning for the North Coast Resource Partnership

AUTHORS: Pepperwood Preserve and US Geological Survey (2016)

FULL REPORT: http://www.northcoastresourcepartnership.org/resources/

FULL TIME-SERIES MAP BOOK: http://www.northcoastresourcepartnership.org/resources/

REPORT SUMMARY

PURPOSE/ OVERVIEW

Building on the foundation of the USGS California Basin Characterization Model (BCM), the report summarizes historical and projected future scenarios for 1) climate, 2) watershed runoff, 3) groundwater recharge, 4) vegetation vulnerabilities, and 5) fire frequencies for the North Coast. The purpose of the analysis is to frame potential long term trends for planning purposes. Projections focus on capturing the effects of "business as usual" emissions on climate on hydrology (as opposed to highly mitigated emissions scenarios) and include low, moderate, and high rainfall scenarios.

This analysis generates assessments of potential hydrologic responses (in terms of runoff, recharge, evapotranspiration, soil moisture, snow pack, and climatic water deficits) to climate change at the watershed-scale for the North Coast region. It also utilizes BCM-derived models of vegetation vulnerabilities and fire risks to assess climate-related impacts on natural vegetation and fire frequency. These results translate to watershed vulnerabilities and can inform adaptation priorities for climate change adaptation, forest, watershed, and groundwater planning.

Broadly, in response to future rainfall scenarios, it is expected that in the North Coast region: air temperatures will increase; evapotranspiration will increase; climatic water deficits (drought stress) will increase; water supply variability will increase; area of forest vegetation prone to climate stress will increase; fire risk will increase; soil moisture will decrease; snowpack extent will decrease; and groundwater recharge may increase or decrease depending on rainfall scenario.

The report provides a brief summary for each analysis, supported by appendices describing project methods and data visualizations in the form of maps and time series data plots to complement delivered data products. It closes with planning principles and recommendations to address planning needs and priorities. The authors conducted a relatively coarse-scale analysis focused on summarizing results for the Region as a whole, and in some cases complement these regional results with summaries for sub-regions including Watershed Management Areas (WMAs), major drainage basins (HUC-8 units), and groundwater basins. A set of data maps *[companion to the report; link last page this summary]* enables users to query the data at finer spatial or temporal scales as needed.

METHODOLOGY/ DATA

Climate Projections

The primary data set used for these analyses was the 2014 Basin Characterization Model (BCM), which is a regional water balance model (Flint et al. 2013; Flint and Flint 2014). The 2014 BCM is a downscaled version of global climate models that accounts for localized topographic effects on solar radiation loading and the effects of geology and soil type on hydrologic response by applying a monthly regional water-balance model to simulate hydrologic responses to climate at spatial resolution of a 270-m grid.

The data produced by the BCM (the outputs) are listed below. The full report defines them in a glossary.

- JJA=average monthly temperature for June, July and August
- DJF=average monthly temperature for December, January, and February
- PPT=average annual precipitation
- RCH=average annual recharge
- RUN=average annual runoff
- AET=actual evapotranspiration
- SWE=snowpack water equivalent as of April 1 on portion of project area exceeding 3000' elevation.
- CWD=climate water deficit (the difference between potential and actual evapotranspiration and an indicator of drought stress and environmental water demand)

The monthly historical climate input data is downscaled from PRISM (Daly et al. 2008), and the daily data set includes historical data measured at weather stations from 1920–2010. NCRP managers selected three future climate scenarios (described below) that provided a set of projections for the next 90 years (2010-2099). Data products derived include 30-year averages to delineate potential long-term trends. This allows comparison of two historic periods 1951-1980 (often referenced as a pre-climate change baseline or "historical"), and 1981-2010 (considered "recent" conditions). These are then compared with three projected periods (2010-

2039, 2040-2069, and 2070-2099). For a summary of BCM global climate model inputs and a glossary of terms see Appendices A and B in the full report.

The BCM approach enables a process-based translation of how climate interacts with physical geography to estimate local watershed response in terms of microclimate, runoff, recharge, soil moisture, snow accumulation, and evapotranspiration. The BCM produces fine scale maps of climate trends as well as tabular time series data for a place of interest. Results are presented at spatial scales ranging from the North Coast Region as a whole, to Watershed Management Area (WMA) boundaries, and Department of Water Resources HUC-8 watershed boundaries (generally defining major river systems) nested within WMAs.

Vegetation Vulnerability

Following the modeling effort of Thorne et al. 2016 that builds on the BCM indicators of pure climate exposure, authors provide vegetation model summaries that also build on a statewide vegetation map produced by the CalFire Fire and Resource Assessment Program (FRAP). The unit of analysis for the vegetation model are "macrogroup" community-level classifications. Vegetation vulnerability summaries are derived from the recently completed climate change vulnerability assessment of California's terrestrial vegetation. The vegetation vulnerability assessment combines multiple BCM outputs with biological data to generate spatially explicit projections for climate vulnerabilities of vegetation across the state in the 21st century under multiple scenarios.

The study generates site-specific assessments of where key vegetation macrogroups will be stressed based on BCM-based projected climate exposures. Nine hydro-climatic variables were sampled to characterize the range and variation of conditions in the study Region including: annual mean minimum temperature (Tmin), annual mean maximum temperature (Tmax), annual precipitation (PPT), actual evapotranspiration (AET), potential evapotranspiration (PET), climatic water deficit (CWD), snowpack depth on April 1st (APRPK), runoff (RUN), and recharge (RCH). Exposure values were then ranked based on specific macrogroup sensitivities, generating a combined metric that evaluates "vulnerability" on a 1-100% scale. The authors generated a temporal sequence of maps for the study area displaying relative rankings of vegetation "exposures"-really vulnerabilities since they combine in-situ macrogroup sensitivities with in-situ climate exposures derived from the BCM.

Fire Risk

Historical fire risk and projected changes in fire risk over the 21st century were modeled by Moritz and Krawchuk (2012) as the probability of burning at least once within a given 30-year interval (probability of burn) and conversely, as the estimated fire return interval (FRI). The probability of burn and FRI data sets were generated from the combination of BCM outputs including: maximum temperature, minimum temperature, total precipitation, potential evapotranspiration, climatic water deficit, and actual evapotranspiration combined with historical fire data and historical and projected human development patterns (Krawchuck and Moritz 2012).

Potential changes in fire activity over time were modeled from the record of recent historic burning across the state, combined with BCM outputs that describe seasonal aridity and vegetation growing conditions, at a spatial resolution of 1080-m and a temporal resolution of 30 years for the 1971-2000, 2040-2069 and 2070-2099 periods. The final set of variables includes maximum monthly temperature, precipitation seasonality, potential evapotranspiration seasonality, actual evapotranspiration seasonality, and climatic water deficit as well as distance to development, with the latter designed to capture risk of ignition due to human activities.

Technical Sources: Published reports with methods and data for this analysis are listed below.

PRISM

Daly, C., M. Halbleib, J.I. Smith, W.P. Gibson, M.K. Doggett, G.H. Taylor, B.J. Curtis, and P.P. Pasteris. 2008. Physiographically sensitive mapping of climatological temperature and precipitation across the conterminous United States. Int. J. Climatol., 28:2031-2064.

BCM

Flint, L.E. and A.L. Flint. 2014. California Basin Characterization Model: A dataset of historic and future hydrologic response to climate change. U.S. Geological Survey Data. doi:10.5066/F76T0JPB.

Flint, L.E., A.L. Flint, J.H. Thorne, and R. Boynton. 2013. Fine-scale hydrological modeling for climate change applications; using watershed calibrations to assess model performance for landscape projections. Ecological Processes, 2:25.

Vegetation Vulnerability

Thorne, J.H., R.M. Boynton, A.J. Holguin, J.A.E. Stewart, & J. Bjorkman. 2016. A climate change vulnerability assessment of California's terrestrial vegetation. California Department of Fish and Wildlife (CDFW), Sacramento, CA.

Fire Risk

Krawchuk, M. and M. Moritz. 2012. Fire and climate change in California: changes in the distribution and frequency of fire in climates of the future and recent past (1911-2099). California Energy Commission Publication. CEC-500-2012-026.

KEY FINDINGS

Region Projections

Temperature

- Summer temperature annual averages are expected to increase on the order of 3-5 **°F by mid-century, and 6-9 °F** degrees by end-century.
- Winter temperature averages are expected to increase on the order of 5-7 **°F by mid-century, and 8-11 °F** by end-century.
- Warmer temperatures are projected to increase rates of modeled actual evapotranspiration on the order of 4-11% by mid-century and 11-13 % by end-century.

Drought Stress

- Increased evapotranspiration rates are projected to increase climatic water deficits, a measure of drought stress, by approximately 10-19% by mid-century, and 16-32 % by end-century. End-century conditions represent an effective loss of 3-6" of rainfall equivalent from soils by the end of the dry season relative to today's conditions.

Snowpack

- While 60% of the project area is estimated to have supported April 1 snow in the 1951- 1980 time window, that area is estimated to have been reduced by 10% for the 1980- 2010 time window. Snowpack extent is projected to shrink to 29% of the project area by mid-century and to only 11% by end-century. April 1 average snow pack depths at elevations over 3,000 feet are estimated to be reduced from approximately 10" (1951-1980) to just 1" by the 2070-2099 time window.
- Variable rainfall and shrinking snowpack will create a more variable water supply, with potential more frequent droughts and possibly floods as well than experienced during the historical record (1951-2010).

Groundwater

- Groundwater recharge may prove a less variable supply of water from year to year than runoff in the future, though average recharge is projected to decrease under low rainfall scenarios. Projected 30-year averages of in-situ regional recharge range from increases of 3% under high rainfall scenarios to decreases of 19% under low rainfall scenarios.

Vegetation Vulnerability

- Changes in climate and hydrology will potentially stress forest vegetation. A vegetation model utilizing our watershed model suggests that while approximately 65% of the region's natural vegetation is currently estimated to be prone to climatic stress, by end- century approximately 85% of the region's vegetation is projected to be potentially prone to be climate-stressed by end-century.

Fire Risk

- Fire risks are projected to increase across the region, increasing the probability of a "fire within the next 30 years" on average by 40% end of century.

Tabular and Mapped Projections

Tables referred to below are included at the end of this summary; maps at the regional and/ or watershed scale are included in a companion report "Map and Time Series Data Visualizations."

Climate Projections Summary

- Table 1. Baseline and recent climatic conditions: Summarizes "historical" (1950-1981) values, considered the observed baseline for comparison with future observed/projected values, and "recent" (1981-2010) values for the BCM outputs.
- Table 3. Change in BCM outputs: Compares recent and projected values to the historical baseline and expresses the change in temperature or inches of water per year for all the BCM outputs.

Climatic Water Deficit by Watershed

- Table 6. Projected outputs: Shows the percent of the North Coast and its WMAs that are at risk of drought stress, defined as projected change exceeding one standard deviation of historical CWD. For the hot, low rainfall scenario, 100% of the project area is projected to be in drought stress by end of century (2070-2099).

Hydrology and Flow Response

- Table 7. Observed and projected annual total water supply: Shows historic values and three projected scenarios for water supply indicators (runoff + recharge) at each WMA.
- Streamflow assessments (runoff recharge time series): Completed for three watersheds with sufficient data (Redwood Creek, Russian, Eel). Streamflow graphs are included in the full report.
- Table 10. Floods and droughts: Shows the range of projected change in annual

discharge extremes (>90th percentile = flood year; <10th percentile = drought year).

Groundwater Recharge

- Table 11. Historic and current attributes of groundwater basins: Shows the area-weighted annual groundwater recharge is highest in Humboldt WMA (44 in/yr) and lowest in the Klamath (4.2 in/yr).

Vegetation Vulnerabilities

- Table 13. Recent and projected vegetation stress: Shows percent of project area in "unsuitable" and "climate stressed" vegetation categories for three end of century scenarios.

Fire Risk

- Table 14. Probability of fire over 30-yr period: Shows an approximately 40% increase in probability of fire across the Region by end-century. For major river basins (Table 15, not included here): The Russian River basin shows the historical (19%) and highest projected probability of burn (23- 26%). The Shasta, Butte and Lost Rivers basins show extremely low historical rates of burning and essentially no projected increases resulting from climate change.

STRATEGIES/ CONSTRAINTS

Climate Projection Scenario Probability

Navigating the necessarily probabilistic nature of climate data projections is perhaps one of the greatest challenges in applying these kinds of data products to real-world management issues. While managers wish an assessment could simply provide the most likely outcome, due to the uncertainty in how climate change will impact rainfall in the North Coast region, one needs to facilitate consideration of multiple scenarios. Presently, in general, all of the scenarios need to be considered as *equally likely* (i.e. the "scenario neutral" approach).

Data Constraints

For each section of the assessment, the report discusses associated data gaps and data limitations with suggestions for analysis improvement. These are outlined below, and detailed in the full report.

Climate Projections

- The 270 meter, or 18 acre, scale of analysis for the 2014 BCM is a limitation on understanding the effects of topography on micro climates. A future opportunity to provide more detailed analysis could be achieved using a finer resolution, 30 meter pixel size BCM.
- Data are limited by the quality of baseline geology and soil maps. Improved soils/geology mapping could provide the opportunity for better modeling of hydrological function across the region.
- One gap includes the lack of future scenario diversity for snow predictions (April 1st snow water equivalent is provided for a warm, moderate rainfall scenario only).

Hydrology and Flow Response

- Hydrological data in the BCM are limited by the quality of baseline geology and soil maps and the location and quality of record for weather stations used in the calibration; better mapping would mean better modeling.
- The BCM is developed to determine the water balance for unimpaired natural conditions. Calibration of streamflow is limited by the upstream impairments and extractions. Additional stream gaging, estimates of actual evapotranspiration, and precipitation gages would improve calibration.
- Data gaps include missing records from streamflow data and inaccurate precipitation records. Primarily, however, unimpaired streamflow data is not available for many upstream locations, particularly in headwaters of streams where the runoff and recharge processes are initiated.

