STATE CLIMATE POLICY AND NATURE-BASED SOLUTIONS: A MATCH THAT PROVIDES MULTIPLE BENEFITS FOR CLIMATE, WATER, AND MORE

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About Water in the West

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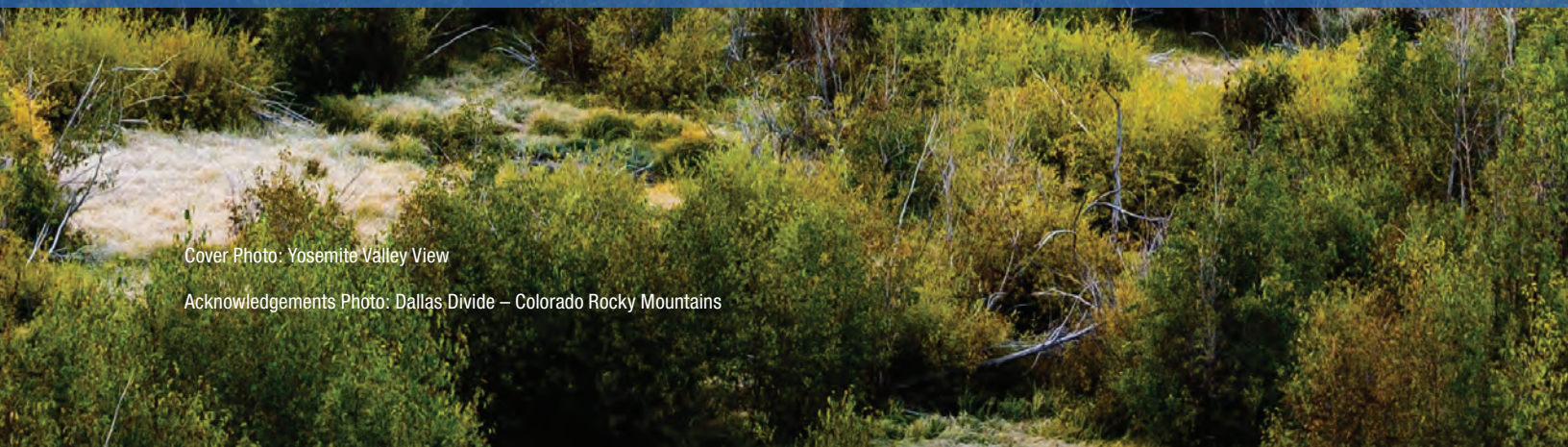

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EXECUTIVE SUMMARY

Overview

Purpose: This report examines potential synergies between state climate policies and nature-based solutions that yield multiple benefits; outlines barriers to meeting that potential; and provides recommendations to accelerate the implementation of nature-based solutions with water benefits in state climate policies. It is not meant to be exhaustive, but to point out areas for further productive work. The audience is non-climate water practitioners working in the Colorado River Basin and state climate policy practitioners who may not be familiar with the opportunities nature-based solutions (NBS) provide for both climate and water. As a result, the report can be considered something of a primer or resource, including basic information about both fields to educate water practitioners as to what state climate plans entail, and to educate climate practitioners about the opportunity to include (and the necessity of including) NBS as part of their climate planning. The report's intent is to illuminate an area where further engagement and technical work can help seize an opportunity to meet the climate and water challenges facing the Colorado River Basin states.

Methodology: This report was developed through research, interviews, and the convening of an "Uncommon Dialogue" that brought together government officials, academics, non-governmental organizations, and the private sector to discuss the intersection of climate policy and NBS with a focus on water benefits.

Focus of the report: The report illuminates the ongoing development of international, national, and state climate policies incorporating nature-based solutions (also referred to as "natural working lands" or NWL in state climate policy). The report reviews state-level policies, with particular focus on the Colorado River Basin states, that address or have clear synergies with climate, water, and NBS to illustrate the policies and practices that states should adopt to gain multiple benefits for climate and water resilience through their climate policies and programs. It surveys the growing opportunities to integrate nature-based solutions that provide water benefits (e.g., sustainable forest management, wetland/meadow restoration, and healthy agricultural practices) into climate policy. It then examines some of the barriers to this integration, which include a lack of adequate quantification of both climate and water benefits from these practices; a lack of resources for developing that quantification or more robust climate policies; political or legal barriers to some policy options; silos of practice and discipline; and the lack of general awareness of the opportunity and necessity of accelerating work in this space. Finally, it makes suggestions both for state climate policymakers and for outside parties that can overcome at least some of these barriers.

The report is meant to focus on the opportunities and challenges in state climate policy specifically rather than on Colorado River Basin sustainability more generally. As such, it can be seen as a supplement to the excellent work already being done to build climate resilience in the Colorado River Basin (See, e.g., Martin et. al, 2021). It also does not attempt to replicate the extensive work being done to quantify or promote the use of NBS for water benefits generally. While there is some discussion of those efforts, as well as efforts to quantify specific landscapes for climate benefits, the focus is on state climate policies and where NBS can provide both climate and water benefits.

Our thesis was that there were untapped synergies to be found between state climate policy and upper watershed ecosystem management in the Colorado River Basin. We looked at forest practices, meadow and wetland restoration, and agricultural practices, particularly grazing. We found both great potential and growing attention to this complex space; however, we also saw that there is a long way to go to realize that potential. While there are clear synergies and opportunities for elevating NBS in the state climate policy arena, they are not as easy to seize as one might hope.

Other than California, most state climate policies (in the states that have them) focus almost exclusively on fossil fuel emissions reduction and encouraging more efficient and cleaner energy development as the prime complementary strategy. This report recommends that states should also have robust complementary NBS or NWL policies if we hope to meet the climate challenge. Those policies will yield multiple benefits in addition to being a critical piece of any successful climate change response effort.

As an illustrative example, California has a robust and growing series of programs to integrate NWL restoration efforts into its climate planning. It has invested billions of dollars of proceeds from its cap-and-trade program into forest management for wildfire prevention and carbon sequestration, mountain meadow restoration for carbon and water benefits, and into its "healthy soils" programs for those and multiple other benefits. Those dollars are not transferable to other states, and other states are unlikely to develop as financially robust a program. California also has a regulatory "offset" program that has generated projects, including some that feature NBS, but, as explained later in this report, they are more limited in size and scope than their visibility in the media may suggest. While California's programs are unlikely to generate funding for programs in the rest of the Colorado River Basin, they can provide inspiration and tools for constructing appropriately customized state programs. There are also opportunities to leverage other public and private dollars for this work. While regulatory offsets are unlikely to yield a great wave of private-sector investment in the upper Colorado River Basin, the field of voluntary offsets or "net-zero" pledges has potential to drive financial resources toward projects. Significantly, some of the most promising efforts on quantification of both climate and water benefits at a watershed level come from this sector, as corporations look to show their contributions in the watersheds they inhabit and seek some standardized way of determining the best opportunities for their investments.

Fortunately, Colorado and New Mexico are also in the process of developing NWL climate policies, but they are in early stages. Engaging in and supporting those efforts can yield great benefits for climate, water, and other societal aims. Enormous opportunities exist to elevate and support efforts to make these plans more robust than they would otherwise be. States other than California, Colorado, and New Mexico thus far have made only token acknowledgement of this opportunity but could be inspired by others over time.

A large-scale coalescing of stakeholders at this intersection to work together across geographies or landscapes does not yet exist, although interest is there if the support can be found. Many groups are developing the quantification and data needed to make a case for NBS in both the climate and water arenas, and in some cases both. They do so to make the policy case for public and private investment, for the purpose of justifying offsets in international or state trading regimes, or to grow and/or monitor the voluntary credit market or net-zero promises.

Significant opportunities exist to marry climate policy and nature-based solutions for multiple societal and environmental benefits, but they need attention, enabling policies, funding, and other kinds of support. Ecologically based forest restoration, wet or mountain meadow restoration, and healthy soils and other agricultural practices can yield such multiple benefits, with the upper[1] Colorado River Basin being blessed with vast high mountain meadows and grazing lands in addition to its forested lands. Of these landscapes, forest restoration is receiving greater attention at the international, national, and state level, with significant dollars being allocated to accelerate forest treatments in the near term. This elevated focus aims to avoid catastrophic wildfires caused by a combination of vegetative overgrowth (often referred to as "fuels" in the wildfire context) and increasing temperatures due to climate change. The attention stems from the growing worldwide recognition that those outsized catastrophic blazes release massive amounts of carbon to the atmosphere beyond what would happen naturally. This recognition, plus the obvious increasing threat to life, limb, and property from these megafires, is driving a large-scale policy shift at the international and national level that is also beginning to be seen at the state level. Innovative financing schemes that bring together the private sector and multiple

1 While this report discusses all seven Colorado River Basin states, the "upper" basin traditionally refers to Colorado, New Mexico, Utah, and Wyoming. For reasons that will become apparent throughout the report, Colorado and New Mexico appear to have the greatest opportunity at present to accelerate the integration of climate policy and NBS in the upper basin, although all states can and should do so throughout the basin.

parties to accelerate this work are growing and becoming more prominent, with water agencies partnering in the work to avoid the costs of cleaning sediment and debris from their reservoirs after conflagrations (e.g., Denver Water and Yuba Water). Substantial funding from the public sector is coming from the federal government and within some states to undertake forest management and restoration for the purpose of limiting the extent of catastrophic wildfire (which will mitigate climate change, protect people and property, and can provide water quality and supply benefits).

This report suggests focusing initially on the intersection of NBS-based forest management and climate policy because that is where the funding is, and because it can help build the case for integration of NBS more fully into climate planning. Supporting ecological forest restoration can and should also build expertise and comfort with NBS in general among climate practitioners. Additionally, the report suggests integrating meadow restoration (and beaver and beaver analogs) into forest restoration to achieve even greater multiple benefits for water and biodiversity. These are efforts to support and build upon.

There are also great opportunities to accelerate this work by bringing together various stakeholders, either within states across disciplines or across states by discipline. State climate policies can be strengthened in all states, including California, through increasing the visibility of the opportunities for NBS generally and in specific locations with the best promise of yielding multiple benefits. At an even bigger scale, the trend toward an overall climate policy mindset that recognizes natural lands as both a "source" and "sink" for carbon that must be addressed if we are to meet the climate-change challenge can drive investments in land management practices for both water and climate benefits. Third parties, whether philanthropic, academic, or other institutions, can support advancement of integrating NBS into climate strategy through elevating the public policy discourse, supporting the development of tools for quantification, mapping, and finance, supporting the use of those tools, and through supporting greater convening and connecting of experts, private-sector parties, NGOs, and others interested in both climate and water. Bringing together the disparate parties engaged in this space into a community of practice should make it possible to achieve efficiencies in developing data, policies, and strategies for specific types of landscapes, and to build a greater public-policy awareness of the benefits of integrating these historically disparate groups of people and practice.

Organization of This Report

Part 1: Overview of Climate Policy and Nature-Based Solutions That Restore or Manage Natural Lands for Mitigation and Sequestration Purposes: This report begins with an overview of climate policy at the international, national, and state levels. It then illustrates the evolving role of NBS as a multiple-benefit strategy that can play an increasingly significant role in climate policy. A state-by-state discussion of existing and developing climate policies in the Colorado River Basin follows, with particular focus on how NBS is treated in those states that incorporate or are considering incorporating NBS into their climate policy. The report then briefly discusses the growing attention to this area in the net-zero and private-sector arena because of the opportunity to leverage public and private-sector funding for projects.

Part 2: Barriers and Technical Needs to Encourage Greater Use of Nature-Based Solutions as a Climate Strategy With Multiple Benefits: The second part of the report identifies some barriers to greater integration of NBS and climate policy, as well as technical needs for tools that can overcome some of those barriers.

Part 3: Recommendations to Advance Climate Policies That Deliver Multiple Benefits for Climate, Water, and Other Good Things Through the Use of Nature-Based Solutions: The final part of the report provides a series of recommendations to state leaders and third parties who can help accelerate the adoption and integration of NBS into climate planning and practice. The recommendations are meant to accelerate positive momentum in the states, to overcome the barriers to adoption of such practices, and to bring together a "community of practice" that can work together on these issues within and across disciplines, geographies, and institutional positions.

Key Conclusions

- **There are great potential synergies between state climate policy in the Colorado River Basin and nature-based solutions (NBS) that provide multiple benefits, including water supply and water quality.** Ecological forest management and restoration that reduces catastrophic fire risk can yield benefits for water supply and water quality while preventing and actively sequestering carbon emissions. Upper watershed meadow restoration, including the reintroduction of beavers or the use of process-based restoration shows great promise. These nature-based solutions could and should be effectively integrated into large-scale ecological forest restoration to gain even greater climate and water benefits in addition to their stand-alone benefits. Agricultural practices that are used to sequester carbon can also yield water benefits and provide other important benefits to agricultural communities.

- **States without NBS as part of a climate portfolio need to add them to have a truly effective climate policy for the same reasons NBS has recently become such a large part of the international dialogue in climate action and planning (in addition to the multiple benefits of such work).** This can take many forms, such as ecologically-based forest management to avoid extreme wildfire, mountain meadow restoration, and enhanced agricultural practices. The work can be funded and undertaken directly by government or through grants or low-cost loans to (or from) water agencies, NGOs, or communities. The work can be incentivized through formal carbon offset programs, informal voluntary offset efforts (more feasible), water agency intervention and investment in upper watershed management, innovative public-private financial partnerships, and other direct state and federal investment. These efforts can be inspired by rapidly evolving efforts at the international and national level to take a broader approach to climate policy than the traditional focus on fossil fuel emissions reductions and complementary clean energy and efficiency policies. The newer and more complete approach integrates NBS into both emissions reduction and adaptation actions as an additional complementary strategy.

- **More sophisticated climate policies in each state should include funding and other incentives for NBS.** State policies are also needed to enable funding to be used for matching and/or leveraging the massive federal funding that will be available in the near future through the recently enacted Infrastructure Investment and Jobs Act and other funding mechanisms. States should invest public dollars in this work because of the multiple benefits it provides. The infusion of federal funding makes that investment possible at scale. State policies also can be shaped to support and enable a far greater influx of private-sector dollars from the voluntary carbon market or from private-sector entities seeking net-zero carbon or water projects, or both.

- **The most promising area of focus is forest management geared toward the multiple benefits of avoiding catastrophic wildfire, protecting life and property, and improving water supply and quality because it is where the most immediate large-scale funding will be in the near future.** With the rapidly growing pace and extent of wildfires due to overgrown forests and increased temperatures, the public and public-policy visibility of doing something to reduce those risks has advanced dramatically in the last few years. Wildfire prevention practices are gaining support at the federal, state, and water agency levels for differing multiple-benefit reasons: protecting life, limb, and property; avoiding extreme carbon emissions; and avoiding the sedimentation and contamination of downstream waters either during conflagrations or in subsequent rain events. This is not to say that forests are more important than meadows or agricultural lands, rather that this is where funding is increasing substantially in the near term and, as such, provides opportunities to do good projects and to grow the field of NBS for both climate and water benefits. Regulatory carbon offset or cap-and-trade programs (most robust in California) will not yield great funding for nature-based solutions outside of California because of political, legislative, and quantification limitations in California and beyond. The greatest funding opportunities are likely to come from the rapidly growing funding being directed at catastrophic wildfire prevention and from voluntary offset or net-zero pledges by institutions, businesses, and individuals.

- **One specific synergy deserving of special attention is the opportunity to integrate mountain or wet meadow restoration into forest restoration planning and programs to gain additional benefits for water and ecological needs while creating natural firebreaks.** This work can include the growing field of beaver reintroduction, "process-based restoration," or construction of "beaver dam analog" projects.

- **Visualization matters.** Identifying and visually displaying specific landscapes in the upper Colorado River Basin with best potential for climate/NBS/water synergies in target areas (e.g., overlay climate mitigation and sequestration opportunities on best locations and types of landscapes for water supply/water quality purposes) is crucial. Visualization is a powerful tool to engage decisionmakers and the public. Doing so can help make a theoretical vision that may seem abstract to policymakers and funders more accessible, practical, and compelling.

- **Better quantification tools are needed to meet this potential.** Although the levels of quantification for voluntary credits or to support state policy and budget decisions are less stringent than those for regulatory offset programs, quantification is needed and helps even if not required. There are growing efforts to quantify carbon benefits for active forest management, mountain or wet meadow restoration, and managed grazing or other agricultural practices, but those efforts are still evolving and need to be done in a geographically specific way. Tool development (and application of tools in a particular region) needs to be accelerated and expanded, as does work on better quantification of certain types of NBS in general (e.g., forests, meadows, rangelands) and at the local or regional level. That quantification will help drive funding, whether from regulatory offsets, voluntary offsets, public investment, of a combination of public and private financing.

- **Quantification standards and practices that expressly take a multiple-benefit approach are still in development and are important in making the policy case for greater investment in NBS.** Quantification and policymaking in this arena tend to be siloed, whether between subject areas (e.g., climate, water, and biodiversity) or between landscapes (e.g., forests, meadows, agriculture). What may not pencil out on a landscape solely for climate may do so for climate, water, fire safety, and other benefits if viewed together. Making the multiple benefit case requires developing methods and frameworks to make it easier for policymakers to act. This work is more advanced in the private/voluntary sector than in the public sector and can yield investment in projects and make the case for more integrated policies and planning.

- **Multiple-benefit thinking and policymaking need to be elevated at every opportunity to develop awareness and a framework for policymakers to integrate climate and water in their climate policies.** Every opportunity should be seized to elevate the visibility of the compelling opportunity to integrate NBS and land-based restoration/management into climate policies through public papers, media, and webinars at appropriate venues in each target state. Tell the evolving international, national, California, and other state stories. Make this a wave to catch.

- **Enhanced financing opportunities and other policy vehicles can incentivize and assist private and public partners to accelerate implementation of NBS with climate and water benefits.** There are some particularly good examples of innovative financing emerging. Elevating and supporting them will stretch both public and private dollars.

- **Creating a "Community of Practice" in this field across the Colorado River Basin is necessary to gain greater visibility, traction, and experience in planning for and implementing NBS.** Find ways to convene practitioners in this arena to share best practices and pitfalls and create a community of practice to leverage experience and accelerate results. This can be across a particular geography or type of landscape or both.

Sawatch Mountains Summer View with Wildflowers

INTRODUCTION

We are at a pivotal time in the world's response to climate change. Fortunately, the policy discourse is evolving at an accelerated rate. There is a growing recognition among world, national, state, tribal, and local leaders of climate change's catastrophic impact on people and the ecosystems they rely on, and of the need to act rapidly to both mitigate that damage and adapt to the inevitable changes to come. At the same time, there is also a growing global recognition that the loss of ecosystem function has a tremendous impact upon climate, water security, and other essential elements of life.[2] Water is at the core of those key issues. As Brad Udall, Senior Water and Climate Research Scientist at Colorado State University's Colorado Water Center, is often quoted as saying, "Climate change is water change."[3] The first effects of climate change manifest in the water sphere, whether through drought, flooding, sea level rise, or stressed species. At the same time, intelligent water management can be at the core of both mitigating and adapting to climate change, with ecosystem and river restoration playing a critical and beneficial role.

Climate change is clearly the issue of our time. The same is true of how we manage water and the people and ecosystems that rely on water.[4] Despite the strong connection between these two issues, historically policies have tended to address one or the other without a strong crosswalk in legislation, funding, policy, projects, or governance. This unfortunate division may be because very different silos of practice have developed in the climate/energy worlds and the water/ecosystem management worlds,[5] or because of the complexity of those issues. It also could be because the science illuminating the connection between the two is less well-developed. Regardless of reason, there are untapped synergies to be found and implemented across the world and in the Colorado River Basin specifically.

At the international, national, and state levels there are great opportunities to deal with both water and climate challenges and their multifaceted causes and solutions in tandem. Under the banner of "nature-based solutions" or NBS,[6] international organizations, the federal government, states, non-governmental organizations (NGOs), and the private sector are engaged in developing policies, doing the science, and implementing projects to achieve both climate mitigation and adaptation results while also enhancing water supply, water quality, and ecosystem function. This encouraging shift provides an umbrella of opportunity to grow this work dramatically. As discussed more fully below, this shift is occurring in real time at the international and national level. Among the states, it is most advanced in California, which can be viewed as illustrative of what could be done in other Colorado River Basin states. Colorado and New Mexico are also undertaking climate planning that integrates NBS in a preliminary and as yet aspirational manner. In all of these, water is mentioned as a co-benefit if not a purpose of the effort.

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2 See e.g., United Nations Environment Program and Food and Agriculture Organization, *Preventing, Halting and Reversing the Degradation of Ecosystems Worldwide* (*https://www.decadeonrestoration.org*) (describing UN Decade on Ecosystem Restoration, 2021-2030).

3 Harvey, C., 2016, "Climate change is water change–Why the Colorado River system is headed for major trouble," Washington Post, August 19, 2016 (*https://www.washingtonpost.com/news/energy-environment/wp/2016/08/19/climate-change-is-water-change-why-the-colorado-river-system-is-headed-for-trouble/*). See also Cassin et al., 2021a, p. 4: "both water and climate constitute risks that are overriding and increase the likelihood or impacts of other risks. Water and climate in particular are closely linked. People will feel the effects of climate change mostly through water. From more and longer or deeper droughts impacting food and energy production, loss of life and damages from more extreme storms and flooding, or the unpredictability of rainfall that can lead farmers to abandon land and spurs internal and international migration, fundamentally, climate is water."

4 The World Economic Forum has ranked water and climate change at the top of world concerns multiple times in the past 3-5 years (Cassin et al., 2021a). A first-of-its-kind global survey of over half of the world's top water officials found that climate change was the most pressing issue facing water security. See Water Policy Group, 2021, "A message for the global water community: If you care about water, you must care about climate change": *https://waterpolicygroup.com/index.php/2021/11/01/on-the-eve-of-climate-cop-26/*

5 See Tett, 2015 (describing how silos of expertise and practice get in the way of communication necessary for true progress).

6 The International Union for Conservation of Nature (IUCN) defines nature-based solutions as "actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (*https://www.iucn.org/theme/nature-based-solutions/about*). There are multiple terms used interchangeably in this arena, but NBS is most commonly used. California, for example, has placed increased emphasis on NBS in a variety of its policies and its current budget documents, but refers to its extensive work on and funding of NBS as part of its climate policies under the rubric of Natural Working Lands (NWL), as do other states. See, e.g., CARB, 2019. "Natural Climate Solutions" and other phrases are also used.

Historically, in both the advocacy and policy worlds, efforts to mitigate climate impacts have focused most heavily on reducing emissions of greenhouse gases from conventional fossil fuel and other direct emitters. Complementary policies have been developed to support energy conservation, the development of renewable or "clean" energy, and regulations and incentives for lower-emission vehicles, appliances, and buildings that can also yield significant emissions reductions from the status quo. While land-based activities such as conventional forestry and agricultural practices, or destruction of wetlands, also contribute to emissions, they have to date received substantially less advocacy and policy attention than the energy and industrial emissions arena. Conversion of natural lands that presently sequester carbon is seen as an ascending area of attention as a source of emissions to be managed (reducing "sources") in addition to providing opportunities to create "sinks" for sequestering carbon emissions from other sources. The notion of natural lands as "sources and sinks" for emissions is growing in the public and policy discourse (IPCC, 2019).

In particular, catastrophic wildfires[7] that emit enormous amounts of carbon that had not been "counted" in climate planning are now becoming a source of focused effort at the state and national level, with a growing recognition that emissions from wildfires—more often catastrophic due to inadequate forest management, fire suppression policies, and/or increased temperatures due to climate change—now make such lands an enormous source for greenhouse gas emissions.[8] Conversely, improved management practices and affirmative restoration of landscapes can reduce emissions and can contribute to greater sequestration of carbon in larger trees (providing a sink), while also being important for adaptation.[9] Better forest management and restoration, similarly, can limit the emissions of catastrophic wildfire not by preventing all fires, but by limiting their intensity such that they emit less and destroy fewer older-growth trees that sequester the most carbon. Those practices can also provide important water quality and supply benefits while reducing net carbon emissions to the atmosphere. The growing movement to protect 30% of the world's land and water resources by 2030 (30x30) for the purposes of biodiversity protection is also frequently framed as an opportunity for climate mitigation and/or adaptation.

As a result, there is a strong case to be made for developing substantial complementary policies to encourage and incorporate NBS as a climate mitigation strategy in state policy and programs, analogous to the now multi-decade work that is paying dividends in the energy arena. This has value in terms of carbon reduction benefits alone, and the combination of those benefits with other societal benefits like better water supply management, better water quality, and enhancing biodiversity is becoming more and more evident to more and more people.

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7 "Catastrophic" wildfire is a term in general use to refer to a blaze that is outsized, usually due to overgrowth of underlying vegetation. That overgrowth (or fuels) develop in forests that have been logged, where the natural variety of trees in size and type has been altered and natural fire has been suppressed, and in more natural forests where fire has been suppressed. Whether through the good intentions of Smokey Bear or others, the suppression of natural fire has created a tinderbox of overgrowth in many of our forests. The greater density of undergrowth leads to fires blazing hotter at the lower and mid-levels, which creates a greater threat to and release of carbon from the larger older trees. A more "natural" forest can better withstand fires that race across the forest floor but do not consume the larger trees. Catastrophic wildfires are also referred to as "extreme" wildfires, "bad" wildfires, or "megafires," in contrast to the inevitable wildfires that are to be expected from lightning strikes and other natural causes or properly managed "controlled" or "prescribed" burns (sometimes referred to as "good" or "natural" wildfires). Ecological forest restoration seeks to reduce some of the more dense and mid-level growth (usually through mechanical means) to more closely resemble a natural forest that can then be maintained through prescribed burns and lighter physical means.

8 Forests can also become a short-term source of emissions when vegetation is removed from forests in an effort to prevent even greater future emissions from outsized wildfire. It is a short-term loss of sequestration in exchange for preventing massive plumes of carbon release in the future. See, e.g., CARB, 2022 (citing long-term reduction in emissions from forest management efforts over time through affirmative forest management that in the short term will release carbon).

9 Better management of natural working lands is frequently thought of as an important climate *adaptation* strategy, while also being a part of climate *mitigation* strategies. Climate policies internationally, nationally, and at the state level have historically focused on mitigation, a combination of reduction of emissions and the sequestration of carbon. "Adaptation" has grown in the public discourse over the past few years significantly, with land management practices straddling both worlds and gaining greater attention over the same period of time. This report focuses on state climate policy generally in the mitigation arena, although the work will also yield great adaptation benefits particularly in the water resilience arena (see e.g., Martin et al., 2021).

As a result, there is a growing movement to incorporate these solutions into climate policies of all kinds[10] and an expanding effort to research and quantify this complex field. Nonetheless, this work remains a far smaller part of the climate policy discussion at the state level than the degree of impact or the opportunities warrant. As discussed more fully below, this is in part due to the more challenging nature of quantifying the climate and/or water benefits of individual nature-based solutions, and to the lack of policy frameworks for selecting multiple-benefit projects that may have lower direct emissions reductions benefits than direct reductions from industrial emissions in the short term, but which serve multiple societal purposes and have great impact in the longer run.[11] Elevating the opportunities to be found in integrating climate solutions and NBS, particularly those with benefits to water supply and/or quality, can provide benefits to communities that are profoundly substantial even if not calculable on a solely quantitative basis. Doing so requires education, greater work on quantification of carbon and water benefits for particular landscape restoration and management practices, and an increasing focus on and elevation of multiple-benefit policies/thinking that make the most efficient use of resources for the greatest good.

PART 1: CONTEXT. Overview of Climate Policy and Nature-Based Solutions That Restore or Manage Natural Lands for Mitigation and Sequestration Purposes

To set the context, this report begins with an overview of climate policy forms at the international, national, and state levels. We then follow with a general description of how natural systems and working lands have been addressed in the context of climate policies, followed by specific descriptions of the climate policies of the Colorado River Basin states and how they each do or do not incorporate NBS. The report also includes a brief discussion of private-sector involvement in voluntary emissions reductions or sequestration tied to NBS with specific respect to the water arena.

International and National Policy

While this report is about the synergies between state climate policy and nature-based solutions that also yield potential water benefits, there is an accelerating trend to incorporate NBS into climate policy that is far stronger at present in the *international* dialogue than domestically, although it is gaining steam at the national level. Those trends hold promise for a similar elevation of nature-based solutions into state climate policy discourse and implementation that should provide motivation for states to pick up the pace.

At the international level, climate policies have focused heavily over the past few decades on aspirational agreements to limit carbon emissions. Most recently, the Paris Agreement called for Nationally Determined Contributions (NDCs) by each country to contribute to carbon emissions reductions through a combination of emissions reductions and carbon sequestration.[12] As relayed in a recent report on the role of NBS in water security:

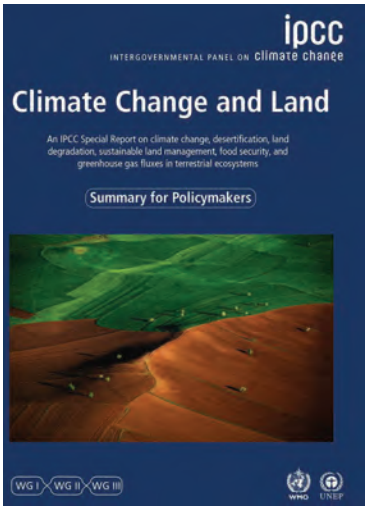
10 For example, The Climate Center (*https://theclimatecenter.org*) is a climate advocacy group that has integrated NBS into its research and advocacy wholeheartedly, along with a focus on traditional anthropogenic emissions reduction and complementary energy policies. See also CEO Water Mandate, 2020.

11 Discussion of natural lands in the climate policy world has tended to be at the margins focused on their use in the "offsets" context, which is mired in controversy. This has distracted the dialogue away from the essential role that natural lands **must** play in meeting the climate challenge. "The climate implications of forests and land use need to be approached on their own terms and are far more serious than the mainstream climate policy community seems to recognize. By viewing climate change as primarily an energy problem, we have failed to recognize the vital importance of protecting and maintaining intact forests and other ecosystems as perhaps the most difficult long-term component of the climate change challenge" (Boyd, 2022, p 107).

12 The NDCs are a country's contributions to reducing its climate emissions through mitigation and/or sequestration. A summary of NDC submissions was published by the United Nations Framework Convention on Climate Change (UNFCCC) on September 25, 2021, prior to the Conference of the Parties (COP26) in Glasgow the first two weeks of November 2021 (UNFCCC Synthesis Report, 2021). The US submission is found at: *https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/United%20States%20of%20America%20First/United%20States%20NDC%20April%2021%202021%20Final.pdf*. The US submission notes that agriculture and forests will play a significant role in meeting the nation's emissions reduction targets, but that role is not quantified.

> NBS have become increasingly important in climate change policy, as reflected in the recognition that NBS have an important role to play in Nationally determined contributions (NDCs) and that a majority of signatories to the Paris Agreement have included NBS in some form in their NDCs (Seddon et al., 2020b; Timboe et al., 2019). (Cassin et al., 2021a, p. 64)[13]

More recently, these pledges have increasingly set a goal of achieving net-zero emissions through a combination of emissions reductions and sequestration.



In the international arena and at the national level, there is now substantial recognition that we cannot meet our climate goals without the integration of NBS (Schonhardt, 2021). Policymakers and observers are recognizing that it is about "sources and sinks." In 2019, the Intergovernmental Panel on Climate Change (IPCC) issued a "Special Report" that announced that limiting carbon emissions from the combustion of fossil fuels and other industrial activities alone could not be enough to stem global warming. The report pointed out that achieving carbon neutrality would require dealing with all sources and sinks from emissions from all sectors, including natural working lands (IPCC, 2019). The IPCC laid out plainly that to avoid the greatest adverse impacts of climate change, the world needed to do more than reduce fossil fuel emissions; it also needed to avoid emissions from land conversion and to sequester carbon. Quite simply, we could convert to 100% clean energy and stop all industrial emissions of greenhouse gases and not meet our climate goals. By some estimates, as much as 30% or more of the solution will have to come from managing land-based emissions.[14]

The current dialogue at the international level centers intensively on net-zero pledges not only by countries but also by corporations, organizations, and sub-national government units. In September 2018, California Governor Jerry Brown issued an executive order (EO B-55-18) establishing a state goal of carbon neutrality by 2045 and maintenance of net-negative emissions thereafter. Other states have followed, but none yet in the Colorado River Basin. There are discussions in New Mexico about considering a net-zero goal, but a bill that would have made net-zero by 2050 state policy failed early in 2022 (Wyland, 2021).[15]

Under the Paris Agreement, many countries are developing their net-zero targets to include a combination of emissions reductions from industrial and nature-based sources and active sequestration (including nature-based restoration and protection). Countries reported on their progress at the most recent Conference of the Parties (COP26) in Glasgow, Scotland, and there was hope that both NBS and water would feature prominently (Walton, 2021). While there was disappointment in the level of progress made on

13 The authors also note that "[h]owever, systematic and targeted implementation at scale is still in the distance. In most of these NDCs there are general goals or visions for including NBS in adaptation or mitigation, but fewer cases of specific nature-based actions, and fewer still of measurable targets for these actions (Seddon et al., 2020b)" (Cassin et al., 2021a).

