MAFAC CBP Task Force
Draft Climate Change Scenario
Kevin Scribner

EARTH DAY—April 22, 2020

Task Force Colleagues—

NOTE: this document is 47 pages, which includes an Appendix. Portrayal of methodology and scenario description are in the first 13 pages.

It is fitting that I write this introductory note on the 50th Anniversary of Earth Day, which I experienced in the Spring of my senior year in high school, for while drafting these sample climate scenarios I tried to keep the future time horizon of 25, 50 and even 100 years in mind. This being the temporal landscape in which our Provisional Recovery Goals were purportedly conceived.

These ***Columbia Basin Climate Scenarios*** are framed by a spectrum of plausible, prevalent Basin-wide attitudes toward climate-influenced change in Basin hydrology, with the rate of change ranging from "slow and steady," to "dramatic and mercurial," and attitudes varying from "resistance to change," to "embracing change." Another set of scenarios could use a similar framework to discern how the Basin salmon runs could/would also respond to climate-influenced change in Basin hydrology, and may focus on salmon's evolutionary response, which, as I understand it, is their primary method of responding to change.

Let me emphasize that these are ***sample scenarios***. I am their sole author, as slipping-away time and then the Pandemic swept away my intention to facilitate group-developed scenarios. These scenarios were informed by the scenario planning methodology that I have referenced a number of times at Task Force meetings, the one championed by Dutch/Shell Oil and the Global Business Network (see **Plotting Your Scenarios**), and used recently by the Pacific Fishery Management Council.

I believe that moving from ***sample scenarios*** to robust Partnership Scenarios will require a full Partnership workshop that invites all the Members to contribute their experience and wisdom. I have included sample *key questions* that could inform such a workshop.

I have also kept in mind Barry's comment upon the value of the SERA Workshop at our September 25-26, 2019 meeting:

> Barry highlighted that this (SERA Workshop) exercise was an attempt to recognize that salmon and steelhead recovery is not just biological – other factors are driving fish abundance and fish abundance also affects those other factors. **He explained that the SCE&E discussion will help the group better determine which scenarios have barriers to implementation.** (emphasis added)

I have also kept in mind the following from the **2018 Fourth National Climate Assessment**:

> **Barriers to Adaptation**
>
> Despite emerging recognition of the necessity of climate change adaptation, many barriers still impede efforts to build local, regional, and national-level resilience. Barriers are obstacles that can delay, divert, or temporarily block the adaptation process, and include difficulties in using climate

> change projections for decision-making; lack of resources to begin and sustain adaptation efforts; lack of coordination and collaboration within and across political and natural system boundaries as well as within organizations; institutional constraints; lack of leadership; and divergent risk perceptions/cultures and values. Barriers are distinguished from physical or ecological limits to adaptation, such as physiological tolerance of species to changing climatic conditions that cannot be overcome (except with technology or some other physical intervention).

As well, I cannot not pay attention to what our region, nation, all nations and planet is experiencing in this Pandemic. We—everybody—now have and will continue to have direct experience with "dramatic and mercurial" systemic change. Last fall, a Pandemic would have been considered a *plausible future*, now it's our reality. I have been collecting commentaries which speaks to the *if and how* the Pandemic can help us prepare for climate change. Some say the Pandemic is a warm-up act for climate change. Another writes that with climate change we don't know exactly when, where and how the changes will occur and that there is no vaccine for this kind of change once it's upon us. Others say that it is already upon us, and the analog to a virus vaccine is *mitigation*, which is more akin to maintaining comprehensive health, fitness and well-being (no underlying health issues = resilient, regenerative SCE&E functions), while everyone on the planet works to minimize or eliminate spreading the virus (virus = green house gases).