Groundwater Recharge p 27

- Groundwater resources are poorly understood in many locations. The analysis done here was done to illustrate the relative extents of groundwater basins and potential recharge across the Region and should not be used quantitatively.
- The accurate assessment of groundwater availability requires hydrogeologic investigations along with groundwater modeling to simulate stresses on the system.
- A notable data gap would be measured estimates of bedrock permeability along with recharge estimates at the watershed scale.

Vegetation Vulnerabilities

- Some data points, which lie far outside the distribution of climate space for the type may represent microclimate variation not captured in the climate data, misclassified vegetation types in source data or historical anomalies.
- Macrogroup 106 (Temperate Pacific Intertidal Shore) was excluded from analysis due to limited distributions, making an accurate fit of climate space unobtainable.

Fire Risk

- Lightning was not included as an ignition source in historical fire models due to the lack of future projections for lightning.
- Changes in human population density and distribution are not accounted for, but these are related to fire risk.
- Data gaps include rural development data across the state and the impact of development levels on fire in rural California.

RECOMMENDATIONS

Adaptive management planning in the context of climate change and other stressors should consider the following principles, in light of projected impacts on forest and watershed hydrology, vegetation resilience, shifts in fire regimes, and groundwater protection.

- Water conservation and long-term plans for water security are more important than ever.
- Protect high value recharge zones and maximize subsurface storage in aquifers.
- Find innovative ways to capture winter precipitation, storm water runoff, and peak flows for use during dry seasons and recycle wastewater streams.
- Increase soil moisture holding capacity of soils where feasible through vegetation management or soil amendments.
- Consider vegetation monitoring for stress and mortality, particularly during drought events, in locations identified with high vegetation vulnerabilities.
- Seek vegetation management tools and treatments capable of reducing accumulated fuel loads and associated fire risks.
- Develop plans for post-fire management that address strategies for native vegetation resilience and mitigation of impacts on watershed runoff.
- Address the data gaps and data limitations that constrain future refinement of this assessment. For example, the authors recommend the model not be used to facilitate pixel-by-pixel comparisons, but rather be applied to minimum units ideally at the scale of sub-watershed planning units, or no smaller than parcels on the order of hundreds of acres.

Maps are compiled in the companion to the technical report. See "Map and time series data visualizations" at http://www.northcoastresourcepartnership.org/resources/

Table 1. Project Area Summary of Historical and Recent 30-year Average BCM Outputs

NCRP Project Area: Basin Characterization Model Outputs, 1950-2010				
CWD (in/year)	Historical		Recent Values	
	1950-1981	±SE	1981-2010	±SE
	20.7	0.5	20.9	0.6
DJF (°F)	31.5	6.2	32.3	6.2
JJA (°F)	80.4	6.2	80.5	6.2
PPT (in/y)	55.7	2.5	54.1	2.8
RCH (in/y)	20.5	1.0	19.3	1.0
RUN (in/y)	18.1	1.8	17.0	1.8
AET (in/y)	16.0	0.4	16.5	0.5
SWE (in/y)	10.0	-	7.9	-

Table 3. Change in Basin Characterization Model (BCM) Outputs, 2010-2099

NCRP Project Area: Projected change from historic baseline (1951-1980), recent plus 3 futures, 30-y time steps										
Variable 1981-2010 2010-2039		**Scenario 1 Warm, Moderate Rainfall**			**Scenario 2 Warm, High Rainfall**			**Scenario 3 High Warming, Low Rainfall**		
		2040-2069	**2070-2069**	**2010-2039**	**2040-2069**	**2070-2069**	**2010-2039**	**2040-2069**	**2070-2069**	
Pct Change CWD	1	5	12	16	2	10	21	6	3	10
Delta DJF (°F)	0.8	2.1	3.0	5.9	2.9	4.6	8.1	2.4	3.5	3.6
Delta JJA (°F)	0.2	2.6	5.1	8.4	2.6	5.0	8.5	2.1	3.2	4.8
Pct Change PPT	-3	1	-1	-1	16	18	23	-1	-2	-12
Pct Change RCH	-6	-3	-6	-11	3	2	3	-8	-10	-19
Pct Change RUN	-6	3	1	2	36	45	63	3	-7	-20
Pct Change AET	4	6	6	12	13	11	11	4	15	8
SWE (in/y)	-23	-	-64	-90	-	-	-	-	-	-

Table 6. Percent of Project Area and WMAs at Risk of Drought Stress

Percent Area at risk of drought stress*				
Site	Projected values			
	Warm, moderate rainfall		Hot, low rainfall ll	
Project Area Eel WMA Klamath WMA Humboldt WMA Russian Bodega WMA Trinity WMA North Coast Rivers WMA 2 North Coast Rivers WMA 1	2040-2069	2070-2099	2040-2069	2070-2099
	41	75	95	100
	12	69	98	100
	72	85	96	100
	17	47	94	100
	0	85	98	100
	53	82	97	100
	28	78	100	100
	13	15	61	100

*Drought stress defined as projected change exceeding one standard deviation of historical CWD

Table 7. Annual Water Supply Indicators for Watershed Management Areas (WMAs)

WMA Water Supply (Average in/y)	**Observed 1920-2009 Average**			**Projected 2010-2099 Warm, High Rainfall Average**			**Projected 2010-2099 Warm, Moderate Rainfall Average**			**Projected 2010-2099 Hot, Low Rainfall Average**		
	Total Water			Total Water			Total Water			Total Water		
	Runoff	Recharge	Supply	Runoff	Recharge	Supply	Runoff	Recharge	Supply	Runoff	Recharge	Supply
Eel	16.3	25.2	41.6	20.6	22.6	43.2	18.5	24.8	43.3	13.3	22.6	35.9
Humboldt	17.8	31.7	49.5	21.9	28.6	50.6	20.3	30.6	50.9	16.0	28.2	44.2
Klamath	15.3	12.5	27.7	16.4	11.6	28.0	15.9	12.1	28.0	13.0	11.2	24.2
North Coast River1 WMA 1	40.5	34.6	75.1	44.1	31.6	75.7	42.7	32.6	75.2	37.4	30.8	68.2
North Coast River2 2WMA 2	13.2	22.6	35.9	17.1	20.8	37.9	15.0	22.8	37.8	10.3	20.3	30.6
Russian Bodega	15.7	11.5	27.2	18.9	11.0	29.9	17.4	11.7	29.2	12.2	10.0	22.2
Trinity	18.3	22.6	40.9	21.0	20.6	41.7	19.6	22.0	41.7	15.2	20.4	35.6

Table 10. Annual Discharge Extremes for Historical Baseline vs. Projected Conditions: Eel River, Redwood Creek, and Russian River (<10 is drought; >90 is flood)

Frequency of annual cumulative discharge exceedance of 90th and 10th percentiles per decade								
Basin	Historical record (time period varies)		Hot, low rainfall (2010 - 2099)		Warm, moderate rainfall (2010 - 2099)		Warm, high rainfall (2010 - 2099)	
	< 10th	> 90th or	< 10th	>90th	< 10th	>90th	< 10th	>90th
Eel River	5	5	12	1	9	12	3	28
Redwood Creek	9	10	7	5	10	19	0	29
Russian River	7	8	19	2	14	9	2	29

Table 11. Groundwater Basin Attributes Summarized by Watershed Management Area (WMA)

Groundwater Basin Summary by WMA					Historical (1951-1980) hydrology (inches/year)		
WMA	Percent area in WMA	No. GWB's WMA	Square Miles	Total GWB Square Miles	WMA equal Weighted average of recharge in GWB	Average Runoff	Average Recharge in WMA in WMA
Eel WMA	16	3682	355	9.6	18.0	26.6	17.1
Humboldt WMA	6	1148	308	26.8	44.4	32.9	18.6
Klamath WMA	11	7039	1097	15.6	4.2	13.1	16.7
North Coast Rivers WMA 1	1	872	114	13.1	10.9	35.3	43.6
North Coast Rivers WMA 2	12	2098	155	7.4	14.9	23.7	13.6
Russian Bodega WMA	14	1628	743	45.6	9.7	12.0	15.9
Trinity WMA	4	2970	25	0.9	25.2	23.8	19.4
Total Project Area	64	19438	2797	14.4	NA	20.5	18.1

Table 13. Percent of Project Area in Unsuitable and Climate Stressed Vegetation Categories by End of Century (2070-2099), Three Scenarios

*Percent of Project Area Vegetation Exposure Class	Recent (1981-2010)	End of Century (2070-2099) CCSM	CNRM	Miroc
Unsuitable (80% to 95%)	9	11	10	9
Climate stressed (95% to 99%)	8	11	15	13
Highly Climate Stressed (99%-100%)	2	8	23	10
Climate Stressed (Non-Analog)	0	0	3	0
Total	19	30	51	32

*Percent area excludes urban and agricultural lands. CCSM is the moderate rainfall scenario, CNRM is the high rainfall scenario, and Miroc is the low rainfall scenario.

Table 14. Probability of Fire over a 30-year Period, NCRP Project Area (two scenarios)

Project Area			
Time Period	Historical	low warming, low rainfall	low warming, moderate rainfall
Probability of Fire	1971 - 2000	2040-2069 2070-2099	2040-2069 2070-2099
(% Chance over 30 yrs)	10	13 15	13 15

CLIMATE CHANGE MITIGATION & ENERGY INDEPENDENCE

TITLE: North Coast Resource Partnership Integrated Strategic Plan: Memo for Technical Area 1—Climate Change Mitigation, GHG Emissions Reduction, and Energy Independence

AUTHORS: Redwood Coast Energy Authority and Schatz Energy Research Center (2017)

FULL REPORT: http://www.northcoastresourcepartnership.org/resources/

REPORT SUMMARY

PURPOSE/ OVERVIEW

This report is intended to provide background technical information that can support the development of a sustainable energy plan for the NCRP region. It presents an energy profile, for the Region and by county, including energy consumption, energy generation, and associated CO2 emissions. The majority of the focus in this report is on renewable electricity generation, but the use of renewable energy sources for heating and as transportation fuels is also considered.

The scope of this report includes an overview of demographics and climate; regional and local energy generation and consumption; existing energy sources and infrastructure; GHG emissions estimates; and existing programs, policies, and incentives. The assessment of regional opportunities focuses on energy efficiency, renewable energy (by type and by county), and potential impacts/ benefits (i.e. social, environmental, economic, and political).

For each resource type discussed and quantified (e.g. biomass, solar, wind etc.), the report offers maps of resource potential; a listing of resources for more information; some applicable case studies; and a checklist of specific technical information needed for a feasibility assessment and/ or project development. A summary matrix of recommended opportunities for each county is presented to highlight the most promising options in each place.

Three key strategies are outlined: (1) increase energy efficiency, (2) develop renewable energy resources, and (3) reduce the consumption of carbon-intensive fossil fuels via fuel switching. These three strategies will be key to a sustainable and prosperous energy future in the region. This report aims to identify opportunities and constraints for pursuing each of these and provides recommendations for next steps.

The potential benefits of implementing the strategies include social, environmental, economic, and political. Direct benefits include increased economic development and job creation, increased energy security and resiliency, reduced greenhouse gas (GHG) emissions, and increased local control. Anticipated impacts associated with a new project must be considered in concert with these potential benefits. Although "green" renewable energy technologies pose some level of impact on the environment, it is important to also understand that the "do nothing" alternative also has impacts (e.g. global temperature increase).

The report concludes with recommendations that synthesize the report findings into nine focus areas for future work. These are: identified information gaps, programs/ policies, community energy, transportation, renewable energy, energy efficiency, microgrids, fuel switching in the heating sector, and future research/ planning.

METHODOLOGY/ DATA

The report summarizes data from numerous technical sources to calculate the energy profile (i.e. production, consumption) and energy resource assessment (i.e. existing and potential) that are the core of this report. These data also generated a series of pie-charts, histograms, tables, and maps. Data sources are listed below:

- Data on population demographics (2010 and projected 2014) are from the US Census Bureau (2015) and data on climate are from Your Weather Service website (2016).
- Data for electricity consumption and energy generation for the Region and counties are from the California Energy Commission (2016).
- Data on GHG emissions are reported on a CO_2 basis for consistency across emission sources, as data for the other GHGs are generally not available. The CO_2 emissions reported in this section were calculated using published emissions factors. For electricity the report uses PG&E published CO_2 emissions factors (2015). Natural gas CO2 emissions were determined using the US EPA emission factor for the combustion of methane (2014). Transportation emissions are from the California Air Resources Board EMFAC database and were calculated using the EMFAC methodology (2014).
- Data on estimated regional gasoline sales for the years 2005 through 2015 are from the EMFAC database, California Air Resources Board.
- Data on current and potential biomass at the state level, parsed to county-level, include the California Energy Commission, National Renewable Energy Lab, UC Davis Biomass

Collaborative, United States Geological Survey, and US Department of Energy (USDOE).

- Data on current and potential geothermal energy are from the USGS.
- Data on current and potential hydropower are from the USDOE, Oak Ridge National Laboratory, and the California Energy Commission websites.
- Data on current and potential solar energy are from the California Solar Initiative project.
- Data on current and potential wave energy are from the National Renewable Energy Lab website.
- Data on wind energy are from USDOE Energy Efficiency and Renewable Energy website.