14 This is not an "either/or" argument, but a "both/and." At the same time as we need to incorporate NBS to a much higher degree, we also need to redouble our efforts to reduce and eliminate fossil fuel and other anthropogenic emissions. As Richard Corey, Executive Officer of the California Air Resources Board (CARB), put it: "[Seeing NBS as additive to rather than a substitute for anthropogenic emissions reductions] creates space to integrate NWL because we need an all-hands-on-deck approach that includes phasing out of petroleum, dealing with short lived climate pollutants, transitioning to a renewable grid, and valuing and incentivizing the role of NWL interventions" (Corey, 2022). This framing is important as we must face the collective nightmare of climate change with an "all of the above" strategy rather than devolving to arguments over which is better. Embracing NBS/NWL should also be based upon the co-benefits that such work provides and should not in any way be used as a suggestion that we should slow our transition away from fossil fuels or other GHG emissions.

15 Bill found at: *https://www.billtrack50.com/BillDetail/1423980*. Governor Michelle Lujan Grisham has expressed support for a net-zero policy in addition to her executive order setting a target of reducing emissions to 45% of 2005 levels by 2030 (Davis, 2021).

the Paris commitments, there was a very noticeable increase in focus on NBS throughout the meeting, including an emphasis on nature on the main stage and in the side events, and the first ever "Water and Climate Pavilion" in the "Blue Zone" side events.[16] As Andrew Roby, Senior Water Security Advisor, Climate and Environment Directorate, Foreign, Commonwealth & Development Office (FCDO), United Kingdom, put it, "Glasgow COP26 put nature at the heart of climate action" (Cassin et al., 2021b).

In the past few years, a movement to preserve 30% of the world's land and water natural resources by 2030, known as "30x30," has also taken hold as a joint climate and biodiversity strategy. Destruction of natural systems has an effect on greenhouse gas (GHG) emissions that can be avoided by preserving those natural systems, and one can sequester additional carbon by increasing natural systems' acreage and capacity to do so. The 30x30 movement also plays an important role in climate adaptation through creating more space for species to survive or to migrate. As noted elsewhere in this report, the US and some states have signed on to this goal with climate as a stated objective, along with other co-benefits to land and water.[17]

16 Author's observations.

17 Lieberman, B., 2021, "Details behind Biden's '30 by 30' U.S. lands and oceans climate goal," Yale Climate Connections, March 11, 2021 (*https://yaleclimateconnections.org/2021/03/details-behind-bidens-30-by-30-u-s-lands-and-oceans-climate-goal/*) (describing Biden administration pledge as part of climate strategy and also discussing ways in which NBS are a part of the climate solution); Jones, B., 2021, "The Biden administration has a game-changing approach to nature conservation," Vox, May 7, 2021 (*https://www.vox.com/2021/5/7/22423139/biden-30-by-30-conservation-initiative-historic*); Gibbens, S., 2021, "The U.S. commits to tripling its protected lands. Here's how it could be done," National Geographic, January 27, 2021 (*https://www.nationalgeographic.com/environment/article/biden-commits-to-30-by-2030-conservation-executive-orders*) (US among 50 countries that have signed on to the initiative; "farms, ranches, and other working lands will contribute to the 30%"). Some states have also adopted the goal, including California (CNRA, 2022).

At the national level, the US has seesawed between support for and opposition to international climate agreements (with the current administration rejoining the Paris Agreement) and has similarly swung between support for and resistance to a formal domestic climate policy along a traditional emissions reduction model.[18] And, as in many states, it has at times, depending upon administration, focused on complementary energy policies to encourage the development of renewable or clean energy sources as well as energy efficiency.

In the current administration, fortunately, there is the promise of a "whole of government" approach to climate response that includes efforts across a range of agencies and practices that explicitly includes NBS and multiple-benefit approaches into climate policy.[19] The issue is mentioned frequently by Cabinet secretaries as a core driving factor in the work of their agencies.[20] Most important, the administration issued a bold net-zero plan on November 1, 2021, to open the Conference of the Parties (COP26) at which world leaders converged to discuss urgent action on climate. In the very first page, the document lays out the significance of NBS and working lands' contributions to *both* emissions-reduction goals and adaptation (Pathways to 2050, 2021). The steps necessary to meet the goals outlined in the plan should bring a wide range of national attention and investment to nature-based solutions of all kinds. The recently passed Infrastructure Investment and Jobs Act (IIJA)[21] provides billions of dollars for a variety of efforts in forest restoration/wildfire prevention and agricultural practices that can prevent emissions (from land disturbance or catastrophic wildfire) or that can sequester carbon through enhanced management practices (NCSL, 2022).[22] These actions have raised the profile of NBS work at the state level and also should lend support to state programs and projects that are prepared to receive federal attention and funding (through staffing, matching funds, and active development of projects to be funded).[23]

So, while not yet fully built out, quantified, or thoroughly established, the integration of nature-based solutions at the international and national level is building momentum. That momentum has the potential to bring more attention and resources to NBS at all levels for planning, quantification, and implementation, though the pathway is by no means clear at this point.[24] The work to integrate NBS into climate planning is complex and less easily measured than traditional climate policy tools but is essential to meeting the climate challenge. Fortunately, it also yields multiple societal and ecological benefits.

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18 The Obama administration designated GHGs as a pollutant under the Clean Air Act to invoke more traditional forms of regulation and the actions have been litigated. The Supreme Court decided to take up the latest challenge and ruled on June 30, 2022 that the USEPA had overstepped its authority by the specific approach it took. See Barnes, R. & Grandoni, D., 2022. "Supreme Court limits EPA's power to combat climate change." Washington Post, June 30, 2022 (*https://www.washingtonpost.com/politics/2022/06/30/supreme-court-epa-climate-change/*).

19 See, e.g., Fact Sheet: President Biden Takes Executive Actions to Tackle the Climate Crisis at Home and Abroad, Create Jobs, and Restore Scientific Integrity Across Federal Government (*https://www.whitehouse.gov/briefing-room/statements-releases/2021/01/27/fact-sheet-president-biden-takes-executive-actions-to-tackle-the-climate-crisis-at-home-and-abroad-create-jobs-and-restore-scientific-integrity-across-federal-government/*); Fact Sheet: Biden Administration Releases Agency Climate Adaptation and Resilience Plans from Across Federal Government (*https://www.whitehouse.gov/briefing-room/statements-releases/2021/10/07/fact-sheet-biden-administration-releases-agency-climate-adaptation-and-resilience-plans-from-across-federal-government/*).

20 See, e.g., Readout of the Fourth National Climate Task Force Meeting: *https://www.whitehouse.gov/briefing-room/statements-releases/2021/06/24/readout-of-the-fourth-national-climate-task-force-meeting/*

21 Infrastructure Investment and Jobs Act, Pub. L. No. 117-58 Sections 40803-40808, 135 Stat. 429 (2021). While we will need many billions more to make a dent in the "billion burnable acres" of forests at risk in the United States alone (Boyd, 2022, ftnt 48 quoting Victoria Christiansen, Chief USFS), the IIJA represents an enormous step forward. Hopefully, it will be the first of many.

22 See also Rogers, N., 2022, "It's Time to Jump-Start a Rapid Scale-Up of Farm and Forest-Based Carbon Solutions," Bipartisan Policy Center, February 2, 2022: *https://bipartisanpolicy.org/press-release/its-time-to-jump-start-a-rapid-scale-up-of-farm-and-forest-based-carbon-solutions/*

23 See e.g., HB22-1379 Wildfire Prevention Water Restoration Funding. Colorado General Assembly Summary: *https://leg.colorado.gov/bills/hb22-1379*

24 Entities such as Forest Trends are focusing attention on this in anticipation of a wave of greater investment in forest management at the international, national, and state levels. They and others are working to illuminate what needs to be done to create the enabling conditions (projects, policies, and practices) to make use of the greater expected infrastructure investments and to accelerate implementation on the ground (Cassin et al., 2021a).

State Climate Policies (General)

There are a variety of state climate policy approaches to be found across the country. Unlike the international and national arena, state climate policies frequently incorporate extensive and specific regulatory measures, particularly focused on fossil fuel emissions regulation, renewable energy promotion, and energy efficiency. This section begins with (1) an overview of state climate policy structures, then (2) discusses how different types of nature-based solutions are being considered as part of state (and national) climate strategy. It then (3) describes how each of the Colorado River Basin states are considering those solutions as part of their climate planning.

The Center for Climate and Energy Solutions provides an accessible guide to state climate policies, summarizing:

- 24 states have adopted specific greenhouse gas reduction targets,[25] 12 states have some element of cap-and-trade program.
- 29 states and the District of Columbia have "renewable portfolio standards" requiring some percentage of a utility's electricity to come from renewable energy sources, with seven states adopting a "clean energy standard" requiring utilities to deliver a certain amount of electricity from renewable or clean energy sources.
- 15 states have energy efficiency policies through mandates or incentives and even more "decouple" rates from volume of energy sold to encourage energy conservation, and seven states have some kind of low-carbon fuel standard.
- 32 states have released a climate action plan or are in the process of revising or developing one (C2ES, 2021).[26]

Emissions reduction targets traditionally focus on the energy sector, the transportation sector, and the building sector, which take up a significant amount of the emissions inventories currently reported and can vary by state. Some states also have specific regulations to deal with "short-lived climate pollutants," such as methane emissions from oil and gas or livestock operations (U.S. Climate Alliance, 2021). Emissions reduction targets typically are based on emissions inventories, frequently displayed as pie charts of different sectors' relative contribution to greenhouse gas emissions. While the pie charts sometimes include some level of direct agricultural emissions (e.g., from dairy operations), they generally do not include emissions from land disturbance or forest fires despite the growing recognition that these "natural sources" are outstripping fossil fuels and industrial emissions.[27] While not in the pie charts, California does produce a substantial inventory of those emissions (CARB NWL Inventory, 2018).

25 "Targets" are important, but easier to put out than the action plans necessary to achieve them. This paper does not attempt to distinguish which states have more significant or specific action plans.

26 For another good inventory of state climate and clean energy policies, see United States Climate Alliance, Inventory of Climate and Clean Energy Policies (detailing policies of its 24 member states, which include California, Colorado, Nevada, and New Mexico of the Colorado River Basin states): *http://www.usclimatealliance.org/state-climate-energy-policies*

27 As discussed more fully below, California has integrated the impacts of wildfire into its climate planning and funding, though it does not appear in the emissions pie chart yet. Even so, it has done a lot of work to inventory, acknowledge, and, most important, act upon that knowledge, because "biological carbon cycles through the system but we are seeing massive fluxes with unprecedented (in modern times) injection of carbon into the atmosphere through climate change induced wildfires, for example" (Corey, 2022).

While there is no uniform categorization of climate policies, they tend to fall into the following categories:

- Direct regulation of emissions by sector (or subsector) similar to other air pollution regulations. Some frameworks allow the use of offsets or credits for a small percentage of their regulatory obligations (described below).
- Cap-and-trade or other carbon pricing mechanism to incentivize reductions in high carbon intensity activities while also facilitating reductions in other emissions sources at lower cost.[28]
- Complementary energy policies, subsidies, or regulations directly favoring building and appliance efficiency, renewable energy, lower-emissions transportation modes, and cleaner fuels. Renewable portfolio standards requiring regulated energy utilities to obtain a certain percentage of their energy from clean or renewable energy sources are common.
- Complementary policies to mitigate or sequester carbon, including those that incentivize or fund nature-based solutions such as forest management, healthy soils and other agricultural practices, and wetland/meadow restoration that can avert wildfires and other carbon emissions sources, enhance water quality and quantity, and sequester carbon. These policies can take the form of investments, such as those funded through proceeds of California's cap-and-trade system or from state coffers, or through other affirmative state policies analogous to those that promote energy efficiency or renewable energy.

A note on offsets that involve natural lands work, especially relating to work with water supply or quality benefits:

The topic of offsets and the controversy over them has garnered considerable attention in the media and public-policy discourse. Because the topic's visibility can lead to a presumption of relevance that is larger than its actual potential utility in generating funding for nature-based solutions in the state climate context, a somewhat lengthy discussion is presented below and elaborated upon in Appendix B.

Offsets involving natural lands work are used in both regulatory and voluntary contexts—and generally represent a recognition of emissions avoided through the active protection and conservation of resources whose removal would emit carbon, e.g., trees and other vegetation that naturally sequester carbon, or the active restoration and management of those natural resources to sequester carbon. Offsets can also be obtained by purchasing credits from an entity that has reduced more carbon than it is required to through more efficient technologies or changes in operations. Offsets can be used in a regulatory context, where a regulated emitter of carbon expends money to achieve carbon emissions reduction or sequestration by investing in actions of others rather than through direct, and often more expensive, emissions reductions of its own.

28 In a cap-and-trade system, the governing body sets a cap on emissions, allocates responsibility, and requires regulated entities to go to auction to buy credits to cover the quantity of emissions they emit. The cap declines over time and the price goes up, giving an incentive to emit less while providing funding to support climate-related projects or provide dividends to the public. See C2ES, Cap and Trade Basics (*https://www.c2es.org/content/cap-and-trade-basics/*). In California, companies are assigned "allocations" based upon their emissions that they must compensate for by purchase of credits at auction (or reduce their emissions). The cap declines over time to assure emissions reductions (*https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/about*).

In other cases, offsets are used in a voluntary context. Offsets began and are more common in the voluntary market, as entities desired to register their early efforts at carbon reduction ahead of what was then expected to be a more formal international, national, and state series of regulatory constructs.[29] Organizations and individuals also wanted to be able to compensate for their own carbon emissions for altruistic or marketing reasons, so nonprofit organizations were formed to develop methodologies for assessing the veracity of both voluntary and regulatory carbon reduction claims and to collect data on carbon emissions reported annually within a digital database called a registry.[30] Registries can include both voluntary and mandatory emissions data. Organizations operating registries can also develop protocols supporting detailed carbon inventories or for validating[31] a particular activity's carbon emissions reductions for both regulatory and voluntary purposes.[32]

As described in more detail in Appendix B, the process for obtaining a regulatory offset is quite expensive. In addition, the use of offsets in the regulatory context is controversial and as a result is more limited in quantity than the media attention they garner would suggest. Voluntary offsets, also described in Appendix B and in the section below regarding corporate and other uses of voluntary offsets and net-zero pledges, require less quantification, but they are also increasingly subject to scrutiny.[33]

Nature-Based Solutions That Are Evolving as Elements of Climate Policy

Nature-based solutions have been part of the climate dialogue and practice for quite some time, with forestry receiving the greatest attention, quantification, and investment to date. "Healthy soils" development and other agricultural practices have received substantial attention in the last decade. The importance of wetlands and meadow restoration has received greater attention in the last few years, with quantification of benefits (like carbon sequestration, water quality, and water supply/timing) becoming far more visible. All of these nature-based solutions are playing an increasing role as the international, national, and state discourse turns to finding every available avenue for reducing carbon emissions, with avoided land conversion (of forests, wetlands, and other natural systems) being primary, and sequestration being seen as secondary. (See, e.g., Burness, 2021.)

While the water quality and water supply/timing benefits of ecological forest restoration, meadow restoration, and enhanced agricultural practices are receiving considerable attention, there are some barriers to greater implementation. At present, there is no third-party quantification or formal registration entity for water supply and water quality benefits equivalent to those in the carbon

29 See, e.g., Carbon Offset Guide (*https://www.offsetguide.org/understanding-carbon-offsets/carbon-offset-programs/mandatory-voluntary-offset-markets/*) (comparing different offset registries and mechanisms).

30 See e.g., The Climate Registry Website (*https://www.theclimateregistry.org*). The Climate Registry, for example, was created by the California Legislature in 2001, before the cap-and-trade program was developed, for entities to voluntarily report carbon emissions and reduction strategies in advance of federal or state requirements. The use of voluntary registries continues and is increasing as corporations track progress toward pledged emissions targets, such as net-zero carbon emissions, through a combination of emissions reductions and offsets or direct actions to sequester carbon. The registry can be adapted to track emissions inventories from organizations, water-energy consumption, value chain emissions, and metrics in the lands sector supporting nature-based carbon removal (Holm, 2021).

31 "Verification" is used to authenticate past emissions reductions. "Validation" refers to assessment of the authenticity of future mitigation activities if carried out in an agreed-upon way.

32 See, e.g., The Climate Action Reserve (*https://www.climateactionreserve.org*). The American Carbon Registry does similar work (*https://americancarbonregistry.org*). Entities can register their offsets with third-party entities like The Climate Registry which rely on The Climate Action Reserve and other entities for the validation of claims through the use of "protocols" (see also Carbon Offset Guide.) There are other international organizations doing this work in support of both international goals and voluntary offsets. See, e.g., the Clean Development Mechanism (*https://cdm.unfccc.int/about/index.html*) and the Clean Development Program (*https://www.cdp.net/en/info/about-us*), which works to assess projects in Europe.

33 The discussion is presented in some detail in this report to suggest that the regulatory offsets market is not a likely robust source of funding for NBS outside of California, and that the voluntary market and complementary climate policies are a far more likely source of support.

sector, but there are entities that provide those services.[34] In addition, private-sector net-zero or watershed protection pledges are driving work toward better quantification methods for both carbon and water benefits (CEO Water Mandate, 2021).

However, as discussed in the "Barriers" section later in this report, there are a variety of ongoing and growing efforts to quantify and support greater use of NBS for multiple benefits, including carbon mitigation and sequestration, water supply, and water quality (CEO Water Mandate, 2020; CEO Water Mandate, 2021).[35] These efforts to integrate water and climate benefits in some quantifiable way within a watershed or a project have promise to draw greater attention to the multiple benefit potential of a variety of land-based protection or restoration activities, but they are by no means ubiquitous or well-developed.

The descriptions that follow focus largely on the climate-related efforts surrounding NBS, with some note of water quality and supply efforts.

Forestry as a Growing Area of Climate Focus

Forests have played the leading role in any discussion at the intersection of climate policy and natural lands. Avoiding deforestation has long been seen as a necessary method of maintaining existing sequestration of carbon, or, in other words, avoiding carbon emissions that come from deforestation. Preventing deforestation, i.e., protecting existing forests, also maintains those forests as carbon sinks. Additionally, the reforestation of previously forested but logged areas has been seen as a prime opportunity for actively sequestering carbon, and the development of credits or offsets, as discussed elsewhere in this report, has largely centered around investments in avoided deforestation and reforestation around the world, including the development of worldwide carbon markets (Boyd, 2010). Forestry credits or offsets have been a major, if not the largest, segment of the regulatory, voluntary, and net-zero carbon markets, although the controversy discussed elsewhere in this report over offsets has led to limitations on the use of offsets in the regulatory arena (Boyd, 2021). The role of forests as both "sources and sinks" is a big-picture way to view forest work given growing recognition of their role as both. This is part of why the Nationally Determined Contributions directives have specific language for agriculture and forestry (Id.).

The Biden administration has announced big plans to fund greater restoration of forests for wildfire prevention and climate sequestration. The Infrastructure Investment and Jobs Act (IIJA) provides over $8 billion for forestry related projects (BIL Guidebook, 2022). More recently, the US Department of Agriculture announced over $1 billion to encourage farmers to adopt climate-friendly practices (Newburger, 2022). More funding was promised in the Build Back Better Act, portions of which passed at a reduced level in August of 2022.[36] States will receive IIJA funding directly and will benefit through funding to the US Forest Service, which controls large percentages of forest lands in the West (57% in California, 47% in Colorado, and 32% in New Mexico). The US Forest Service in January 2022 released an ambitious 10-year plan to treat 50 million acres of federal, state,

34 See, e.g., LimnoTech (*https://www.limno.com*), used by River Partners on Mapes Ranch and National Forest Foundation projects mentioned below. Substantial work by researchers at UC Merced is being used by the North Yuba Forest Partnership (also discussed below) and others, e.g., "New Tools Indicate How Thinning and Fire Affect Forest Water Use and Boost Runoff" (*https://news.ucmerced.edu/news/2020/new-tools-indicate-how-thinning-and-fire-affect-forest-water-use-and-boost-runoff*). The increasing development of "water funds" is also driving quantification efforts for slightly different reasons. Working with water funds or water trusts to combine resources may yield data that is useful in both contexts. See e.g., Water Funds Field Guide, 2018.

35 For a broad look at the benefits of NBS for both water and climate benefits, as well as mitigation and adaptation benefits, see Cassin et al., 2021a.

36 The House Build Back Better Act, released October 28, 2021 (H.R. 5376), opens with over $15 billion in funding for various forest management efforts related to fuels reduction, including $1 billion specifically targeted to vegetation management in conjunction "with a water source management plan of a watershed protection and restoration or action plan" (Section 11001 (a)(4)), and $3 billion for grants to tribal governments, states and local governments for forest management work of various kinds on state, tribal, or private lands (Section 11002). A 20% cost share is required but can be waived by the Secretary of Agriculture (Section 11001 (f)). *https://rules.house.gov/sites/democrats.rules.house.gov/files/BILLS-117HR5376RH-RCP117-17.pdf* A significantly smaller but nonetheless significant version of the bill with similar provisions was renamed and passed as the Inflation Reduction Act of 2022. The forestry provisions in the bill stand at $5 billion and the agricultural provisions are even larger. *https://www.congress.gov/bill/117th-congress/house-bill/5376*.

tribal, and private forest lands that focuses on reducing "extreme" wildfire risk.[37] In the most recent legislative session, Colorado lawmakers also adopted funding measures to give direction to and funding for staff to use forest management for both carbon and water benefits and explicitly linked that work to enabling greater ability to obtain the federal government's funding through the Infrastructure Investment and Jobs Act.[38]

The Role of Wildfire

While forest offsets are controversial (along with other offsets), the prevention of catastrophic wildfire generally is not.[39] Active, accelerated, and restoration or ecologically based forest management to lessen the risk of outsized fires is an area of growing focus and has the greatest potential to achieve water benefits along with carbon benefits in the short term, while protecting life, property, and ecosystems.[40]

37 US Forest Service, 2022, *Confronting the Wildfire Crisis: A Strategy for Protecting Communities and Improving Resilience in America's Forests,* January 2022 (good explainer on the problem of forest fuels build-up exacerbated by climate change, a strategy to focus on "firesheds," and the use of "Shared Stewardship Agreements" discussed later in this report). (*https://www.fs.usda.gov/managing-land/wildfire-crisis*)

38 See HB22-1379 Wildfire Prevention Water Restoration Funding. Colorado General Assembly Summary: *https://leg.colorado.gov/bills/hb22-1379*

39 Parties with objections include those who are averse to cutting any trees, those who believe that money should be spent on "home hardening" instead of forest management, those who question whether forest management is an excuse to increase logging for commercial gain on public land, and those who argue with the techniques employed in a given locale.

40 This is in contrast to more natural-size fire or prescribed burns, as fire in general is important for maintaining ecosystems and preventing the overgrowth that causes catastrophic wildfire. For a description of the differences between "natural" and overgrown forests, see USFS, 2003. There is also a rich history of tribal land and forest management using prescribed and cultural burning, among other tools. See e.g., Irfan, U., 2021. "We must burn the West to save it," Vox, July 13, 2021 (*https://www.vox.com/21507802/wildfire-2020-california-indigenous-native-american-indian-controlled-burn-fire*).

While climate discussions have centered around forests as a source for additional sequestration through the planting of additional trees or protection of existing forest stocks, we have reached the point where, due to land disturbance, historic forest practices, and increased wildfire, forests have become a source of carbon emissions even exceeding their potential for sequestration. This recognition that forests are both "source and sink" (i.e., that forests have transitioned from being net sinks to net sources) has driven a discussion of the nature of forest management rather than just taking a "more trees is better" approach focused solely on sequestration.[41] The visible impacts of outsized, catastrophic forest fires, particularly the increasing intensity of those wildfires, are gaining far greater public notice during the past few years, leading to increasing investment and focus in this area of natural working lands.[42]

> The combination of a century of fire exclusion practices that have generated far greater fuel loads, historic timber harvesting methods that removed many of the largest, most fire-resilient trees, and climate change impacts have culminated in far more large, catastrophic wildfires. Our forests are, or are becoming, a carbon source — emitting more carbon than they remove from the atmosphere. Without climate smart forest management, we cannot count on them being carbon sinks in the future. (CA NWL Climate Smart Strategy, 2022, pp. 24-25)

Efforts to grow funding for wildfire prevention through ecologically based forest restoration are accelerating dramatically. Support for traditional methods of forest management, such as prescribed or cultural burning undertaken by Native American tribes, other methods of prescribed burning, and mechanical removal of overgrown vegetation, is also increasing. California recently passed legislation to limit liability for prescribed burns, specifically including cultural burns, to make the practice less formidable (Larson, 2021), and there is increasing media attention toward tribal prescribed-burning practices that have been used for millennia to keep forests healthy (Flesher, 2021).

In addition to the massive carbon emissions of these increasingly visible wildfires, there are multiple and ongoing studies of the water quality impacts these conflagrations bring, with at least one study suggesting that 10% of western US rivers were negatively affected by wildfire (Ball et al., 2021). As explained by the University of New Mexico's press release on the report:

> The study alerts that there is growing evidence that wildfires trigger cascading impacts in river networks. Although wildfires are not specifically mentioned on the U.S. Environmental Protection Agency's Clean Water Assessment, wildfire disturbances contribute to at least 10 of the top 20 most critical disturbances listed in the assessment, such as elevated sediments, nutrient enrichment, organic enrichment and oxygen depletion, elevated temperature, elevated metal concentrations, habitat alterations, elevated turbidity, flow alterations, elevated salinity and/or total dissolved solids, and changes to pH and conductivity. Since forested watersheds supply drinking water for around two-thirds of those living in the western U.S., the impact is massive, in terms of both economics and water security. (Delker, 2021)

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41 In fact, there is considerable controversy over the notion of simply planting more trees, as there is a potential for degrading other important natural features for the sake of planting tree plantations for sequestration purposes alone. The more sophisticated approach is not only to reforest deforested areas or prevent deforestation, but to undertake active and intentional forest management that takes an ecological approach over the longer haul. In California, for example, CARB recognizes that, in achieving optimal forest management to avoid catastrophic wildfire and protect the larger, more carbon-sequestering trees, there will initially be a drop in the amount of total carbon sequestered as underbrush and smaller trees are removed (Botill, 2021b; Livingston, 2021b; Brill, 2021).

42 Forest fires were earlier seen as climate neutral because the trees eventually grow back (sequestering the carbon again) in the normal course of events, but new evidence and the obvious growing intensity of these fires due to a combination of overgrowth (from inadequate maintenance or intentional fire suppression) and higher temperatures (due to climate change) have made it clear that the prior assumptions were not well founded, or at least are not well founded anymore. See, e.g., CARB, Frequently Asked Questions: Wildfire Emissions (*https://ww3.arb.ca.gov/cc/inventory/pubs/wildfire_emissions_faq.pdf* p. 3); CARB, An Inventory of Ecosystem Carbon in California's Natural & Working Lands, 2018 Edition (*https://ww3.arb.ca.gov/cc/inventory/pubs/nwl_inventory.pdf*).

As discussed more fully below, studies increasingly suggest that strategic forest management can yield water-supply benefits for downstream water users (e.g., water agencies, hydropower) in addition to water quality benefits that come from well restored forests and avoided conflagration.[43] However, there is understandable controversy around the notion that trees should be cut to yield more water downstream for that purpose alone, and more support for the ecologically-based forest management that can thin forests through selective thinning and prescribed burns to yield benefits for the ecosystem, while making forests less susceptible to the outsized catastrophic conflagrations that come from overgrown forests. Well-managed forests can preserve larger trees and remove overgrowth that can fuel bigger fires, while allowing inevitable fires to move through the less overgrown forest without killing as many of the larger trees (those that can sequester the most carbon over time and release the most carbon when burned).[44] At the same time, "in many cases NBS can be a more cost-effective alternative: for example, protecting source watershed forests and wetlands to maintain water quality for drinking water supplies can reduce treatment costs and/or avoid the need for new treatment plants, while also providing a suite of co-benefits" (Cassin et al., 2021a, p. 70).

One of the clearest linkages between wildfire prevention work and water stems from the enormous impact that wildfires have on downstream water supplies. Large-scale fires, particularly the outsized conflagrations that come from combustion of overgrown forests, both send pollutants downstream and deposit an enormous amount of material (sediments and other contaminants) into reservoirs. This not only results in pollution and turbulence within the reservoirs, it displaces future storage space for flood protection and water supply—a precious resource for which the reservoirs were built. Water agencies spend millions to remove those sediments, if they even can do so, and have become the linchpin of efforts in their upper watersheds to prevent the fires from happening at scale in the first place. The Yuba Water Agency and Denver Water are two leaders in this work.[45]

Figure 1. Influence of Forest Structure on Wildfire Behavior and the Severity of its Effects

Historical

Present

Hypothetical simulation of changes in vertical arrangement and horizontal continuity in forest stand structure. Today's forests are more spatially uniform, with higher densities of fire-intolerant species and suppressed trees.

Source: "Influence of Forest Structure on Wildfire Behavior and the Severity of its Effects," November 2003. [Online: *https://www.fs.fed.us/projects/hfi/2003/november/documents/forest-structure-wildfire.pdf*, p.2] (Accessed May 20, 2022).

43 See, e.g., Bales & Conklin, 2020; Burke et al, 2021 for discussion of the potential value of forest management to water supply and acknowledgement that the benefits will be very site specific. Pacific Forest Trust has spent considerable time developing the case for forest protection and restoration for the purpose of gaining water benefits in addition to climate benefits. See website: *https://www.pacificforest.org/what-were-doing/protect-water-resources*

44 See USFS, 2003. Not everyone agrees, but many of those who once held up any kind of active tree removal on public lands have gone from a mainstay of the environmental community to a far smaller group. See, e.g., Sabelow et al., 2021, "'Self-serving garbage': Wildfire experts escalate fight over saving California forests," Sacramento Bee, October 14, 2021 (*https://www.sacbee.com/news/california/fires/article254957722.html*).

45 See Nilsen, E., 2022, "Disaster upon disaster: Wildfires are contaminating the West's depleting water with ashy sludge," CNN, May 29, 2022 (*https://www.cnn.com/2022/05/29/us/wildfire-pollution-water-quality-drought-climate/index.html*) (describing impacts of fires on taste and odor, treatment costs, interference with hydroelectric operations, and other impacts of fire on water agencies).

"Water Agencies to the Rescue"

One of the most promising efforts to restore forests with both climate and water benefits is found in forest restoration projects supported by downstream water agencies and consortia of state, federal, local, and private-sector partners. One prominent example is the North Yuba Forest Partnership,[46] which involves the Yuba Water Agency (Yuba Water), the US Forest Service, the state of California, Blue Forest Conservation, the National Forest Foundation, and others, including a local tribe, a regional NGO, and local communities. In that project, an upper watershed on USFS land is being treated to reduce catastrophic wildfire risk by leveraging private-sector funding to do in four years what would take at least 10 if left to the USFS, with the local water agency and the state also contributing funding.[47] The benefits include avoiding large-scale wildfires that emit massive amounts of carbon; protecting the people of the watershed; protecting downstream reservoir capacity and quality; and providing a variety of other community benefits. Yuba Water's 2017 Strategic Plan update includes "watershed protection," which they interpret as healthy forests.[48] They see a functioning watershed as "part of their mission" (Whittlesey, 2021).[49]

The innovative funding for the project is a product of Blue Forest Conservation, which organized a variety of institutional investors to front the money to get the work done more quickly, with investors being paid back (or technically reimbursed by other parties) over time by other state and federal governmental funding sources.[50]

Willie Whittlesey, General Manager of Yuba Water, said he felt it was obvious that the agency should join in this partnership based solely on the anticipated expense of removing sediment and debris, some of it toxic, from their main reservoir after a large fire. He estimated that the costs of recovery could exceed $40 million, so investing in a multi-stakeholder effort for a few million dollars while leveraging other funding sources was a wise decision. In addition, he saw it as a contribution to the people and health of the watershed (Whittlesey, 2021). Yuba Water also decided to invest because of the value of the larger collaboration for public safety, water quantity, and water quality (Lessard, 2021a). The pilot was so successful that the alliance expanded to work together across the entire watershed even before the pilot was completed.