KEY FINDINGS

Regional Energy Profile

- The NCRP Region has a wealth of sustainable energy resources to draw upon, including opportunities for gains in energy efficiency, renewable energy resource development, low-carbon transportation fuels, and fuel switching in the heating sector.
- The first place to start with energy sustainability is with energy efficiency measures, as they are typically the most cost effective. Energy efficiency is key to reducing GHG emissions in the NCRP region, and California the investor owned utilities are required to collect and spend funds from ratepayers for efficiency programs.
- There is vast renewable energy potential in the NCRP region. These resources are not distributed evenly throughout the Region and each jurisdiction has particular energy needs and demands based on its demographics, climate, and other factors.
- Typically, only a very small portion of the technically available resource can be economically developed. The total *technical potential* for the Region is about 140 times as great as the total consumption. However, the *economic potential* is likely to be only a small fraction of the total technical potential, because there can be many barriers that can make a technically feasible resource undesirable to develop in practice (e.g. cost, environmental impacts, and community opposition).
- The Region is a net exporter of electricity (i.e. generates more than it consumes), with much of the power sold outside of the region. Of the 6,200 GWh that were generated, approximately 5,800 GWh was from renewable energy sources, predominantly geothermal (nearly 90%). This 5,800 GWh of renewable electricity slightly exceeds the region's total 2015 electricity consumption of 5,300 GWh.
- Geothermal generates the most power, followed by hydro, natural gas, biomass, and solar.
- Solar and off-shore wind dominate the region with over 94% of the total technical potential. Onshore wind, wave, biomass and geothermal resources make up most of the remainder.
- The energy related greenhouse (GHG) emissions in the Region appear to be dominated by the transportation sector. As such, efforts to reduce the consumption of transportation fuels via both fuel efficiency improvements and reductions in vehicle miles.
- Commercially available alternative transportation fuels include biodiesel, electricity, ethanol, hydrogen, natural gas, renewable natural gas, propane, and renewable diesel. The alternative fueling infrastructure in the NCRP region, as of December 2016, includes: electric vehicle charging stations (147), propane fueling stations (17), biodiesel fuel pumps (4), and hydrogen fueling stations (1)
- Fuel switching in the heating sector will be crucial to achieving GHG reduction goals in the energy sector. With a low-carbon electric grid such as exists in the NCRP Region there are big gains to be achieved when switching from fossil fuel based space and water heating systems to electric heat pumps.

Energy Profile by County

- Sonoma, with its larger population, has the greatest energy consumption. However, it also has the lowest electricity consumption per capita. In contrast, Trinity County gets all of its electricity from hydropower, so the CO2 emissions associated with electricity consumption in Trinity County are zero.
- The transportation sector accounts for nearly all of Trinity County's CO_2 emissions. It appears that a relatively high level of diesel fuel consumption and a low population are the key reason Trinity County's per capita CO_2 emissions are higher than the other counties shown.
- All of the petroleum fuels consumed in the NCRP Region are imported into the region. Sonoma County has the largest gasoline consumption by a substantial margin, followed by Humboldt, Siskiyou and Mendocino, which are tightly clustered, and then followed by Del Norte, Trinity and Modoc Counties. Like with electricity consumption, these differences are largely driven by differences in the population for each of these counties.

- Only three counties (Humboldt, Mendocino and Sonoma) have significant natural gas service. The remaining counties are reliant on propane, fuel oil, wood and electricity
- All of the natural gas consumed in the NCRP Region is imported, with the exception of Humboldt County, where about 10% of the gas consumed comes from gas wells located within the county.
- Humboldt County is a net importer if electricity. It features biomass (3) and natural gas (1) facilities.
- Mendocino County is a net importer of electricity. It features hydropower (2) and solar (4) facilities.
- Siskiyou County nearly meets total energy demand with hydropower, but in most years some import is required. It features hydropower (6) and biomass (1) facilities.
- Sonoma County is the largest power producer and largest electricity exporter in the NCRP region. Its portfolio is diverse; the vast majority is from geothermal (13) including at The Geysers plant. It also features solar (9), natural gas (2), landfill gas (3), and hydropower (1).
- Trinity County has been a consistent exporter of electricity, with local generation exclusively from hydropower sources (6).

Biomass

- Humboldt, Mendocino and Siskiyou, are in the highest biomass resource category listed. Within the NCRP region, forest biomass accounts for over 90% of the total biomass resource.
- Biomass wastes that are centrally located are more convenient because they are easier to collect and may not need be transported very far. In contrast, non-centralized wastes in the forestry sector (thinnings, residues) are problematic: it is difficult to cost-effectively transport these materials long distances; 50 miles is often used as a rough guideline for how far you can transport forest residues.
- Direct biomass combustion technologies are technologically mature and commercially readily available. Gasification systems are less mature.
- Conversion of woody biomass into energy can have adverse environmental impacts (e.g. air pollution emissions, lack of carbon neutrality, unsustainable forest management policies). However, in a well-managed system, utilization of woody biomass for energy production can provide many benefits.
- Biogas from biomass can be used to generate heat and/ or electrical power. Sources are wastewater treatment plants, animal farm manure, landfill gas, and food waste (part of solid waste stream).

Geothermal

- Geothermal potential within the NCRP counties is concentrated chiefly in Sonoma County, Siskiyou County, Modoc County, and Mendocino County.
- Sonoma County utilizes much of its geothermal resource with the existing facility at The Geysers.
- While geothermal power currently accounts for 78% of renewable power capacity within the NCRP region, additional utility scale generation will be hindered by resource constraints, local cultural considerations, and prohibitive costs. Small-scale applications may be viable.
- Critics cite environmental concerns with EGS technology due to similarities between EGS and hydraulic fracturing (e.g. increased seismicity and potential contamination of groundwater).

Hydropower

- There may be substantial amount of new hydropower potential in the NCRP region, especially in Del Norte, Humboldt, Siskiyou and Trinity Counties. Very few of the apparent hydropower opportunities would actually prove feasible. Environmental impacts are one key barrier.
- A hydropower facility can only qualify as a renewable energy facility if it does not cause an adverse impact on the instream beneficial uses of the affected waterway. Thus, the CEC only considers small hydropower facilities eligible for renewable status.
- The construction of new dams is very unlikely. Other hydropower development opportunities exist that do not involve new stream-reach development, such as conversion of existing non-powered dams to hydroelectric production (e.g. in Modoc, Siskiyou, Humboldt and Sonoma Counties).

Solar

- The renewable resource with the greatest potential in the NCRP Region is solar power - a very mature technology. Solar has become competitively priced vs. conventional forms of electricity production.
- Solar clearly offers the greatest total potential across all the resources examined (68% of the total estimated renewable resource potential), due to the simple fact that the sun shines everywhere.
- Modoc and Siskiyou exhibit the greatest potential because they have a large amount of suitable land area and are situated inland where the solar resource is more intense. Mendocino and Sonoma

are next, and their location further south in the NCRP Region works to their advantage. Del Norte ranks very low in solar resource potential.

Wave

- Wave Energy Converters (WECs) utilize ocean waves to produce power. While the technology is not mature and has yet to see any major installations, wave energy has the potential to provide around-the-clock power to coastal communities.
- There are substantial wave energy resources in the NCRP Region. Wave energy in the Region is not likely to be limited by resource availability, but instead by cost, supporting infrastructure, competing stakeholder needs, regulatory complexity, and public acceptance.
- For development of any wave energy project, a deep-water port is also absolutely necessary. This makes deep Humboldt Bay most feasible for wave energy demonstration/ deployment in the Region.

Wind

- Wind power is a mature technology. Wind power prices are now competitive with conventional sources. There are some good wind sites onshore, but the best wind resource is found offshore.
- Viable wind power sites include access to the electrical transmission grid, adequate road access, and proximity to population centers. It is important to find out if there are any important bird or bat areas in the vicinity, as these could present conflicts.
- The offshore wind resource is generally strong off both Humboldt and Mendocino Counties, with Cape Mendocino exhibiting the strongest resource in the region.

Fuel Switching in the Heating Sector

- Fuel switching in the heating sector is crucial to achieving GHG reduction goals in the energy sector.
- With a low-carbon electric grid such as exists in the NCRP Region there are big gains to be achieved when switching from fossil fuel based space and water heating systems to electric heat pumps.

Alternative Transport Fuels

- The transportation sector accounts for a large portion of the energy related GHG emissions in the NCRP region. As such, efforts to reduce the consumption of transportation fuels via both fuel efficiency improvements and reductions in vehicle miles.
- Commercially available alternative transportation fuels include biodiesel, electricity, ethanol, hydrogen, natural gas, renewable natural gas, propane, and renewable diesel.
- Alternative fueling infrastructure in the NCRP Region includes: electric vehicle charging stations (147), propane fueling stations (17), biodiesel fuel pumps (4), and hydrogen fueling stations (1) (DOE 2016).

LAW AND POLICY

Regulations Related to GHG Emissions Reduction

- California Assembly Bill 32 (the California Global Warming Solutions Act) requires reduction of greenhouse gas emissions to 1990 levels by the year 2020, and 80% below 1990 levels by 2050. In 2016 Senate Bill 32 amended AB 32 to require California to reduce GHG emissions to 40% below 1990 levels by 2030.
- In October of 2015 California passed Senate Bill 350, the Clean Energy and Pollution Reduction Act. The bill lays out the following goals for 2030: A 50% reduction in petroleum use, 50% of utility power coming from renewables, and 50% increase in energy efficiency in existing buildings.
- In addition to AB 32 and SB 350 California has passed a number of bills that are working to combat climate change including via GHG mitigation. (http://focus.senate.ca.gov/climate/full-- package).

Regulations Related to Alternative Fuel Adoption

- AB 32 requires a Scoping Plan, to be updated every five years, that lays out strategies to reduce GHG emissions based on the latest science and technologies. The California Air Resources Board (CARB) was charged with developing the Scoping Plan and subsequent updates.
- California Senate Bill 375, the Sustainable Communities and Climate Protection Act of 2008, requires metropolitan planning organizations (MPOs).
- California Senate Bill 350 commits to more renewable energy and increased energy efficiency.
- The Energy Policy Act (EPAct) of 1992 (Public Law 102-486) was passed by Congress to address the country's increasing dependence on petroleum. The act mandated an increasing percentage of new vehicles in government fleets be alternative fuel vehicles, and developed a renewable fuel standard.
- The State Agency Low Carbon Fuel Use Requirement will be in effect starting January of 2017 at which time at least 3% of bulk transportation fuel

purchased by the state must be very low carbon fuels (having no greater than 40% of the carbon intensity of the closest comparable petroleum fuel).

- Executive Order 13693 guides planning for federal sustainability in the next decade, and specifically addresses fleet and vehicle efficiency.
- Congress enacted Corporate Average Fuel Economy (CAFE) standards to reduce energy consumption by increasing vehicle fuel economy. The National Highway Traffic Safety Administration (NHTSA) sets

STRATEGIES/ OPPORTUNITIES

The report discusses the benefits, challenges, and application of three strategies that are considered key to a sustainable and prosperous energy future. Each is considered at length therein.

- STRATEGY 1: Increase energy efficiency
- STRATEGY 2: Develop renewable energy resources
- STRATEGY 3: Reduce the consumption of carbon-intensive fossil fuels via fuel-switching.

Implementing the strategies will present both challenges and opportunities. These include: (1) the intermittent nature of some prominent renewable resources and the value of energy storage and demand response, 2) the need for adequate transmission infrastructure, 3) the challenges and opportunities associated with distributed [small-scale] generation, 4) the opportunity for microgrids and combined heat and power, and 5) the opportunity for power plant ownership.

Specific challenges that should be addressed with additional strategies include social equity and social justice issues; unintended environmental consequences; local economics and job security; and political/ stakeholder engagement. The report discusses ways to identify and confront these challenges, and to turn them into opportunities.

RECOMMENDATIONS

This section makes recommendations for future planning and research efforts and identifies areas where additional information is needed. Next steps should include creation of a vision statement and development of a detailed, regional strategic energy and climate plan.

Fill Identified Information Gaps

It is recommended that further research be conducted in an attempt to fill most or all of the information gaps listed below.

- There is no data readily available for the quantity of propane or fuel oil consumed in the NCRP Region by county.
- The benefits of switching to other sources of heat, for example heat pumps, cannot be measured unless there is a reliable baseline for comparison.
- Data on the number of fleet vehicles, number of organizations with fleet vehicles and the miles traveled by fleet vehicles
- There is a multitude of energy related data that would be useful to have compiled and put into a geographic information system format.
- Actual gasoline and diesel fuel sales data at the county level.
- Data and info on electric utilities and CCAs in the region
- Complete energy related GHG emission and criteria pollutant emission data associated with the energy consumed in the NCRP region. Only CO_2 emissions estimates are presented
- Significantly more analysis should be performed to better estimate the resource potential in the Region and to assess what is technically and economically feasible. In addition, it will be important to assess potential challenges and barriers and identify preferences of the local communities where these resources would be developed.

Develop/ Pursue Programs and Policies

The report is intended to provide background technical information that can support the development of a sustainable energy plan for the NCRP region. It is recommended that this effort be continued, including the following activities:

- Develop a vision statement with broad goals and objectives and a corresponding strategic energy plan for the NCRP region.
- Consider creating a regional energy organization,
- Pursue regional funding for energy planning and program and project development.
- Pursue development of demonstration projects that can be replicated.
- Pursue research and development opportunities

Consider Community Energy

- A large fraction of the population in the NCRP Region is, or shortly will be, purchasing electricity from either a community choice aggregation program or a municipal utility.
- Community Choice Aggregation (CCA) should be considered for all jurisdictions that are not currently served by a CCA or a municipal utility.

Address Transportation

- To address the gap in consumer confidence with regard to ZEV, it is critical for the NCRP Region to accelerate the deployment of alternative fueling infrastructure.
- In addition to building alternative fuel infrastructure, continued implementation of supporting activities called for in regional readiness plans is critical to accelerating adoption. For example, the North Coast Electric Vehicle Readiness Plan.

Expand Renewable Energy

- Distributed generation projects should be pursued.
- Forest biomass many benefits far beyond the energy related benefits. The key counties for biomass energy include Humboldt, Mendocino, Siskiyou and Trinity Counties.
- Geothermal opportunities exist in the NCRP region, though it appears unlikely that a large-scale power plant like the one that currently exists at the Geysers could be developed somewhere else in the region. Small-scale geothermal is a viable option.
- Hydropower opportunities, while not insubstantial in the region, are likely to face significant challenges with regard to feasibility.
- Distributed solar should definitely be pursued in the NCRP Region
- Wave power is an immature technology at this point in time. Humboldt Bay is a well-suited deep-water port that could provide the needed supporting infrastructure for a wave energy project, and could position itself as a prime location for early wave energy demonstration projects in California.
- Wind energy offers numerous opportunities throughout the NCRP region. The best known is the Cape Mendocino area in Humboldt County. Perhaps the best wind resource opportunity in the Region is offshore. Smaller community-scale wind projects or facility scale wind projects might prove feasible in the right locations

Increase Energy Efficiency

- There are currently many energy efficiency programs that operate in the NCRP region, however programs for areas served by PacificCorp are lacking. The authors recommend expanding programs into PacificCorp territory.

Use Microgrids

- Development of microgrids throughout the region, as part of a local energy assurance planning effort, is highly recommended. In addition to providing resiliency, microgrids can also encourage the use of distributed renewable resources.

Promote Heating-Fuel Switching

- The most economically viable opportunity is to convert propane or fuel oil users over to electric heat pumps. However, the key question is who would establish and carry out such a program. A municipal utility could easily take it on, or if a CCA were serving the entire NCRP Region they could offer such a program.

Figure 14: The total consumption in the region and the annual generation by fuel source for counties in the NCRP region.

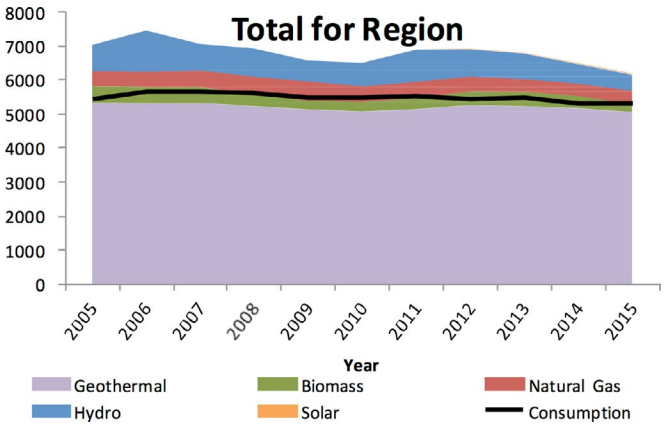


Figure 27: Renewable electricity generation potential by resource (total technical potential = 765 TWh/yr).

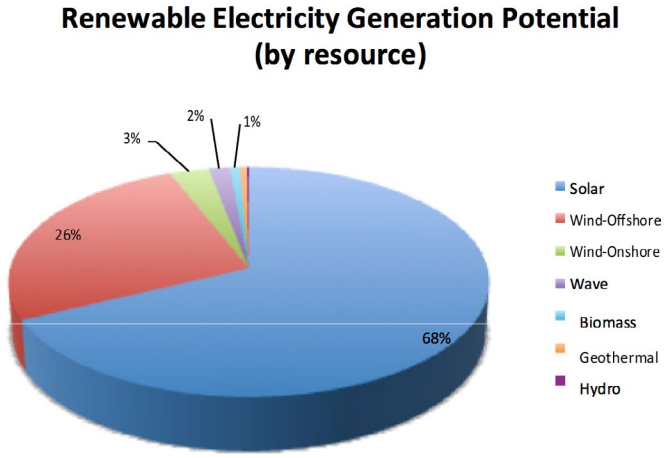


Figure 28: Renewable electricity generation potential by county (total technical potential = 765 TWh/yr).

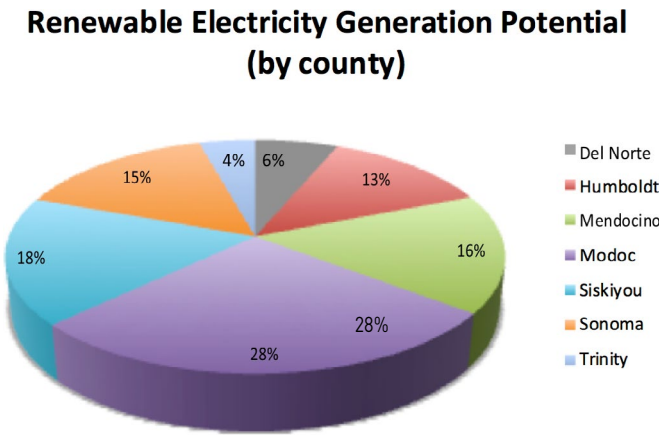


Table 13: Renewable energy opportunity matrix by county and resource for the North Coast Resource Partnership region.

	Del Norte	Humboldt	Mendocino	Modoc	Siskiyou	Sonoma	Trinity
Biomass	Low	High	High	Medium	High	Medium	High
Geothermal	Low	Low	Medium	High	High	High	Low
Hydro (Total)	Medium	Medium	Low	Low	Medium	Low	Medium
Solar	High	High	High	High	High	High	High
Wave	High	High	Medium	Low	Low	Medium	Low
Wind-Onshore	High	High	Medium	Medium	High	Low	Medium
Wind-Offshore	High	High	Medium	Low	Low	Medium	Low

Table 3: Generation capacity and number of plant by fuel type for the NCRP region.

Fuel	MW	Number of Plants
Biomass	74.7	4
Gas	176.6	4
Geothermal	1368	13
Hydro	233	15
Landfill Gas	16.0	3
Solar	17.2	13
Total	**1886**	**52**

GREENHOUSE GAS EMISSIONS ASSESSMENT ROADMAP FOR THE NORTH COAST RESOURCE PARTNERSHIP

TITLE: Greenhouse Gas Emissions Assessment Roadmap for the North Coast Resource Partnership

AUTHORS: Redwood Coast Energy Authority and Schatz Energy Research Center (2017)

FULL REPORT: http://www.northcoastresourcepartnership.org/resources/

REPORT SUMMARY

PURPOSE/ OVERVIEW

In order to address climate change governments, organizations, companies and other entities are trying to reduce their production of greenhouse gas (GHG) emissions. Greenhouse gas emissions accounting has received significant attention and development in recent years due primarily to national government policy decisions and the establishment of carbon trading schemes. The objective of this report is to guide decision makers in the process of tying GHG emissions accounting efforts to policy and project implementation.

This report establishes a set of key criteria, and utilizes it to develop a GHG emissions accounting roadmap for the North Coast Resource Partnership region. There are numerous decision criteria that determine how an entity accounts for its GHG emissions. The large number of decision criteria has resulted in the development of myriad methodologies/ protocols for assessing GHG emissions that differ in nuanced and technical ways; use of different methodologies/ protocols can produce different results and/ or may be appropriate for different focal groups. Because of this, there is a need for a standardized set of key decision criteria to guide stakeholders toward choosing the appropriate assessment elements.

This report explains what a greenhouse gas emissions accounting protocol is; identifies a set of key decision criteria; defines terms that comprise these criteria; and summarizes historic GHG accounting efforts within the NCRP region. Two decision matrices are created using the key decision criteria. One matrix is populated with recommended Protocols/ Methodologies/ Tools, and the other with recommended data sources. Recommendations are targeted to the local government sector of the North Coast region, but the decision matrix structure can be populated with recommendations targeted to any stakeholder group.

The report offers a useful, but still incomplete, set of recommendations. Key next steps are to reach out to stakeholders in the NCRP region to finish populating the two decision matrices with additional recommendations for local governments, and then to expand this roadmap to other stakeholder groups. Additional work could also include the development of best-practice recommendations that address aspects of GHG emissions accounting that are often poorly addressed in existing protocols.

METHODOLOGY/ DATA

The methodology for developing this reported roadmap is as follows: Section 1.1 defines a number of key terms and concepts within greenhouse gas emissions accounting; Section 1.2 sets the context within existing efforts of the NCRP region; Section 1.3 uses the key terms and concepts to develop a decision matrix through which recommendations for existing Methodologies and Protocols of interest to the region; the same decision matrix is also used to provide recommendations for data sources and best practices for utilizing the Methodologies and Protocols. Table 1 (below) represents the roadmap (i.e. decision-support structure) for drafting and tailoring a local GHG assessment.

KEY FINDINGS

For this report, the term GHG emissions accounting is defined as, "the assigning of responsibilities for [Greenhouse Gas] emissions and removals, in order to calculate debits and credits".

Greenhouse gas (GHG) emissions accounting and emissions Life Cycle Assessments (LCAs) are related (Figure 1), but not equivalent. There are two key differences between LCAs and GHG emissions accounting:

- GHG emissions accounting focuses specifically on GHG emissions while LCAs often assess a large number of environmental, social, and cost factors.
- GHG emissions accounting looks at a snapshot in time while LCAs typically consider emissions over a long period of time such as a typical useful life of a product, or over decades or centuries associated with total expected environmental, social, or cost impact.

One purpose of this report is to identify and define key terminology (**Terms**) in GHG emissions accounting; the Terms represent the key decision criteria that are needed to structure decision matrices that form the core of the roadmap. [see Table 1]

An entity can have numerous motivations for assessing greenhouse gas emissions. For the purposes of this report, the **Motivation** for pursuing GHG accounting is grouped into two buckets: mandatory and voluntary. The Motivation for assessing emissions is important as it can significantly limit the methodology options available to the entity (e.g. some entities that are mandated to assess emissions may be bound to a specific methodology).

This report focuses on local government agencies: entities bound to regulations that require an assessment of GHG emissions. However, there are a number of voluntary reasons to conduct a GHG emissions assessment, including:

- Public or private entities intending to participate in a carbon trading scheme
- Public or private organizations interested in assessing operational environmental impact
- Businesses interested in creating/ marketing products with a lower environmental impact

Two main approaches to defining the **Boundary** of a GHG emissions accounting effort have emerged: Inventory or Footprint.

- **GHG Inventory**: Represents an emissions production perspective, aimed at sources and sinks, generally within a defined geographic or fiscal boundary, typically a snapshot in time.
- **GHG Footprint**: Represents a consumption perspective, looking at emissions associated with the consumption of products and services, generally by a specific geographic region, population group, or other community or organization, and usually over time (i.e. LCA).

An Inventory or a Footprint can follow either of the following two **Classes**:

- **Attributional**: this focuses on the absolute emissions associated with a particular entity or action.
- **Consequential**: this focuses on the potential change in emissions associated with an activity or decision relative to a reference or baseline scenario.

In essence the two Classes are used to identify whether a GHG emissions accounting effort intends to identify the potential change in emissions rather than quantifying total emissions.

Note that Attributional GHG Inventories conducted for different years can also be compared against each other to obtain insight into a change in emissions. This is currently the common approach used in government climate action planning efforts, where a baseline Attributional GHG Inventory is completed for a community or local government organization, then updated regularly to assess the success of actions implemented between GHG Inventory years.

When considering sources/ sinks/ activities that result in GHG emissions there are a few common **Categories** used to bucket them. They are:

- **Sector:** bucket emissions sources, sinks and activities into specifically defined sectors such as "built environment", "transportation", or "land use change."
- **Scope:** Scope 1 Emissions="All direct GHG emissions;" Scope 2 Emissions="Indirect GHG emissions from consumption of purchased electricity, heat or steam;" Scope 3 Emissions="Other indirect emissions, such as the extraction and production of purchased materials and fuels."
- **Direct/ Indirect:** Direct emissions are considered in Inventories and Footprints, while Indirect emissions are considered in Footprints and may be considered to a limited extent in Inventories.
- **Source/ Activity:** Source = "Any physical process inside the jurisdictional boundary that releases GHG emissions into the atmosphere;" Activity = "The use of energy, materials, and/ or services by members of the community that result in the creation of GHG emissions."

There are five main **Entities** or **Actions** that can define who or what the Inventory or Footprint being developed will **Focus** on: a community, an organization, a policy, a project [see CEQA definition of a project in §15378], or a product/service. The **Focus** chosen will directly influence the applicable Class, as well as the various mass and energy flows that will be considered. For example, a GHG Inventory of the emissions of a community typically uses an Attributional approach while a GHG Inventory of the potential impact of a policy decision typically uses a Consequential approach

The efforts of three North Coast counties with regard to GHG accounting are summarized in the report.

- **Humboldt County:** With the exception of the City of Arcata, Humboldt County and jurisdictions within recently began actively inventorying GHG emissions; the City of Arcata (and the count of Sonoma) joined the Cities for Climate Protection Campaign developed by ICLEI and completed their first GHG inventory. Jurisdictions in the county are pursuing climate action plans.
- **Mendocino County**: The Mendocino Council of Governments has been including GHG reduction as a motivation in transportation planning since 2000; the 2004 City of Ukiah General Plan directly includes reductions in GHGs, two years before the passage of AB 32; the 2009 County General Plan specifically discusses GHG reduction goals, and in the same year the Ukiah Department of Planning and Building completed a city- wide GHG inventory.

- **Sonoma County**: The Center for Climate Protection (CCP) in Sonoma County has been conducting GHG Inventories for the County since 2003; In 2016 the Regional Climate Protection Authority (RCPA) developed a climate action plan for the county.

LAW AND POLICY

Legislative development has been a key driver motivated by state, federal and international momentum. Local governments are increasingly looking to understand GHG emissions in the context of policy development. For local governments, the key areas driving GHG emissions efforts are California Environmental Quality Act (CEQA) compliance, SB375 (Sustainable Communities and Climate Protection Act of 2008) compliance, and the development of local legislation that considers and/ or addresses GHG emissions. CEQA also serves a motivating role through §15183.5, which provides guidelines for local jurisdictions on adopting GHG mitigating plans in a way that legally facilitates streamlining the CEQA compliance process.

Some entities that are mandated to assess emissions may be bound to a specific methodology, such as large polluters required to report their emissions annually to the California Air Resources Board (CARB) under California's Regulation for Mandatory Reporting of Greenhouse Gas Emissions. Other entities mandated to assess emissions may have more leeway in the methodology they pursue. For example, projects pursued in California are subject to environmental review under CEQA. However, the current language of CEQA leaves the choice in methodology up to the lead agency (see §15064.4). See http://www.arb.ca.gov/cc/reporting/ghg-rep/reported-data/ghg-reports.htm for additional information on CARB regulation.