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46 North Yuba Forest Partnership website: *https://www.yubaforest.org*

47 This work is facilitated by legislation allowing the federal government to enter into partnership agreements with public and private partners to undertake actions on federal land. See, e.g., USFS Good Neighbor Authority (*https://www.fs.usda.gov/managing-land/farm-bill/gna*) and USFS Shared Partnership Strategy: Toward Shared Stewardship Across Landscapes: An Outcome-Based Investment Strategy (*https://www.fs.usda.gov/sites/default/files/toward-shared-stewardship.pdf*).

48 California as a matter of policy also interprets healthy forests/watersheds as part of the state's water infrastructure in Assembly Bill 2480: *https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB2480*

49 In addition to the specific water agencies mentioned here, at a statewide level, the Association of California Water Agencies, the California Forestry Association, The Nature Conservancy, the California Farm Bureau Federation, and the Rural County Representatives of Calfornia came together to form the California Forest Watershed Alliance (CAFWA) to promote upper watershed forest restoration precisely because of the nexus with water. See (*https://www.caforestsandwatersheds.org*).

50 Lending investors, which included the Rockefeller Foundation, the Moore Foundation, CSAA Insurance Group (an arm of AAA Insurance), and Calvert Impact Capital, each put in a million dollars. The two foundations made 1% program-related investments (PRIs) and the market-rate investors made 4% loans. On the repayment/reimbursement sources: "Yuba Water committed $1.5M over 5 years, so $300k per year. YWAs commitment allowed us to put roughly $1.25M to on the ground program work, the remaining $250k was used to cover interest on the whole $4M investment and pay for a yearly outside audit as well as to cover a yearly impact report. There was a CalFire CCI [California Climate Investments cap-and-trade proceeds funding] award that was roughly $2.75M. The USFS provided in kind work exceeding one million dollars that allowed for layout and prep (necessary prior to restoration) and NEPA permitting. The USFS contributions were not financed in this first transaction" (Wobbrock, 2021). See also Yuba II FRB Press Release, "New Forest Resilience Bond Will Finance $25 Million of Restoration to Reduce Wildfire Risk on the Tahoe National Forest in California," October 26, 2021 (*https://www.blueforest.org/journal/yuba-ii-frb-press-release*). For more information about Blue Forest Conservation, the group responsible for pulling together disparate funding agencies and developing the funding vehicle, see the website: *https://www.blueforest.org*

The next, much larger phase (Yuba II) will involve a $6 million investment by Yuba Water and proportional contributions from the other partners (Wobbrock, 2021). The expanded program will involve an $11 million revolving loan that will leverage the $25 million cost of restoration work on the ground (Id.).[51] Yuba Water's goal with the second, larger program is to complete all of the other projects included in the North Yuba Forest Partnership plan "to become the first fully treated watershed in California" (Whittlesey, 2021). There are a variety of targeted goals for each project area based on the US Forest Service's analyses of existing condition and historical range of variation, which includes meadow and aspen stand restoration, forest thinning, and other ecologically based treatments (Lessard, 2021a).

While the project is being funded based upon the cost avoidance noted above as well as the community value, data is being collected on both the carbon sequestration and water supply benefits that also come from the project over time.[52] The partnership is contracting with the Sierra Nevada Research Institute at UC Merced and others to do the work. They have a project with the University of Nevada, Reno, to model the capacity to retain snowpack longer if they do the forest restoration in particular ways (Lessard, 2021b). That data will be of great assistance in promoting and supporting future private- and public-sector funding efforts (Whittlesey, 2021). Even before obtaining the data, the expanded "Yuba II" project explicitly cites water supply and quality as key benefits of the project:

> Reduced fire risk also protects communities from risk to their drinking water supply from increased sediment and toxins. Reduced vegetation water use after restoration enhances water supply for Yuba Water Agency and the communities and farmers in their service area. In addition, overall healthier forests help sustain good water quality for the communities that live downstream of the Yuba River Watershed…. Protecting water quality and enhancing water quantity for the Yuba Water Agency has the potential to provide hydroelectric power, drinking water, water for agriculture, and flood control for 30,000+ people. (Yuba II, 2021)

Photo courtesy of JoAnna Lessard.

51 For an inspiring "story map" to the Yuba II projects, see "Yuba II: A Forest Resilience Bond Project" (*https://blueforest.maps.arcgis.com/apps/Cascade/index.html?appid=c034415b1d69410c9df5d69e172260a8*) (Yuba II, 2021).

52 Different partners are supporting different facets of the data tracking, with Blue Forest Conservation doing much of the carbon tracking and Yuba Water supporting much of the water quality and supply benefit tracking (Lessard, 2021b).

The project is being closely watched for its innovative funding model.[53] Other similar projects are being undertaken by California and the USFS, some longstanding, such as work around the Tahoe National Forest.[54] In 2020, California and the USFS inked a "Shared Stewardship Agreement: a long-term, coordinated, and science-based forest management strategy," because the USFS owns 57% of California's forests.[55] Similar agreements using this innovative tool are in effect in Colorado, New Mexico, and elsewhere in the West where the federal government owns and tries to manage significant portions of the states' forests.

In Colorado, Denver Water, like Yuba Water, has stepped up to be a linchpin of efforts to restore watersheds to protect water resources, while also enhancing ecosystems and preventing large-scale wildfires that emit carbon.[56] Like Yuba Water's effort, Denver Water's investment is justified by the tremendous cost of recovering from wildfire's impacts upon their water system. Their "Watershed Management: From Forests to Faucets" initiative also works with the USFS, as well as the Colorado State Forest Service and the Natural Resources Conservation Service. The program's work is explicitly credited with lessening the impact of fires in the treated areas.[57] Similar work is happening in Arizona and other states in partnership with groups like the National Forest Foundation.[58] Other water agencies could do more, and there are efforts to begin to increase this work across the Front Range, but far more can and should be done (Wiltshire, 2021a).

Colorado's effort to develop a natural working lands climate plan actively includes integration of climate and water benefits in the forestry sector. As noted elsewhere in this report, Colorado state agencies are working with the Colorado chapter of The Nature Conservancy to conduct a technical analysis to estimate the climate mitigation potential of natural and working lands in Colorado and New Mexico. The project, titled "Using Natural and Working Lands to Meet the Ambitious Greenhouse Gas Reduction Goals Set by Colorado and New Mexico," is part of the state's broader partnership with the U.S. Climate Alliance (Citron, 2021).[59] The state also has established a NWL Task Force and expects to release a NWL Strategic Plan for public comment in 2022 after a series of listening sessions were held in the late summer of 2021. The NWL Strategic Plan will be a component of the Colorado Greenhouse Gas Pollution Reduction Roadmap (Colorado Roadmap, 2021).

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53 See USEPA Water infrastructure and Resiliency Finance Center, 2021, The Forest Resilience Bond: Structural Design and Contribution to Water Management in Collaborative Forest Restoration Partnerships: *https://www.epa.gov/sites/production/files/2021-04/documents/forest_resilience_bond_report.pdf*

54 The French Meadows project is hailed as a premier partnership but does not invoke or appear to be monitoring for carbon benefits. They do have some good recommendations generally on partnerships for water benefits (Edelson et al., 2019).

55 "The Tahoe-Central Sierra Initiative is a partnership of state, federal, non-profit, and private entities to improve the health and resilience of the Sierra Nevada through large landscape forest restoration. To date, partners have secured over $32 million in grant funds to implement high-priority forest health projects that sequester carbon and reduce the risk of wildfires" (CA NWL Climate Smart Strategy, 2022, p. 17).

56 For a description of Denver Water's efforts, see their website: *https://www.denverwater.org/your-water/water-supply-and-planning/watershed-protection-and-management*

57 A wealth of stories have been written about the Denver Water program. See, e.g., Barrett, K., & Stanton, T., "Why Denver Spends Water Fees On Trees," Ecosystem Marketplace (*https://www.ecosystemmarketplace.com/articles/why-denver-spends-water-fees-on-trees-2/*). This report spends more time on the Yuba Water program, but the Denver Water model also is one to be replicated and expanded upon in the upper Colorado River Basin.

58 The National Forest Foundation does projects that involve forest restoration, wetland restoration, and other efforts at the intersection of public and private investment in this work. They have projects in Arizona, Colorado, California, and other states. They also developed the Northern Arizona Forest Fund (*https://www.nationalforests.org/who-we-are/azforestfund*) in 2015, which includes the restoration of forests and wetlands working with a variety of agencies (Selig, 2021). They are currently working on a carbon offset protocol for work done on federal lands dealing with fire risk reduction and attendant avoided emissions (Id.).

59 The project is part of a "challenge" developed by the Alliance to obtain better information to set baselines and identify best practices to inform the development of better climate policies and projects in the NWL arena. The White House is directly involved in listening sessions and the objective is to make a distinction between projects (such as offsets) and programmatic approaches (bigger picture, accounting for both mitigation and resilience) (Leslie-Bole, 2021). While USEPA has a basic methodology for developing state climate NWL inventories, it is seen as having a great deal of uncertainty as to its practical utility. There is wide agreement that more research is needed (Id.).

Figure 2. North Yuba Forest Partnership

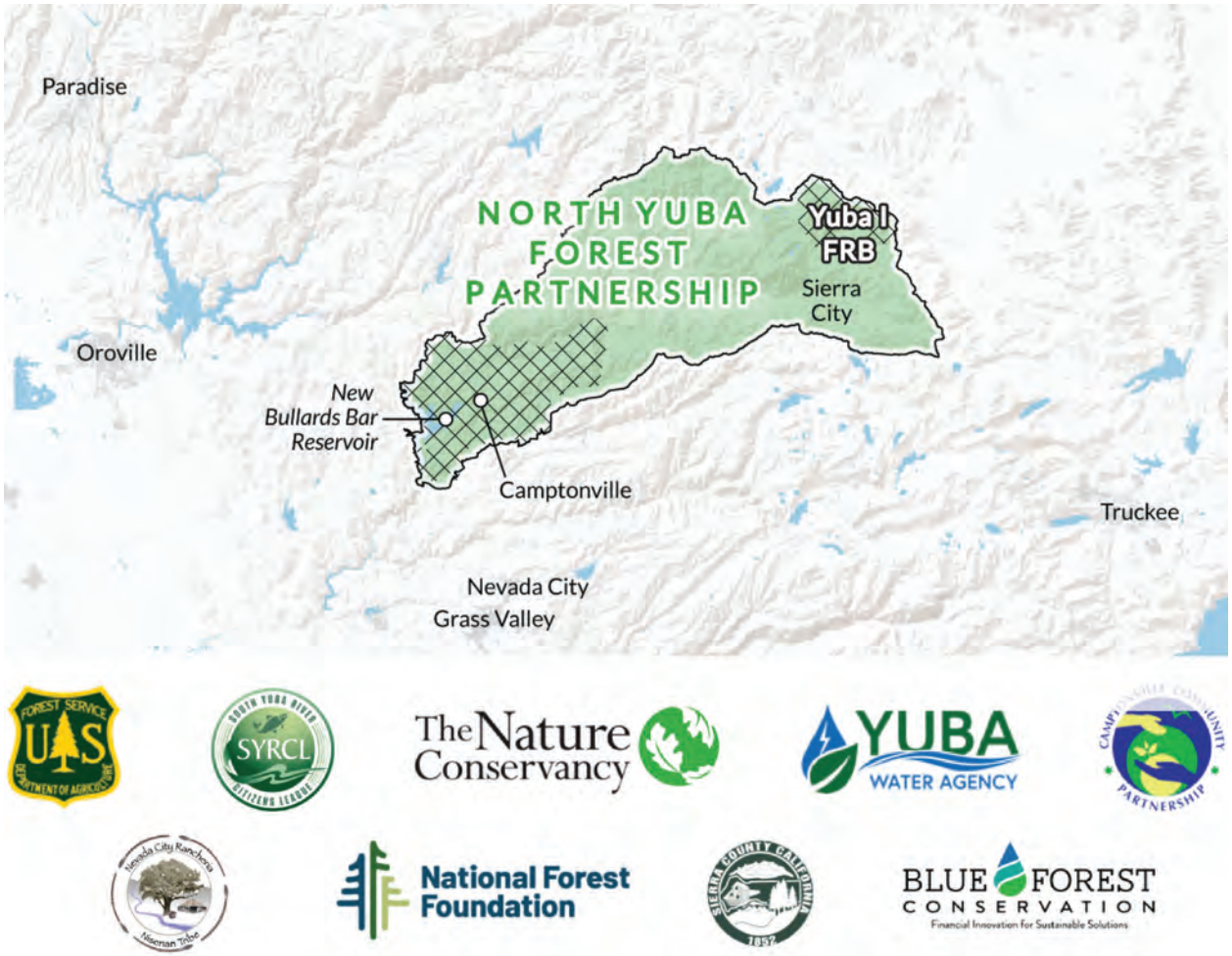

Image courtesy of Blue Forest Conservation.

While lacking a final climate policy that incorporates natural working lands, the New Mexico Energy, Minerals and Natural Resources Department's (EMNRD) Forestry Division is adapting its forest management to deal with climate stress to come, developing seedlings in nurseries for eventual reforestation that are appropriate to the future climate rather than the current one. They are stressing the seedlings to ensure that the more hardy survive, an unusual approach (McCarthy, 2021). The Forestry Division also has developed a "nucleation" strategy for reforestation that plants seedlings in islands that can be protected, obtain water, and include buffers for fire prevention.[60] Forest protection and management is explicitly linked to water. "The value for water is priceless—without forests New Mexico's water security is compromised" (Id.). The Forestry Division also awards grants each year for projects that provide public benefits, including water source protection, wildfire risk reduction, and fish and wildlife habitat conservation under the state's Forest and Watershed Restoration Act (FAWRA).[61] The program does not yet reference climate, but it may once the state's climate plan is finalized.

Arizona's forest projects mostly center around water quality protection but also offer volumetric water benefits (Selig, 2021). This is most likely due to the lack of a state climate policy. There is, however, interest in replicating Denver Water's "forests to faucets" approach.[62] The Flagstaff Watershed Protection Project, a partnership between the US Forest Service and the City of Flagstaff, stems from a $10 million bond passed by residents to accelerate forest treatments to protect their watershed. The project is not described with any reference to climate (Flagstaff, 2012).

Perhaps most important for this report's purposes, California's updated approach to natural working lands and climate policy is to move away from looking at forestry work solely in terms of forests' sequestration potential to a practice of building healthier forests to avoid catastrophic wildfire and to enhance the multiple benefits that healthy forests provide. By taking a holistic view of the role of forests in the carbon cycle, the state has developed an inventory that "quantifies all of the carbon stored in the state's forests, soils, and other natural lands. Looking year over year at the data in the inventory, we can see clear trends of carbon loss in California's natural and working lands, with most of those losses coming from wildfires" (CARB FAQ).

> Achieving maximum carbon sequestration in natural and working lands will not be the objective for this work or for the Scoping Plan, because overstocked forests with high carbon sequestration can lead to future catastrophic wildfires, disease, pests, and ecosystem imbalances. The 2022 Scoping Plan will instead focus on what is needed for forests and other natural and working lands to be more resilient and healthy and to continue to provide water, air and biodiversity benefits to California, in addition to supporting carbon neutrality for the State. (Id.)

This is quite different from a prevailing thought that "the more sequestration the better" and that planting more trees is a solution by itself. As such, at least in the domestic context, climate policies may be moving to a "healthy forests" perspective, which will have benefits for both wildfire avoidance (and its attendant life, property, and carbon emissions impacts) and for multiple benefits, including water. As a result, funding opportunities are more likely to come from policy drivers supporting healthy forests than from offsets or other vehicles tied to counting the sequestration potential of restoration alone.[63]

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60 See also Reese, A., 2021, "Tree by Tree, Scientists Try to Resurrect a Fire-Scarred Forest," Scientific American, August 5, 2021: *https://www.scientificamerican.com/article/tree-by-tree-scientists-try-to-resurrect-a-fire-scarred-forest/*

61 EMNRD website: *https://www.emnrd.nm.gov/sfd/forest-and-watershed-restoration-act-fawra/*

62 Friends of the Verde River, 2021, "Case Study - Denver Water Forest to Faucet Partnership": *https://verderiver.org/case-study-denver-water-forest-to-faucet-partnership/*

63 There are additional reasons to manage forests more aggressively, including preventing significant air quality impacts on public health. In California alone, it is estimated that 1 million additional acres a year need to be treated to reduce fire risks because we have passed the point where fire fighting alone has a chance. See, e.g., Wara, M. (2021). A New Strategy for Addressing the Wildfire Epidemic in California. Stanford Woods Institute for the Environment. [Online: *https://woodsinstitute.stanford.edu/system/files/publications/New_Strategy_Wildfire_Epidemic_Whitepaper_1.pdf*.](Accessed June 30, 2022). In addition, massive wildfires pose an enormous risk to electricity transmission lines and are responsible for disrupting electricity systems either through the fires themselves, or through preemptive power shut-offs to avoid electrical systems causing fires. See, e.g., Thorbecke, C. (2021). "PG&E's preemptive wildfire-prevention power shutdowns impact thousands in California," ABC News, October 11, 2021: *https://abcnews.go.com/Business/pges-preemptive-wildfire-prevention-power-shutdowns-impact-thousands/story?id=80517112*.

The Forest Service, while a target of complaint for its history of inadequate and underfunded forest management, has been working on research in both the forest and grassland arenas to look at the climate impacts of deforestation or other natural land conversion as well as the impacts of specific management practices on emissions and sequestration.[64] In the USFS, as in state forestry programs, we are at a stage when forest professionals are "evolving as we speak," moving from focusing on harvesting trees and fighting fires, with the "environment and critters as a constraint," to a more holistic approach of integrating preventive protection of the forest ecosystem for multiple benefits (Wright, 2021).

Treated forest (left) and untreated forest (right), Greyhorse Valley, California. Part of French Meadows Partnership program, central Sierra Nevada. Treated forest on left still approximately 2X more dense than pre-fire suppression.

Credit: Roger Bales, UC Merced.

While forestry is the most promising NBS at the intersection of climate and water benefits because of scale, funding, and the constellation of multiple benefits that include reducing carbon emissions from outsized fire and saving life and property, other landscapes are also critically important. "[O]ther components of a broad landscape-scale approach to restoration include restoring streams, watersheds, and meadows; expanding the use of prescribed burning; and managing individual forests to establish a more heterogenous and resilience forest ecosystem that can recover quickly from large-scale natural disturbances" (Boyd, 2022, p. 124).

64 For a nice summary of scientific efforts, see US Forest Service Climate-Smart, 2021.

Wetlands and Mountain Meadows as a Growing Area of Climate Focus

While forests have long been the central player in sequestration discussions in the international, national, and state arenas, wetlands and meadows also have a role to play, with coastal wetlands being at the top of the list for both sequestration and sea-level rise buffering potential along with the multiple benefits of habitat creation, fishery health, and open space. Nonetheless, a strong movement to embrace and quantify inland wetland or wet meadow creation and restoration as a climate-fighting tool is gaining traction because such restoration can yield carbon sequestration, water quality, and water supply benefits in addition to creating firebreaks and refugia for wildlife during fires. An interesting and promising type of restoration involves the reintroduction of beavers or the creation of "beaver dam analogs" or "process-based restoration" to create even more subsurface water retention and other benefits than other types of restoration by letting the beavers (or beaver mimicry) do the work. The carbon benefits of this work are also being studied. The quantification of most of these efforts is a work in progress.

Mountain or Wet Meadows[65]

While not as intensively studied as coastal wetlands for climate and other benefits, inland meadow restoration activity has been lauded for its habitat value, its role in protecting water quality, and its potential to substitute for snowpack as a method of natural storage,[66] and as a potentially significant sequestration tool. Increasingly, researchers and advocates are specifically focusing on the linkage between upper watershed mountain meadows, or "wet meadows," and climate and water benefits combined.

Meadows have a vast capacity to slow and store water, to let it sink and spread across a wide area that can provide habitat, serve as refugia in fires, and slow water's path down a watershed in much the same way that snowpack holds water and releases it throughout the later months, albeit at a smaller scale. In her introduction to "Water Always Wins: Thriving in an Age of Drought and Deluge," Erica Gies describes the benefits of slowing the flow:

> But when water stalls on the land, that's when the magic happens, cycling water underground and providing habitat and food for many forms of life, including us. The key to greater resilience … is to find ways to let water be water, to reclaim space for it to interact with the land. The innovative water management projects I visited around the world all aim to slow water on land in some approximation of natural patterns. (Gies, 2022, p. 8)

65 While mangroves and coastal wetlands have long been seen as environmentally important due to their role in being "nurseries" for fish and other aquatic species, they are taking center stage in wetlands conversations related to climate. Two key reasons include their vast sequestration potential, and their role as a buffer against sea-level rise. Recent media reports have extolled the virtues of mangroves for sequestration, flood protection, and erosion prevention. Because these are not the main landscapes in the upper Colorado River Basin, the following discussion focuses on mountain or wet meadows, sometimes called "montane" meadows, found in great abundance in the basin. The same is true of peatlands, which also sequester vast amounts of carbon or can release vast amounts of carbon when disturbed through farming or fire. See, e.g., Booth, 2021 (peatlands as a "carbon bomb"). Because the Colorado River Basin is not known for its peatlands, the topic is not discussed here in depth. However, the presence of peat helped the Delta Conservancy in California to obtain what may be the first official climate protocol for wetland restoration. See Ellison, 2022 and Appendix B discussion of the Delta Conservancy offset protocol.

66 The California Water Action Plan (CWAP) issued by the administration of Governor Jerry Brown in early 2014 expressly embraced mountain meadow restoration for this purpose (*https://resources.ca.gov/CNRALegacyFiles/docs/california_water_action_plan/2014_California_Water_Action_Plan.pdf*, pp. 9-10).

Photos courtesy of Saxon Holt and River Partners

California has a robust Sierra Meadows Partnership comprising groups from across the state and the nation, including The Sierra Fund, CalTrout, American Rivers, the National Forest Foundation, Trout Unlimited, the University of California, the California Tahoe Conservancy, the California Department of Water Resources, the California Department of Fish and Wildlife, and the US Forest Service, with active participation from landowners and, significantly, numerous additional local, state, and federal agencies. The goal of the Partnership is to increase the pace and scale of meadow restoration and conservation in the Sierra Nevada. Activities of the Partnership include joint information sharing and joint projects along with research on a variety of fronts. Of particular significance here, the Partnership's objectives include a focus on both water and climate benefits. One of its objectives is to "advance meadow restoration protocols and strategies to achieve multiple outcomes including enhanced sequestration of greenhouse gases" (Sierra Meadows Partnership website). From the beginning, both climate and water were driving forces in

the work: "Meadows are the poster child for multi-benefit restoration and provide 'charismatic carbon.'"[67] Most of the projects featured on the Partnership website include descriptions of benefits, including "increase carbon storage above and below ground" and "increase groundwater levels and extent of surface water." Joint projects include development of prioritization tools, mapping of meadows and meadow restoration opportunities, and a repository for meadows research hosted by UC Davis (Sierra Data Clearinghouse).

One of the group's first endeavors was to come up with methods for prioritizing meadow restoration targets. They then did a large-scale mapping project in the Sierra that identified 200,000 acres of critical meadow opportunities for preservation, enhancement, or restoration, with half of the meadows being classified as degraded wetlands. Their goal is to restore 30,000 acres by 2030 (Monohan, 2021).

Valley in the Eastern Sierra Mountains, California

67 Group interview with Sierra Meadows Partnership, comment by Ryan Burnett, Point Blue Conservation Science. March 12, 2021.

Local community members planting willows in spring 2018 with the Students and Teachers Restoring a Watershed (STRAW) program.

Photo courtesy of Sarah Yarnell

Most of the initial members of the Partnership were scientists from NGOs, universities, and federal and state agencies. Over time, the Partnership expanded to include tribal members, ranchers, and other NGOs. They invested in capacity building and are integrating traditional ecological knowledge into their work. Some members focused on restoration techniques, others on sequestration potential (see examples described by Amy Merrill and Julie Rentner in accompanying boxes). They believe that meadows, per acre, have far more potential for sequestration than forests alone (Monohan, 2021), and may achieve three to four times more sequestration than the surrounding forests.[68] Meadows are "small but mighty."[69] Corporations like Coca-Cola and General Motors interested in voluntary offsets or quantification for their net-zero pledges became interested in helping fund the meadow restoration efforts of the Partnership (see discussion of corporate voluntary opportunities below) (Soderstrom, 2021). The members truly work as a collective, supporting and being inspired by each other.[70] The process has been very inclusive and "bottom-up."[71] Supporting and replicating this successful partnership model could provide a boost for collective efforts in other states.

68 Part of the calculation is that degraded wetlands are emitting carbon (a net source), so restoring them yields the double benefit of decreasing emissions while enhancing sequestration.

69 Comment by Amy Merrill as part of Sierra Meadows Partnership conversation. March 12, 2021.

70 Author's observation. Jim Wilcox, a founding member and widely revered by the group as the "godfather of the meadow restoration movement," is a powerhouse on integration of carbon and water, and a master of implementation on the ground. A paper coming out in the near future will detail a time-sequenced series of projects Wilcox has done over the years.

71 Comment by Amy Merrill as part of Sierra Meadows Partnership conversation.

The Partnership actively develops pilot projects. One of the key meadow climate/water linkage projects underway is led by American Rivers with the participation of many of the member groups. The project is quantifying the water and carbon sequestration potential of 15 different meadow landscapes in the Sierra to better make the case for restoration to public agencies and funders. Seven meadows have been restored, six are "controls that stayed degraded," and two are reference sites thought to be in great condition. The work looks at "how the meadows responded to restoration—did they actually store more or less carbon following restoration and what made the difference [between meadows that did and did not store more carbon]?"[72] The project will focus on sequestration values over time and should yield important information that can also serve as a template for doing similar estimates in other states. The results of the project are expected sometime in 2022. The goal is to quantify the value of "rewetting a meadow and turning it into carbon" (Merrill, 2021).[73] It builds on previous work studying 13 Sierra Nevada "montane" meadows that found that some wetlands are sources and some are sinks, highlighting the complexity and location-specific nature of the work (Reed et al., 2020).[74]

In a different project doing quantification research, River Partners, a nonprofit that does extensive river restoration work with landowners, is also doing both water and climate research. They obtained a grant from the California Department of Conservation under the department's Carbon in Riparian Ecosystems Estimator for California (CREEC) program to estimate the carbon sequestration of their projects in the San Joaquin Valley (Rentner, 2021). They hope to obtain voluntary credits for their work, which is promising, and paint a picture of the type of projects that can be developed at the intersection of climate policy and water benefits as well as some of the challenges. They are currently "poised to sell carbon credits in the voluntary markets and will have a prospectus on the streets next year. This will be the first time carbon crediting is deployed in the floodplain of the lower river below the terminal dams" (Rentner, private communication, November 1, 2021).[75] The project has been mentioned in the Modesto Bee as one specifically geared around climate.[76]

72 Private communication from Amy Merrill, October 31, 2021. See also Little, 2017 describing the program and specifically the Childs Meadow project that looked at both water and carbon benefits of meadow restoration.

73 The team includes Ben Sullivan, Steve Hart, Dennis Baldocchi, and Mary Firestone. Some of the partners have done significant work on specific sites, showing where restoration both can lose and gain carbon. See, e.g., University of Nevada-Reno, 2020, "Researchers quantify carbon changes in Sierra Nevada meadow soils: Collaborative study indicates meadows hold promise to help control carbon released into the atmosphere," UNR, November 10, 2020 (*https://www.unr.edu/nevada-today/news/2020/carbon-in-meadows*).

74 Part of the challenge of estimating climate or water benefits from meadow restoration is that each one is so different in terms of spatial extent, hydrological or soil attributes, proximity to other water bodies, or climate. Each project needs to be tailored to the specific circumstances, a task worth doing as they are of critical value and have potential for many multiple benefits.

75 The Delta Conservancy project described in Appendix B is the first wetland project expected to have a protocol certified for regulatory offsets.

76 Holland, J., 2021, "Floodplain restoration helps both fish and people where Tuolumne and San Joaquin meet," Modesto Bee, May 17, 2021 (*https://www.modbee.com/article251070899.html)* (quoting Resources Agency Secretary Wade Crowfoot). For good descriptions of the larger project, see Ronayne, K., 2022, "California leads effort to let rivers roam, lower flood risk," Associated Press, April 19, 2022 (*https://apnews.com/article/floods-climate-science-business-wildlife-502590d610a78cb027baf260e79b8555*); Rogers, P., 2022.,"California to open first new state park in 13 years," San Jose Mercury News, May 13, 2022 (*https://www.mercurynews.com/2022/05/13/california-to-open-first-new-state-park-in-13-years/*).

The upper Colorado River as it flows alongside the Colorado River Trail in Rocky Mountain National Park, Colorado, USA.

Also in California, substantial funding has been made available for Sierra meadow restoration through California Climate Investments (CCI), which is funded by the state's cap-and-trade program. The Wetlands Restoration for Greenhouse Gas Reduction Program is administered by the California Department of Fish and Wildlife. As of 2021, it had awarded $47 million in grants to wetlands restoration including coastal wetlands and mountain meadows (CCI website). These funds do not require the level of quantification necessary for a regulatory offset, a voluntary offset, or any other credit program. Because of the clear (even if not quantified)

linkages between meadow restoration, water storage and timing benefits, and climate sequestration, the administration and the state Legislature, acting on the recommendation of the state's Fish and Wildlife Department, recommended that funds go toward this effort. The funding is allocated as part of a yearly grant program. Members of the Sierra Meadows Partnership noted that it would be more efficient to incorporate the funding into the much larger allocations for forest restoration and incorporate meadow and meadow-feature restoration into all forest restoration programs. This promising approach could yield multiple benefits and efficiencies in any state.

In Colorado, which boasts enormous mountain meadows that are far larger than in California, there are efforts to develop a more aligned and broad meadow restoration program. The state is working with researchers at Colorado State University's Colorado Natural Heritage Program (Colorado NHP) as wetlands partners in developing the upcoming natural working lands climate policy described below (Funk, 2021). Groups are active in meadow identification and restoration but there does not yet appear to be a broad effort to integrate carbon benefits concurrently with evaluating water benefits,[77] although efforts are beginning. For example, The Nature Conservancy is developing a broad effort to assess both water and climate benefits of restoration in their forest and meadow projects generally (Hawes, 2021).[78]

The TNC/U.S. Climate Alliance Challenge project mentioned above that will inventory and assess potential strategies for natural working lands to achieve climate benefits in Colorado and New Mexico includes meadows and grasslands in the landscapes that they will evaluate (Citron, 2021).

New Mexico has a program to encourage meadow restoration for climate purposes, including supporting the expansion of beaver habitat. The program explicitly notes both the water and climate benefits that such restoration can bring (USEPA, 2016). Overgrazing in and near wet meadows or riparian areas leads to water scarcity as the land loses its water-holding capacity. Riparian buffers are nature's way of putting in firebreaks and green strips.[79] Meadow restoration also breaks up forest canopy and leads to more water-saturated soils (McCarthy, 2021a). Efforts like the National Forest Foundation's Taylor River Watershed Beaver Dam Analog & Restoration Project discussed below invoke climate and water as reasons for and objectives of the project. Similar projects that could achieve the same result have been done under the umbrella of water alone but could be moved into the "both/and" category with funding or other incentives.