Review §4.5.1.d in the 2014 Humboldt County Association of Governments, "Humboldt Regional Transportation Plan 2013/14 Update - Final Environmental Impact Report," Humboldt County Association of Governments. http://hcaog.net/sites/default/files/vroom_rtp_2013-14_upd_feir.pdf

STRATEGY

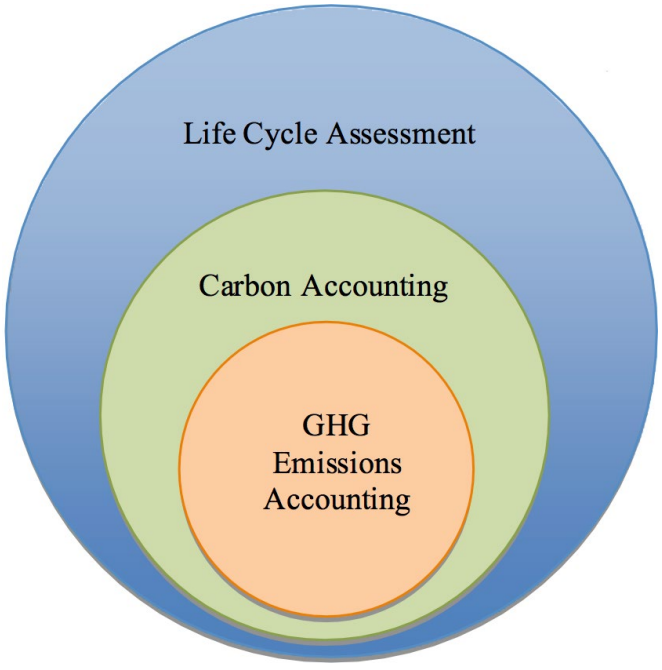
The strategy adopted by this report is to develop a GHG accounting template and process ("roadmap") that completely leverages existing GHG emissions accounting Protocols and Methodologies applicable to the North Coast Region. Rather than define how to calculate, track, and report greenhouse gas flows, this roadmap parses existing Protocols and Methodologies based on an extensive literature review of the discipline and of GHG emissions accounting efforts in the region. The end results [i.e. tables in the report Appendix] can guide stakeholders towards recommended existing and well-established Protocols and Methodologies based on the stakeholders' specific needs and circumstances.

RECOMMENDATIONS

A preliminary set of recommendations (i.e. Protocols, Methodologies, Tools, and Data) was developed to assist local entities in navigating through the myriad options for accounting of GHG emissions. To be most practically utilized, recommendations are aggregated by focus entity or action; and they are organized into specific categories where each category is defined as Direct by Sector (e.g., Built Environment, Transportation, Water/ Wastewater, etc.), or as Indirect. Each recommended protocol, data source, etc. is briefly described and links are provided for relevant information resources.

Recommendations were created using a "decision matrix" approach, and are thus presented in matrix (tabular) format in the report Appendix: summary Table 3 recommends methodologies and Table 4 recommends data sources. Note the choice of data source used in a GHG emissions assessment is a critical step, as this directly impacts the assessments credibility, comparability, and repeatability of the assessment. Data sources listed in this report are ranked "best," "good," or "fair," with the latter used only if no other data sources exist.

Figure 1: Relationship between Life Cycle Assessments (LCAs) and Greenhouse Gas (GHG) Emissions Accounting.



BIOMASS ENERGY ASSESSMENT

TITLE: Biomass Energy in the North Coast Region: An Assessment and Strategy for Ecologically and Socially Compatible Development

The Watershed Center (2017)

FULL REPORT: http://www.northcoastresourcepartnership.org/resources/

REPORT SUMMARY

PURPOSE/ OVERVIEW

The purpose of the report is to assist the North Coast region develop sustainable, environmentally compatible, appropriately scaled biomass energy systems that give the rural communities in the region the ability to promote power generation for the greatest local benefit now and in the future. It outlines an approach to biomass energy capable of addressing watershed and ecosystem function paired with local economic development accomplished through collective actions by the North Coast member counties and partners.

The scope of the report covers the uses of woody biomass; potential benefits and costs; feedstock characterization; existing facilities; regulatory environment; finance strategies; and a synthesis including region-specific strategies to address identified challenges. Categories of woody biomass (forest thinnings, slash, and shrubs; sawmill residue; agricultural waste; urban landscape trimmings; and construction/ demolition waste) and their uses (from lumber to energy) are reviewed.

The potential social and ecological benefits of biomass facilities, particularly for energy generation, are identified in this report, including: protection of water quality, improved forest health, increased carbon sequestration, decreased carbon emissions compared to fossil fuels and soil amendments, decreased particulate matter emissions over existing waste disposal and avoided open burning, and reduced threat of catastrophic wildfire. Economic contributions from biomass energy generation include direct and indirect job retention and creation; increased tax revenues; increased revenues/ reduced costs for forest and agricultural landowners; energy cost savings to local institutions; local utility generation and transmission revenues; and potentially long-term income from power sales for local and regional equity holders.

Concerns about biomass energy production (e.g. forest ecology, air quality, feedstock transportation, energy transmission, politics, and financing) are scrutinized. Political disagreement regarding the appropriateness, impacts, and sustainability of using forest and agricultural feedstocks to produce renewable energy from biomass have driven change in the biomass energy sector in California since 2012. It is acknowledged that biomass energy development could have net environmental, social and economic costs, where profit maximization is placed ahead of ecological and social considerations.

It is concluded that the North Coast can be a key player in assisting the State of California to meet its renewable energy goals, but not without adequate financial and organizational support. The authors encourage local, state, and federal representatives to assist in lending adequate support in pursuit of these objectives. Biomass energy is a unique, intersectional tool: success with biomass can impact the overall momentum of the region.

METHODOLOGY/ DATA

Document Review

In developing this strategy document, the authors conducted a literature review of biomass energy works including policy/legislation, technical issues, financial considerations and the existing regulatory framework. In addition, documents and resources pertaining to watershed health, water quality/quantity, ecosystem health, disadvantaged communities and economic development were reviewed with the intent of exploring the nexus between these disciplines and biomass energy.

Personal Interviews

Interviews were conducted with local, regional, state and national experts, elected officials, regulatory agency staff members, industry professionals, and environmental advocates—to help gain a clearer understanding of the social context, the capacity of local communities, governments and business, social values, and political realities. Interviews provided key social and political perspectives about the level of awareness of biomass energy; opinions regarding its use and implementation; and views in both directions of the region and the governmental and regulatory players in both Sacramento and in Washington D.C.

Report Compilation

This combined process of fact-finding and perspective-compilation provided the information and views that are included within this strategy document. The authors are hopeful that this document will fulfill its purpose as a regional strategy to facilitate biomass energy production and utilization.

KEY FINDINGS

- Biomass energy holds significant promise for enhancing both the current condition and long-term resilience and stability of local rural community economies, along with the broader regional economy.

- Biomass energy has higher, longer-lasting, and more localized economic impacts than most other renewables in that it is labor intensive to collect, process, and convert to power.
- Proximity to a biomass market is the most critical factor in determining the benefit to land owners and land management.
- Procurement of affordable and consistent biomass feedstocks is often the most challenging aspect of both securing initial capital financing for biomass project development and for economically operating biomass-to-energy facilities over time. The authors encourage a broad diversity of biomass uses at multiple scales to create a more resilient economic system.
- The annual supply of biomass for the region is estimated at 2,337 MWs of operating capacity, assuming a 90% capacity factor. Given today's energy pricing that translates to annual revenues of $ 1.84 billion. Updating this estimate is a key recommendation of this report.
- Available biomass varies throughout the region (Table 3): Humboldt and Mendocino counties have the highest forest biomass with the majority of land ownership as private (timber) companies. Siskiyou and Trinity counties also have high woody biomass availability, with different species and terrain. Trimmings from vineyards can potentially be a significant source of biomass for Sonoma County. In Del Norte County growth productivity is extremely high, but is mostly on public lands used for preservation/ recreation. Modoc County offers an opportunity to utilize a significant amount of biomass (i.e. western juniper being removed from 400,000 acres of sage grouse habitat).
- Four facilities exist within the North Coast Region (Table 3), with the majority of these being located in Humboldt County. In the past two years, two of them have stopped operations and a third is operating at partial capacity. These plants compete with natural gas power plants for pricing structure, and were not able to gain contracts for power production at rates high enough to cover operational costs.
- One of the primary environmental concerns associated with electrical generation from woody biomass is the emission of both criteria (regulated) air pollutants (CAPs) and greenhouse gasses (GHGs). Technologies in biomass power generation continuously reduce emissions at power production facilities. Some critics equate GHG emissions from biomass-to- energy projects, which is carbon that already exists in the ecosystem, with use of fossil fuels.
- The average biomass feedstock haul mile distance vs. the amount of total energy expended reached a threshold of diminishing returns at around 60 miles; the authors recommend 45 miles. To meet the goal of both reducing emissions and lowering energy use overall, a smaller geographic sphere of influence should be considered.
- Transmission of generated energy is a major challenge in the region. The Renewable Energy Transmission Initiative (RETI) was a statewide initiative that has identified the transmission projects needed to accommodate California's renewable energy goals, support future energy policy, and facilitate transmission corridor designation and transmission and generation siting and permitting.
- There is a decreasing scale of cost per MW for plant construction, making it easier to finance a large plant than a small one. In order for small-scale biomass facilities to be capitalized, other benefits (social, environmental, emissions) will likely need to be monetized, or at the very least, accounted for, as public and private investment is considered.
- Community-scale, rather than industrial-scale, is needed. The intent with smaller scale plants is to mitigate feedstock demands over time to ensure that forest ecosystems can provide an ecologically sustainable supply while also providing adequate nutrient cycling and habitat conditions for species of concern.
- Bioenergy Market Adjusting Tariff (BioMAT) allows urban, agricultural, and sustainable forestry waste to fuel plants exporting 3 MW or less to the grid. Total plant size can be 5 MW if 2 MW are used behind the meter. Price offerings per MW start at $127 and can go as high as $190 before programmatic review is triggered. The BioMAT program began in 2016 and sunsets in 2021.
- Potential key financial partners include a diverse group of entities including members of the electrical utility industry. Public Utility Districts, Rural Electric Cooperatives, CCAs, and Investor Owned Utilities have access to capital sources for both equity and debt financing. Financing and capitalization should include these six components: Proven technology, reliable feedstock, customers to purchase output, secured project site, and economic viability with costs < income.
- There is a low level of knowledge regarding the real impacts, ecologic and economic, of

biomass energy within the general populace within the region. Misinformation or application of information from activities in other parts of the country to our region will be large political challenge if not addressed effectively.

LAW AND POLICY

State and Federal Regulatory Environment

In 2012 and 2016, California passed bills requiring forest biomass power generation, but with restrictions on the type of biomass that can be used as fuel for the facilities. While California addresses biomass retention standards through its Forest Practice Act, the interactions with emerging climate and energy legislation and regulatory rulemaking surrounding California's cap and trade program may have implications for forest-derived biomass.

- **Facility Operations/ Air Quality/ Environmental Protection:** Engagement with the California Air Resources Board through the local Air Quality Management District as early as possible is a key to establishing clear communication of expected goals and outcomes as any project moves forward. Cal EPA is the other significant agency within this sector and should be consulted directly in the same fashion as with the Air District.
- **Energy Generation/ Transmission:** Agencies involved in this part of permitting and operation depending on the type, size and location of the facility. Interconnection work will require following Electric Generation Rule 21, governed by the California Public Utilities Commission, or Wholesale Distribution Open Access Tariff, governed by the Federal Energy Regulatory Commission. The Federal Energy Regulatory Commission (FERC) and the U.S. Department of Energy (U.S. DOE), along with the CEC and the California Independent System Operator, have all been involved in establishing California's Renewable Energy Transmission Initiative 2.0, Western Renewable Energy Zones, and potential upgrades to the California-Oregon intertie. The CEC also established California Renewable Energy Zones and participated in the Western Renewable Energy Zone (WREZ) development.
- **Pricing/ Market Regulation:** The CEC, California Public Utilities Commission (CPUC), the DOE and the Federal Energy Regulatory Commission (FERC), Cal Fire, and Cal EPA, as well as the California state legislature, all have a certain level of influence over market regulation and pricing that are important for local policy makers to become familiar with. Opportunities for the North Coast as a region to influence the viability of biomass energy and other renewable energy production will pivot on relationships with these agencies in these sectors. The legislature and CPUC have the highest potential, among those listed, to have a direct effect on the price paid and incentives for biomass energy projects.

Utilities Operating in the North Coast Region

With the adoption of AB 32 (2006) and SB 350 (2015), both public and investor-owned utilities and Community Choice Aggregation entities are required to expand their portfolios to include 50% renewable power. California's utility players and their respective roles are quickly evolving from the traditionally investor owned utilities (IOUs) to publicly owned utilities (POUs) to a number of other consortiums of power purchasing, wielding and marketing entities. Urban/ rural connections through energy sales are becoming more commonplace with urban utilities financing and purchasing power from rural providers and projects.

STRATEGIES

Strategies were developed to mitigate the challenges identified with biomass energy development in the North Coast region.

Challenge 1. Energy development is complex, competitive, and requires organization. Affecting policy, developing transmission and distribution upgrades, gaining grid access, and funding for investments in R&D, demonstration and project development for commercial technologies require resources above-and-beyond the capacity of many North Coast counties and businesses. Also, there is inadequate transmission and distribution infrastructure to potential sites that could be located in an appropriate field-to-facility sphere of influence.

Strategy 1. Work regionally. The Counties and partners of the North Coast Region should pool their energy through the NCIRWMP or other regional collaboration processes to develop shared strategies that will result in project build out: Attract new and existing businesses to sites across the region; affect policy to reflect opportunities and challenges unique to North Coast, such as existing infrastructure and shipping barriers; understand transmission requirements to improve grid access; funding for investments in R&D; and demonstration and project development for commercial technologies going forward. The world of energy development and policy is complex and competitive, and regional entities will compete more effectively at the state-level if they act as a regional unit. Engaging with US Forest Service Region 5, Cal Fire, California Public Utilities Commission, Governor's Office of Business, and other state agency

offices as a group with a recognizable name and ability to comment on statewide plans is essential.