As high mountain meadows in Colorado form a large proportion of landscape, with far larger complexes than in California, more focused work on the opportunities for water and climate synergies in this landscape (meadows) would provide enormous potential benefits for water and climate (think large and mighty). While a tremendous amount of work is being undertaken for water benefits, the highlighting of water and climate benefits on the same landscape is not so apparent, nor is the discussion as connected and deep as the California conversation or investment despite the latter's smaller footprint. Developing multi-stakeholder, public, private, NGO, and academic partnerships in each state akin to the Sierra Meadows Partnership could leverage resources for mapping, quantification, and project development. The Theodore Roosevelt Conservation Partnership and American Rivers are working to support the development of similar approaches in select Colorado River and Upper Rio Grande watersheds (Funk, 2022).

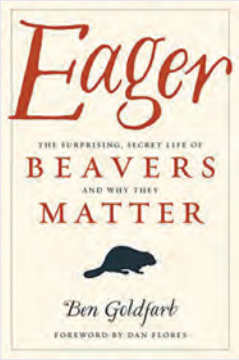
77 There is, conversely, excellent work being done to identify climate's impact on water resilience in the Colorado River Basin (Martin et al., 2021). Excellent work is also being done on the linkage between NBS and process-based restoration and water benefits (Corday, 2020).

78 For a good example of a meadow restoration project, see The Nature Conservancy: Gunnison Basin Wet Meadow and Riparian Restoration and Resilience-Building Project: *http://www.sagegrouseinitiative.com/wp-content/uploads/2017/06/2017.06.08_ExecSummary_GunnisonWetMeadows-sm-Final.pdf*

79 "Beaver dams slow water, and sediment drops out of the flow and begins to raise the stream bottom. Eventually, water can access the floodplain again and disperse across the landscape, slowing it further, reducing scouring, erosion, and flash floods. Then microbes have time to break down pollution and water can infiltrate underground for storage" (Gies, 2022).

"Beaver Believers"

A large magnificent beaver climbing over the beaver dam towards the viewer



The role of beavers and "beaver analog" features as part of meadow restoration has grown by leaps and bounds in recent years, sparking an entire subculture of "beaver believers." The dams built by beavers naturally slow water flow and restore some of the meanders that have been lost to development, industrial forestry, and grazing. That "slowing of the flow" results in more saturation of soils, growth of riparian vegetation, lowering of temperatures, and natural firebreaks.[80] These ponds and canals also create wet meadow features that create habitat for numerous species. Films and videos such as "Beaver Believers"[81] and "Leave It to Beavers"[82] are appearing more frequently in the media, while books such as "Eager: The Surprising, Secret Life of Beavers and Why They Matter" (Goldfarb, 2018a) and reports like "Beaver in California: Creating a Culture of Stewardship" (Lundquist et al., 2016) are joining a cascade of articles and websites.[83]

80 Emily Fairfax is one of many engaging beaver experts, writing papers and being very active on social media about the beauty of beavers, specifically their skill at creating firebreaks that slow fire spread (a climate connection) as well as providing refugia for other species, and the obvious water benefits of slowing, sinking, and storing flow. See, e.g, Fairfax, E., & Whittle, A. (2020), "Smokey the Beaver: beaver-dammed riparian corridors stay green during wildfire throughout the western USA," Ecological Applications, 02 September 2020 (*https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/eap.2225*). Ben Goldfarb, the author of "Eager:The Surprising, Secret Life of Beavers and Why they Matter" and numerous articles is another source of great narratives around the importance of beavers to ecosystems.

81 The Beaver Believers: *https://www.thebeaverbelievers.com*

82 See, e.g., Leave it to Beavers, PBS, KQED: *https://www.pbs.org/wnet/nature/leave-it-to-beavers-production-credits/8860/#*

83 Websites abound, such as those of the Beaver Institute (*https://www.beaverinstitute.org/education/beaver-basics/*); Occidental Arts & Ecology Center's "Bring Back the Beaver Campaign" (*https://oaec.org/projects/bring-back-the-beaver-campaign/*); and those of Emily Fairfax, who has specialized in the manner in which beaver ponds are a great buffer against wildfire ("Can't start a campfire with soggy sticks. Beavers=Firefighters": *https://emilyfairfaxscience.com/research/firebeavers/*); Beavers: Wetlands & Wildfire: *https://www.beaversww.org*; and Martinez Beavers: *https://www.martinezbeavers.org/wordpress/* ("Because the beaver isn't just an animal, it's an ecosystem").

While "nature's engineers" are endearing, the results of their industriousness have also been called out as a natural firebreak and potential widespread tool for slowing fire,[84] making their reintroduction an important part of potential plans to expand meadow restoration efforts or integrate meadow restoration into forest management.[85] The role of beavers in wildfire prevention/mitigation has been elevated in the media since the large wildfires of this past year, which should also add focus on this important and restorative means of integrating nature-based solutions.

> The science demonstrating the benefits of beavers' hydrological work is young but an active field of research. Researchers in 2015 found that the average beaver pond contains 1.1 million gallons of water and stores another 6.7 million gallons of water underground. Beaver water complexes can even act as a fire break against the megafires that climate chaos is wreaking here. And given that desiccated plants are volatile tinder for fires, it's possible that a widespread return of beavers could help reduce fires both by keeping plants better watered and by providing more local evaporation from the ponds and transpiration from plants to fuel local rain. (Gies, 2022, p. 118)

Aerial View of Beaver Dam and River

84 See, e.g., Hager, A., 2021, "Even Colorado's Largest Wildfire Was No Match for Beavers," KUNC, September 23, 2021: *https://www.kunc.org/environment/2021-09-23/even-colorados-largest-wildfire-was-no-match-for-beavers*

85 For a great overview of what beavers (and beaver dam analogs and process-based restoration) can do for climate and fire resilience in less than 10 minutes, see "Want to Solve Wildfires and Drought? Leave it to BEAVERS!" (*https://www.youtube.com/watch?v=6IT5W32xRN4*).

The reintroduction of beavers is not universally acclaimed, and obstacles lie in the path of significant reintroduction in many places. Of particular significance, beavers and their work can cause flooding on adjacent agricultural lands or can cut down valued trees, and sometimes landowners are opposed to their reintroduction. In some areas, beavers are subject to being killed or removed from the land (as illustrated in the "Beaver Believers" film). California has made it illegal for private individuals or organizations to translocate beavers in the state since 1950, although, happily, that appears to be changing.[86] As Kate Lundquist of the Occidental Arts & Ecology Center put it, "California has something of a 'beaver blind spot'" (Lundquist, 2021).[87] She added that El Dorado Hills was "Beaver Mordor" (Id.). In contrast, Utah considers beavers "protected wildlife" and has a formal beaver management plan whose goal is to "maintain healthy functional beaver populations in ecological balance with available habitat, human needs, and associated species."[88] The plan actively works to restore beavers in appropriate habitats and relocate beavers who cause undue problems, e.g., "potential problem dams." Proposals to deal with this challenge include state "insurance policies" to compensate landowners for flooding or other impacts stemming from the reintroduction of beavers to their land (Needham et al., 2011).[89] In other places, ranchers have embraced reintroduction of beavers or restoration that mimics their work to support their cattle (Goldfarb, 2018a). Other western states with supportive beaver policies include Washington and Oregon (Koenigsberg, 2021; Gies, 2022).

Photos courtesy of Ben Goldfarb.

86 Margie Caisley, Senior Hydrologic Engineer, California Department of Fish and Wildlife, at the April 7, 2021, Beaver Summit (California is only western state that doesn't allow beaver reintroduction, so the department has focused on beaver dam analogs). See also Lundquist et al., 2016; Granahan, A. "Bringing Back Our Beavers" website: *https://oaec.org/our-work/projects-and-partnerships/water-institute/about-the-water-institute/bringing-back-beavers/* (explaining reason for California's historic limitation). As, noted below, California is actively changing its stance on beavers this year. Prior to 1950, the state had an active program for translocating beavers. See Occidental, 2021 and cartoon they present as part of their press release announcing California's changing policy (found on next page).

87 Although this is currently changing as noted.

88 Utah Beaver Management Plan 2017 revision (*https://wildlife.utah.gov/pdf/furbearer/beaver_plan_2010-2020.pdf*). This is not to say that beaver get a pass in Utah. Efforts to reintroduce them in the Escalante Basin failed due to local opposition and concern about felling trees and fencing requirements (personal communication from Margaret Bowman, October 14, 2021).

89 Other incentives can include the use of "mobile easements" to compensate for damages done by beavers (Sarah Marshall, Colorado Scoping Session—Meadows and Wetlands, 2021).

On May 13, 2022, Governor Gavin Newsom announced a proposal for California to develop a new policy, complete with significant funding and staffing, to develop a beaver strategy. Climate and water benefits are both prominently noted. The proposal, which has yet to be adopted by the Legislature, explains:

> To be successful in our efforts to protect biodiversity, the Department must take a proactive leap towards bringing beavers back onto the landscape through a concerted effort to combine prioritized restoration projects, partnerships with local, federal, and state agencies and tribes, and updated policies and practices that support beaver management and conservation throughout the State.

> Beavers are known for their ability to build dams and change waterways – but the ecosystem benefits provided to other native species in the process may be less recognized. It might be odd, but beavers are an untapped, creative climate solving hero that helps prevent the loss of biodiversity facing California. In the intermountain West, wetlands, though they are present on just 2 percent of total land area, support 80 percent of biodiversity. (CDFW, 2022)

Occidental, 2022

The proposal was adopted by the legislature and signed by the Governor on June 30, 2022 (Occidental, 2022).

Many meadow restoration efforts use what are known as "beaver dam analogs" (BDAs) that can achieve many of the same benefits of the real thing without violating the law and with more control over placement and implementation.[90] In these efforts, low-level structures (often a grid of upright branches interwoven with greenery) are put across streams to begin to slow water flow to allow it to pool, spread, and meander. Sometimes they are used to attract beavers as starter dams; sometimes they do the work on their own. BDAs are:

> …perhaps the fastest-growing stream restoration technique in the U.S. West. Federal agencies such as the U.S. Forest Service, nonprofits such as The Nature Conservancy, and even private ranchers have installed the structures to return life to deeply eroded streams and, in some cases, to help re-establish beavers in long-abandoned territories. In Wyoming, BDAs are creating wet meadows for a vulnerable bird. In Oregon, they're rebuilding salmon streams. In Utah, they're helping irrigate pastures for cattle. (Goldfarb, 2018b)

90 Other terms used for restoration using natural processes like the introduction of beavers refer to "process-based restoration" or "low-tech stream restoration." See, e.g., "Ask An Expert: Joe Wheaton, Associate Professor and Fluvial Geomorphologist, Utah State University, Department of Watershed Sciences, Sage Grouse Initiative" (*https://www.sagegrouseinitiative.com/what-is-low-tech-stream-restoration/*). See also Charnley, S., 2018, *Beavers, Landowners, and Watershed Restoration: Experimenting with Beaver Dam Analogues in the Scott River Basin, California*, US Forest Service, December 2018 (*https://www.fs.fed.us/pnw/pubs/pnw_rp613.pdf*).

In California, the US Forest Service is conducting research on the integration of meadow restoration, including BDAs, into forest restoration work, particularly after fires. They are undertaking:

> …a focused research initiative supported by the US Forest Service, Pacific Southwest Research Station (PSW) … to gain scientific information needed to expand meadow restoration potential across forested landscapes, especially within wildfire devastated areas.
>
> … [the] multi-disciplinary and multi-agency team [is] assessing the efficacy of pairing instream restoration with disturbances to restore headwater meadows and reduce downstream sedimentation. Given the recent unprecedented wildfires in California, we have an opportunity to test whether implementing basic instream sediment-capture approaches, such as installing post-assisted log structures (PALS) and beaver dam analogs (BDAs), could make use of the expected sediment pulses off of burned hillslopes for habitat restoration while reducing harm to downstream water infrastructure. We are focused on ecological approaches that leverage natural sediment depositional processes and onsite wood as tools to rework channels because these approaches require less planning and permitting and do not involve construction disturbance and so could be applied quickly and extensively in degraded low-gradient, depositional regions within recently burned landscapes to hold sediment where it is needed. (Pope, 2021)

Also in California, as part of the suite of meadow restoration projects being undertaken by the Sierra Meadow Partnership, BDAs are being used to measure both carbon and water benefits in the context of meadow re-creation in overgrazed landscapes. The study (Childs Meadow) found elevated groundwater levels in treated areas and greater sequestration of carbon compared to dry grasslands from which beaver had previously been removed. As the study authors explain:

> There are several mechanisms by which the activity of beaver or creating structures that mimic their behavior can increase the carbon storage, habitat value, water supply reliability and resilience of meadows. Beaver dams increase the vertical and lateral connectivity of rivers and create heterogeneous habitat for riparian birds and frogs. Beaver dams increase surface and groundwater storage, store sediment and organic material, and increase the frequency and magnitude of overbank flow. The dams attenuate moderate and small flood flows and support late-season flows, sometimes converting intermittent s al. 1988). By raising the water table around dams, beaver increase vegetation that they rely on for forage, which in turn increases abov beaver create wetland ponds they increase methane emissions, yet both carbon storage and methane emissions requires additional res 2020, p. 6)

The study focused on what happens when beavers are removed from the landscape, leading to drier grasslands that draw cattle grazing, so the study involved comparing grazed areas, areas with beaver present, and BDAs introduced with and without fencing to keep out cattle. Other studies have taken place in Colorado, including one that studied carbon storage from beaver complexes that once existed in Rocky Mountain National Park and found, among other things, "beaver meadows disproportionately serving as carbon sinks within mountainous river networks [Wohl et al., 2012]" (Wohl, 2013 p. 3631). The loss of active beaver populations was estimated to reduce carbon storage significantly, by a factor of more than three (Id., p. 3635).

As with meadow restoration generally, there is a need to quantify the water and potential carbon-sequestration benefits of various types of beaver and BDA restoration projects. More work has been done on the former than the latter, although that work is being done (see, e.g., Gies, 2022, p. 120):

> When beavers and willows were removed and grazing cattle introduced, mountain meadows changed from seasonally flooded land with braided channels into single channels cut into the earth, with wide-ranging consequences—not just for water, but also for greenhouse gas emissions. One study from the Rocky Mountains estimated that beaver meadows once stored about 23 percent of the carbon in this type of landscape. When people hunted out beavers, converting wet meadows to dry grasslands, carbon storage decreased to today's average of about 8 percent.

Colorado has a particularly large project taking shape that centers around meadow restoration using BDAs and which specifically is geared toward both climate and water benefits. The Taylor River Watershed Beaver Dam Analog & Restoration Project (Taylor project) is being developed by the National Forest Foundation in the Gunnison National Forest in partnership with the US Forest Service, and several other partners. The goal of the project is "to restore historic wetlands by beaver dam analogs and other water retention features that mimic the structures once created by beavers." The expected water benefits of the project include up to 66 million liters (55.5 acre-feet) of water per year, and the estimated carbon benefits of "restoring 20 acres of wetlands by rewetting and planting native, wetland vegetation is estimated at 42.8 metric tons of CO2 per year" (NFF, 2021, p.2). This is a project to watch.

Agriculture as a Growing Area of Climate Focus

Healthy Soils, Rangelands, and Grasslands

Agriculture (outside of forestry) has received considerable attention in recent years for the potential for changed practices to lower carbon emissions, sequester carbon emissions, and yield water benefits.[91] Estimates of potential are very high, though the challenges of capturing and validating those theoretical benefits are also high. One highly cited example notes the potential benefits of this work:

> We show that soil carbon represents 25% of the potential of natural climate solutions (total potential, 23.8 Gt of CO2-equivalent per year), of which 40% is protection of existing soil carbon and 60% is rebuilding depleted stocks. Soil carbon comprises 9% of the mitigation potential of forests, 72% for wetlands and 47% for agriculture and grasslands. Soil carbon is important to land-based efforts to prevent carbon emissions, remove atmospheric carbon dioxide and deliver ecosystem services in addition to climate mitigation. (Bossio et al., 2020)

Ranch in northern New Mexico

91 For an accessible summary of the potential, see California Climate and Agriculture Network, "Climate Change Solutions in California Agriculture" (*https://calclimateag.org/solutions/*). See also Stanton, C., Mach, K., Turner, P, Lalone, S., Sanchez, D., & Field, C., 2018, "Managing cropland and rangeland for climate mitigation: an expert elicitation on soil carbon in California," Climatic Change (2018) 147:633-646 (*https://doi.org/10.1007/s10584-018-2142-1*); van der Pol, L., 2021, "To make agriculture more climate-friendly, carbon farming needs clear rules," June 30, 2021 (*https://source.colostate.edu/to-make-agriculture-more-climate-friendly-carbon-farming-needs-clear-rules/*); Marks, A., 2020, "(Carbon) Farming Our Way Out of Climate Change," Denver Law Review (*https://scholar.law.colorado.edu/articles/1294/*); Carbon pools and decision support tools in New Mexico, USDA Climate Hubs (*https://www.climatehubs.usda.gov/hubs/southwest/topic/carbon-pools-and-decision-support-tools-new-mexico*) (discussing USDA Climate Hub); and Addressing Ecosystem Services, Conservation Programs, and Market Potential Across New Mexico (*https://www.climatehubs.usda.gov/sites/default/files/FinalListeningSessionReport.pdf*). For an example of advocacy on behalf of NBS with a focus on agriculture, see The Climate Center. (2022). "Setting an Ambitious Sequestration Goal for California's Working Lands: Analysis and Recommendations for Net-negative Emissions by 2030," January 2020. *https://theclimatecenter.org/wp-content/uploads/2022/02/The-Climate-Center-Setting-an-Ambitious-Sequestration-Goal-for-CA-WL-Jan-22.pdf*.

The California Climate Investments program described above has put millions of dollars over the past six years into a variety of healthy soils programs, and the federal government has done the same off and on for even longer via Natural Resources Conservation Service programs. A variety of voluntary carbon-credit programs invest regularly in different farming practices such as changed tilling or grazing practices, buffer zones, and other practices. The Biden Administration has extended those programs to include climate friendly agricultural practices as they have for forest management.[92]

All of the Colorado River Basin states except Wyoming have a healthy soils policy of some kind, though not all couch them in terms of climate or water or climate and water benefits combined.[93]

The field of "regenerative farming" is growing by leaps and bounds, with the term describing farming or grazing practices that conserve soils, sequester carbon, and reduce water pollution from pesticides and fertilizers.[94] These practices are not covered in this report, other than to note that the field is expanding,[95] that the federal government is anticipated to invest substantially greater sums of money into promoting such practices,[96] and that the states are similarly looking at these practices in their updated or developing plans to incorporate natural working lands into their climate policies. Because the upper Colorado River Basin has an abundance of rangeland, that landscape is discussed below.

Rangeland as a Promising Subset of Agriculture

"Rangeland" describes an assortment of ecosystems that have highly variable carbon storage. The literature defines rangelands in a variety of ways and there is no consensus on what rangelands are. Some literature defines rangelands as grazed areas (a use description); others describe it as a grassland ecosystem (an ecosystem description) (Booker et al., 2013).

However defined, rangelands and grasslands may provide excellent opportunities to meld climate and water benefits, but, as with meadows, the field is in a state of development.[97] As noted by researchers at UC Davis:

> Because of the potential for climate change to add to the already significant challenges to rangeland sustainability, and conversely because of the potential for well-managed rangeland to contribute to regional climate mitigation and adaptation, rangeland preservation for multiple ecosystem services may need to become a higher priority for local and state government agencies in the coming decades. (Balachowski et al., 2017)

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92 USDA, 2022. "U.S. Secretary Vilsack Highlights Efforts to Combat Climate Change in 2021,": *https://www.usda.gov/media/press-releases/2022/01/18/us-agriculture-secretary-tom-vilsack-highlights-key-work-2021* (Press release summarizing USDA funding and other efforts). See also Flesher, J., 2021, "Carbon storage offers hope for climate, cash for farmers," Associated Press, May 21, 2021 (*https://apnews.com/article/climate-change-climate-business-science-environment-and-nature-cb5a64441149f73d183c2cbc56f773cf*); Indigo Ag website (*https://www.indigoag.com/carbon/for-farmers*); Ioannou, L., 2019, "This is a $15 trillion opportunity for farmers to fight climate change," CNBC, June 12, 2019 (*https://www.cnbc.com/2019/06/11/this-is-a-15-trillion-opportunity-for-farmers-to-fight-climate-change.html*) (includes rangeland).

93 See, e.g., State Healthy Soil Policy Map (*https://nerdsforearth.com/state-healthy-soils-policy/*). See also California (*https://www.cdfa.ca.gov/healthysoils/*); New Mexico (*https://www.nmda.nmsu.edu/nmda-homepage/divisions/apr/healthy-soil-program/*); and Colorado (*https://ag.colorado.gov/conservation/soil-health/soil-health-initiative*).

94 See, e.g., Sumlin, C., 2019, "The Rise of Regenerative Agriculture in Colorado," 5280: *https://www.5280.com/2019/08/the-rise-of-regenerative-agriculture-in-colorado/*

95 A prominent carbon offset provider in agriculture is Indigo Ag: *https://www.indigoag.com/carbon/for-farmers*

96 See, e.g., USDA, May 20, 2021, Climate-Smart Agriculture and Forest Strategy: 90-day Progress Report: *https://www.usda.gov/sites/default/files/documents/climate-smart-ag-forestry-strategy-90-day-progress-report.pdf*

97 For a useful set of references, including conferences and notes on carbon markets, see the University of California Agriculture and Natural Resources website on Rangeland Ecosystem Services: *https://ucanr.edu/sites/RangelandES/*

An estimated 10% to 30% of the world's presently sequestered carbon lies in grazing lands. Managing them to protect and increase that carbon store is a dynamic field. To do so, however, requires active management practices, such as "grazing, nitrogen inputs, and improved plant species" (Schuman et al., 2004). The potential is there, but the requirement of active and ongoing management is significant. Other experts question whether the estimates, particularly in the arid West, are overly optimistic, and suggest that such management may actually release more carbon, and that protection of lands for multiple benefits is the better strategy (Booker et al., 2013).

The variability of rangeland definitions and, further, the variability of carbon-sequestration potential in different types of rangelands, makes it difficult to define best management practices or to fully understand the carbon-sequestration potential in a generalized way. That doesn't mean there aren't clear trends. Just as California's wet forests and Colorado's drier forests differ in their sequestration potential, aridity limits rangelands' carbon-sequestration potential. As with healthy soils or regenerative farming efforts, the work to improve rangeland potential is dependent upon undertaking specific management practices, such as the addition of compost, as well as certain rotational grazing practices that require ongoing effort, expense, and monitoring.

Generally, in the West, state climate planners currently see rangeland data as insufficient to be able to give a tremendous amount of weight in their climate planning, although there is interest. Nevada (Nevada Climate Strategy), Colorado (Colorado Roadmap, 2021), and New Mexico (New Mexico Climate Strategy, 2020) all mention the carbon-sequestration potential of rangelands (New Mexico describes them as grasslands). However, all three states identify the first step as more research to better measure and manage the carbon stock. Nevada and New Mexico do not list concrete plans for more research.

Figure 3. Carbon Cycling

Source: Carbon Cycle Institute.

There are, however, very promising and active efforts to demonstrate the sequestration potential of rangelands in the non-profit world and through collaborations between the public and private sectors. The Marin Carbon Project and the Carbon Cycle Institute have done pilot projects to show how active rangeland management, through the addition of compost, changes in grazing practices, and other methods can yield sequestration benefits (Carbon Cycle Institute, 2016). The Institute is working specifically on how to manage for both climate and water benefits. As Torri Estrada of the Institute put it, it is hard to put together adequate documentation for both water and climate on a single project. The goal of the Institute is to do "farm systems at watershed scale. No one farm can do this and connect adequately to ecological process" (Estrada, 2021). The Nature Conservancy has a research project at Canyonlands Research Center in San Juan County, Utah, working with a group of scientists to demonstrate the carbon-sequestration potential of different restoration techniques. The partnership includes the federal Bureau of Land Management, the National Park Service, the US Forest Service, the US Geological Survey, and a Utah science agency. The effort is focused less on specific carbon and water benefits and more on overall rangeland health, though the data gained should be useful for both (Bellagamba, 2021).[98]

The U.S. Climate Alliance's NWL Challenge (U.S. Climate Alliance NWL Challenge) that Colorado and New Mexico have signed onto promises to yield insight into the potential for a range of NWL interventions, including agricultural efforts, although the TNC-led project that is part of supporting the states' commitment will take some time to yield results (Citron, 2021). The data, particularly for grasslands and agricultural soils is piecemeal at present. If states want to develop inventories, they need to collect "lots" of data (Leslie-Bole, 2021). The Challenge was developed to inspire them and to help them. Unfortunately, under the challenge, "meadows" are not an inventoried item, and they are combined in a bigger category of "grasslands." "All rangelands are grasslands; all grasslands are not rangelands (they could be pine meadow)" (Id.). The case for co-benefits should drive projects and not let quantification stall action (Id.). As with forests, local conditions matter, and not just in terms of quantified values. For example, Colorado may not have as much carbon-sequestration potential in its grasslands from a blade-by-blade perspective as elsewhere, but it does have a vast amount of potential grassland to protect and is losing what it has at a rapid clip (Holst, 2021).

While integration of rangelands and grasslands into state climate policies is not extensive, there is great hope that that will change with the development of more data and the success of more demonstration projects. A large body of work focuses on the potential benefits to water resources. However, there is not a great deal of specific focus on integrating rangelands and grasslands into climate policy because of the multiple benefits that protection or changed practices can yield for both climate and water benefits.[99] The benefits to water are recognized as a co-benefit in a generalized way, particularly in California (CARB, 2019; CA NWL Climate Smart Strategy, 2022; CDFA, 2021). As with forestry and meadow restoration, the aspiration and acknowledgements are there, but not in a way that yields extra incentives specifically for projects that do both.[100]

98 There are a wide array of specific efforts happening in many places, and this report doesn't begin to list them. This example and others are given as one of many in the upper Colorado River Basin. Focused efforts in any area need to be targeting to the specific characteristics, hydrology, aridity, and geology of each location, so demonstration projects are needed in many locales. Assessment of potential at a landscape scale may provide the best roadmap and advertisement for effective state intervention over time.

99 This is true of all the landscapes considered in this report.

100 Some states in the Colorado River Basin have engaged farmers and ranchers In dialogues around climate, sometimes including water in the discussion, and how the state can help. See, e.g., California Department of Food and Agriculture, "Farmer and Rancher-led Climate Change Solutions: Summary of Listening Sessions," November, 2021: *https://www.cdfa.ca.gov/oefi/climate/docs/cdfa_farmer_and_rancher-led_climate_solutions_meetings_summary.pdf*; Colorado Department of Agriculture, "CDA Seeks Input on Climate-smart Agriculture Plan," October 27, 2021: *https://ag.colorado.gov/press-release/cda-seeks-input-on-climate-smart-agriculture-plan*

While in practice (and in this paper) the forestry, meadow, and agricultural landscapes are discussed separately, they are actually not so separate when one takes a watershed perspective. One of the more charismatic and vocal agricultural leaders who speaks at the intersection of water and climate is Pat O'Toole, a Wyoming rancher, who with his wife Sharon, carries on a family farming tradition dating to 1881. Pat is also the President of the Family Farm Alliance. When asked to testify in Congress, he took his time to point out that upper watershed forest restoration was essential to protecting water resources downstream: "Fierce Western wildfire disasters are becoming an annual occurrence,...This underscores the importance of improving on-the-ground management and restoration actions that can lead to improved forest health, which benefits every Western watershed's water supply capability."[101]

State Climate Strategies (With Emphasis on References to Nature-Based Solutions or Natural Working Lands)

While several of the Colorado River Basin states have some kind of climate change legislation, California is by far the furthest along. California, Colorado, New Mexico, and Nevada all have climate policies of some sort, and all have some element of their strategies that acknowledge the role that nature-based solutions can play in climate action.[102] Because California's efforts are so much further advanced, the bulk of the discussion below focuses on California not to suggest that other states should "be like California" but to give an illustration of the types of efforts that other states could and should consider. Perhaps of greatest importance, California is evolving from a regulatory model focused on emissions from traditionally regulated entities like manufacturing, transportation, buildings, and other facilities to one that is adding the more holistic approach of looking at the entire emissions profile of the state, including land-based emissions (e.g., wildfire), and working to develop policies that will both decrease emissions from land-based sources and increase sequestration. They are explicitly recognizing that such nature-based efforts are important due to their multiple benefits (in which water features prominently), the importance of adaptation, and the importance of nature in general.

Colorado, New Mexico, and Nevada all have some type of explicit climate policy or policies at the executive or legislative level that acknowledge the connection between NBS and climate solutions, though none are as comprehensive as California's. They have renewable, clean energy, or energy efficiency policies as the primary complementary policy currently being implemented.

Arizona, Utah, and Wyoming thus far do not have overt strategies that address climate explicitly, although there may be opportunities to integrate policies not so explicitly named. Utah and Arizona do not appear to have any specific climate action plans, and some laws prevent such work in those states. Nonetheless, Utah and Arizona seem to have renewable-energy goals and active landscape conservation and restoration programs that can serve the dual purposes of climate and water benefit without the label.

California

California has the most advanced set of climate legislation and policy in the US if not the world, including various methods for acknowledging and recognizing NBS (referred to in California's planning as "Natural and Working Lands" or NWL). As a result, this section is longest for the purposes of illustrating possibilities, not to suggest that any state should adopt any particular element of California's programs, which are themselves in flux.

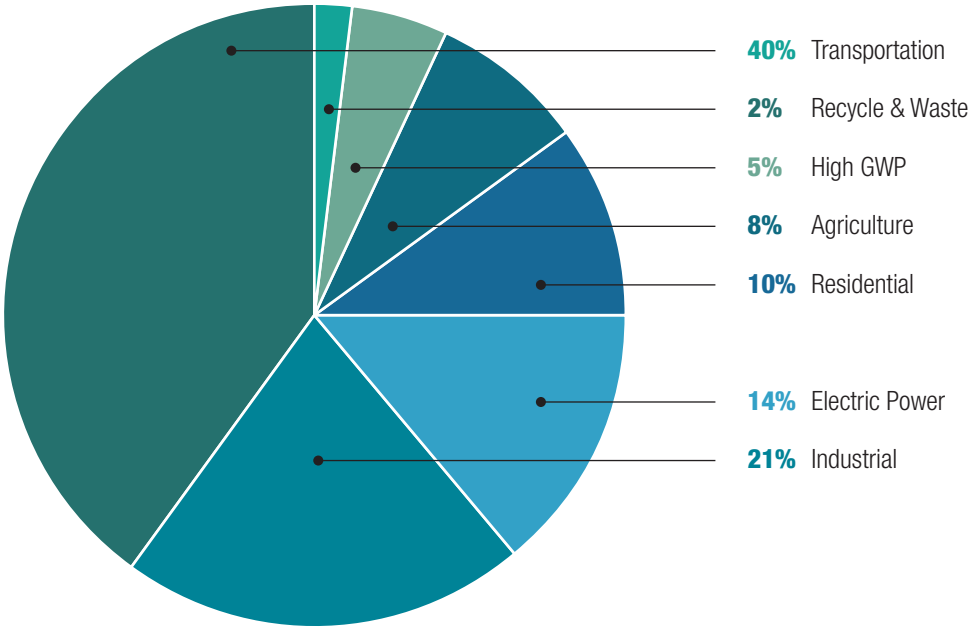
101 Rawlins Times Staff (2022). "Local Rancher Testifies for Senate Committee," Rawlins Times, June 22, 2022 (*https://www.wyomingnews.com/rawlinstimes/news/local/local-rancher-testifies-for-senate-committee/article_6a18b5ae-3647-59fb-b339-16065d1a1a49.html*). Pat and Sharon O'Toole attended COP26 in Glasgow and specifically pointed out at the water pavilion that upper watershed forest management was the key to farming's future since that is where the water originates. Conversation with author.

102 Interestingly, state water policy documents frequently invoke climate as a key driver, while water may or may not get even a mention as a co-benefit in state climate plans.

California passed the Global Warming Solutions Act of 2006, which called for a plan to reduce greenhouse gas emissions to 1990 levels by 2020. At the time, the 2020 goal was characterized by critics as unachievable, and some said it would lead to businesses fleeing the state. However, during this period California's economy was one of the fastest growing in the United States, serving as a hub for investments in climate action, and the state reached its 2020 target four years ahead of schedule. The 2020 goal was subsequently updated by the Legislature in 2016 to direct a reduction in GHG emissions 40% below 1990 levels by 2030. In 2018, Governor Jerry Brown updated that goal via an executive order to carbon neutrality by 2045.[103] The process through which the California Air Resources Board (CARB) develops a comprehensive strategy for achieving these goals involves creating a "Scoping Plan" every five years that considers emissions inventories and various potential policies to achieve the goals. Following completion of the Scoping Plan, the state works through a series of regulatory and non-regulatory public processes to amend existing regulations, develop and adopt new regulations, develop supporting guidelines, and administer billions of dollars in incentive programs, all of which support the implementation of the Scoping Plan. The state is currently implementing plans outlined in the 2017 Scoping Plan and is in the process of developing what will be the 2022 Scoping Plan.[104]

The key elements of the state's policies, as in many other states, include explicit regulations targeting reductions in emissions from industrial sources, transportation, and buildings. A key regulatory strategy for putting a price on carbon to drive down emissions is the state's cap-and-trade program described below. Other regulations explicitly target specific industries or products, such as fuel economy, or fuel formulation (e.g., Low Carbon Fuel Standard, Reformulated Gasoline). A variety of complementary strategies, under the control of CARB and other agencies such as the California Public Utilities Commission (CPUC) and the California Energy Commission (CEC), focus on promoting alternative clean energy and energy efficiency.[105]

Figure 4. 2019 California State GHG Emission Contributions by Scoping Plan Sector



103 Executive Order B-55-18 to Achieve Carbon Neutrality: *https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf*

104 See current "draft AB 32 Climate Change Scoping Plan" (CARB, 2022).

105 For a listing of various regulations under CARB jurisdiction, see, e.g., CARB website: *https://ww2.arb.ca.gov/our-work/programs?f%5B0%5D=topics%3A323* (listing of climate programs under CARB jurisdiction). See also CEC (*https://www.energy.ca.gov*) and CPUC (*https://www.cpuc.ca.gov*) websites.

As one part of an overall regulatory strategy, CARB operates a substantial cap-and-trade program, by which regulated companies can buy credits through an auction to compensate for their GHG emissions over an assigned "cap" or reduce their emissions. Some do both.[106] This creates an incentive to reduce GHG emissions at the source and also generates substantial funding for state-funded programs or grants to reduce GHGs (CARB, 2021a). The "cap" on emissions is reduced over time (which assures emissions reductions over time), and "trading" refers to the ability to purchase equivalent emissions reductions from others through an auction process. The goal is both to incentivize industries to reduce their carbon emissions to avoid having to purchase credits, and to create a market-based, cost-effective vehicle for industries to transition to lower emissions while funding the most cost-effective strategies available. Most significant for this discussion, the funds derived from these auctions go into a "Greenhouse Gas Reduction Fund" (GGRF) from which the state can allocate funding for activities that will further reduce GHG emissions.[107] There are no stringent rules on the linkages, with the Legislature making the ultimate budgetary decisions on how the money is spent after the administration makes a budget recommendation. That recommendation is based on a public process where CARB works with the Department of Finance to develop a suggested investment plan every three years after engaging other agencies and stakeholders. An annual funding plan is developed to reflect the year-to-year legislative appropriations.

The cap-and-trade program has generated more than $15 billion since it began. There are limitations on how these funds can be spent. For example, legislation requires that at least 25% of cap-and-trade proceeds are to be spent in disadvantaged communities that historically have felt the greatest impact from air pollution.[108] The projects also should have a nexus or connection to climate change emissions reductions, although that connection is very much left up to the state budget process and the views of the Governor and Legislature.[109] The funding includes subsidies for clean vehicles, agricultural equipment and vehicle replacement, water/energy conservation/efficiency, energy efficiency, wood stove conversion, affordable housing and sustainable communities (to reduce vehicle miles traveled), high-speed rail, and other important programs including natural working lands (CARB, 2021a). These funds, while considerable, are spent only in California.

In practice, these "California Climate Investments" (CCI) (which are funded by the GGRF) have been used on a great volume of NWL programs that have demonstrable multiple benefits in addition to GHG reduction including water and environmental benefits, although not explicitly linked as such. Examples include forest management for wildfire reduction purposes, healthy soils management, and meadow restoration in addition to urban and community forestry. For example, between 2015 and 2021, $47 million was spent on the CCI's "Wetlands and Watershed Program,"[110] $340 million on "Climate Smart Agriculture," $48 million on "Forest Carbon Plan Implementation," $56 million on "Urban and Community Forestry," $318 million on "Forest Health Programs," $318 million for "Fire Prevention Program," $122 million on "Regional Forest Health Collaboration" and "Urban Greening Program," and $46 million for "Sustainable Agricultural Lands Conservation" (CCI Dashboard).

106 The cap-and-trade program represents an increasingly smaller percentage of the emissions reductions of the state's overall plan. This is in part due to the increasing stringency of other direct regulatory measures, and in part due to the controversy over offsets (CARB, 2022, p. 86).

107 When the funds are appropriated, they go into the "California Climate Investments" fund (CCI) from which grants are made.

108 CalEPA, California Climate Investments to Benefit Disadvantaged Communities (*https://calepa.ca.gov/envjustice/ghginvest/*). California Climate Investments puts this percentage at 35% (Id.). In 2021, CARB announced that 51% of California Climate Investments went to disadvantaged communities (*https://ww2.arb.ca.gov/news/california-climate-investments-reports-implementation-9-billion-projects-reduce-greenhouse*).

109 For example, the single largest appropriation in the allocation of these funds has been to high-speed rail and includes investments in safe drinking water subsidies for disadvantaged communities, affordable housing, and other programs that have a citable nexus to GHG emission reductions. Fortunately, the funds have been used for the development and implementation of NBS projects as well.

110 While delighted by the funding, members of the Sierra Meadows Partnership made clear that this grant program is challenging in not giving quite enough time to finish projects, in being a grant program that requires a lot of paperwork, and in being built as "reimbursable grants" which require an initial outlay that is difficult to muster. They suggest integrating meadow restoration into the larger forest restoration program both to make it more reliable year to year and to assure efficiency. They also suggest having the state do large-scale programmatic environmental documentation to ease the burden on grantees and develop programs at landscape scale.

In its 2021 Annual Report, CARB explicitly noted the benefit of considering multiple benefits and nature-based solutions in these efforts:

> The drought, flooding, wildfires, and extreme heat experienced in the state over the last decade have demonstrated to Californians that climate change has wide-ranging impacts and that California cannot solve pressing environmental, economic, and public health challenges without efforts that address the intersection of these issues. In 2020, Governor Gavin Newsom issued two climate-related executive orders (EOs): EO N-79-20, which sets a path forward to decarbonize the transportation sector, and EO N-82-20, which focuses on preserving biodiversity and conserving natural and working lands…. The targets and actions included in these EOs establish a bold, ambitious framework for state agencies to work together on urgent and coordinated climate strategies. California Climate Investments help implement these EOs by providing incentives for zero-emission vehicles and equipment; supporting low-carbon transit, active transportation, and sustainable community development; and funding a variety of programs focused on nature-based strategies to protect and restore natural and working lands. (CARB, 2021a pp. 7-8)

Legislation is currently pending in the California Legislature to set targets for sequestration to grow this area. AB2649 would require the sequestration of "an additional 60 million metric tons (MMT) of carbon dioxide equivalent (CO2e) per year by 2030, increasing to 75 MMT annually by 2035." in the natural working lands arena.[111]

An additional note on the role of offsets in the California context:

The California Compliance Offset Program issues offsets as a "cost-containment element" within the cap-and-trade program. CARB issues offset credits to projects that reduce or sequester GHGs if they comply with what are now six approved "Compliance Offset Protocols," which are themselves part of the regulation and approved by CARB after a public process.[112] As of now, the approved protocols include those for certain types of domestic forest projects, urban forest projects, certain rice cultivation practices, ozone depleting substances projects, mine methane capture projects, and certain livestock projects (CARB Compliance Offset Protocols). Approximately 80% of credits have been for forest projects (Sahota, 2021).

Because of the controversial nature of offsets (described more fully elsewhere in this report; see Appendix B), their use as a compliance substitute is quite limited.[113] For example, they cannot be used for more than 8% of requirements for emissions reduction through 2020, going down to 4% from 2021-25, and back to 6% for 2026-30. In addition, starting in 2021, no more than half of that can come from projects that do not provide direct environmental benefits to California (CARB Compliance Offset Program; CARB, 2022, p. 86). As a result, while some might see the California program as a source for funding for nature-based solutions elsewhere through offsets, that funding is unlikely to be useful in the upper Colorado River Basin. Offset consumers also are more likely to look to areas with deeper and more developed sequestration potential in places with growing carbon sinks, such as tropical forests, wetlands, or resources in less arid regions.

111 The Climate Center, 2022, About the Natural Carbon Sequestration and Resilience Act of 2022 (AB 2649) (*https://theclimatecenter.org/natural-carbon-sequestration-and-resilience-act-ab2649/*). Earlier legislation requires CARB to set a target to set specific CO2 removal targets for 2030 and requires the California Natural Resources Agency to develop the NWL Climate Smart Strategy (discussed below) and to develop and maintain a registry to identify projects in the state that drive climate action on natural and working lands (CARB, 2022).

112 Compliance Offset Program: *https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program*

113 While the scale of offsets is far smaller than it would seem from the outsized focus they get in the media, the work to assess and validate those offsets in the natural lands area has value in driving quantification research and data that can lend support to other policy and investment decisions.

CA 2030 Natural and Working Lands Climate Change Implementation Plan Draft

In addition to the GGRF funding or other offsets, CARB has worked to integrate NBS into its overall climate change strategy under the title "Natural Working Lands" (NWL) for several years. While technically a draft, the 2019 Draft California 2030 Natural and Working Lands Climate Change Implementation Plan (CARB, 2019) is a significant statement of the state's intention to incorporate NWL into its climate planning and has served as the inspiration for much of the considerable funding that the state has invested in NWL as part of its climate investments program. The 2019 NWL Plan's goal is to at least double the pace and scale of state-funded land restoration and land management activities (5x cultivated lands and rangelands, 2x pace and scale of forests managed or restored, 3x pace of reforestation of oak savannas and riparian areas, and 2x the rate of wetland and seagrass restoration). The draft plan estimates emissions from land-based activities such as deforestation, wildfire, and agricultural practices, and proposes measures to reduce those emissions. The greatest single source of emissions is wildfire. Water and other ecosystem benefits are among the co-benefits identified as a goal of the program (water quantity and quality, air quality, biodiversity and habitat and ecosystem health, food and fiber production, public health, and resilience to climate change). This illustrates the more holistic climate policy that international and national governments are moving toward through recognizing and trying to reduce land-based emissions in addition to intensifying energy and fossil fuel focus.

Four broad pathways are identified for intervention: Conservation, Forestry, Restoration, and Agriculture (see box). Significantly, the plan identifies water as a co-benefit of nearly all of the listed practices and sets acreage targets for most of the pathways described above except where not yet practical to do so (CARB, 2019, Figure 7). The plan also makes an explicit commitment to "consider and measure non-carbon benefits," which include water-related benefits.

Four pathways under 2019 Draft NWL Implementation Plan:

- **Conservation includes:** Land protection to maintain existing carbon sinks and directing new growth to existing communities.
- **Forestry includes:** Improved forest health to reduce wildfire severity; enhancing carbon in forested ecosystems; extending harvest rotation lengths; establishing larger harvest buffers around riparian and habitat areas; reforestation in wildfire- and pest-impacted areas; and increased biomass utilization to create a market for materials that can reduce the embodied GHG emissions of building materials.
- **Restoration includes:** Riparian restoration; oak woodland restoration; wetland restoration (including rice cultivation implemented in tandem with such restoration); montane meadow restoration; chaparral and shrubland restoration and management; and urban forestry and urban greening.
- **Agriculture includes:** Compost application; agroforestry (the integration of trees and other woody plants with livestock or agricultural crops); grazing and grassland management (e.g., prescribed or rotational grazing); and cropland management (e.g., cover cropping, mulching and certain tillage practices).

An implementation section follows with specific direction to various state departments contributing to the plan and a summary of some of the work done during the preceding two years. Implementing agencies are to report annually on progress that will include statewide, regional, and land type-specific categories of progress and expected GHG reduction outcomes. Agencies are to develop monitoring metrics, and the inventory of record for the sector is the "Natural and Working Lands Greenhouse Gas Inventory"

(CARB NWL Inventory, 2018).[114] As explained in California's recently finalized NWL Climate Smart Strategy, "CARB's Inventory of Ecosystem Carbon in California's Natural & Working Lands helps California understand trends in our ecosystem carbon stocks. The inventory tracks how much carbon exists in California's ecosystems and where that carbon is located at discrete moments in time. It also estimates how much carbon is moving in and out of the various land types and carbon pools" (CA NWL Climate Smart Strategy, 2022, p. 18).

A summation of the importance of NWL to California's future climate strategy is encapsulated in the following:

> The scientific assessment supporting this Plan found that almost all of the activities evaluated provide both near- and long-term climate benefits. Others, particularly forest fuel reduction treatments, involve near-term carbon costs but long-term benefits from removing excess material from overstocked forests that has resulted from decades of fire suppression. These fuel reduction activities, such as mechanical thinning and prescribed fire, reduce stand densities and fuel loads, restore the structure and composition of forest ecosystems, and lower the potential for damaging, high-severity fire, which is currently the primary cause of GHG emissions and carbon loss from the land sector. In the long-term, these activities result in climate benefits and healthier, more stable, and more resilient forests. … Despite near-term carbon losses, thinning overstocked forests will result in lower forest densities, larger and more fire-resistant trees, and reduced fuel loads to minimize long-term black carbon and GHG emissions and create more stable carbon sequestration. (CARB, 2019, p. 14)

While not fully implemented and not incorporating all of California's lands (the plan focuses on lands under the state's control), the plan lays out a framework that other states can adapt to suit their unique circumstances. While a draft, it was designed to begin implementation immediately and has served as a roadmap for the work that has taken place since its issuance. The state is building upon the 2019 draft strategy as part of its pending update of CARB's Scoping Plan and in the state's new "climate smart strategy," both described below.

CARB's next big step—the 2022 Scoping Plan

In addition to the 2019 CA NWL Plan, CARB is undertaking a public process to develop the 2022 Scoping Plan, which includes an extended planning horizon to 2045 for the achievement of carbon neutrality. This is the first plan that fully integrates the key role of NWL into the state's climate strategy. The new Scoping Plan will incorporate and update the work being done under the draft 2019 plan and take it further. The process is expected to be completed in 2022, with workshops and public engagement along the way.[115] The Draft 2022 Scoping Plan was released May 10, 2022. The draft Scoping Plan pays far more attention than previous plans to NWL in two of its three proposed alternative scenarios, including the initial preferred proposed scenario, which is chosen in part because of the multiple benefits that enhanced attention to forest management can provide. "The results of the modeling demonstrate that regular NWL management over the

114 This inventory is now somewhat outdated but will be updated and still serves as a useful model. The recently released draft Scoping Plan also contains a Technical Support Document describing the modeling, scenarios considered, and other assumptions contained in the Plan (CARB, 2022, Appendix I) and a modeling spreadsheet that contains inventories (CARB, 2022).

115 An initial workshop on how targets would be set for working lands was held July 20, 2021. The materials demonstrate the sophisticated level at which management scenarios will be evaluated and provides modeling tools that others could adapt and use elsewhere. The CARB presentation is available at *https://ww2.arb.ca.gov/sites/default/files/2021-07/nc-carb_sp_nwl_july2021.pdf*. A public hearing was held June 23, 2022 with more to follow.

next two decades can increase carbon stocks from the Reference Scenario trajectory, reduce GHG emissions from lands, and improve ecosystem and public health. This effort is the most comprehensive scientific effort taken by any government to include NWL within its overall climate strategy" (CARB, 2022, p. 71). The draft plan also explicitly calls out the water benefits of this approach. The forest and shrublands portion would "Restore health and resilience to overstocked forests and prevent carbon losses from severe wildfire, disease, and pests. Improve air quality and reduce health costs related to wildfire emissions. Improve water quantity and quality and improve rural economies…." (Id., p. 42).

Part of the drive to expand the work in this area is the state's recognition that forests have become more of a source than a sink, despite initial hopes that the reverse would be true. That recognition meant that a change in direction and a greater focus on natural working lands, particularly forests, was necessary to develop a truly adequate climate policy response. Matthew Botill, Assistant Division Chief of CARB, described the shift: "We started with mitigation and quantification … but now we've gotta flip the narrative," and evolve the work on climate and resilience to incorporate more issues (including wildfire) (Botill, 2021a). As the current Executive Officer of CARB, Richard Corey, puts it, they now need to see their work in "two bins." One is a traditional bin looking at transportation, methane, hydrofluorocarbons, electricity, stationary sources, and a transition away from fossil fuels to cleaner energy for business, daily life, and transportation. The other bin, by virtue of needing to get to carbon neutrality, has to include NWL, because if one honestly looks at all sources of carbon emissions, it is essential to deal with them to achieve the goal. The state needs to deal with carbon loss to the atmosphere in the natural lands arena (through wildfire and other degradation) and will also have to look more seriously at the role NWL can play in active sequestration. With respect to co-benefits like benefits to water supply and quality, he noted that multiple legislative bills called upon them to consider co-benefits of all kinds in their planning (Corey, 2021).

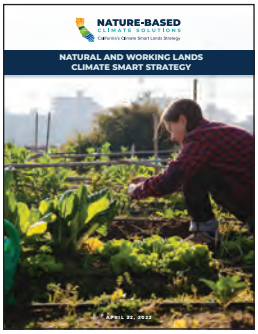
CARB's goal is to think at a systems level that includes ecosystem, habitat, water, and climate rather than just one aspect (Botill, 2021b). CARB also recognizes that forest management to prevent catastrophic wildfire requires reducing vegetation presently sequestering carbon in the near term but that that short-term loss in sequestration would result in long-term gain through reducing the risk of catastrophic wildfire and through healthier, bigger trees that could sequester more carbon (Id.). This is a long-term effort that will lessen forests' role as a source over time and create more sinks (through larger trees and fewer catastrophic wildfires) while realizing multiple benefits (like water supply and water quality) along the way. The question then shifts to: "What does a healthy, resilient ecosystem look like and what is its relation to carbon?" The strategy will go beyond cap-and-trade and offsets, which is where NWL has usually been discussed (Livingston, 2021a). In addition to being a good thing, CARB also views multiple-benefit work as a way to connect with more people to advance complex work like NBS which requires community participation and engagement of multiple disciplines. The state is developing an advanced modeling tool that can capture both climate and water interfaces and can run scenarios and see trade-offs at landscape scale.[116] Although CARB is seen as the "gold standard" in quantification (Brill, 2021a), it is focusing on the level of landscape "directionality" in impacts as well, with a clear sense of the different levels of quantification necessary for regulatory offsets vs. investments in programs that will yield long-term carbon benefits (Botill, 2021b; Livingston, 2021b). This is work that other states can build upon and adapt for their specific landscapes.

116 See 2022 Scoping Plan Update, Technical Workshop, Natural and Working Lands, July 20, 2021, Presentation: *https://ww2.arb.ca.gov/sites/default/files/2021-07/nc-carb_sp_nwl_july2021.pdf*; see also *https://ww2.arb.ca.gov/sites/default/files/2022-04/SP22-Initial-AQ-Health-Econ-Results-ws-CARB-NWL.pdf*. California is using a model, known as RHESSys (Regional Hydro-Ecological Simulation System), which is a "hydro-ecological model designed to simulate integrated water, carbon and nutrient cycling and transport over spatially variable terrain" (*http://bioearth.wsu.edu/rhessys_model.html*). The RHESSys approach is not unique to CARB and can be applied in any state, but it needs to be applied. The North Yuba Forest Partnership used it (Wobbrock, 2021).

At present, the CARB team is focusing most heavily on forest management opportunities because forests comprise the biggest natural land feature and contain the greatest carbon density in the state, and because wetlands and mountain meadows do not have as robust a degree of research,[117] but they are still very supportive of expanding that work and are supporting research across the full range of natural landscapes (Botill, 2021a; Livingston, 2021a).

This work is being accelerated and expanded in tandem with the state's commitment to 30x30 (Botill, 2021a; Livingston, 2021a) and through parallel work being undertaken by the California Natural Resources Agency to develop an "NWL Climate Smart California Strategy," both discussed below (Botill, 2021a; Livingston, 2021a).

California's new Natural and Working Lands Climate Smart Strategy



While California's climate planning undertaken by its official regulatory body, CARB, is already the most evolved of the Colorado Basin states in integrating natural working lands, the state is also integrating NWL into an overall "Climate Smart" state strategy. The strategy, "Nature-Based Climate Solutions: California's Climate Smart Lands Strategy, Natural and Working Lands Climate Smart Strategy" (CA NWL Climate Smart Strategy, 2022), is specifically intended to implement nature-based solutions to meet its climate goals while also implementing projects that provide benefits to public safety, the economy, species, water, and other public goods. The draft strategy was released on October 11, 2021 and issued in final on April 22, 2022 (CA NWL Climate Smart Strategy, 2022). The strategy:

- Defines California's eight natural and working landscapes.
- Describes how improved management of these landscapes can deliver on our climate change goals and advance broader environmental, economic, and social objectives.
- Highlights priority nature-based climate solutions to address the climate crisis.
- Outlines regional opportunities for climate smart land management.
- Identifies options to track nature-based climate action and measure progress.
- Packages recommendations to scale nature-based climate solutions in California identified through [their] public engagement process.

The strategy repeatedly refers to the multiple benefits to be generated by including NWL in a climate strategy, explicitly calling out water and water-supply benefits, particularly in the context of meadows and forests (Id., p. 8). The plan describes eight natural land types that it covers: Forests, Shrublands and Chaparral, Developed Lands, Wetlands, Seagrasses and Seaweeds, Croplands, Grasslands, and Sparsely Vegetated Lands. Three of those landscapes, the subjects highlighted in this report, are excerpted in Appendix C: forests, wetlands (including mountain meadows), and grasslands (Id., p. 3).

The strategy acknowledges state efforts toward water sustainability and references other state programs, noting, "In addition to climate-smart management on our landscapes, there are water-centric nature-based solutions that also help the state meet its climate goals" (Id., p. 51).

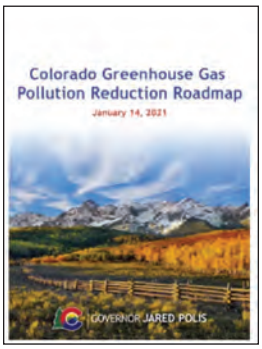
117 The Delta wetlands work described In Appendix B to preserve peat soils is an exception and is called out and slated for significant action in the Scoping Plan (and in the Governor's Proposed Budget "May Revise" released May 13, 2022). Funding for meadow and wetland restoration also is called out significantly in the California Natural Working Lands Climate Smart Strategy discussed below and can and should remain a large part of investments of the California Climate Investments discussed above (cap-and-trade proceeds). Meadows are not as large a part of the California landscape as they are in Colorado. As such, Colorado would have more incentive to develop a large-scale meadow restoration program in addition to focusing on forests (given the available funding from the federal government).

The strategy also notes the need for greater monitoring, data collection, science, and coordination across sectors, as well as financing tools and the development of economic metrics for job creation and other factors.[118] It includes a regional breakdown by climate stressors and opportunities that could be emulated by other states as appropriate to their particular landscapes, with the Sierra Nevada and North Coast regions providing examples with relevance to forests and mountain meadows in particular (Id., pp. 68-103). It also ends with a list of of implementation actions that echo and go beyond many of the recommendations in this report (Id., pp. 105-108). Excerpts from the strategy appear in Appendix C.

California also recently finalized its 30x30 plan, specifically recognizing the linkage to climate and water benefits: "California's 30x30 is part of an international movement to utilize nature-based solutions to combat climate change, protect biodiversity, and build a more resilient future" (CNRA, 2022).

If adopted and implemented, the combination of an updated CARB Scoping Plan with the CA NWL Climate Smart Strategy and the 30x30 plan can provide inspiration to the other Colorado River Basin states and stakeholders interested in adopting the type of holistic climate mitigation and adaptation policies that are necessary to meet the climate challenge.

Colorado



Colorado is the most advanced of the other Colorado River Basin states[119] in thinking about the integration of natural working lands or nature-based solutions into its climate planning after California. The planning is still in process, although it has the imprimatur of the Legislature and Governor. It is not a heavily resourced endeavor, and the administration has made clear that its goals are to provide incentives for integration of natural working lands into its climate policy rather than regulation. It is a ripe area for targeted engagement and support as noted in the recommendations below.

In 2019, Colorado passed statutory targets for emissions reductions from 2005 levels of 26% by 2025, 50% by 2030, and 90% by 2050 (HB 19-1261, 2019). In January 2021, Colorado released the Colorado Greenhouse Gas Pollution Reduction Roadmap (Colorado Roadmap, 2021). The plan has only a few pages on "natural and working lands." Current efforts listed by Colorado include:

- Signing on to U.S. Climate Alliance's Natural and Working Lands Challenge.[120]
- In 2020, convened an interagency Natural and Working Lands Task Force (NWL Task Force).
- A partnership with the Colorado Chapter of The Nature Conservancy to conduct a study of the climate mitigation potential of natural and working lands management.

118 Metrics needed include carbon emission and sequestration, ecological, economic, infrastructure, social justice/equity, and public health (CA NWL Climate Smart Strategy, 2022, pp. 61-67).

119 There are other states in other parts of the country, e.g., Oregon, that are aggressively integrating NWL or NBS into their climate policies. This report focuses on the Colorado River Basin states.

120 The U.S. Climate Alliance's Natural and Working Lands Challenge lays out a series of goals that states that sign on to the challenge are expected to commit to including improved inventory methods for "land-based carbon flux," best practices to reduce GHG emissions and increase resilient carbon sequestration, actions to support a collective goal of using NWL as a net sink of carbon, and integrating "priority actions and pathways" into state GHG mitigation plans within two years of joining the challenge. The areas to be addressed include multiple benefits such as watershed protection: "U.S. Climate Alliance States will consider and, as appropriate, adopt practices that increase long-term carbon sequestration in forests and forest products; reduce losses from catastrophic wildfire and land-use change; protect existing natural and working lands from conversion; support healthy soils on farms and ranches; restore coastal wetlands and sub-tidal habitats that protect shorelines against sea level rise; restore ecosystems and open space for watershed protection and recreation; and grow the urban forest and other greenspace to improve health and livability. These actions to reduce GHG emissions and increase carbon sequestration will be undertaken in a manner that supports watershed health from source to tap; protects the viability of vital farmland, ranchland and productive forestland; fosters resilient rural economies; restores critical habitat and bolsters ecosystem adaptation to climate change; and offers recreational opportunities across our states" (U.S. Climate Alliance NWL Challenge).

- Colorado State Forest Action Plan.
- Identifies the possibility of conservation easements to achieve goals. Brief mention of water, but primarily for adaptation.[121]

The state's inventory includes agricultural emissions and forestry and land-based emissions (CO GHG Inventory, 2021, pp. 77-87; 96-101), along with notes on the uncertainty associated with those estimates (Id., pp. 87-88 & 101). The additional impact of catastrophic wildfire does not yet appear to be estimated.

The Colorado Department of Natural Resources has been holding listening sessions on the NWL plan and expects to release a draft plan sometime in 2022. The sessions have been sparsely attended and staffing for the effort is slim.[122] In each of those sessions, staff and stakeholders have mentioned the water co-benefits of preservation or restoration of wetlands, forests, or agriculture, including grazing.[123] The goal of the Colorado NWL Task Force is to "reduce greenhouse gas emissions and restore, protect and enhance carbon sequestration across all natural and working lands in Colorado."[124] The goals for near-term action are to develop and refine a NWL emissions inventory and to develop voluntary and incentive-based approaches. No regulatory components are expected. The task force also hopes to improve soil function and carbon sequestration through regenerative farming and support voluntary participation in efforts like field-to-market, soil health, and other programs. The only measurable goal stated so far is the reduction of 1 million metric tons of carbon by 2030 (Colorado Scoping Session—Meadows and Wetlands, 2021).

Speakers and state staff noted the variable nature of carbon and the need for careful site-specific measurement, noting that wetland functions, including carbon storage, work best when in good condition. Natural processes are key, and intact wetlands are easier to conserve than to restore.[125]

The Nature Conservancy project to estimate the climate mitigation potential of NWL in Colorado and New Mexico identified in the Colorado Roadmap is promising. The project is supported by the U.S. Climate Alliance, which relies on the World Resources Institute for staffing. That project, which is part of the U.S. Climate NWL Challenge, will provide a foundation upon which both states can further develop their climate plans. While the study is for both Colorado and New Mexico, it is very landscape-specific, so the drivers and results may appear to differ (Citron, 2021; Leslie-Bole, 2021). The expectation is that the carbon benefits may be small for certain landscapes within the scheme of the overall state emissions pie, but the hope is that the work will assist in "stacking" benefits, such as carbon, water quality, biodiversity protection, climate resilience, and water quantity, along with avoided wildfire in appropriate circumstances, as well as providing other benefits of proper ecosystem protection. The most predictable benefit of the project will be to "stack, not to solve" (Citron, 2021). They are adapting a model developed to support California's efforts, CALAND, and will be running "spatially specific scenarios" looking at carbon benefits of protecting and restoring wetlands, avoided conversion of forests and wetlands, and reforestation, among other landscape opportunities. The project will estimate the climate mitigation benefits of "natural climate solution pathways" implemented on natural and working lands. These pathways, which are management actions to reduce GHG emissions and/or increase carbon sequestration, include conservation approaches such as avoided conversion, improved forest management, reforestation of burned areas, and wetland restoration. Preliminary results are

121 Legislation created the Agricultural Drought and Climate Resilience Office to support technical assistance and nonregulatory approaches to help the agricultural sector adapt to and mitigate climate change. See HB21-1242 (*https://leg.colorado.gov/bills/hb21-1242*).

122 There are no full-time staff working on the plan, although those that work on it are experienced and dedicated. With respect to stakeholders present, although the sessions were small, some of the attendees were very engaged and experienced, including Jackie Corday, with the Healthy Headwaters Working Group, Sarah Marshall, a wetland ecologist with the Colorado Natural Heritage Program at Colorado State University, and Ellen Wohl, a well-known expert in the field. Discussion included examples from Gunnison and sage grouse restoration, including discussion that active beaver complexes can sequester more carbon than other wetland areas.

123 Participation by author.

124 Comments by Angela Boag, Assistant Director for Climate, Forest Health and Energy, Colorado Department of Natural Resources (Colorado Scoping Session—Meadows and Wetlands, 2021).

125 Comments by Sarah Marshall, Wetland Ecologist, Colorado Natural Heritage Program, Colorado State University (Colorado Scoping Session—Meadows and Wetlands, 2021).

expected in 2022. Given the non-regulatory mindset of the current state administration and the historic controversy over offsets, the multiple-benefit and "stacking" approach is the one that they hope to support with their efforts.

Although semi-arid and at altitude, Colorado boasts landscapes that would seem very promising, including vast high mountain meadows and extensive grasslands and rangelands. The results of the TNC/U.S. Climate Alliance project will lay a foundation for more effectively planning and prioritizing efforts to elevate natural lands into the Colorado climate policy discussion.

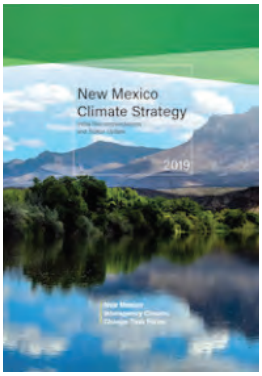
Conservation Colorado and Western Resource Advocates have called for a 30x30 plan, but one has not yet been endorsed by the Governor or the Legislature.[126] Their proposed plan makes the explicit link between natural lands and both climate and water benefits.