Challenge 2. Limited capacity for engagement in energy development that would yield high benefits for local communities. Interviews revealed lower overall local-knowledge of the energy markets functionality, processes, limitations and regulatory environment than for other regional issues such as water quality and land management issues. The level of knowledge also varies greatly among people and by sector (power, natural resource policy, costs, processes, political environment). There is fairly significant knowledge in some key agencies but less with others. There was an overall expression of uncertainty about organizational capacity with regards to education, technical knowledge, market sophistication. There is room for improvement and market opportunities will likely see parallel improvements with a change in strategy to address these gaps.

Strategy 2. Increase regional energy knowledge and capacity for engagement. There is a need for the development of educational materials, regular discussions, access to technical assistance, and programming for local decision makers, county staffs, and development partners to increase their familiarity with CA energy policy, the logistics and economics of biomass energy development, transmission and interconnection, and the ecological and social dimensions of biomass energy. This will facilitate regional participation and success in the emerging field of opportunity for biomass energy as well as development of a biomass energy industry that reflects local values.

Challenge 3. Financing biomass energy projects while ensuring equitable benefits for counties-of-origin. While rich in biomass, local entities rarely have the financial resources to actively participate in financing energy projects that ensure equitable financial returns to those counties and communities where the biomass feedstock is derived. The export of natural resources-derived revenues with limited financial returns provides little direct and long-term benefits beyond labor and associated income tax revenues, and is undesirable.

Strategy 3. Engage urban and suburban power customers. Forge new partnerships with end-of-line power customers (local urban/ suburban/ rural utilities) and state and federal agencies to facilitate equitable project financing. Explore linkages with Community Choice Aggregations (CCAs), Joint Power Authorities (JPAs) and other partnership structures to leverage resources. This strategy will require developing working relationships with end-of-line power customers such as IOUs and POUs representing urban customers. An initial step might include forming a North Coast regional ESCO project and to help drive the investigation and forge the necessary partnerships.

Challenge 4. Demonstration and technology commercialization of "scale-appropriate" emerging technologies. Projects appropriately scaled to economically available and socially acceptable biomass feedstock supplies would in many instances have to be considerably smaller (1-10MW) than is currently feasible given commercially available conversion technologies. While feedstock costs and energy pricing are major factors, this lack of commercially available small-scale conversion technologies represent a major impediment to progress.

Strategy 4. Leverage available funding to develop demonstration projects and technology commercialization of "scale-appropriate" emerging technologies. State and federal assistance programs such as the US Forest Service Wood Innovations grant program, California Energy Commission EPIC grant program, USDA Rural Energy for America Program grant and loan guarantees, and New Market Tax Credits could support project construction and commercialization of appropriately scaled conversion technologies; however, these are awarded in limited amounts across the region. In the immediate future, developing projects that qualify for the BioMAT program, and thus have a stable market, is likely to result in more projects than those that would not.

Challenge 5. Securing socially and ecologically appropriate biomass supply. Securing adequate biomass feedstock for financing and to profitably operate a biomass energy plant ensures an ongoing challenge for biomass power plants not co-located with a wood product facility. Federal lands represent a large portion of the land base and potential feedstock source in many of the North Coast counties. 10-year stewardship contracts could provide the necessary contractual assurances necessary to finance new projects not associated with existing sawmills within the North Coast region, but can take 3-5 years to complete.

Strategy 5. **Work on project development through partnerships and collaboration.** Practice collaboration and build partnerships to forge long-term and environmentally sustainable feedstock supply contracts and balance ecological and social values with project economics. In the private sector, existing mills and industrial landowners can explore opportunities for partnership. Given that energy production is not the core business of such companies, private sector partnership and financing assistance may well be required to direct their feedstocks towards publicly beneficial biomass energy projects.

Challenge 6. Grid interconnection estimates make up 20-40% of total project cost. For the handful of new community-scale biomass power plants that are being considered in the North Coast region, interconnection cost estimates are prohibitively high. Working with other distributed generation technologies to promote "rate-basing" the total cost of upgrades and finding other ways to spread the cost across all beneficiaries will reduce the cost of that barrier to project development.

Strategy 6. Strategically target new facility locations and work with partners to strategically avoid overpaying for grid upgrades. Site reviews have traditionally included information like road and utility access, zoning, proximity to feedstock, potential for hazardous material or environmental impact, and cost of site control. Consideration should be given to the electric grid and the opportunity for sharing the cost of interconnection with entities motivated to upgrade the system for other reasons. Co-locating facilities with existing load and targeting sites near substations with the potential to provide benefits after upgrading beyond capacity to handle additional generation will allow projects to avoid escalating interconnection costs.

Challenge 7. Lack advocacy for biomass energy pricing equity. Pricing for biomass energy sized larger than 3 MW, even when listed as renewable under the California's Renewable Portfolio Standard, is currently based upon price of natural gas - which is extraordinarily low this decade. Pricing for wind and solar power, and 1-3 MW biomass power, has additional pricing incentives/requirements driving up the cost.

Strategy 7. Advocate for biomass energy pricing equity. Biomass plants can provide baseload power, which is different from other renewable power sources like wind or solar. This can be a benefit to the grid but is not reflected in pricing regulation. We need to advocate for fair-accounting energy pricing and feed-in tariffs that acknowledge the many ancillary benefits of biomass energy. Pilot and demonstration projects, supported by the Public Utilities Commission, may serve as a first step for more systemic policy direction.

RECOMMENDATIONS

Recommendation 1. Continued Regional Industry Cluster Analysis. Either with a formal regionwide approach, or a less formal organic accumulation of contacts and examples as was done informally with this document is one of the recommendations of our proposed strategy.

Recommendation 2. Confirm the estimated value of biomass energy supply in the Region (e.g. 2,337 MW at $1.84 billion). Overlay analysis of spatial feedstock availability with transmission and distribution constraints. Also include the potential energy generation, by county, by megawatt, based on sustainable feedstock supply available within a given area.

Recommendation 3. Leverage mutually-beneficial goals. Many urban and suburban areas are emphasizing renewable energy as a priority, in some cases setting their sights on targets above the Renewable Portfolio Standard, and paying a premium to insure its delivery. In our interviews with both urban and rural leaders we found a unique point of synergy in that rural areas are motivated to pursue renewable energy production and have the resources available to produce if the proper investment was made.

Recommendation 4. Use shared challenges to forge a unified mission. This supports development of a renewable energy production and utilization model, within which biomass energy can play a role. Four elements are suggested:

- **Build Regional Energy IQ**: A significant effort should be made in increasing the Energy IQ for the region. Starting with local elected leaders and staff, share how energy markets work, the status of the local and regional infrastructure, and the resources available to local governments and private enterprise.
- **Enhance Networks, Outreach, and Advocacy**: Rural supply, meet your new best friend, urban demand. At times, these two factions have been at odds on a range of issues but the coalescing on the renewable energy issue demands that this relationship be healed, nurtured and expanded on to the economic benefit of both regions.
- **Organize Regionally**: Individually the rural counties of the North Coast hold little sway in Sacramento and Wall Street, especially in the current dynamic economic environment. Organizing regionally around Energy 2.0 for the North Coast is crucial to ensure that both the economic and ecologic benefits are maximized for the people and landscapes of the region.
- **Leverage an Existing Entity to Drive the Process:** A number of regional organizations exist, including NCIRWMP, that include representation from elected members in each county. In our review of the current political environment, state agency assistance available and future market demands, it would not take a great effort to build this process into an existing regional organization's portfolio of services offered to their county government members.

Biomass Supply

Table 3 shows the quantities of woody biomass in Northern California counties, taken from a biomass availability study completed in 2010 (Williams, 2010). The paper breaks out these numbers into categories listed above. Such products are available in potentially economically viable quantities in Sonoma, Mendocino, and Humboldt counties.

Biomass Facilities

Four facilities exist within the North Coast Region, with the majority of these being located in Humboldt County. In the past 2 years, two of them have stopped operations and a third is operating at partial capacity. These plants compete with natural gas power plants for pricing structure, and were not able to gain contracts for power production at rates high enough to cover operational costs.

Table 5. Biomass Facilities in North Coast Region, Various Sources

Name	Fairhaven	Scotia	Blue Lake	Weed
County	Humboldt	Humboldt	Humboldt	Siskiyou
Plant Type	Biomass to energy	Combined heat and power	Biomass to energy	Combined heat and power
Feedstock Source	Uses over 250,000 tons of various forms of wood waste from local sawmills annually	Uses mill residuals, other available biomass to provide heat and power to the Town of Scotia and the adjacent saw mill	Uses mill residuals, non-merchantable hardwoods, other waste from timber stand improvements and other timber operations	Waste materials from veneer plant, additional feedstock (is expansion of the current cogeneration capacity at the Weed facility)
Nameplate Capacity (Mw)	19 Mw	34 Mw	14 Mw	12 Mw
Operational Capacity (Mw)	18 Mw	28 Mw	12.5 Mw	?
Main Power Customer	PG&E	Mill and town of Scotia	San Diego Gas & Electric	Proposed PPA is cancelled and/ or in dispute
Owner	DG Fairhaven Power	Greenleaf Power, LLC	Blue Lake Power, LLC	Roseburg Forest Products
Address	97 Bay St. Samoa, CA 95564	Sacramento CA	200 Taylor Way, Blue Lake, CA	Weed CA
Phone	(707) 445-5434	(916) 259-0930		(530) 938-2721
Contact	Bob Marino, GM	Rob Crummet, Fuel Buyer	Glenn Zane	Arne Hultgren, Manager

CARBON INVENTORY ESTIMATE

TITLE: Carbon Inventory Estimates for the North Coast Resource Partnership

AUTHOR: Dogwood Springs Forestry (2017)

FULL REPORT: http://www.northcoastresourcepartnership.org/resources/

REPORT SUMMARY

PURPOSE/ OVERVIEW

This report presents inventory estimates of carbon stored (sequestered) in landcover classes throughout the North Coast Region (watershed boundaries of Del Norte, Humboldt, Lake, Mendocino, Modoc, Siskiyou, Sonoma, and Trinity Counties). The carbon stocks quantified for the study are in soils, barren, forest, grassland, orchard, row crops, shrubland, urban, vineyard, and wetlands. Both soil carbon and non-soil carbon are calculated for each. Because carbon is also sequestered as harvested wood products, as well as wood waste in landfills, this inventory does account for CO2e in these sources.

In total, more than 4.2 gigatonnes of CO2e are held in the study area. The vast majority (~4 gigatonnes) of the carbon sink is in forests. Grasslands and shrublands are the next-largest carbon pools while urban, barren, and row crops each account for relatively small carbon pools. Vineyards, orchards, and wetlands contribute extremely minor carbon stocks, mostly due to the exceedingly small area they comprise. It is worth noting, though, that wetlands are estimated to be the most carbon-dense landcover type, per acre. Distribution of carbon varies by county, but roughly corresponds to the distribution of forest-pool of carbon, because this category swamps the other landcover types. Therefore, highly forested counties (Humboldt, Mendocino, Siskiyou, Trinity) harbor the largest carbon stocks.

METHODOLOGY/ DATA

The inventory approach is focused one quantifying carbon in the major biological reservoirs in the study area. Inventory estimates are provided for each landcover class within the study area. The inventory approach tiers from, and adds on to, a statewide inventory developed by the California Air Resources Board. The resolution of the inventory estimates, therefore, is generally derived from statewide estimates. No effort was made to calculate confidence statistics in the inventory estimates within the study area. Standard errors for biomass estimates are more than 25% of the mean at the 95% confidence interval for the state. Estimates that tier off of the statewide data, such as this study that is looking at a narrow window of the statewide data, would certainly have even higher standard errors.

Inventories of biomass in trees, shrubs, and grasses are typically developed by first estimating volume in the plant material and converting the volumetric estimates to carbon estimates by adjusting based on the density and the moisture content of the plant material. Carbon values are often converted to Carbon Dioxide Equivalent (CO2e) values since we are most concerned with the role plants have from a climate perspective, in the event they are released to the atmosphere from decay or burning or in sequestering CO2 through sequestration. CO2e is a standard to which all greenhouse gases, including methane, nitrous oxide, and others, are converted to reflect the global warming potential of a given amount of a greenhouse gas. Carbon inventories are presented in this section as Carbon Dioxide Equivalent (CO2e). This inventory report does not include other Greenhouse Gases such as methane and nitrous oxide.

For forests, regression estimators were developed from biomass estimates from Forest Service FIA plots, with exact coordinates intersected with LANDFIRE pixels, and used both size and density of forest vegetation as variables. Aboveground shrub biomass was developed by analysis of data available from LANDFIRE and other published sources. Where data was unavailable for a specific shrub type, the shrub types were included in a broader stratification with shrub classes that did have data. For non-woody classes (mostly grasses), biomass estimates were derived from estimates of net primary production. The inventory development process leans heavily on LANDFIRE data.