> Additionally, conserving natural places is a valuable strategy for combating climate change. Intact nature and ecosystems make Colorado a more resilient place in the face of a warming climate, creating more connections for wildlife to adapt to changes in habitat conditions. Natural lands can help offset or soften the impacts of climate change on a variety of fronts including drought, extinction, food and water security, and wildlife migration. By managing lands to be net neutral or net negative in their carbon emissions, land managers and land management policies can play a powerful role in helping keep global temperatures from rising over 1.5 degrees Celsius, the recommended threshold of climate scientists to prevent the worst effects of climate change. Thankfully, one of the most cost-effective strategies for mitigating climate change is to protect more connected and resilient land and water. (Colorado Pathways, p. 10)

Similarly, a coalition of land conservation groups has proposed a "Keep It Colorado Statewide Private Lands Conservation Plan" to leverage private-property conservation to achieve climate goals for multiple benefits, including climate mitigation and adaptation and fostering 30x30 goals (Keep It Colorado).

New Mexico

New Mexico does not yet have a fully developed or legislatively adopted climate plan but is in the process of developing one at the Governor's direction. Currently, an interagency task force is working on the plan.



In 2019, Governor Michelle Lujan Grisham released an executive order to address climate change. The order sets the goal of a statewide reduction of at least 45% by 2030 as compared to 2005 levels (NM Executive Order, 2019). New Mexico is considering a cap-and-trade program.[127]

The order established a Climate Change Task Force (Task Force) charged with developing a "New Mexico Climate Strategy." The order itself does not mention natural and working lands other than to say that "All State Agencies shall evaluate the impacts of climate change on their programs and operations and integrate climate change mitigation and adaptation practices into their programs and operations. The agencies shall share these actions with the Climate Change Task Force for inclusion into the New Mexico Climate Strategy document." An emissions inventory done for New Mexico

126 New Mexico U.S. Senator Martin Heinrich and Colorado U.S. Senator Michael Bennet have introduced legislation endorsing the Biden administration's call for a 30x30 objective. Colorado has not adopted one, but New Mexico's governor recently did so by executive order (Colorado Pathways, 2020). Colorado is, however, having conversations about setting a state-specific goal rather than relying on the global goal (Citron, 2022).

127 "New Mexico's Climate Change Task Force, a group appointed by Governor Lujan Grisham, is currently evaluating market-based climate programs, such as cap-and-trade. Maddy Hayden, a public information officer with the New Mexico Environment Department, said cap-and-trade can be effective at reducing pollution and boosting health outcomes. New Mexico is interested in working with other states or existing programs, she added" (Pew Stateline blog: *https://www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2020/12/23/landmark-climate-policy-faces-growing-claims-of-environmental-racism*).

covers emissions from agriculture and forestry in the inventory (Cummins, 2020).

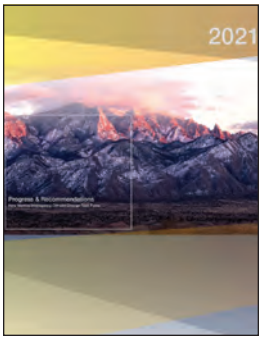
The Task Force has issued three annual reports thus far. While not yet proposing a complementary NWL policy, the first report (NM Task Force, 2019) does mention natural and working lands in the context of reducing wildfire and increasing sequestration, notes the passage of a "Healthy Soils Act" to improve soil quality and increase sequestration, and calls for improving inventory methods for understanding land-based emissions and sequestration potential. The report also calls for integrating natural and working lands into state climate mitigation plans by 2020 (Id.), acknowledges New Mexico's acceptance of the U.S. Climate Alliance's Natural and Working Lands Challenge, and commits to complete a Natural and Working Lands Climate Plan by fall 2020 as part of accepting the pledge.[128] The report also briefly discusses the importance of forest resilience and the threats to ecosystems as part of an adaptation strategy (Id.). Water is handled in the context of adaptation planning, with a basic focus on planning for source water protection, but the report clearly outlines the importance of wildfire control and remediation for watershed health:

> NMED will increase the number of action plans for wildfire control/remediation and watershed health starting in 2019. Pre-fire action plans are developed to reduce the risk of watershed wildfires. Between 2019 and 2023 NMED will conduct at least one planning project, covering at least one priority watershed, to be supplemented, updated, or completed each year. In post fire action plans, NMED coordinates with other government agencies to evaluate burn severity and suggest best management practices to slow water runoff and improve stream health. Post-fire actions reduce sedimentation, which then reduce impacts to water quality and protect aquatic habitat. Any year in which a major wildfire occurs in a watershed with cold or cool water aquatic life, the affected watershed(s) are identified as priority watersheds for Clean Water Act Section 319 funding opportunities under NMED's nonpoint source management program.
>
> Beginning in 2019, NMED will encourage pre-wildfire protection efforts, such as source water protection planning and watershed management (e.g., prescribed burning) to reduce the potential for intense wildfire, by awarding more points to solicited project proposals submitted to NMED that include preventative actions and by providing water quality and forest ecology information when reviewing forest plans to prevent unnaturally intense wildfire. (Id., p. 25).

In 2020, the Task Force issued its second annual report, again largely focused on fossil fuel emissions reduction, increasing renewable energy generation, and decarbonizing the transportation sector, but it expanded its discussion of natural working lands (Chamberlain, 2020; NM Task Force, 2020). As in the first report, the 2020 report includes a small section on "Natural and Working Lands" as a method for greenhouse gas reduction and another on "Water and Natural Resource Resilience" as an adaptation and resilience measure (NM Task Force, 2020, pp. 24-27, 34-38). With respect to NWL, the report focuses on forest management for wildfire reduction risk for both emissions reduction and sequestration. It also mentions the partnership with The Nature Conservancy to "improve emissions reduction and sequestration potential estimates and refine inventory methods" for both Colorado and New Mexico. The report again recognizes the benefits of post-fire actions to reduce sedimentation and its impacts on water quality and aquatic habitat and focuses on those efforts, and again adds that in 2021 the New Mexico Environment Department would encourage "pre-wildfire protection efforts by providing information related to water quality and forest consideration when reviewing funding proposals under the Forest and Watershed Restoration Act and Water Trust Board funding programs, and when reviewing Forest Plans required by the National Environmental Policy Act, as a means of preventing impacts to water quality from unnaturally intense wildfire" (Id., p. 26). The report mentions the importance of source

128 While the state does not appear to have met that deadline, its three annual reports are substantial.

water protection in mitigating impacts from fire (Id., pp. 25-26). With respect to agriculture and grasslands, the report expresses a need for more research and notes that the New Mexico Department of Agriculture and New Mexico State University Extension are identifying partners to develop science-based inventory methods to enable landowners to participate in carbon markets (Id., pp. 26-27).



The Task Force's 2021 Progress & Recommendations report builds on the previous reports. With respect to NBS, the report highlights 2200+ acres of forests treated to "enhance the adaptability and resilience of New Mexico's forests and watersheds to climate change and wildfire, improve water quality, and support economic activity..." (NM Task Force, 2021, p. 7). The state's Forestry Division launched a new natural and working lands initiative focused on "sequestering carbon in forests and other natural and cultivated lands....this program will also assist in stabilizing watershed functions, such as snowpack storage, surface water regulation,, absorption of stormwater, soil health, and below-ground carbon storage (Id., p. 23). Compared to prior reports, the report focuses on the establishment of goals and the selection of strategies for landscape scale fire reduction and mitigation in high risk and high priority areas, prescribed burning..., landscape-scale restoration to improve soil health..." and describes efforts to establish baseline measures and targets for carbon storage in natural and working lands. The report also details specific projects of various kinds to develop technical data (Id., pp. 24-25). An update on adaptation and NWL is also included (Id,, pp.31-32) as is an update on adaptation and water resource planning (Id., p. 36).

Compared to Colorado, New Mexico is characterized by a drier landscape. Like Colorado, the state has a long grazing tradition. The landscape boasts "a complex mix of meadows and rangelands, with layers of old rural forest mountain communities" and years of cultural tension with the US Forest Service (Fleck, 2021).

New Mexico enacted a complementary statutory clean-energy standard in 2019.[129] It requires 50% renewable energy by 2050 and 100% carbon-free energy use by 2045. The bill also allows securitization to help reduce the financial burden of the transition away from coal plants. It directs new investment for renewable energy into communities where fossil fuel production is being reduced and sets standards for apprenticeship programs.

Governor Luhan Grisham has adopted a state 30x30 goal by executive order (Kelley, 2021).

Nevada

Nevada enacted statutory targets in 2019 to reduce greenhouse gas emissions. The state is targeting reductions of 28% by 2025 and 45% by 2030 compared to 2005 levels and hopes to reach zero or near-zero by 2050.[130]

The state released its climate action plan in January 2021. Its subtitle reads "'Home means Nevada,' and climate change has hit home."[131] The plan notes a stated focus on climate justice and transportation emissions but also includes a section on natural and working lands. It identifies a large information gap regarding available metrics, and focuses primarily on forest sequestration, but conveys interest in conserving its sagebrush and rangeland ecosystems as part of its plan. It identifies co-benefits from this work, such as dust reduction, flood reduction, and fire reduction, and it pledges to undertake an inventory of wetlands in the state as part of the planning. Nevada has a greenhouse gas inventory that recently expanded beyond fossil fuel emissions to all large sources

129 SB 489: *https://www.nmlegis.gov/Sessions/19%20Regular/final/SB0489.pdf*

130 Nevada SB254: *https://trackbill.com/bill/nevada-senate-bill-254-an-act-relating-to-greenhouse-gas-emissions-requiring-the-state-department-of-conservation-and-natural-resources-to-issue-an-annual-report-concerning-greenhouse-gas-emissions-in-this-state-and-providing-other-matters-properly-relating-thereto/1719120/*

131 Nevada's 2020 State Climate Strategy: *https://climateaction.nv.gov/wp-content/uploads/2021/01/NVClimateStrategy_011921.pdf*

including land-use and forestry emissions (sequestration).[132]

While noting the state's large federal ownership of land as a potential obstacle to taking action on natural lands, the plan points to the success of conservation credit programs like the Sagebrush Ecosystem Council and suggests it may be a future model for federal-state landscape cooperation as it pertains to climate.[133] It is possible that innovative efforts by California and Colorado in engaging the US Forest Service to accelerate forest restoration can lead to greater engagement in Nevada.

Arizona

Technically, Arizona has a "Climate Change Action Plan" that was developed by an official Climate Change Advisory Group, but it has not been implemented and has not been endorsed by the Legislature and therefore does not have the force of law (Arizona Climate Change Advisory Group, 2006). It contains recommendations for the "Agriculture and Forestry (AF) Sectors" that includes conversion of agricultural land to grassland or forest to increase carbon sequestration, reduction of conversion of farms, rangelands, and forests to developed uses, increasing reforestation and restoration of forests, and improving forest ecosystem management. It has not been implemented by the administration. The state does have a renewable portfolio standard, known as the Renewable Energy Standard, requiring regulated energy utilities to have 25% of energy produced by renewable energy by 2025 (AZCC, 2006).

As noted elsewhere, Arizona has projects for upper watershed restoration (including forest and meadow restoration to protect downstream waters) but they are not couched in terms of climate change by the state.

Utah

Like Arizona, Utah does not have an official climate action plan. There have been indications of interest by state elected officials and within the Legislature (Burr, 2019). At the urging of high school students, the Legislature asked a University of Utah think tank to develop a plan. The think tank released the plan in 2020, but it has not yet been passed into law (Utah Roadmap, 2020).[134] The draft plan focuses on a renewable-energy portfolio, other emissions (especially considering air quality and smog issues in Salt Lake City), and transportation emissions. The university's plan mentions natural and working lands, and proposes individual incentives for agriculture, improving forest management for fires, and reforestation, but they are minor references (Id., pp. 11, 16). The state has a voluntary renewable energy portfolio goal of 20% by 2025 (CNEE, 2018).

132 Nevada Division of Environmental Protection, 2020, Nevada Statewide Greenhouse Gas Emissions Inventory and Projections, 1990-2040, 2020 Supplemental Report: *https://ndep.nv.gov/uploads/air-pollutants-docs/ghg_report_2020.pdf*

133 Nevada Division of State Lands, Sagebrush Ecosystem Program: *http://lands.nv.gov/resource-programs/sagebrush-ecosystem-program*

134 See also Fahys, J. 2020. "How Utah May Have Found a Model for Bipartisan Climate Action," Salt Lake Tribune, January 22, 2020: *https://www.sltrib.com/news/environment/2020/01/22/utah-climate-change-plan/*

Wyoming

No climate policies or renewable portfolio standard.

Corporate/Public Agency/Organizational Voluntary Efforts

While the focus of this report is on state climate policies that can provide multiple benefits, including water supply and quality benefits, it is instructive to look at the considerable efforts by corporations and others in the private sector and nonprofit worlds to achieve multiple benefits on a watershed scale. These integrated efforts are far more fully evolved in the voluntary context and can provide tools and frameworks for integrating such efforts into state policies. States can also encourage such voluntary actions as a complement to their more formal climate policies.[135]

Corporations are making these commitments in different ways. Many are pledging to achieve net-zero carbon emissions through emissions reductions in their facilities and supply chains, purchase of registered offsets, or investments in emissions reduction and/or sequestration efforts in local areas in which they work. Some are also pledging net-zero water use or "Net Positive Water Impact."[136] Coca-Cola and other beverage companies have long been involved in net-zero water use pledges and actions that involve watershed protection. The tech industry has followed suit, with Google, Microsoft, and Facebook making similar pledges in the past year.[137] Many of these involve watershed protection efforts, and many include explicit links to carbon emissions reductions and sequestration as part of their objectives. There is a great opportunity in this arena to integrate both climate and water net-zero efforts (along with other goods such as biodiversity and local jobs).

Corporations are looking to register or otherwise obtain third-party validation of their actions to achieve the marketing, employee, investor, and customer appreciation they can gain by taking these actions (in addition to their obvious physical benefits, e.g., water conservation, ability to maintain green spaces in drought, and ability to absorb water and mitigate flooding). Because these are voluntary efforts, the quantification required for a non-regulatory pledge of action may be less daunting than that required for a regulatory or otherwise institutionalized offset or as part of a formal cap-and-trade program.[138] For example, with respect to carbon neutrality in particular, The Climate Registry has just recently opened a net-zero pledge portal as a public registry of commitments and projects that is expected to debut in 2022.[139]

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135 See, e.g., New Mexico, which is promoting science-based inventories explicitly to help their agricultural sector take advantage of external offset or credit programs mentioned above (NM Task Force, 2020, p. 20).

136 Net Positive Water Impact (NPWI) implicates more than an amount of water used and includes a more holistic view of a company's water impacts, including quantity, quality, and water and sanitation needs in a watershed in addition to the amount extracted. See, e.g., Water Resilience Compact, NPWI (*https://ceowatermandate.org/resilience/net-positive-water-impact/*). Getting to net-zero and beyond can include supporting offsite water replenishment projects (including NBS), retrofits of fixtures, appliances, or landscapes offsite, or better utilizing water that is already on site, such as capturing and using stormwater or air conditioning condensate, and by treating wastewater on site for reuse for non-potable purposes. Bonneville Environmental Foundation is one well-regarded institution that verifies projects including restoration of flows to the environment. See, e.g., "Water Restoration Certificates" program: *https://www.b-e-f.org/programs/water-restoration-certificates/*

137 Google recently announced a net 120% water pledge to make each watershed they work in 20% better than it would be from a water resource perspective than if they were not there by 2030. Their efforts include substitutions for potable water in their use and watershed enhancement projects (*https://sustainability.google/commitments/water/#*).

138 This is not to say that quantification isn't of growing importance here, as noted elsewhere in this report. In addition, the Securities and Exchange Commission is considering requiring corporations to report on their climate impact, which will lead to greater incentive to reduce emissions and sequester carbon. Reporting tools will become even more important. See, e.g., SEC Proposes Rules to Enhance and Standardize Climate-Related Disclosures for Investors (*https://www.sec.gov/news/press-release/2022-46*). The Commodity Futures Trading Commission recently announced that they will "be taking a closer look" at the voluntary carbon market to assure that "these offsets deliver the emissions reductions they promise." (Ellefeldt, A., 2022, "Regulator tackles CO2 offsets, as 'crisis of integrity' looms," ClimateWire, June 3, 2022: *https://subscriber.politicopro.com/article/eenews/2022/06/03/regulator-tackles-co2-offsets-as-crisis-of-integrity-looms-00036866*); also found at *https://08731174954916089993.googlegroups.com/attach/3fde651e83bde/Regulator_tackles_CO2_offsets__as__crisis_of_integrity__looms_-_EENEWS.pdf?part=0.1&view=1&vt=ANaJVrF_YRZjxt1tx92fATmUCotWTd3naiMLxK9UQYiJJGMGXDsYKE7KxrRFWJpAoPyYN4Y1LSjcyujBH8M8IoWZJMeJ-TKWnIBCLXPXTIXQv85dLPAcF_4*.

139 See The Climate Registry net-zero Portal: *https://www.theclimateregistry.org/thoughtleadership/net-zero-portal/* and *https://www.theclimateregistry.org/wp-content/uploads/2021/03/Net-Zero-Portal-Info-Sheet.pdf*

Considerable work is also being done to integrate carbon benefits of NBS with watershed and other benefits. Food, beverage, and tech companies are leading this effort as they seek to show their corporate responsibility on a watershed scale, but this is also being sought by other large corporations seeking to be better stewards of a range of environmental issues for a variety of reasons (CEO Water Mandate, 2020; CEO Water Mandate, 2021). Coca-Cola, for example, has worked closely with the National Forest Foundation and others to invest in upper watershed management (Selig, 2021). They rely upon LimnoTech as the "gold standard"[140] for assessing water benefits of the work they sponsor (Id.).[141] Danone is also a leader in this space (Brill, 2022).

As noted below, the CEO Water Mandate, a nonprofit association created to advance water security and resilience in the private sector in partnership with the United Nations, is leading efforts to encourage and quantify efforts, including those utilizing NBS, to improve water supply and water quality by corporate players and is explicitly incorporating climate benefits into that work.[142] More pertinent to this report, they are also leading considerable and important work to standardize guidance across a range of environmental benefits, including carbon and water, as part of a multiple benefits vehicle for quantifying those benefits (CEO Water Mandate, 2021; CEO Water Mandate, 2020). The CEO Water Mandate has identified the lack of standardized methods for accounting for water and carbon benefits of NBS as one of many reasons why there is less investment in NBS than there could be, and they are engaged in a multi-stakeholder, phased project to develop those methods.[143] They have finished the first stage of assessing opportunities and landscapes, identifying barriers and evaluating existing frameworks for evaluating, measuring, and demonstrating the value of NBS benefits (CEO Water Mandate, 2020; CEO Water Mandate, 2021). They have also developed a standardized method to account for "stacked water and carbon benefits and identify wider co-benefits of NBS for watersheds" (Brill, 2022). Current stages of work look to build on the first stage by considering benefit forecasting (how different benefits accrue proportionately over time and across spatial scales across multiple habitat and intervention types) and benefit valuation (cost-benefit and return on investment estimates) (Id.).

The CDP (formerly the Carbon Disclosure Project), an international organization focused on private-sector environmental stewardship and disclosure efforts, estimates that the cost of inaction on water security is five times the cost of action.[144]

The growth of net-zero and net-positive pledges holds considerable promise in general, but also provides the impetus for doing more of the quantification work and cautionary "guardrail" work (Lubber, 2021) that have equal applicability to the public sector if invoking net-zero pledges. Corporate dollars are often more flexible and faster to obtain than public funding, albeit at a smaller scale. These projects also can be useful as part of a larger public/private combination of funding (as in the North Yuba Forest Partnership) or can be used as a pilot to demonstrate the concept, which can then support greater public or private investment at a larger scale (Kammeyer, 2022).

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140 LimnoTech applies the "volumetric water benefit accounting methodology" that some corporations calculate in house (WRI, 2019; Kammeyer, 2022).

141 See also Logan, J.R., 2016, "Influx of corporate dollars could mean more restoration in Valle Vidal," Taos News, October 27, 2016: *https://www.taosnews.com/news/influx-of-corporate-dollars-could-mean-more-restoration-in-valle-vidal/article_4e53acc3-2be2-5cb7-824a-70cf29fc42d7.html*

142 See CEO Water Mandate: Benefit Accounting of Nature-Based Solutions for Watersheds (*https://ceowatermandate.org/nbs/*) for a description of their efforts generally with respect to water supply and quality quantification and their multiple products. The next phase of the project will involve methods of benefit estimation and evaluation to better illuminate those benefits.

143 As Carla Muller-Zantop of Danone noted at a webinar hosted by the CEO Water Mandate, TNC, and Danone, the lack of a standardized approach limits investment because responsible companies do not want to claim benefits that are not likely to be real. Adding standardization, even if more specific assessment is later needed in specific cases, will spur investment. The audience for the tool is the private sector, but the public sector, NGOs, investors, international development banks, and academia will benefit from the tool in many ways. The example given was in Indonesia, where the work centered around wetland benefit accounting plus carbon accounting for various restoration projects across the watershed (webinar attended by author, March 4, 2021).

144 Carbon Development Program, 2020, "A wave of change: The role of companies in building a water-secure world: Global Water Report 2020" (*https://www.cdp.net/en/research/global-reports/global-water-report-2020*). The report focuses on reduced emissions from the water sector's 10% contribution to global carbon emissions primarily but notes the role and importance of wetlands and other nature-based solutions to achieving carbon neutrality.

These corporate net-zero and net-positive pledges have the potential to drive considerable funding to NBS of all kinds. To gain the most benefit from these efforts, issues of quantification and questions of ecosystem value and social justice need to be considered (Lubber, 2021). For example, projects that plant tree plantations to store carbon but that do not take into account ecosystem function can cause significant harm in the course of otherwise laudable carbon sequestration. Similarly, projects that displace indigenous communities, or do not respect local communities of all kinds, can have adverse social and environmental consequences. As the welcome interest in NBS grows around the world, increasingly there will be calls to make sure that those projects provide co-benefits, like water quality and supply benefits, rather than causing untoward consequences.

Groups skeptical about corporate net-zero or other crediting programs are raising issues of greenwashing and are calling for strict standards. In response, or anticipation of or agreement with these concerns, other entities such as the CEO Water Mandate, Ceres, the International Union for Conservation of Nature, University of Oxford, and others are in the process of developing quantification metrics or standards to apply to these pledges.[145]

This is an arena that those interested in fostering climate/water-related restoration projects should watch and engage in.[146]

PART 2: Barriers and Technical Needs to Encourage Greater Use of Nature-Based Solutions as a Climate Strategy With Multiple Benefits

Barriers

Barriers to the adoption of NBS that benefit carbon and water objectives include the lack of adequate quantification, lack of standardized methods of quantification or formal quantification protocols, legal and political barriers, and other issues.

The lack of adequate quantification or established methods for quantification is perhaps the most important and complex challenge for both carbon reduction and water supply/quality efforts with any kind of crediting or net-zero pledge attached. While exact quantification is not necessary for all policy judgments or funding vehicles, a more robust and established set of measures and tools can help build confidence in and support for innovative policies to integrate NBS into carbon policies, water supply/quality policies, and policies that can implement both. In the context of a regulatory offsets framework, quantification needs are greater for the reasons discussed previously. Better quantification can support, help prioritize, and drive investments in the voluntary offset or net-zero context and will become even more essential as the field grows in visibility. Better quantification can also help make the case for direct public investment.

Water Quality Quantification

In the water quality arena, quantification has occurred in varying ways for years. The most celebrated cases for water quality benefits of upstream watershed protection involve avoided filtration costs. The US Environmental Protection Agency (USEPA) allowed New York City to avoid the expense of filtration of water brought from its upper watersheds because of its extensive efforts to protect the watershed from human incursion and attendant pollution sources.[147] USEPA allowed San Francisco to do the same, and Boston, Seattle, and Portland, Ore., have similar status (WQP, 2018). USEPA and many states have also expended substantial grant funds on land protection measures, such as fencing livestock away from streams, through nonpoint source control grant

145 See discussions re: "Barriers" in Part 2 below.

146 The California Water Action Collaborative is one model where NGOs and corporate entities are seeking to expand opportunities to make positive water progress in the private sector. See California Water Action Collaborative website: *https://cawateraction.org*

147 See decision by USEPA Region 2, 1999. Filtration Avoidance: *https://archive.epa.gov/region02/water/nycshed/web/html/filtad.html*

funding under Section 319 of the Clean Water Act. The US Department of Agriculture (USDA) has a whole suite of programs to support water quality improvements that stem from agricultural practices (e.g., planting buffer zones between crops and waterways) through the Natural Resources Conservation Service and other programs.[148] USEPA and various states have also extended the use of State Revolving Funds for the purchase of lands for managed forestry or wetland restoration purposes that will yield water quality benefits.[149] Programs for "mitigation banking" by preserving or constructing wetlands in exchange for permits to impact wetlands that are issued by the US Army Corps of Engineers involve quantification.[150] Perhaps the most well-known example involves the active nutrient trading programs on the Chesapeake Bay, which have quantification methods that are robust and widely recognized.[151]

Water Supply Quantification

In the water quantity arena, efforts are underway to identify and calculate the volumetric water benefits of upstream conservation and management activities including mountain forest and meadow vegetation management and restoration. This work is challenging for a variety of reasons and is highly dependent upon specific local circumstances (Wiltshire, 2021a). Nonetheless, progress is being made in standardizing methodology. For example, a recent joint working paper by World Resources Institute (WRI), LimnoTech, and others identified a standardized approach that could be applied in various circumstances (WRI, 2019). LimnoTech's work is similarly employed in ongoing forest management programs across many states, including the Taylor Project mountain meadow restoration mentioned above. The work of Roger Bales and colleagues at the University of California, Merced is also at play in the North Yuba Forest Partnership and has been used to make the case for active management and restoration of forests to achieve improvements in the timing and quantify of flow in the Sierra as well as elsewhere. The UC Merced program has done extensive work related specifically to forest health and water supply.[152] Similarly, the American Rivers study mentioned above of 15 mountain meadows in California seeks to quantify the interplay of water and carbon benefits.[153] The benefits of mountain meadow restoration, including beaver dams and beaver dam analogs, for water supply are also frequently extolled, but there is not a standardized method for quantification, and, as with carbon, or water quality, the quantification is site specific (Burke et al., 2021). The Bonneville Environmental Foundation has an extensive program to help corporations, farms, and others calculate their water savings, as well as water flow replenishment.[154]

Much of the work that has been done in this arena has been done through modeling, which is necessary to understand the counterfactual (e.g., what would have happened without an intervention), but still considered by some to be inadequate for precision (Khan, 2021).[155] Improvements in modeling, guided by blending detailed ground-based and satellite measurements, are providing

148 See, e.g., Natural Resources Conservation Service website: *https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/climatechange/* National Water Quality Initiative website: *https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/financial/eqip/?&cid=STELPRDB1047761*; and Environmental Quality Incentives Program website: *https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/*

149 See, e.g., Yurok Tribe forest/carbon/water project described in Appendix B.

150 See Army Corps of Engineers Mitigation Banking website: *https://www.nae.usace.army.mil/Missions/Regulatory/Mitigation/MitigationBanks/*

151 See, e.g., USEPA Website: Trading and Offsets in the Chesapeake Bay Watershed: *https://www.epa.gov/chesapeake-bay-tmdl/trading-and-offsets-chesapeake-bay-watershed*

152 UCMerced Newsroom, "New Tools Indicate How Thinning and Fire Affect Forest Water Use and Boost Runoff," July 29, 2020 (*https://news.ucmerced.edu/news/2020/new-tools-indicate-how-thinning-and-fire-affect-forest-water-use-and-boost-runoff*) (noting a series of articles by the Sierra Nevada Research Institute regarding the use of remote sensing to make the water quantification assessment). See also Roche et al., 2020; Bart et al., 2021.

153 Other entities mentioned by interviewees included EcoMetrics (Ed Pinero), Ecometrix (out of Seattle), Natural Capital Project, Green Climate Fund, IUCN, UNEP Global EbA Fund and others.

154 See Bonneville Environmental Foundation website, "Business for Water Stewardship": *https://www.b-e-f.org/programs/business-for-water-stewardship/*

155 Kate Brauman also observes that "in practice we don't see what you'd expect from modeling, perhaps because modelers are more optimistic…" noting that "ecosystems aren't static" and referring to Anna Lintern's (Lintern et al., 2020) work evaluating the impact of NBS on water quality (Brauman, 2021).

actionable data to inform decision making.[156] There are pilots being undertaken by the California Natural Resources Agency for the Trinity, upper Sacramento, McCloud, Pit, and Feather rivers to establish a comprehensive understanding of forest management and restoration needs.[157] These efforts are intended to provide underlying baseline data for monitoring and assessment outlined under AB 1492 (Moreno et al., 2018) and identify priority areas for restoration, and that also can be used to monitor response to management actions (Khan, 2021). Research and lessons learned under the French Meadows and North Yuba restoration programs within the Tahoe-Central Sierra initiative planning area are informing scaling strategies for forest restoration (Edelson et al., 2019).

As noted earlier, the level of quantification required may vary based upon the context in which the information is needed. In the case of GHG emissions quantification, the degree of precision necessary for a regulatory offset or other regulatory decision will be higher than for a voluntary measure or for a policy decision on where to spend public funds to achieve a goal, particularly a multiple-benefit goal for which one can value a project for its many benefits rather than a single one. In the water quantification arena, this is true as well. "When decision-makers need only general hydrologic information about the direction and magnitude of hydrologic impact, either to reaffirm their commitment to investing in NBS or to convince others, simple models with well-understood limits to accuracy often suffice" (Brauman et al., 2021, p. 144).

The multiple-benefit standardization work led by the CEO Water Mandate also focuses on water targets--at a preliminary level adequate (for now) in the voluntary arena. This same work holds promise for making the case in the public investment arena.[158]

Climate Benefit Quantification

Quantification of the climate benefits of NBS has both a substantial body of work behind it and has some significant challenges. The degree of quantification necessary, for example, to justify a regulatory offset or purchase a credit in the voluntary registered market like that run by The Climate Registry, for example, is far higher than the degree of quantification necessary to make a case for inclusion of land-based restoration work in climate policy generally or making a policy decision about the wisdom of providing public or private funding to a project.

Part of the challenge is that it is more difficult to calculate either avoided emissions or the sequestration value of protecting or restoring a forest (or protecting or restoring a mountain meadow or implementing specialized agricultural practices) than it is to measure avoided emissions out of a smokestack or tailpipe. With the need to demonstrate "permanence," "additionality/ no leakage," and ongoing monitoring also comes additional expense. And, because each project is different in terms of climate, geology, hydrology, etc., each project's value needs to be calculated individually, and monitored individually, to derive any financial investment benefits for the work to be done. That work needs to be re-done and validated annually or every 5 years depending upon the circumstance (see, e.g., Delta Conservancy and Yurok Tribe examples described in Appendix B).

This is not to say that no work has been done in this arena. A considerable amount has been done to support regulatory and voluntary offsets, particularly in the forestry sector, but it is labor and financially intensive, especially if looking for a regulatory credit. The U.S. Climate Alliance's Natural and Working Lands Challenge is one such effort of many to improve inventories and measurement. The International Union for Conservation of Nature in partnership with Oxford University recently announced a project to certify NBS to assure that NBS contributions are legitimate and substantial (Oxford NBSI, 2021).

156 See for example, the publicly available decision-support tools and data developed by the Center for Ecosystem Climate Solutions: *https://california-ecosystem-climate.solutions*

157 See AB2551 (legislation directing studies): *https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB2551*. See also Saksa et al., 2020.

158 See UN Global Compact (2019). See also Mandle et al. (2019).

More and better quantification work will help make the case for voluntary credit programs that can drive or support private- and public-sector investments. In the forestry arena, investments in certain locations, whether in the regulatory context or the voluntary context, will yield greater carbon benefits in wetter environments where trees may grow more quickly. On the other hand, regardless of climate, developing quantification at a more localized level can help drive investment by private-sector entities who operate in that locale or have customers who will be motivated by multiple benefits (e.g., customer or staff loyalty, community reputation, or climate or water benefits within a watershed in which they work). In addition, the rapid advance of remote sensing tools using satellites will assist tremendously with quantification and monitoring, with capacity to gather information related to forests, meadows, their health, and the impact of various interventions.[159]

The evolution of thinking about quantification outside the regulatory context is striking, as more and more of the international, national, and state discourse moves toward voluntary or a more integrated climate policy. Instead of looking for credits, many have suggested that looking at natural working lands is about "future proofing" to avoid big emissions from wildfires, or to enhance watersheds, or to mitigate other disruption. Making the case for public or private funding to reduce the risk of catastrophic wildfire requires some level of quantification, but not to the extent than an offset would (Holst, 2021). California's recently adopted NWL Climate Smart Strategy prioritizes development of the science, measurement, and monitoring tools that will help make public investments more likely to yield the carbon reduction and other benefits sought over the long and short terms. Other states, as noted earlier, are also hoping to develop greater quantification or other tools to leverage public or private sector investments in NWL.