The inventory estimate developed for the NCRP uses the data and procedures from Saah et al., 2014 as the basis for inventory development. [*Saah D., J. Battles, J. Gunn, T. Buchholz, D. Schmidt, G. Roller, and S. Romsos. 2015. Technical improvements to the greenhouse gas (GHG) inventory for California forests and other lands. Submitted to: CARB Agreement #14-757.*] Refinements to the study beyond the Saah 2015 methodology are: 1) Soil carbon has been added to the inventory estimate using a national dataset; 2) Since the last LANDFIRE data was developed for 2010, we 'grew' forest estimates to reflect growth between 2010 and 2014 for forest vegetation; 3) Urban forests have been sampled independently for each county to derive and urban forest biomass estimate; and 4) The LANDFIRE vegetation classes have been organized to align with landcover classes being used concurrently by the California Department of Conservation's jurisdictional accounting

The base unit of inventory in the ARB statewide inventory is the combination of the LANDFIRE vegetation community definition (EVT), the height class (EVH), and the density class (EVC). For a given combination of EVT, EVH, and EVC, the non-soil carbon estimates are the same. Each of the EVTs has been grouped into

a Landcover Class and a Sub-Landcover Class, which have been defined as part of this inventory effort to improve the ability to report the LANDFIRE classes. The base sources of data used to generate the estimates in this report vary. The methods used are described in detail in the methodological description for each landcover class. The full classification scheme is provided in Appendix A. [*not included in this summary*]

KEY FINDINGS

Overall

Forest cover dominates the landcover classes within the study area. Approximately 3.5 million hectares, or almost 70% of the surface area within the study area are in forest cover. Forests also store the most amount of carbon with almost 4 gigatonnes (billion-tonnes) of CO2e, or 90% of the carbon within the study area. The next most carbon-rich are grasslands and shrublands (each approaching 200 million tonnes). Figure 2 displays the area and CO2e associated with each landcover class within the study area. [*see last page this summary*] Inventory results for each landcover type are summarized below.

Soils

Soil carbon is associated with every landcover type. Landcover classes that contain woody material have a greater proportion of their carbon in non-soil reservoirs. Forests, for example, store substantial portions of carbon in trees, both in above-ground and below-ground portions (roots), lying dead wood, litter, and duff and a smaller proportion in soils. In landcover classes that don't have as much woody material, the bulk of the carbon is stored in soils. The carbon densities in forests within the study area are among the highest in the United States. Figure 3 displays the estimates of CO2e per hectare by soil and non-soil reservoirs by landcover class. [*see last page this summary]*

Barren

Barren landscapes (roads, open water, bare spots) have little or no vegetation cover. Barren landscapes are less than 4% of the study area and account for less than 1% of its carbon stocks.

Forests

Coniferous and woodland forest types combined are 70% of the study area and account for 90% of its carbon stocks. Coniferous forest constitutes 85% of forests and woodland (mostly oak) makes up around 14% of forests. Most of the carbon (~77%) in forest landcover is in non-soil biomass such as roots, live and dead trees, lying dead wood, litter, and duff. The bulk of forests and forest carbon are in Humboldt, Mendocino, Siskiyou, and Trinity Counties.

Grasslands

Grasslands are 12% of the study area and account for 4% of its carbon stocks. Most of the carbon in grassland ecosystems is found in the soil. Most grassland is in Humboldt and Mendocino Counties.

Orchard

Orchards are less than 1% (36 ha) of the study area and account for less than 1% of its carbon stocks. The majority (64%) of orchard carbon is in the soil carbon pool. Mendocino County alone comprises 70% of orchard cover, with Siskiyou providing the next highest proportion (16%).

Row Crops

Row crops are 1.6% of the study area and account for less than 1% of its carbon stocks. The carbon in row crops is almost entirely (>99%) in soil carbon. The majority of row crops occur in Modoc and Siskiyou Counties.

Shrubland

Shrublands are 12% of the study area and account for 5% of its carbon stocks. The majority of shrublands are in Mendocino, Siskiyou, and Sonoma Counties, though Humboldt, Modoc, and Trinity Counties contribute a substantial proportion as well.

Urban

Urban areas do contain carbon in trees, shrubs, herbaceous materials, and soils. Urban areas are less than 2% of the study area and account for less than 1% of its carbon stocks. The county with, by far, the most urban cover class is Sonoma County (17,169 ha), followed by Humboldt (7,511 ha) and Mendocino (3,772 ha). Unlike other landcover types, the calculation of carbon in the urban category requires independent analysis (the method is described in the full report "Defining the Urban Forest Area in highly-developed areas.")

Vineyard

Vineyards are less than 1% of the study area and account for less than 0.1% of its carbon stocks. Approximately 89% of carbon in vineyards is in the soil carbon pool. Most vineyards in the study area are in Sonoma (~75%) and Mendocino (~25%) Counties.

Wetlands

Wetlands are only a few hectares (<5) and less than 1% of the study area and account for less than 1% of its carbon stocks. However, wetlands are estimated to be the most carbon-rich landcover class, on a per-acre basis. The majority of carbon in wetland systems is found in the soil. Wetlands identified by LANDFIRE data are in Del Norte and Trinity Counties.

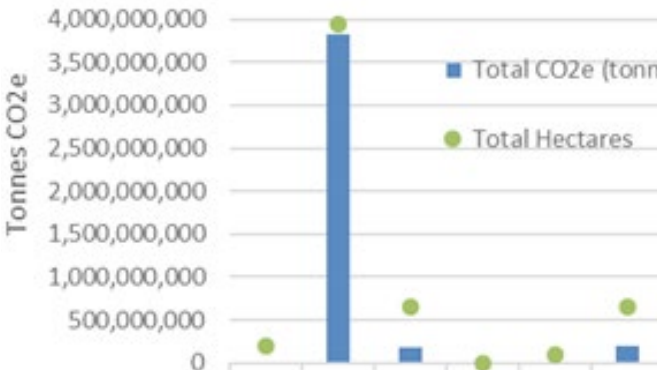
Harvested Wood Products and Landfills

When trees are harvested, CO2-e may remain sequestered for long periods of time in harvested wood products and in landfills before they decompose and release the carbon stored in them to the atmosphere. The average timber harvest in the study area has averaged 850,637,000 board feet per year between 2012 and 2016. This harvest amounts to 1,211,067 tonnes of CO2e in sequestered wood products and landfills each year. This value is expected to increase as harvest volumes slowly increase in the future as forest inventories recover.

LAW AND POLICY

AB 32, the Global Warming Solutions Act of 2006: This law requires the California Air Resources Board (ARB) to set statewide Greenhouse Gas (GHG) emission limits, to develop regulations to reduce emissions, and to periodically inventory GHG emissions and removals, including emissions and removals from natural and working landscapes.

Figure 2 a-b. Total estimated CO2e and area associated with each landcover class within the study area



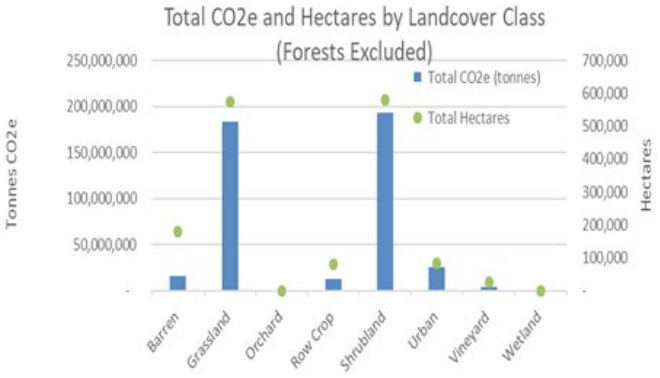
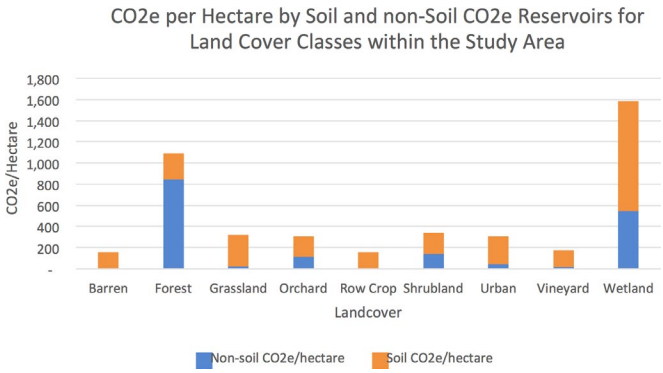


Figure 3. Estimates of soil and non-soil CO2e by landcover class.



POTENTIAL FUNDING SOURCES

TITLE: A Review and Assessment of Potential Funding Sources for the North Coast Resource Partnership

AUTHORS: ECONorthwest (2017)

FULL REPORT: http://www.northcoastresourcepartnership.org/resources/

REPORT SUMMARY

PURPOSE/ OVERVIEW

The NCRP is exploring potential funding sources to expand and stabilize its organizational capacity and to build on the investments already being made in the North Coast region. The assessment of potential funding sources in this report provides information that the NCRP can use to evaluate specific opportunities and compile a comprehensive financing strategy.

As of 2016, the North Coast has successfully secured funding through grants awarded by three California agencies, including the Department of Water Resources (DWR), the California Energy Commission (CEC), and the Strategic Growth Council. The total funding earmarked through the state grant programs is over $93 million. Matches generated in excess of $50 million in additional funding, for a total investment in the Region of over $129 million to date. The NCRP is aware of $750 million in funding needs in the region. These dollars represent projects that are developed sufficiently to submit for funding: undoubtedly, the demand for project funding is much greater.

The NCRP has historically relied almost entirely on state grant funding sources, leveraged by additional local and federal matching funds, some of which originate through federal grant programs. The NCRP is not interested in increasing the competition for these state and federal grant project funding opportunities by pursuing them directly, and instead would prefer supporting local partners in their applications for these funds. The plan is to maintain existing funding channels through DWR, the Strategic Growth Council, other State agencies and SCWA, and there is an effort at the state level to secure ongoing financial support from the state for the Regional Watershed Management Groups.

The NCRP prepared a draft funding strategy in 2016 that outlines the organization's goals, objectives, and criteria for identifying and pursuing new funding sources. The NCRP would like to develop appropriate funding sources to diversify its financing and provide stability should state grant opportunities change in the future. Instead of identifying additional grant programs, the opportunities selected for further analysis focus primarily on tapping new sources of revenue and reallocating existing revenue streams that better align with the NCRP's goals and objectives. In this report, three overarching categories are assessed: taxes and fees, legislative programs, and opportunities to leverage Ecosystem Service Values.

Economists often group assets into four categories of capital: built infrastructure, natural resources, social structures, and human resources. Valuing the entire stock of capital in the North Coast Region as a snapshot at any given time is theoretically possible, but technically difficult given the tremendous quantity of information such a task would require. An assessment of local and regional demand corresponding to the services and values indicated is necessary before identifying potential beneficiaries and funding sources.

Despite the challenges, NCRP has attempted to measure the value of the region's assets, focusing on its natural capital (e.g. in stormwater management and treatment, air quality regulation, carbon sequestration, and amenity value). Earth Economics determined the present value of the natural capital is between $473 billion and $1.4 trillion. Without on-going investment, the economic value of these goods and services will decline. With steady or increasing investment, however, the Region is capable of producing even greater quantities of goods and services that would satisfy growing demand for things like clean water, alternative energy, and carbon sequestration.

METHODOLOGY/ DATA

ECONorthwest reviewed background material provided by the NCRP to understand the NCRP goals and objectives and past and current funding sources. After developing a working understanding of the situation, including demands for future funding and current and past funding sources, the authors identified a list of potential funding sources to research further.

Using publicly available information and key-informant interviews, the authors researched each potential funding source and assembled information to evaluate against the goals and objectives of NCRP. The information about each source was then distilled into a set of quantifiable metrics used to compare their relative strengths, weaknesses, benefits, and costs. That step yielded a color-coded comparison matrix (Table 8) that provides an overview and summary of the funding sources. The fully scored matrix is presented at the end of this report summary.

Indicators (metrics) that were used to quantify the relative strength of various potential funding options are listed and briefly described below. The final score was tallied for each potential source by adding individual scores (e.g. 1-3) as appropriate for each metric.

- **Funding Capacity**: Rather than addressing the amount of funding available from each funding source directly, this metric compares the

uncertainty surrounding how much revenue each funding source would yield. (3 = funding amount is known -- 1 = funding amount is unknown)

- **Administrative Requirements**: This metric addresses the logistics of implementing necessary legal and administrative requirements to collect and distribute revenues. Funding sources that utilize existing legal and regulatory mechanisms for generating revenue score the highest, because the administrative functions are already in place. (3 = staff/ org resources exist -- 1 = new staff/ org resources required)
- **Long Term Stability**: One of NCRP's objectives in evaluating new funding sources is to provide a revenue stream that is more predictable and stable over the long term. Funding sources that last at least 5 years are ideal. (3 = funding duration known to 5+ years -- 1 = duration and amount unknown for any period)
- **Flexibility**: This metric addresses the ways a funding source may be used. Restrictions are not inherently undesirable, as long as they are known and planned for. But some restrictions, especially those arising from recent legal developments applying to taxes and fees, could make it more difficult to use funds in broad ecosystem-based collaborative efforts. (3 = funding is for planning through implementation -- 1 = funding restricted to project type)
- **Acceptability**: To assess acceptability, three specific questions are posed: Is the funding source likely to enjoy widespread support? Is there precedent in the Region for the funding source? Is the funding source equitable? (additive; 1 point per affirmative answer)
- **Ancillary Benefits**: Some funding sources are more capable of producing benefits ancillary (e.g. local jobs) to the primary funding goals. The focus of this metric is on the funding source itself, not the result of the projects it funds. Three questions are posed: Does the funding source produce jobs or generate income in the region? Does it facilitate relationship building and collaboration? Does it benefit rural or disadvantaged communities by lower costs or increasing capacity? (additive; 1 point per affirmative answer)

KEY FINDINGS

Innovative financing strategies that are explored (i.e. described, assessed/ scored) in the report are listed below. Table 8 [last page this summary] shows the results of the authors' scoring exercise, applying the indicators and points described in Methodology above to each of the listed funding sources. The final score (out of a possible 18) for each is included in brackets in the list above. Overall average score for the strategies is 12.4. Items scoring well above average (13, 14) are shown in bold.

- Local Funding Measures (average score 13.5)
  - » **Sales tax** (14)
  - » **Property tax** (13)
  - » **Transient Occupancy Tax** (14)
  - » **Fees** (13)
- Legislative Programs (average score 11.5)
  - » AB 32 (California Global Warming Solutions Act) Auction Revenues (11)
  - » Enhanced Infrastructure Finance Districts (EIFD) (12)
  - » **Community Choice Aggregation (CCA)** (14)
  - » SB 375 (Sustainable Communities Act) Integration (10)
  - » **Regional Advance Mitigation Planning (RAMP)** (14)
  - » Public Goods Charge (12)
  - » Regional Energy Networks (RENs) (8)
- Payments for Ecosystem Services (average score 12.5)
  - » **Natural capital as large-scale infrastructure** (13)
  - » **Pre-disaster climate mitigation via CEMA/ FEMA** (14)
  - » **Carbon markets** (14)
  - » Foundation Partnerships (11)
  - » Research Partnerships (11)
  - » **Public-Private Partnerships** (i.e. cannabis, wine, tourism, timber) (13)

The scored list represents a high-level, coarse assessment. Individual program results are assessed in more detail elsewhere in this summary (see Opportunities and Constraints).

LAW AND POLICY

Assembly Bill 32 (2006), The California Global Warming Solutions Act, establishes a program for monitoring and reducing greenhouse gas (GHG) emissions in California. The goal of the program is to reduce the state's GHG emissions to 1990 levels by the year 2020. To accomplish this goal, AB 32 established a cap-and-trade program, which mandates an upper limit on the amount of carbon that can be released into the atmosphere in each year. Under statutory requirements, 60% of AB 32 auction revenues are required to be appropriated for identified public programs while the remaining 40% is available for the Legislature.

Assembly Bill 117 (2002), the Community Choice Aggregation Law, allows local control over the purchase and mix of energy sources. By aggregating their purchasing power, communities are able to create large contracts with power generators, something individual buyers may be unable to do. The main goals of CCAs have been to either lower costs for consumers or to allow consumers greater control of their energy mix, mainly by offering "greener" generation portfolios than local utilities.

Assembly Bill 2087 (2016) Regional Conservation Investment Strategies (RCIS). A coalition of California agencies, federal agencies, and NGOs, initiated Regional Advance Mitigation Planning (RAMP) in 2008, but it has taken the state some time to develop new policies to effectively implement. To this end, California legislature recently authorized AB 2087 which serves the dual purpose of providing a framework for regional conservation planning and opportunities for advance mitigation.

CEQA (1970), The California Environmental Quality Act requires state and local agencies to identify environmental impacts from their projects and, if those impacts are unavoidable, to mitigate the them. A coalition of California agencies, federal agencies, and NGOs, initiated Regional Advance Mitigation Planning (RAMP) in 2008 to fulfill this requirement more efficiently (AB 2087 above).

Proposition 218 (1996) limits the ability of local jurisdictions to levy new taxes and fees by requiring two-thirds majority approval for special taxes, property-related fees, and special assessments. These limitations may reduce the feasibility of developing and implementing these funding mechanisms to support NCRP goals: pursuing them would require careful design and widespread public support.

Senate Bill 375 (2008), the Sustainable Communities Act, intended to reduce greenhouse gas emissions from automobiles and light trucks through integrated transportation, land use, housing and environmental planning. The program sets regional greenhouse gas targets and seeks to focus regional achievement of the objectives by emphasizing regional planning, providing California Environmental Quality Act incentives for projects consistent with the legislative goals, and coordinating regional housing needs allocation with transportation planning.

Senate Bill 628 (2014) authorized jurisdictions to form EIFDs that use tax increment financing (TIF) revenue to pay for infrastructure improvements. With few tools available to generate revenue to fund local infrastructure investments, especially in disadvantaged and rural communities, the California legislature crafted the EIFD legislation. It allows communities to use TIF revenue for traditional public works projects, but emphasizes projects that enhance community sustainability, energy efficiency, and reduced carbon emissions.

OPPORTUNITIES/ CONSTRAINTS

The anticipated opportunities and constraints that are associated with each potential funding source (particularly with legislative programs) are researched and discussed in detail by the authors, forming the bulk of their report. A very brief summary follows.

Local Funding Measures

Opportunities: District taxes can supplement local general fund revenue, or be dedicated to a specific purpose. Sonoma County is unique in the Region in its assessment of a 0.25% district tax to support the Sonoma County Agricultural Preservation and Open Space District (SCAPOSD). Revenues are spent on conservation planning, stewardship and land acquisition activities. Local jurisdictions can levy transient occupancy taxes on the rental of temporary (30 days or less) accommodations. Using TOT revenues for water infrastructure or environmental improvement is not without precedent. Until voters approved an increase in 2016, Sonoma County collected a 9% TOT that contributed to the county's general fund. Despite challenges, the Sonoma County Water Agency has successfully maintained surcharges in its water delivery contracts with retail agencies.

Constraints: Except for SCAPOSD, few other examples of sales taxes designed to fund local conservation efforts exist in California. Establishing a new TOT or increasing an existing TOT requires a vote. Levying fees for services has become more challenging in recent years, after the passage of several laws intended to increase accountability among local jurisdictions. Fees and surcharges that utilities or special districts have successfully passed since voters limited their scope

and raised the thresholds required for approval may not provide sufficient revenue to accomplish their purpose.

Legislative Programs

AB 32 Auction Reserves

Opportunities: The NCRP could generate revenue to fund projects that involve carbon sequestration, low-carbon energy generation, and energy efficiency, by attracting investments from regulated entities in search of offsets to meet their legal obligations. The state allocates permits to carbon-generating industries; some are made available for purchase to emitters through an annual auction. The annual auctioning of carbon permits generates revenues for the state, who is required to spend these revenues on programs that reduce GHG emissions. AB 32 auctions have generated $3.5 billion in state revenue. Many of the programs that are, or have previously been funded using AB 32 auction revenues align with NCRP's goals and objectives and local project priorities. The NCRP may also attempt to directly influence the program priorities: an intermediate-term opportunity for NCRP may be to engage with the state working group to advocate for projects with a North Coast focus.

Constraints: NCRP cannot apply directly for AB 32 auction revenues, but instead must apply for grants through agencies that receive appropriations from the program. These and other grant programs are competitive and there is no guarantee of funding success. Regular reevaluation of program strategies may present some long-run challenges with funding opportunities as investment strategies evolve over time to emphasize key initiatives. Also, the specific amount of funding available for different priorities varies over time, and total program funding in the future is somewhat uncertain. The LAO predicts that revenues for the next few years will decline, suggesting revenue uncertainty.

Enhanced Infrastructure Finance Districts

Opportunities: EIFDs may be formed to fund a variety of infrastructure improvements that are consistent with NCRP's priorities. The NCRP could provide the regional framework to support local jurisdictions in establishing EIFDs in the Region to address specific project financing needs. EIFDs are particularly successful when there is widespread agreement on funding project or priority, the project or funding priority is large in scale (e.g., a storm water treatment facility), and there is community support and involvement in resolving funding deficiencies.

Constraints: These are politically challenging to implement because of the number of jurisdictions and taxing authorities; an EIFD must be in an area where the voters in overlapping taxing districts support and promote the EIFD; administration of EIFDs can be cumbersome and costly; and there is uncertainty about level of oversight local jurisdictions must cede to the state for EIFD creation.

Community Choice Aggregation

Opportunities: Community Choice Aggregation (CCA) programs allow local governments to aggregate electricity demand within their designated jurisdictions, which allows government entities to procure alternative sources of electricity, while maintaining distribution of electricity thorough an existing Investor Owned Utility. Two of California's approved CCAs operate within the NCRP boundary: Sonoma Clean Power (serving Sonoma and Mendocino Counties) and Redwood Coast Energy Authority (serving Humboldt County). The NCRP's goals related to energy independence and climate adaptation, as well as ecosystem conservation and enhancement may overlap with the function of CCAs. Both PG&E and Sonoma Clean Power include a small mix of biomass in their energy portfolios. Depending on the cost-competitiveness of biomass, NCRP could partner with these firms to develop strategies for supplying renewable energy as a funding source.

Constraints: CCAs tend to be heavily locally-focused, so it is unclear if demand would materialize from CCAs outside the region. CCAs are not able to directly administer public goods funding for energy efficiency programs. It is not clear if NCRP would be able to work directly with Sonoma Clean Power as a funding organization. May need additional R&D expenditures to develop a viable supply of biomass or geothermal energy.

SB 375 Sustainable Communities Act

Opportunities: The general principles of SB 375 align with multiple goals and objectives of the NCRP, including economic vitality and climate adaptation and energy independence. Sonoma County lies within the Metropolitan Transportation Commission (MTC), one of the 18 MPOs charged with implementing SB 375. It may be possible to align certain NCRP projects with the MTC's stated goals under its SCS, and tap into the reallocation of transportation funds to secure additional revenue that may not have been available absent SB 375.

Constraints: Since the regional GHG goals apply only to a small part of the NCRP region, and the program's emphasis is primarily on housing and transportation investments, the extent to which the NCRP may tap the redirected transportation revenue streams may be limited.

Regional Advance Mitigation Planning

Opportunities: The RAMP approach promotes planning and coordination at a regional scale to produce mitigation projects that are less costly and have the potential to produce a greater range of higher-quality ecological and

community benefits. RCIS is a conservation planning document that identifies conservation and habitat enhancement opportunities within a particular region. Any local jurisdiction (e.g., City, County, Open Space District, Public Lands Conservancy) or state agency can initiate a RCIS, with a state agency sponsor. California Department of Fish and Wildlife currently has the authority to approve the RCIS. RAMP in general and the RCIS program in particular appears to complement NCRP's planning process well. The landscape-scale, cooperative planning approach to identifying targets for conservation and habitat enhancement mirrors the process NCRP has implemented for over a decade. RCIS program in particular, through its proposed Mitigation Credit Agreements, may provide a revenue source to support expanded project implementation.

Constraints: Uncertainty regarding legal liability, long-term management responsibilities, and funding all complicate the adoption of what is otherwise a very promising opportunity.

Public Goods Charge

Opportunities: A public goods charge (PGC) is a usage fee applied by utilities to ratepayers to generate revenues for projects in the public interest. One of the primary goals of applying a PGC to water is to use prices as a signal for water scarcity. Many PGC programs create a volumetric fee on water consumption (or other commodities, like electricity) to encourage conservation and adoption of technologies that improve efficiency. The revenues from a public goods charge almost certainly would be available in some form to further the goals and objectives of the NCRP. Some of the proposals would have funneled money directly through the IRWM program.

Constraints: There is currently no statewide PGC in place in California. After the failure of the last effort in 2015, with zero support from the state's water utilities and significant opposition to the idea from other sectors, a statewide PGC appears politically unfeasible option in the near future.

Regional Energy Networks

Opportunities: Regional energy networks (RENs) are administrative programs authorized by the State of California to operate independent of investor owned utilities (IOU) to provide flexibility in managing energy efficiency programs. California Public Utility Commission (CPUC) requires that a REN looks for opportunities to address energy saving investments in disadvantaged and low-income communities. NCRP and BayREN overlap jurisdictionally in Sonoma County so there may be opportunities to work with BayREN on local pilot programs across shared goals.

Constraints: Program goals and funding is geared toward codes and standards, single family homes, and multifamily home investments, which is a narrower scope than NCRP goals. Low population and distance from the Bay Area likely would constrain funding awards for most of the rural North Coast.

Payments for Ecosystem Services

Opportunities: Payments for ecosystem services (PES) are payments to individuals or institutions for land conservation or improvements that yield environmental benefits. The report describes several avenues through which organizations have found success leveraging funding through ecosystem services: (1) securing funding normally reserved for large-scale infrastructure for ecosystem improvement; (2) tapping the emerging markets for carbon, through the AB 32 offset program; and (3) accessing disaster-preparation funding from FEMA/ CEMA for ecosystem (and thus community) resilience. Regulatory compliance drivers and pursuit of cost-savings efficiencies are common forces driving market activity. State and federal agencies provide grants, loans, and direct funding for projects that provide water supply, water quality treatment, flood protection, and similar objectives that might be achieved via well-functioning watersheds and ecosystem services. Multiple examples of ecosystem service markets currently exist in California: water supply, water quality trading, and carbon cap-and-trade with offsets. NCRP may have opportunities to create local revenue streams through the carbon offset market in particular. Private partners (e.g. in cannabis, wine, tourism, timber) may find incentive to voluntarily participate in PES programs.

Constraints: NCRP is unlikely to be able to participate directly in the purchase and trading of credits in any regulatory carbon markets. Participation in water supply and quality transactions may be an option for water rights holders within the NCRP, but is not likely a useful strategy for the NCRP to pursue collectively. With regard to foundation partnerships, leveraging a dependable stream of revenue through this vein typically involves extensive relationship building with the right organization.

RECOMMENDATIONS

1. The NCRP is not alone in searching for funding solutions. Resources for investing in water-related goods and services are lacking throughout California. This is a statewide problem, and efforts at the state level may yet yield a statewide solution that could, at least in part, become part of NCRP's overall funding strategy.
2. No single funding source will provide NCRP with the stability and level of investment required to accomplish its goals and objectives.

3. A strategy that focuses on integrating multiple funding sources holds the best potential for supplying the NCRP with a stable and long-term revenue stream.
4. Many potential funding sources, particularly those emerging from recent legislation, hold huge potential but are still in development. This presents NCRP with two opportunities: to nudge the policy development in ways that align with the goals of the region; and to lead in implementation, which may afford more opportunities for experimentation and innovation. This leadership may come with additional costs as well, in the form of uncertainty and social capital development. These costs should be factored into a decision to pursue less-well-developed funding sources.
5. The NCRP should consider new regional assessments, in the form of taxes or fees, to pay for environmental investments. This type of funding source provides long-term stability and comes with relatively low administrative overhead. The logistics of implementing and collecting the revenue across the Region may prove more challenging, but worth exploring.
6. NCRP should initiate the development of a formal funding strategy as a next step. This would involve a detailed assessment of all or a subset of the funding sources identified in this report, with the goal of assembling an integrated portfolio of funding sources that would yield a quantifiable amount of revenue over a set period of time. The strategy document would outline a timeline and specific set of steps for developing this integrated portfolio over time (e.g., a five-year development period).