Multiple Benefit Quantification

Quantification across multiple benefits, e.g., across climate and water, is even less well developed. Nonetheless, there are encouraging efforts to "build the case" for nature-based solutions of all kinds across the spectrum of benefits, including climate and water. This is particularly important in this space because NBS may not be seen as cost-effective in the sense of a dollar per unit of carbon reduced or an acre-foot of water gained or slowed or protected, despite these benefits being considerable if taken together.[160] Oftentimes, policymakers can "know it when they see it" and support programs and policies that provide win-wins. Examples include the hundreds of millions of dollars allocated by California under its California Climate Investments (CCI) program—funded by its cap-and-trade regulatory program—for forest management, healthy soils, meadow restoration, and other programs. As explained earlier, the largest portion of the program devoted to natural working lands funds forest restoration programs to avoid wildfire for the multiple benefits of saving lives and property; preventing destruction of biodiversity, protecting against downstream water pollution and future flooding; and avoiding the massive carbon and other air pollution attendant to extreme wildfire. The program also funds healthy agricultural practices to sequester carbon or avoid carbon and other air pollution emissions, and funds programs to protect nearby waterways or protect habitat for a variety of species. Significantly, the program has funded mountain meadow restoration to sequester carbon, provide water benefits, and enhance biodiversity, along with other social goods and services. The state has also funded these programs from other sources, e.g., general fund, bond funds.

159 The CTREES effort is one of many, with the capacity to track down to the tree level--and marvelous visualization tools (*https://ctrees.org/*) (Corey, 2022).

160 A recent example of multiple benefit analysis yielding results is in the field of solar energy over canals. Examining the issue on solely the water saved from evaporative loss or the energy produced by solar doesn't necessarily "pencil out," however, looking at the multiple benefits achievable yields a very different and more compelling picture. Recent analysis in California by teams from UC Merced and UC Santa Cruz led to a $30 million pilot project at a localized level. See Roth, S. (2021). "Solar panels on California's canals could save water and fight climate change," Los Angeles Times, April 22, 2021: *https://www.latimes.com/environment/newsletter/2021-04-22/solar-power-water-canals-california-climate-change-boiling-point*; McKuin, B., Zumkehr, A., Ta, J. et al. Energy and water co-benefits from covering canals with solar panels. Nat Sustain 4, 609–617 (2021). *https://doi.org/10.1038/s41893-021-00693-8*; Bales, R. (2022). "California is About to Test Its First Solar Canals," Smithsonian Magazine, February 25, 2022: *https://www.smithsonianmag.com/innovation/california-is-about-to-test-its-first-solar-canals-180979637/*

Although not required for CCI funding or for appropriation of public funds, quantification of these individual benefits helps make the case for their multiple benefits and ongoing support and maintenance. They can also support policymakers in making decisions that appear (and are) more grounded in data in the court of public opinion. Quantifying at least some of the benefits in a public-policy or funding decision can also help give policymakers a way to make important qualitative decisions in a way that has some quantitative rigor and helps prioritize tough budget decisions. In addition to the CEO Water Mandate work discussed above, there are a range of multiple-benefit methodologies and calculators available, but no "gold standard" or single tool that can be used in all circumstances.

Some examples of multiple-benefit assessment methods that include carbon include:

- **The CEO Water Mandate:** The CEO Water Mandate is a corporate water stewardship commitment platform run by the Pacific Institute and housed within the UN Global Compact.[161] The program is leading efforts to encourage and quantify efforts, including those utilizing NBS, to improve water supply and water quality by corporate players and is explicitly incorporating climate benefits as well.[162] More pertinent to this report, they are also leading considerable and important work to standardize guidance across a range of environmental benefits, including carbon and water, as part of a multiple-benefits tool (CEO Water Mandate, 2021; CEO Water Mandate, 2020). The CEO Water Mandate has identified the lack of standardized methods for accounting for water and carbon benefits of NBS as one of many reasons why there is less investment in NBS than there could be, and they are engaged in a multi-stakeholder phased project to develop those methods.

  They have finished the first stage of assessing opportunities and landscapes, identifying barriers and evaluating existing frameworks for evaluating, measuring, and demonstrating the value of NBS benefits (CEO Water Mandate, 2020; CEO Water Mandate, 2021). They have also developed a standardized method to account for "stacked water and carbon benefits and identify wider co-benefits of NBS for watersheds" (Id.). Current stages of work look to build on the first stage and work by considering "benefit forecasting" (how different benefits accrue proportionately over time and across spatial scales spanning multiple habitat and intervention types) and "benefit valuation" (cost-benefit and return on investment estimates).

  The NBS Benefits Explorer tool allows organizations to identify and account for the potential benefits that could accrue from an NBS project. This tool presents linkages between NBS activities (e.g., removing alien vegetation) and the benefits that could accrue (e.g., improved habitat quality) across different habitat and intervention types. The tool also presents a series of indicators and calculation methods to estimate and quantify benefits after implementation. This tool help builds the business case for NBS, as it showcases the potential for benefit accrual across water quality, water quantity, carbon and climate, biodiversity and the environment, and socio-economic themes. Further additions to the tool's functionality are planned for 2022 and 2023, including benefit forecasting and valuation.[163]

- **Pacific Institute:** The Pacific Institute is a nonprofit doing a considerable amount of work at the intersection of water and climate, including significant work on multiple-benefit calculation. Their project "Moving Toward a Multi-Benefit Approach for Water Management" has developed multiple publications and guides. Their website contains information on their work and a resource guide to others doing such work (Pacific Institute, 2022; Diringer et al., 2020). The work focuses on water management but offers methodology to integrating multiple benefits for greening, equity, water supply, water quality, and other measures. It also acknowledges the importance of integrating qualitative values into a quantitative frame.[164]

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161 The UN Global Compact is a sustainability effort calling on companies "to align strategies and operations with universal principles on human rights, labour, environment and anti-corruption, and take actions that advance societal goals": *https://www.unglobalcompact.org/what-is-gc*

162 See CEO Water Mandate website (*https://ceowatermandate.org/about/what-is-the-mandate/*) for a description of their efforts generally with respect to water supply and quality.

163 Website: *https://ceowatermandate.org/nbs/*. See also Shiao et al., 2020.

164 Pacific Institute also houses the CEO Water Mandate.

- **Oxford University:** Oxford University's water program has developed a "Nature Based Solutions Initiative: Designing nature-based mitigation to promote multiple benefits" (Busch et al., 2013). The publication describes the scientific research that can bolster the case for ecosystem protection and climate policy. It also describes how achieving multiple benefits can in turn increase the sustainability of and investment in nature-based mitigation. IUCN is a partner in this effort.
- **The Natural Capital Project:** The Natural Capital Project, based at Stanford University, has done considerable work quantifying and building the field of "ecosystem services" through projects around the world.[165] The group has piloted its InVEST software, which can be applied in specific locations, and is currently working on integrating satellite remote sensing data into its models. Much of the group's work centers around water security for downstream users, but it also addresses water quality, although not particularly in the carbon sphere (Daily, 2021).[166]

The work to assess both water and climate benefits from nature-based solutions is still developing. As Kate Brauman put it, "We still have bits and pieces out there, but not a framework for how it could all fit together.… People talk about different things but don't really realize they are talking about the same things. We also have examples that scale up from individual projects to watershed-scale impacts" (Brauman, 2021). Even within carbon evaluations being done, for example, in the forestry sector, it does not appear that efforts are being made to include wetland or meadow features or restoration opportunities in forest surveys.[167] This is a missed opportunity.

Given the uncertainty of quantification at this point in time for water supply benefits and carbon sequestration benefits, a multiple-benefit approach may yield the greatest opportunity by allowing projects to "stack" benefits vs. looking to strict quantification protocols (Brauman, 2021).

Political Barriers

In addition to the detailed and expensive work necessary to obtain approval of regulatory offset protocols, regulatory offsets also generate broader public controversy. As explained above, and in detail in Appendix B, challenges to the use of offsets range from concerns about whether they are legitimately quantified reductions, whether regulations are a preferable way to go, and whether offsets have the pernicious effect of allowing greater pollution loads in disadvantaged communities.

To the extent that NBS are used as a source for regulatory offsets, controversy deepens (Boyd, 2021).[168] The controversy comes in many forms, but two stand out. In one series of arguments, the need for emissions reductions is so great that the ability to purchase offsets elsewhere at less cost is seen as an inadequate substitute for compelling emissions locally. In essence, the argument, expressed frequently but not exclusively by environmental justice advocates and noted previously, is that a scheme that allows industry to purchase credits in essence enables them to emit more pollutants locally, with negative consequences to the nearby community.

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165 Natural Capital Project: *https://naturalcapitalproject.stanford.edu/?gclid=Cj0KCQjw-4SLBhCVARIsACrhWLVgzAfPI8KBdjg_dF0YZ9Aj594JztYaz6A45qtM4WSIh-wz58OoefkaAlkQEALw_wcB*

166 They have authored many papers in this area, including "Green Growth That Works," which includes a chapter on Water Funds. They have done less work in the carbon arena.

167 Comments of Sarah Marshall (Colorado Scoping Session—Meadows and Wetlands, 2021). At least one carbon registry appears to be moving into capturing water benefits of some kind. See, e.g., VERRA: *https://verra.org/vcs-and-socialcarbon-join-forces-streamline-development-multiple-benefit-carbon/*

168 See also, Budryk, Z., 2021, "Bipartisan agriculture climate bill clears Senate," The Hill, June 24, 2021 (*https://thehill.com/policy/equilibrium-sustainability/560073-bipartisan-agriculture-climate-bill-clears-senate*) (noting passage of a bill to provide support for carbon mitigation and sequestration efforts by agriculture, but also noting the controversy within the conservation community that such credit allows industrial emitters to forgo reducing their own emissions).

In addition to these and other objections in principle to the use of regulatory carbon offsets, other commentators and advocates question the validity or stringency around the rules that govern the calculation of credits and argue that they are a less certain, or even a corrupt, method of meeting our urgent climate goals.[169] While one can continue to debate the merits of these arguments, from a political perspective, as one interviewee who didn't want to be cited put it, "that train has left the station," as states like California strictly limit their once more open-ended use of offsets and others, including the federal government, shy away from cap-and-trade policy proposals.[170]

This is not to say that the use of voluntary offsets, or even net-zero pledges, are without political controversy; it is simply that the controversy is far less acute. "As we delink from offsets, demand goes down for precision" (Boyd, 2021). Nonetheless, while "voluntary" actions may require a less stringent level of precision in quantification, increasingly there are calls for it to be more standardized, validated, and stringent both from the environmental community and in the corporate world. In the corporate sphere, e.g., those seeking to meet net-zero goals, there is a desire for more standardized methods to facilitate prioritizing investments over greater landscape scales to get the most bang for the proverbial buck (CEO Water Mandate, 2020), and to avoid charges of "greenwashing."

Legal Barriers

Legal barriers can also inhibit the use of NBS, such as through concerns that water rights holders downstream of forest or meadow restoration work can be affected by restorative actions upstream — although there is also an argument that slowing the flow for later release is beneficial to downstream users, as well as other arguments that environmental restoration activities (vs. new extractive development) should not be inhibited by a downstream users perceived benefit from that degradation.[171] Other legal limitations can include concerns over liability for damage caused by restoration work if it causes flooding to adjacent lands, which has inhibited the easy acceptance of restoring beavers to a landscape.[172]

Other Barriers in Practice

There are other barriers that can make implementation of NBS challenging in general and in the context of carbon or water objectives. Those include:

169 As noted elsewhere, there are different levels of offsets (regulatory, voluntary) and different rules in different jurisdictions (California, Europe) which are sometimes conflated with one another.

170 As noted elsewhere, this discussion is not meant to debate the merits of these strongly held beliefs one way or the other. Studies have been done to show no such impact, and other have been done that found the opposite. Other trading programs have shown remarkable effectiveness and cost effectiveness (e.g., acid rain program). They are raised in this report simply to flag the issue as a significant limitation on large amounts of funding for NBS in the Colorado River Basin coming from this particular source. Decoupling conversations about NBS and climate from the offsets debate also allows for a more free discussion about the larger opportunity and necessity of including a more robust NBS program into any effective climate policy (Boyd, 2022). This report argues that states should affirmatively embrace, expand, and support programs to incorporate NBS into their climate policy and that public and private funding from many sources should be found to implement them.

171 This is currently a live issue of discussion in Colorado, which is a heavily quantified state in terms of its water resources. In other states, and in communities in Colorado as well, restoration is considered a net plus for its potential to beneficially affect the timing of flows, provide wildfire breaks, and other things that benefit the community, including downstream water users.

172 As noted earlier, states have found ways to support the reintroduction of beaver while compensating or otherwise protecting adjacent landowners.

- **Funding:** Lack of up-front capital and the need for long-term operation and maintenance funding can inhibit the development of NBS projects. Significant administrative costs also come with managing complex multimedia projects with many funding sources. Even with the expanded funding from the federal government in the Infrastructure Investment and Jobs Act, experts estimate that the funding needed to deal with the hazardous fuel loads even just in federal forests is two to four times current spending per year (or over $12 billion/year) (Boyd, 2022). (The Forest Resilience Bond measure used by the North Yuba Forest Partnership is one innovative and important response to this challenge.)[173]
- **Scale:** To be effective, these projects should be done at a landscape scale rather than piecemeal. The challenge is in assessing how to do this work at large enough scale to matter, but small enough scale to get folks to relate to and support the project, and to get it funded. Some of the mapping and assessment projects, such as the TNC Colorado/New Mexico assessment project, may lay a foundation for a broader scale, landscape scale vision of projects, as would the mapping and environmental study recommended below.
- **Duration of projects:** The fact that these projects may take a long time to construct and show benefits is a significant challenge. They may require ongoing maintenance and monitoring that requires staffing and continuity. In the offset context, this adds a significant level of ongoing costs. As noted, if going for formal carbon credits, there is a need for yearly validation (or sometimes a bit longer), which can be costly and time-consuming, or may require a longer-term commitment than a landowner may wish to take on. Even in the non-offset context, the work must be done over decades just to lessen the impact of forest loss due to massive wildfires, let alone adding to carbon sequestration (CARB, 2022).
- **Separation between ownership and operation of land:** A situation in which a different person owns the land than does the work can make implementation and maintenance of a project challenging and less certain in duration.
- **Ownership:** Particularly in the forest context, a huge percentage of land in the West is in the hands of the US Forest Service, which requires specialized agreements to allow others to implement forest management on its behalf. Given the uncertainty of year-to-year funding for operation and management of forests, the USFS can handle a small fraction of the forest restoration made necessary by decades of inadequate or inappropriate management. As mentioned earlier, relatively recent legislation has opened the door for innovative financing and delivery systems where other parties can invest in financing and third parties can accelerate work on the backlog of maintenance. States, operating within their climate, water, and public safety policy vehicles, can and do invest in restoration of USFS lands as well as their own as in the North Yuba Forest Partnership and Denver Water projects noted above. Building a stewardship culture vs. a firefighting or extraction culture is also a piece of this, whether at the federal or state forest management level (Wiltshire, 2021b; Wright, 2021).
- **Practical ability to process cleared vegetation:** There are not yet well-developed markets for the vegetation removed mechanically in forest management, much of which is not marketable by traditional timber operations. There is a need to create businesses that can economically transport and transform that biomass into usable and salable material. Because of remote location, transport costs can be especially high, and markets for resale or goods made from the removed vegetation take time to build. The cost is high, and the workforce and entities for processing the material are hard to find, but can be developed. (Wiltshire, 2021b; Lessard, 2021b).

173 See also National Forest Foundation, 2021, "The Forest Resilience Bond: A Tangible Solution to the Wildfire Crisis": *https://www.nationalforests.org/blog/the-forest-resilience-bond*

- **Permitting challenges:** While permitting expense and uncertainty are present in any physical project, they can be particularly challenging for restoration projects on a tight budget.[174]
- **Need for greater interagency collaboration across silos:** This is a problem in any project that involves more than a single entity but is worth noting because it requires focused attention, skill, and specific support to deal with an organization's natural inclination to want to control projects (Tett, 2015; Rosenblum et al., 2022). Interagency work requires a high level of communication and specific attention to issues of governance, economics, regulation, liability, and other factors. NBS are more complex than building a "gray infrastructure"[175] project and frequently require ongoing maintenance and agreements. The California NWL Climate Smart Strategy is an illustrative and encouraging vehicle for building a framework for multiple agencies to engage across sectors to deal with land-based climate efforts. Efforts are needed to bring together agencies at all levels of government, along with NGOs and the private sector, to rise to this challenge, particularly in project implementation.
- **Staffing:** Enhanced staffing is needed—in the public or private workforce to do the implementation work; in the agencies coming up with the plans, reviewing permits, or in charge of delivering funding; and in organizations of practitioners in the field looking for water and climate benefits, developing metrics, and envisioning or implementing projects.
- **Lack of broad public awareness about the value and potential of these projects:** "Fire and water are how climate reaches people" (Bowman, 2022). The amount of funding and organizational effort required for NBS is considerable, so public support is essential. A concerted effort at communicating the value of NBS to protecting communities, fighting climate change, and providing water benefits would go a long way toward greater investment by the public sector in these projects as well as incorporation into climate planning.
- **Lack of awareness of potential economic impact of doing this work, or <u>not doing</u> this work:** There is potential for rural economic development in doing much of this restoration work, and there are economic consequences to not doing it and having more forests go up in catastrophic megafires with the attendant loss of life and property and destruction of communities. The financial impact of sedimentation from fires that motivates Yuba Water and Denver Water is similarly huge. Yuba Water and Denver Water's leadership recognize the cost of cleaning up after wildfire and have invested accordingly. Traditional measures of dollar per additional acre-foot of water or potential carbon reduction per dollar spent alone cannot make the case for the level of investment required. Economic studies that demonstrate the cost of inaction/cost of wildfire to communities as well as the potential economic benefit of creating an industry to do ecological forest and other landscape management can help make the case for investment so that more people and organizations can gain insight as to where their economic interests lie.

174 Managing through environmental review and permitting processes can be challenging, although important for many reasons. One encouraging step toward streamlining the many agency permitting processes in the restoration process is in California, where Sustainable Conservation spent several years working closely with the National Marine Fisheries Service, the US Fish and Wildlife Service, the California Fish and Wildlife Department, and the State Water Resources Control Board to develop a streamlined permitting process for certain kinds of restoration processes (Sustainable Conservation, 2021).

175 "Gray infrastructure" frequently is used to describe "brick and mortar" or concrete engineered construction, while "green infrastructure" refers to more natural systems, such as using wetlands for water treatment or capturing stormwater. For example, building a dam or a levee would be considered "gray." Creating a floodplain setback to dissipate flood flow would be considered "green."

Technical Needs

These can be considered as a preliminary list of suggestions that will address some of the barriers noted above but are presented separately as research and implementation needs.

Quantification Work

There is value both in quantification that reaches the carbon "protocol" level necessary for regulatory offsets and for quantification that reaches the level used in the voluntary marketplace or in other voluntary contexts. Considerable value also exists in the even less precise quantification required to make the policy argument for investment by government or other private or public interest investors (e.g., California CCI funding, socially responsible investors, the voluntary credit market, net-zero corporate pledges). Nevertheless, more support for all kinds of quantification of climate and water benefits is necessary to enable NBS work of all kinds to grow in this multiple-benefit space. Some examples of need include

- More research on quantifying qualitative "goods," or articulating how to factor them into good policy (see, e.g., Diringer et al., 2020).
- Whether considering forests, rangeland, healthy soils, or mountain meadow, improved methodologies, pilots, and case studies will build the case and make quantification more reliable over time.
- While methodology to explicitly assess the multiple benefits of NBS is being developed and standardized at a more global scale to facilitate greater investments particularly from the private sector (CEO Water Mandate, 2021), quantification at a more specific and regional scale is also necessary to justify investments for both carbon and water benefits of specific projects or to drive programmatic investment at the state and federal level. Quantification is necessary to better elevate public and policymaker awareness of the benefits of restoration work to achieve climate and water goals. This can be done at a specific project level and can also be done at more "regional" scale, e.g., by targeting parts of the upper Colorado River watershed. This is true for the range of landscapes.[176] Efforts like the detailed Delta wetlands quantification protocol (Appendix B), the multiple meadow study being done by American Rivers, the Taylor River Watershed Beaver Dam Analog & Restoration Project, and the North Yuba Forest Partnership monitoring results will give greater heft to the argument for NBS than aspirational arguments. The ongoing TNC/U.S. Climate Alliance inventory study will help draw focus to the opportunities in the Colorado River Basin. Specific studies that dive into specific locations will help draw attention and dollars.

Data and Measurement Tools

- Water supply and water quality results from changed forest, changed agricultural, or ecosystem restoration practices need more robust measurement to demonstrate value over time. The same is true for climate benefits.
- Measurement devices can give more life and strength than modeling to show the water supply benefits in particular (Khan, 2021). This can be a combination of stream gages, remote sensing, and other tools that can paint a more realistic picture of what this work on the ground can do. It will also help with calibrating and validating models over time.
- Remote sensing technology in particular is increasingly being used to assess water flow, find beaver complexes, and other features in a relatively cost effective way. Developing and integrating this tool into the nature-based solution story can be helpful.[177]

176 One method to deal with the uncertainty in quantifying natural lands (because "nature is not linear") is to do the best one can, and then apply a "discount" to be safe (Perciasepe, 2021). However, the better the quantification, the better the case to be made.

177 Jim Wilcox of the Sierra Meadows Partnership suggests that big data of all kinds can be used to assess trees and "green-ness" while looking for meadows and meadow restoration opportunities. This data can be fed into fire behavior models to assess the value of meadows in resisting and preventing fire. He calls for a suite of investment in "high-tech tools" (Wilcox, 2021).

- Monitoring is key. Ability to assess whether promised water or GHG improvements are maintained over time requires active measurement.

Mapping

At present, there are no readily available mapped opportunity landscapes at scale in the upper Colorado River Basin. Focused comprehensive study of a specific area, complete with maps, can better make the case for projects. For example, studying the best locations for meadow/wetland restoration or preservation in specific locations in the upper Colorado River watershed that integrate climate and water benefits could be extraordinarily helpful. The TNC/U.S. Climate Alliance project holds great promise and needs to be supported, replicated, and expanded upon by taking their assessment of the possibilities, and targeting the best ones for water, climate, or other benefits. Similarly, it would be immensely helpful to take some of the great work being done on assessing NBS potential for water (see, e.g., Corday, 2020) and add a climate lens. Similarly, adding a water lens to work being done to assess climate benefits from NBS can make a more compelling story for action and investment.

Institutional Needs

While there are people and institutions in the upper Colorado River Basin that are interested in NBS, climate, and water, they are neither connected at scale or focused on the opportunities to combine climate and water together (with exceptions). Case studies and an inventory of models for successfully doing this work can also help to accelerate and demystify the complex relationships and agreements necessary to develop, promote, and accomplish multiple-benefit projects. It is natural for organizations to want to develop and work on projects within their control or in their specific area of expertise. To accomplish the type of projects necessary to achieve synergies between climate and other benefits in land-based work requires working across traditional organizational lines and specialties (Rosenblum et al., 2022). They can also require legislative or regulatory instruments, such as the provisions that allowed the USFS to enter into agreements to have non-federal partners implement forest management projects on USFS land mentioned above. There may also be a need for new organizations to be developed to achieve efficiencies, to aggregate voluntary or regulatory credits, and/or to help projects achieve formal protocols or register credit or net-zero pledges in registries.

Funding

Funding, both public and private, is needed for technical assistance and predevelopment of specific projects as well as implementation and monitoring. This includes the technical work of developing quantification, mapping, and projects. Naturally, project implementation is another category requiring greater funding. Significantly, operations and maintenance funding to manage NBS over time can be more challenging to obtain than capital dollars.[178]

A significant funding gap exists within state agencies themselves. Staffing is inadequate to even develop state climate policies in this arena as fully as it should be. For example, in the Colorado development of the NWL plan directed by the Colorado Roadmap, staffing is limited. The same is no doubt true in many other states. Nature-based solutions are complex and require integration between agencies and the public and private sectors and it takes staff with adequate resources and time to meet across institutional and sector divides to make progress.

178 There is an entire field of finance expertise in both the private and public sectors working on developing funding streams for planning, construction, operation, and maintenance of land restoration projects. That is beyond the scope of this report, although it is critically important to support visioning, planning, and implementing projects. For a good summary, which could be added to almost daily, see Liquid Assets, 2015. Other groups focusing on innovative funding in this intersection include Blue Forest Conservation, discussed elsewhere in this report, and Quantified Ventures (*https://www.quantifiedventures.com*). Another group to engage would be the Conservation Finance Network (*https://www.conservationfinancenetwork.org*).

PART 3: Recommendations to Advance Climate Policies that Deliver Multiple Benefits for Climate, Water, and Other Good Things Through the Use of Nature-Based Solutions

The following list serves as a menu of actions that can support the integration of climate and water policy and projects in the Colorado River Basin.[179]

Recommendations to States: Policy, Research, Actions

States without an overall climate policy should develop one.

States should develop an overall climate policy that includes both traditional emissions reduction actions and land-based emissions reduction and sequestration to achieve overall carbon reduction vs. focusing on industrial and energy sectors alone. This is fundamental to achieving climate impact in the real world. This is happening at the international, national, and advanced state levels and needs to be accelerated. A big-picture climate policy should deal realistically and honestly with the climate crisis and it can yield multiple benefits, which is just good public policy.

State policy needs to recognize the multiple benefits accrued from NBS. By a single investment, multiple objectives can be reached, including improved water, sanitation, and other public health benefits, climate mitigation and adaptation, biodiversity conservation, livable cities and communities, food, fuel, and fiber provision, etc. NBS can help achieve these ambitions simply by providing multiple ecosystem services. (Brill, 2021b).

All states should aim for at least a net-zero climate policy.

All states should aim for at least a net-zero climate policy within a reasonable amount of time to keep pace with the international, national, and state trends (see, e.g., California carbon neutrality goal by 2045).

179 These recommendations are the recommendations of the author.

States should include NBS of all kinds into their climate policies as a complementary policy akin to their complementary energy policies.

This will enable states to honestly seize opportunities to avoid carbon emissions, to sequester carbon, and to adapt to climate change impacts in their state climate plans along with multiple benefits for water supply and quality, biodiversity, recreation, and the other benefits of restoration work. States with existing climate policies that incorporate or are beginning to incorporate NBS should include them in a more robust or comprehensive way. This is in addition to accelerating work on traditional emissions reductions and complementary energy policies. Tools can be regulatory, incentives, direct investment, or finance. A range of policies are possible, e.g.:

- Develop complementary policies to encourage multiple-benefit nature-based projects analogous to complementary policies that encourage the growth of low-carbon energy sources and energy efficiency. These plans should assess and acknowledge land-based emissions from outsized wildfires, unmanaged deforestation, agricultural practices, and loss of wetlands as emissions to be managed rather than leaving them out of the "pie charts" or other lists of emissions to be mitigated. (California is one example moving in this direction; Colorado and New Mexico have program development potential.)
- In lieu of or in addition to any carbon reduction or trading scheme, add targeted state funding investments for NBS that yield carbon emissions avoidance or sequestration, done in a way that can be quantified, monitored, and managed as part of a measurable carbon reduction/sequestration policy. Make this an affirmative "public works" effort of the state. Outsized attention to the role of land-based climate work in the offsets market has led to far less attention to the importance of doing this work for its own sake, and ours.

Even more specifically, states should identify and articulate the linkage between improved forest management for reducing extreme wildfire risk with climate and water benefits as part of an effective climate policy.

In many ways, the avoided economic cost and physical harm from outsized catastrophic wildfire may be easier to quantify or anticipate than the avoided carbon emissions, water supply and quality impacts, and rural economic and public health impacts. Given the opportunity to meet multiple objectives, incorporating water and other benefits can only grow support for greater investment in this space.

States should provide adequate support for staffing.

States should provide adequate support for staffing to develop and implement the appropriate policies, projects, and quantification protocols (or state process for adopting protocols developed by third parties). Adequate staffing is also needed to provide capacity to work with federal, local, private, academia, and non-profit partners. This work requires diverse partnerships and working outside traditional silos.

States should invest in quantification and mapping at the state or regional level of premier opportunities in the upper watershed.

States should undertake or commission mapping of climate mitigation and sequestration opportunities overlain with ecosystem restoration opportunities that provide water supply and/or water quality benefits. Such mapping can inform funding, integrate into climate policies, and drive private, philanthropic, and federal/state funding opportunities. It can create a portfolio of projects that are, if not "shovel ready," at least ready to be ready for funding opportunities. Build on existing efforts, e.g., the Colorado Natural Heritage Program at Colorado State University that has extensive resources on mountain meadows/wetlands in the state.[180] The Western Environmental Law Center has done mapping for wetlands invoking both climate and water benefits.[181] And, as noted below, non-profits like The Nature Conservancy have done some mapping and are doing more.

States should invest in improved quantification tools to measure climate and water benefits from NBS projects.

While there are quantification tools in process and in use, better tools can yield greater incentives for investing public and private funding into NBS that provide multiple benefits. States should invest in measurement in addition to modeling to assess water supply and water quality benefits of restoration of forests, meadows, and agricultural lands. Models are enormously useful as guides; measurement leads to efficient and effective implementation over time.

States should streamline permitting for restoration projects.

States should streamline permitting for restoration projects, particularly in the wildfire prevention arena to get more projects from vision to implementation. See, e.g., Sustainable Conservation's work to streamline permitting for restoration projects in California. (Sustainable Conservation, 2021). Another example of how to do this could include undertaking programmatic environmental reviews of large watershed areas that can make individual projects more strategic and less costly (Lessard, 2021b; Sierra Meadows Partnership group conversation). Doing this work at landscape scale is necessary to maximize benefits.[182]

180 In addition to other tools mentioned in this report, Colorado State University has a mapping tool that might be a base to build on. Comments of Sarah Marshall (Colorado Scoping Session—Meadows and Wetlands, 2021). See Colorado Wetland Information Center, 2021. "Wetland Ecological Systems of Colorado": *https://cnhp.colostate.edu/cwic/wetlandtypes/ecological-systems/.*

181 Western Environmental Law Center, "New Mexico Wetland Jewels": *https://westernlaw.org/defending-wildlands/protecting-public-lands/wetland-jewels-nm/*

182 California Natural Resources Agency also led a process engaging multiple agencies in speeding up permitting for ecosystem restoration projects in the San Francisco Bay-Delta as part of its "EcoRestore" program. The state also has a cutting "green tape" initiative to help speed permitting of environmentally beneficial projects. See also Environmental Science Associates, "Finding Common Ground to Advance Watershed Restoration in California's Delta and Beyond," and interview with Erica Lovejoy of Sustainable Conservation and William Harrell of the California Department of Water Resources (*https://esassoc.com/news-and-ideas/2019/09/finding-common-ground-to-advance-restoration-in-californiasdelta-and-beyond/*). See also previously described Sustainable Conservation-led multi-year process with numerous state and federal agencies to streamline permitting for land-based restoration practices ("Simplified Permitting to Accelerate Restoration," *https://suscon.org/project/simplifiedpermitting/*).

States should develop economic assessments of the potential for rural economic development.

States should develop economic assessments of the potential for rural economic development through improved forest management and better agricultural practices to promote climate and water benefits as appropriate to the state's situation and economy. States can also help develop markets for the material removed in forest wildfire prevention and restoration projects.

States should develop explicit policies that encourage or incentivize multiple-benefit projects that help both achieve climate and water goals and remove or amend those policies or rules that serve as barriers to implementation or funding of those projects.

States should prioritize projects with multiple benefits for funding, regulatory approvals, or other incentives—e.g., carbon reduction projects that also provide water benefits, or water management projects that also provide carbon mitigation or sequestration benefits. This prioritization can be done in a number of ways, either through explicit awarding of points in a scoring system, or through policy direction to funding agencies.[183]

States should encourage and develop financing to support NBS.

States should encourage and develop financing to support NBS through grants, loans, loan guarantees, or other methodologies that facilitate more rapid restoration and management of natural lands for climate and water benefits. These can go to water agencies, private property owners, and third parties doing the work (e.g., agreements between the National Forest Foundation and the US Forest Service, or partnerships with a state using USEPA State Revolving Loan or other funding to help support work). Similarly, states should advocate for greater federal funding, especially but not exclusively for work on federal lands, and states should engage private sector funders to fully leverage all available sources of funding. Some of the measurement noted above can also help draw private sector funding to projects, e.g., New Mexico's efforts to help agriculture quantify climate benefits.

States should develop the capability to work with federal partners.

States should develop the capability to work with federal partners to align state and federal funding to achieve a greater scale of NBS for climate and water benefits so as to be ready to apply for and receive federal funding, such as the Infrastructure Investment and Jobs Act, and other funding likely to be generated during the current administration. States should actively and strategically develop projects that could be funded (e.g., North Yuba Forest Partnership). As noted previously, Colorado has authorized funding and staffing for the explicit purpose of doing so.

183 For example, New Mexico gives additional points in funding for forest restoration projects for those that include other benefits (NM Task Force, 2019, p. 25).

States should incorporate meadow protection and restoration into studies, planning, and projects that involve forest management and restoration.

All forests have water features or the potential for restoration or creation of meadows that can retain and slow water flow, serve as firebreaks, and enhance the biodiversity and health of forest resources. Treating the two landscapes as separate with different management and funding is inefficient and misses opportunities to gain maximum water, climate, biodiversity, and fire prevention benefits.

States should expand resources devoted to meadow restoration and agricultural practices that yield climate and water benefits.

This report prioritizes forest restoration because that is where the greatest short-term funding opportunities and interest lies across the public and private sectors. However, growing programs in the non-forestry arena is also important for meeting climate goals and water needs.

States should develop programs to incorporate beavers, process-based restoration, and beaver dam analogs into their climate and water resilience planning.

States with barriers to such projects should eliminate them. Many states have developed programs that mitigate concerns of neighboring landowners. Enlisting "nature's engineers" can cost-effectively and charismatically accelerate the integration of climate and water objectives in a watershed.

Recommendations to Non-State Actors (e.g., Philanthropy, NGOs, Academia)

The following are recommendations for non-state actors wishing to advance and accelerate the use of NBS to meet climate and water goals.

Commission a state-by-state quantitative assessment of the contribution that NBS can make in meeting each state's climate goals to illustrate the magnitude of the opportunity.

This would help elevate the importance of the value of NBS as a key contributor worthy of elevated "complementary" strategy work and will be more effective in making the case than pointing to the California model alone. Projects done by third parties like The Nature Conservancy helped lead to California's evolved thinking, and the TNC/U.S. Climate Alliance Colorado/New Mexico project should create a foundation to build upon in the upper basin states. While states should definitely do this work, oftentimes third parties can move faster and elevate issues in a way that can lead to state action.[184]

184 See also, e.g., WFF, 2021 ("water atlas" mapping of nitrate and phosphorus pollution from cropland).

As recommended for states, above, undertake mapping at the state or regional level of premier opportunities in the upper watershed.

Third parties should undertake mapping of climate mitigation and sequestration opportunities overlain with ecosystem restoration opportunities that provide water supply and/or water quality benefits in the upper basin states. These can include forest and mountain meadow restoration or can target agricultural lands for which improved land management practices can achieve both climate and water benefits. Tangible mapping and projects can help make the case for policy changes and funding (and can accelerate private investment that can leverage more resources from both public and private sources and greater speed of implementation). While ideally done by the states, this effort should be undertaken even without state participation or as a collaborative effort (e.g., the TNC/U.S. Climate Alliance project is a joint project between Colorado and New Mexico and philanthropic entities).

Two examples from California illustrate the concept, which should be taken to the most granular degree possible, even beyond that shown here:

- A consortium of parties, including TNC and organized by Next 10, prepared an accessible study titled "Toward a Carbon Neutral California: Economic and Climate Benefits of Land Use Interventions." It paints a clear picture of the value of this work to the climate and economic interests in the state. It would be valuable to address these issues plus water in a visual and concrete manner for each state. Recommendations are very specific and include detailed mapping, modeling, and specific estimates of costs and benefits (Next 10, 2018).
- TNC also prepared a "roadmap" to accelerate action on nature-based climate solutions in California that is compelling and complete with maps and amply makes the case for co-benefits for water (California Roadmap, 2021).

Build a repository of projects that have been done or are being undertaken in key state watersheds and other analogous settings.

Support efforts to highlight/elevate the visibility of the compelling need to integrate NBS and land-based restoration/management into climate policies through public papers, media, and webinars at appropriate venues in each target state or across multiple states. Tell the evolving international, national, California, and other state stories.

- Show what's possible, including lessons learned.
- Share data to save other project proponents time and money and to build a community of practice.
- Build the case for conservation in pursuit of climate objectives that also yield water benefits.
- Organize promising projects by state and by type of landscape work undertaken, e.g., forest restoration/active management, wet meadow restoration, beaver dam analogs, and managed agricultural or healthy soil practices.

Support and develop pilot projects in selected watersheds to demonstrate the climate and water benefits of specific types of landscapes and in specific locations to continue to build the case for public and private investment and to provide opportunities to scale.

For example, the pilot in the North Yuba Forest Partnership very quickly led to a much bigger project across the watershed. That project will collect climate and water data all along the way that can help make the case for other projects elsewhere. Pilots can lead to landscape scale projects, taking NBS from theory to practice on the ground.

Help develop better tools that can help others make the case on a state-by-state or project-by-project basis.

Lend support to efforts on standardization, quantification, and integration of benefits from NBS generally, with specific emphasis on multiple-benefit assessment efforts (e.g., ecosystem services quantification).

While each landscape will differ in its capacity to provide benefits and customized assessments will be necessary to support specific projects, supporting efforts to find methods for standardized assessment of climate or water benefits (or both) in different landscape types can help to drive public- and private-sector investment at least cost (CEO Water Mandate, 2021).[185]

Convene people across geographies or disciplines to develop a "Community of Practice" at the intersection of climate, water, and NBS.

The power of convening and collaborating is critical in emerging issues, especially when those issues require working across traditional silos of practice like climate or water. For example, the Walton Family Foundation has supported a community of practice along the Colorado River to address river management issues, which has enabled greater effectiveness of stakeholders and greater visibility to a range of crucial river challenges and opportunities. Similarly, lending support for a cohort of stakeholders and experts to focus on NBS and its potential to yield both water and climate benefits in the watershed would make a big difference in this space. Reaching beyond traditional silos of practice to create broader communities of practice is necessary to realize the promise of multiple benefits and accelerate NBS. Some options could include:

- Support periodic convening of people working in this synergistic space from the governmental, tribal, private, and NGO sectors across the Colorado River Basin states for mutual support to accelerate creative solutions, draw public and private investment, and raise awareness of opportunities and methods to develop and implement NBS. Building a team of "dedicated people, institutions, and regulatory partners" can help lift this work in visibility and effectiveness.[186] Water experts need to learn climate. Climate experts need to learn water (and the value of NBS generally). Forest, meadow, and agricultural experts need to integrate their actions with each other wherever possible. All parties need to learn how to integrate equity and traditional ecological knowledge into this work.
- Support focused convenings of NBS, water, and climate public, private, Tribal, and NGO experts to discuss opportunities by region.
- Support teams to emulate the integrated climate and water focus of the Sierra Meadows Partnership in each state. The same could be done for forest management, or agricultural practices, e.g., rangelands, too.
- Support the development of a cadre of people working specifically on multiple-benefit approaches to land-based management that include both climate and water (for example, TNC's California chapter is shifting all their programs on climate to deliver on multiple benefits) (Passero, 2021). CARB is doing the same at a state level.

185 See also TerraCount, a joint project of the California Department of Conservation and The Nature Conservancy to create a tool that can model both climate and other co-benefits, including water, for California landscapes and should be replicable and adaptable in other states (TerraCount, 2021).

186 Comment by James Dalton, Director, Global Water Program, IUCN, April 19, 2021, at WRI Webinar – Using Forest-Water Connections to Accelerate Implementation of the NDCs: *https://www.greengrowthknowledge.org/webinar/wri-webinar-using-forest-water-connections-accelerate-implementation-ndcs*

- Support a key group of stakeholders and policymakers to follow the ongoing Scoping Plan development in California as it pertains to the state's natural working lands climate and natural resources policies (this is not to say "be like California"—but significant resources have already been invested there and more will be, so it is a useful process to follow for ideas, tools, and inspiration).
- Support water stakeholders to engage in climate policy development in Colorado and New Mexico specifically to assure that NBS is integrated more substantially into climate policy, and that co-benefits for water supply and quality are included as much as possible. Support for the limited staff working on these plans would be helpful.
- Support practitioners in NBS and the water space to follow private-sector efforts at quantification of NBS for both climate and water benefits (e.g., CEO Water Mandate, IUCN/Oxford University, and other work).

In addition to convening stakeholders generally, support efforts to convene federal, state, local government agencies to engage in this work together.

Governmental agencies frequently have strained budgets, or budgets that limit their ability to travel and to spend time developing relationships across agencies or levels of government. Philanthropic support can help make it easier for them to come together to build relationships, share data, and do the joint planning and projects that are essential to the rapid expansion of NBS that we need to meet the climate challenge. Efforts to do so have yielded progress in various locales around the country, e.g., Lake Tahoe, Colorado River Basin, North Yuba Forest Partnership, Chesapeake Bay.

Support funding measures at the federal and state level for NBS projects and convene private- and public-sector funding experts and policy leaders to accelerate innovative funding models.

While funding is growing in the NBS field, particularly for fire-prevention-related forest treatments, that funding is inadequate to the task before us.[187] Just as climate and water practitioners are in separate silos, the finance and policy sectors do not convene across climate, water, public sector, and private sector as often as we need to grow the funding toolbox. Creative solutions emerge from unusual connections, and those connections don't happen without assistance.

187 Think a "billion burnable acres" (Boyd, 2022).

CONCLUSION

There are tremendous opportunities to enhance the visibility, use, and funding for nature-based solutions in state climate policy. California provides one model that can be instructive. The international movement to take a more "net-zero" and more holistic approach to climate change that includes **both** traditional energy and production emissions and nature-based solutions can inspire action at both the national and state levels. This is a wave that state policymakers should catch. Moreover, while regulatory offsets can be limited in generating financial resources and are controversial, there are opportunities in the voluntary offset and climate and water net-zero arenas to generate funding for projects that can accomplish both climate and water benefits and lay a foundation for greater public investment at the scale needed to meet the climate challenge. Greater public investment on its own is growing at the federal and some state levels, but the need for even greater investment is enormous. Most promising from a variety of perspectives, the field of forest restoration to prevent catastrophic wildfires will (or should) attract considerable resources to protect life, limb, and property and reduce carbon emissions while also being capable of generating benefits for water supply and quality. Integrating other landscapes such as mountain meadows and certain agricultural practices into this work can yield significant benefits for both water and climate. To support the integration of these programs into state climate policy, the issues must be elevated in the policy arena and discourse. Doing so will require stakeholder education and engagement, and more work quantifying and illustrating the opportunities for both carbon and water benefits in landscape restoration. While it is not an easy lift, the opportunities are there, particularly in California, Colorado, and New Mexico, which are actively developing new natural working lands elements into their climate plans and who can serve as a model for others. At a time when the fate of our planet is at stake, NBS offers the opportunity to advance sound climate policy while meeting other societal needs, particularly for water. The work is complex but attainable, rewarding, and essential for a liveable future.

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Wiltshire, Kimery, Executive Director, Confluence West. Interview, June 21, 2021. (Wiltshire, 2021a)

Wiltshire, Kimery, Executive Director, Confluence West. Interview, June 22, 2021. (Wiltshire, 2021b)

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APPENDICES

Appendix A – Experts Consulted Through Interviews and/or Meetings

Bales, Roger, Professor of Engineering, UC Merced

Bellagamba, Sue, The Nature Conservancy, Ranch Manager

Belin, Letty, Alletta Belin Consulting LLC

Boag, Angela, Assistant Director for Climate, Forest Health, and Energy, Colorado Dept. of Natural Resources

Botill, Matthew, Division Chief, California Air Resources Board

Bowman, Margaret, Principal, Bowman Environmental Consulting

Boyd, William, Professor of Law, Faculty Co-Director, Emmett Institute on Climate Change and the Environment, UCLA

Brauman, Kate, Associate Director, Global Water Security Center, University of Alabama

Brill, Gregg, Senior Researcher, CEO Water Mandate/Pacific Institute

Buccino, Sharon, Senior Attorney, Natural Resources Defense Council

Burnett, Ryan, Sierra Nevada Group Director, Point Blue Conservation Science

Carranco, Nina, Program Officer, Water Foundation

Citron, Aaron, Senior Policy Advisor, The Nature Conservancy (CO)

Corday, Jackie, Corday Natural Resources Consulting

Corey, Richard, Executive Officer, California Air Resources Board

Cummins, Pat, Senior Policy Advisor, Center for the New Energy Economy, Colorado State University

Daily, Gretchen, Co-Founder and Faculty Director, Natural Capital Project

Dolman, Brock, Co-Director, WATER Institute, Permaculture Design Program, and Wildlands Program, Occidental Arts & Ecology Center

Ebert, Craig, President, Climate Action Reserve

Estrada, Torri, Executive Director, Carbon Cycle Institute

Fahlund, Andrew, Senior Program Officer, Water Foundation

Fisher, Konrad, Director, Water Climate Trust

Fleck, John, Director of Water Resources, University of New Mexico

Flynn, Nora, Agricultural Water Resources Specialist, Colorado Water Conservation Board

Funk, Alexander, Director of Water Resources, Theodore Roosevelt Conservation Partnership

Gordon, Kate, Senior Advisor to the Secretary, US Department of Energy. Former Director, Governor's Office of Planning and Research, California.

Groosman, Britt, Vice-President, Climate-Smart Agriculture, Environmental Defense Fund

Hall, Maurice, Vice President, Climate Resilient Water Systems, Environmental Defense Fund

Hansen, Amanda, Deputy Secretary for Climate Change, California Natural Resources Agency

Hartman, Fay, Conservation Director SW Division, American Rivers

Hawes, Taylor, Colorado River Program Director, The Nature Conservancy (CO)

Holm, Amy, Executive Director, The Climate Registry

Holst, Eric, Associate Vice President, Working Lands, Environmental Defense Fund

Hunt, Luke, Field Operations Manager, Sierra Nevada Conservancy

Ingram, Campbell, Executive Officer, Delta Conservancy

Jacobs, Kathy, Director, Center for Climate Adaptation Science and Solutions, University of Arizona

Jacobson, Sandra, South Coast Regional Director, CalTrout

Kammeyer, Cora, Senior Researcher, Pacific Institute

Kelly, Mary, Partner, Culp & Kelly, LLP

Key, Nuin-Tara, Deputy Director for Climate Resilience, California Governor's Office of Planning and Research

Khan, Safeeq, Assistant Adjunct Professor, Sierra Nevada Research Institute, UC Merced

Koenigsberg, Sarah, Director, Tensegrity Productions

Knight, Zach, Co-Founder and CEO, Blue Forest Conservation

Kraft, James, Executive Director, Washington Water Trust

Leslie-Bole, Haley, Associate, U.S. Climate Initiative, World Resources Institute

Lessard, JoAnna, Project Manager, Yuba Water Agency

Livingston, Shelby, Manager Cap-and-Trade Offsets Program and Natural Working Lands, California Air Resources Board

Lundquist, Kate, Co-Director, WATER Institute and Bring Back the Beaver Campaigns, Occidental Arts & Ecology Center

Matthews, John, Executive Director, Alliance for Global Water Adaptation

McCarthy, Laura, State Forester, New Mexico Forestry Division, New Mexico Energy, Minerals and Natural Resources Department

Merrill, Amy, California Regional Director (Interim), American Rivers

Miller, Bart, Healthy Rivers Program Director, Western Resource Advocates

Monohan, Carrie, Science Director, The Sierra Fund

Osman, Sami, former Policy Director, Climate Action Reserve (now President and Chief Policy Officer, AgriCapture)

Passero, Michelle, Director, Climate and Nature-based Solutions, The Nature Conservancy (CA)

Patton, Vickie, General Counsel, Environmental Defense Fund

Perciasepe, Bob, Senior Advisor, Center for Climate and Energy Solutions

Porterfield, Sara, Water Policy Associate, Western Water and Habitat Program, TroutUnlimited

Pope, Karen, Research Wildlife Biologist, US Forest Service Pacific Southwest Research Station

Rentner, Julie, President, River Partners

Rice, Matt, Colorado Director, American Rivers

Ryan, Kate, Director of Programs and Senior Staff Attorney, Colorado Water Trust

Sahota, Rajinder, Deputy Executive Officer for Climate Change and Research, California Air Resources Board

Schultheiss, Andy, Executive Director, Colorado Water Trust

Selig, Marcus, Vice President, Field Programs, National Forest Foundation

Smith, Nancy, Conservation Director, Colorado River Program, The Nature Conservancy Soderstrom, Elizabeth, Strategic Partnerships Officer, Water Foundation

Sorensen, Kathryn, Director of Research, Morrison Institute for Public Policy, Arizona State University

Stockdale, Karyn, Senior Director, Western Water Initiative, National Audubon Society

Udall, Brad, Senior Water and Climate Scientist/Scholar, Colorado Water Center, Colorado State University

Vogl, Adrian, Lead Scientist, Natural Capital Project

Whittlesey, Willie, General Manager, Yuba Water Agency

Wilcox, Jim, Executive Director, Plumas Corporation

Wiltshire, Kimery, President and CEO, Confluence West

Wobbrock, Nick, Co-Founder and COO, Blue Forest Conservation

Wright, Patrick, Director, Governor's Wildfire and Forest Resilience Task Force (CA)

Ziegler, Jay, Director of Policy and External Affairs, The Nature Conservancy (CA)

Ziemer, Laura, Of Counsel, Culp & Kelly LLP

Appendix B – More Detailed Discussion of Offsets

The terms carbon "offsets" and "credits" are frequently used interchangeably but are slightly different. The offset is the quantification of emissions reduction or sequestration. The credit is when it is turned into a vehicle for transfer to another (Irfan, 2020). For an offset to have regulatory value, the regulatory agency must accept a "protocol" after it has been developed by someone in concert with a third-party validator (e.g., The Climate Reserve, American Carbon Registry). If accepted by a regulatory agency, the carbon credits can be purchased to offset some portion of required emissions reductions (Id.). Voluntary credits can also use third-party validated protocols without regulatory review and sign-off, but the requirements are not as strict for adoption or subsequent monitoring or verification. There are far more protocols and validators for voluntary offsets than there are accepted regulatory protocols, and the level of stringency for regulatory approvals varies by regulator.[188]

As noted below, offsets in the regulatory context can be expensive to authenticate. Offsets also can be controversial either because of concerns about their validity or because there is concern that the purchase of offsets diminishes the pressure to reduce emissions from all sources, particularly those located near communities. As such, while receiving enormous coverage in the media and seeming to create the potential for an accessible funding stream for nature-based projects such as avoided deforestation, reforestation, meadow restoration, agricultural land practices, etc., the actual availability of this method to provide resources to the Colorado River Basin for multiple-benefits projects is less strong in the regulatory context, but more promising in the voluntary offset context.

One noteworthy development that straddles the agricultural and wetland worlds and yields both carbon and water benefits is in California and illustrates the costs and challenges of gaining protocol approval. The Delta Conservancy, a state agency charged with helping protect the rich farmland and legacy communities of the Delta near Sacramento, has invested tens of thousands of dollars in quantifying the avoided carbon release benefits of re-wetting the Delta's peat soils. Peat soils, when drained, are another source of intensive carbon emissions that are gaining notoriety for the high level of emissions they generate. In the San Francisco Bay Delta, formerly tidal wetlands were turned into "islands" through levee building. The interior of the islands provide some of the richest agricultural soils in California. However, with tillage and exposure, the peat soils oxidize, and both emit greenhouse gases and dissipate such that some of the farms are now 20 to 30 feet below the surrounding river levels. The Delta Conservancy, formed to enhance the environmental and economic viability of the area, invested in extensive research and obtained approval through the American Carbon Registry (ACR) of a protocol for quantifying avoided carbon emissions from farms that convert farming operations. The protocols allow farmers to receive carbon credits for conversion of their lands from farming back into a more natural state, or to farm rice, which keeps the peat soils submerged. The re-wetting stops the oxidation process and reduces carbon releases compared to other kinds of farming in the Delta.[189] The protocol is awaiting approval for adoption by the California Air Resources Board. Big challenges

188 Offsets are frequently conflated as if there were only one kind or one entity approving protocols or other assertions of validity. At times, when critiquing regulatory offsets, people may use examples of flawed offsets that have not necessarily gone through the rigor of the regulatory process, or may have been approved by a different, less stringent regulator. Calls for better quantification or protocols in the voluntary context are also growing from both the environmental and corporate sectors. As noted elsewhere, the discussion of offsets in this report is not to resolve any of those controversies, but to note the controversy.

189 See American Carbon Registry, "Restoration of California Deltaic and Coastal Wetlands": *https://americancarbonregistry.org/carbon-accounting/standards-methodologies/restoration-of-california-deltaic-and-coastal-wetlands*

include the cost of land conversion and carbon credit certification, and the 40-year permanence requirement stipulated in the ACR protocol (Ingram, 2021). To make it feasible and less costly, the Delta Conservancy protocol is exploring five-year agreements and an insurance policy to make the process economically possible. Obtaining similar protocols may not be nearly as viable or generate as high a value in other types of farming that are not avoiding as substantial emissions as peat soils (Id.).[190]

Delta wetlands, California

Photo courtesy of Campbell Ingram

190 For more detail on how this would work in practice, see Ellison, 2022, which tells the story from a farmer's perspective.

Part of the expense and complexity of developing an approved protocol has to do with important requirements to demonstrate its validity as a tool in either the regulatory or the voluntary context (although the standards and necessity of a registered offset are greater in the regulatory context). For an offset to be valid, it needs to meet a series of criteria:

- **What is the "permanence" of the offset?**

  How can we assure that it will remain viable over time? Some offsets are issued for a yearly value, others longer term (e.g., some forest offsets require 100-year protection using insurance vehicles or a requirement to replace a resource if lost, for example, to fire). California and other states or registries make use of a very large forestry offset "buffer pool" where those seeking offsets must dedicate a percentage of their emissions savings to an account that can be used to make up for lost sources, e.g., sequestration lost through wildfire.[191]

- **Is it "additional"? Is there "additionality"?**

  Can one show that there was a risk of loss (in the case of avoided emissions), or that the offset really makes a difference that would not have been made in the absence of the offset? There is a sizable amount of controversy in this area.[192]

- **Is there "leakage"?**

  Can one assure that avoiding an impact in one place will not simply result in that impact moving to another location? Avoiding "leakage" is a critical area of evaluation here as in other regulatory efforts (e.g., setting fuel standards). For example, water conservation, while linked in numerous studies to significant energy conservation[193] is not readily endorsed as an acceptable offset because water use reduction in one place does not guarantee that that water will not be used elsewhere.[194]

- **Are they "verifiable," "validated," and "enforceable"?**

  How can we know these are real reductions and that the promised actions happen? This is where third parties come in to verify that the action has happened and validate that they will continue to happen. That verification comes at a cost, with verifiers needing to make site visits, review records, and in some cases take measurements.

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191 The viability of these "buffer pools" is being questioned by opponents of offsets, while those that certify offsets have said that if the pools are insufficient to compensate for wildfire, they will increase the buffer pool requirements. See, e.g., Hodgson, C., 2021, "Carbon offsets going up in smoke as company-linked forests burn," Financial Review, August 3, 2021: *https://www.afr.com/world/north-america/carbon-offsets-going-up-in-smoke-as-company-linked-forests-burn-20210803-p58fi1*

192 The issue was the subject of a series of news reports and back-and-forth arguments between the watchdog group CarbonPlan and the California Air Resources Board (CARB). The Yurok Tribe in California, in an innovative project spanning water and climate, purchased land that had originally been the tribe's land from a commercial timber company, Green Diamond, in a canyon off the Klamath River that had special cultural meaning for the tribe. They were able to purchase the land through a loan from California's State Water Resources Control Board with an easement that it only be logged sustainably. The purchase financing was possible due to a conservation group obtaining funding to pay for the easement, making the land itself affordable for the tribe. The State Water Resources Control Board offered the tribe a low-cost loan because the tribe's proposed management regime would have significant water quality benefits. The loan would be paid back through logging in a sustainable fashion. Later, the tribe was successful in getting approval for additional funding, via an offset, for protecting more of its forest. The tribe's staff received funding from the offset to measure the growth of the trees to verify carbon sequestration rather than cutting more of them. The tribe could thereby repay their loan while cutting fewer trees. CarbonPlan insisted that CARB's methodology was flawed and questioned the additionality of the offset. CARB responded defending the scientific validity of the offset, and the issue remains a visible example of a dispute over the validity of an offset, even in the context of a wonderful project.

193 See, e.g., Spang et al., 2018, describing how California's mandatory drought conservation rules in 2015 saved as much energy as traditional energy efficiency programs.

194 The California Public Utilities Commission, however, developed a water-energy calculator that was able to quantify emissions reductions at a local level (through focusing on the energy used in heating water in the home) for use to justify energy utility expenditures on water conservation to achieve energy efficiency goals (*https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/water-energy-nexus-programs*). See also Szinal et al, 2021 (discussing extent of benefits of water efficiency to energy efficiency).

As noted, third-party validators help develop protocols that assure that an offset will meet its intended or advertised goals. For an offset to be valid in a regulatory framework requires that a regulatory agency accept the protocol and that the offset be verified over time in accordance with that protocol. Protocols can be costly to develop, and not assured of approval.

Throughout this process, quantification of carbon benefits is a challenge and not easily standardized, especially in the natural lands context. In addition to disagreement over the use of offsets in general, in some cases the controversy is over whether an offset is real even if accepted by a governing body. In other cases, and in a growing number of venues, groups have objected to the very concept of allowing emitters to purchase offsets elsewhere. The concern is that emissions locally, including emissions of co-pollutants, may be higher in one community than they otherwise would theoretically be under a regulatory regime without offsets. This has been a point of controversy in the environmental justice community and beyond.[195]

In the voluntary context, while there are no such formal standards or approvals, there is a growing call for more standardization and oversight to avoid "greenwashing" (Appunn, 2021). Vehicles for registering such voluntary measures exist, including within entities that also register formal regulatory offsets, e.g., The Climate Registry.

As discussed more fully in the report, voluntary offsets serve a variety of purposes for the entities purchasing them, including providing multiple benefits beyond climate benefits. They do not have the same level of controversy attached to them and are not as limited as the field of regulatory offsets. They also are not as expensive to develop at this point in time and may provide some greater opportunities for supporting nature-based solutions with attendant water benefits (which are also eligible for funding from a variety of sources that can be combined to "stack" credits or funding sources).

195 This a big reason why California only allows offsets for a small proportion of an entity's regulatory compliance. Offsets can be used for only 4% to 8% (depending upon the year) of a regulatory compliance requirement, and at least half of the offset must take place within California (Boyd, 2021). California has also enacted legislation to assure that a large proportion of cap-and-trade dollars go to disadvantaged community projects. The state also enacted parallel legislation to increase enforcement and other regulatory efforts to further reduce local exposure to toxic co-pollutants that the environmental justice community is concerned will be higher in communities than they otherwise would be in the absence of trading programs. See, e.g., Johnson, N., 2020, "Cap and Trade-Offs: did California's landmark legislation help or hurt the state's most vulnerable?" Grist, October 19, 2020 (*https://grist.org/climate/the-biggest-fight-over-cap-and-trade-isnt-about-what-you-think-it-is/*). The toxics reduction legislation, AB617, creates a "Community Air Protection Program" at CARB to focus more attention on reducing hazardous air pollutants in communities (https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program/compliance-offset-protocols). As noted above, the validity of particular protocols or the merits of the controversies around offsets is beyond the scope of this report but are raised to put a cautionary note on any assumption by those in the natural-resources world that obtaining support for multiple-benefit, even very wonderful projects from the climate offset arena is simple.

Appendix C – Excerpts from California NWL Climate Smart Strategy Related to Specific Landscapes

For forests, the California's NWL Climate Smart Strategy calls for a series of actions, many of which invoke water-related benefits and avoided impacts:

A. Protect resilient forests and large trees and advance proactive vegetation management in more vulnerable stands, using forest thinning, which includes methods such as prescribed and cultural burns and managed natural wildfire, to reduce the risk of catastrophic wildfire, increase resilience to future drought, increase carbon sequestration rates, and stabilize carbon storage.

B. Increase active reforestation efforts in areas recovering from severe wildfires and suffering from reduced natural regeneration as a result. Timely post-wildfire reforestation efforts can also prevent conversion of forest to shrublands74 and reduced water storage capacity in watersheds.

C. Protect and restore riparian forest ecosystems to enhance carbon storage, protect biodiversity, and expand wildlife corridors and climate migration pathways for native species.

D. Reconnect aquatic habitat within forests to help fish and wildlife endure drought and adapt to climate change.
Increase voluntary cultural easements for cultural burns and to ensure California Native American tribes have access to natural cultural resources and cultural landscapes. (p. 26)

With respect to wetlands, the Strategy recommends:

A. Protect against habitat loss, degradation, and fragmentation to help maintain carbon sequestration, protect biodiversity and culturally-significant species, reduce climate risks, and increase climate resilience.

B. Restore and enhance coastal wetlands in a manner that ensures these habitats can keep pace with future sea level rise, such as conserving and restoring inland areas to allow for upland migration and through sediment augmentation.

C. Identify and prioritize wetland restoration near communities most vulnerable to climate change and where climate smart land management can improve groundwater and water quantity, protect communities from flooding, and increase access to nature.

D. Restore Delta tidal wetlands to improve ecological function and flood protection. Encourage conversion of deeply subsided Delta peatlands to rice cultivation and managed wetlands to stop subsidence and resulting carbon emissions.

E. Restore rivers, floodplains, and estuaries and facilitate their natural function and connectivity.

F. Protect and restore mountain meadow function and hydrology using site appropriate solutions, such as beaver reintroduction, to enhance water quality and reliability, biodiversity, carbon storage, and natural system connectivity.

G. Identify opportunities to reconstruct wetlands and saltmarshes where possible, for example during construction projects in areas where these nature-based solutions could deliver climate and other beneficial outcomes to communities.

H. Treat water through nature-based solutions such as constructed wetlands and treatment channels, which can often store recycled and/or treated potable water, provide habitat for wildlife, and increase access to nature, educational opportunities, and recreation.

I. Construct living shorelines, which are protected, stabilized shorelines constructed with natural materials that can sequester carbon and maintain carbon stores of the wetlands they protect, build resilience to sea level rise, improve water quality, and provide coastal access and habitat. (p. 28)

The Strategy focuses heavily but not exclusively on coastal wetlands due to the extensive nature of California's shoreline and exposure to sea-level rise. With respect to grasslands, the Strategy recommends:

A. Increase climate smart and regenerative practices on grasslands, such as range planting, riparian restoration, grazing management regimes that work to support positive ecological outcomes and to increase the amount of deep rooted, quality rangeland grasses for improved vegetation for feed, carbon and water storage, and fire resiliency.

B. Preserve and restore native grasslands to improve carbon storage, biodiversity, and connectivity.

C. Protect grasslands from development and conversion to more intensive agricultural production.

D. Apply compost in ecologically appropriate contexts to grasslands to enhance carbon sequestration and storage, increase water quality and availability, and support the overall health of grazed or historically degraded grasslands.

E. Increase adoption of compost production on farms and application of compost in appropriate grassland settings for improved vegetation and carbon storage, and to deliver waste diversion goals through nature-based solutions. (p. 51)

The Strategy notes that grassland management for augmented carbon and water benefits requires the active application of compost and other ongoing practice and suggests that future research is needed to understand the benefit of long-term, potentially durable sequestration in the extensive root systems.

Autumn at a cattle ranch in Colorado near Ridgway.

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