The Covid-19's mortal effect on humans with underlying health issues may counsel us to look at our salmon runs with a similar lens: which runs have underlying health issues, which are on life support, which are currently sufficiently fit and resilient to withstand various rates of change in Basin hydrology? How can we foster fitness in all 24 stocks, and to accomplish this in time to respond to plausible slow, steady or dramatic, mercurial change? And, equally important, how fit, healthy, resilient and regenerative do our Basin SCE functions need to, in turn, be the stewards of the Basin's hydrology so its fosters fit, healthy, resilient and regenerative salmon runs? And which driving forces influencing SCE functions are within control of the Basin, and which driving forces buffet the Basin from outside our control.

The Pandemic will also show us how willing, able and prepared we are to *adapt* to dramatic, mercurial change. The **National Climate Assessment** has identified *mitigation* and *adaptation* as two key responses to climate change.

But, one may ask, what climate-influenced changes are we envisioning, anticipating, expecting? Where? When? How? The *plausible futures* scenario planning approach does not purport to foretell the future, rather, it poses an array of futures that give us stories in which to explore how we could achieve our goals in each of them. It is in this spirit that I have drafted these ***sample scenarios***.

If and when we have a Climate Scenario workshop, we can share our personal experiences with hydrological change. Some of us who live in the Blue Mountains region experienced a 100 year flood in February, with our previous 100 year flood occurring just 20 years prior, and some climate models indicating more of the same, and potentially more frequent. Joel can tell you about fishing offshore in the *blob seasons* and experiencing an array of new marine species. No doubt, we all have a story.

In closing this introductory note, I must say something about our younger generations, as I have also been collecting commentary both from and about them. I've read op-ed's from millennials who list the negative driving forces that have buffeted their upbringing: 911, 2008 Great Recession, Pandemic—and they then ask the adults in the room (if there are any): ***WTF?***

How to authentically bring them to the Partnership Table will be a challenge, and I very much appreciate and honor the efforts by Zach and Katherine to do so. And here is a comment from a high school senior, a member of what I've read will likely now be referred to as Generation C (Covid-19):

> Jerome Foster II just finished Week 57 of climate-striking, every Friday, in front of the White House. The high-school senior has become a force—just last month, the Audubon Naturalist Society gave him its Youth Environmental Champion award (and, since youth are now driving the environmental movement, this is no niche prize). This interview has been edited and condensed for clarity.
>
> *What 's the essential message that young people would like to get across to older people about climate change—what do you think older generations are not understanding correctly?*
>
> Two things. In order for substantive progress to take place to stymie the climate crisis, humanity needs to operate from a standpoint of intergovernmental solidarity, empathy, equity, and moral clarity. These should be the pillars on which we forge the pathway to a sustainable future. Also, what older generations are not understanding is the meaning of the Native American proverb, "We do not inherit the earth from our ancestors; we borrow it from our children."

Lastly, here is an excerpt from a blog entry I wrote about Bristol Bay and its salmon, after spending 2019 summer there, and in the context of the existential threat of the Pebble Mine:

> **Our Children's Children's Children's Children's Children's Children's Children***
>
> Seven Generations—My Native American colleagues have taught me to think of the future in this way. It's certainly a challenge to get a good grasp of the future, much less plan for it. And it gets downright brain boggling if we try to wrap our minds around the concept of *forever*. So, instead, let's think in terms of seven generations, or roughly 200 years, calculating 30 years per generation.
>
> It is with ease that I can envision the Bristol Bay salmon running abundantly for the next 200 years—and effortlessly I can envision this going on for time immemorial—if we only let them do so. On the other hand, I can't, for the life of me, envision the toxic residue from a Pebble Mine being safely contained in a reservoir for forever, much less 200 years. The arrogance of anyone calmly proclaiming that the toxic aftermath of Pebble Mine will be confined and taken care of forever… can this ever pass the laugh test? Isn't this a proclamation more suited for the theater of the absurd?
>
> …$1.5 billion is generated every year by the Bristol Bay salmon fishery. Multiply this by 4,000 years (remember the EPA Bristol Bay Watershed Assessment's declaration of 4,000 years of salmon fishing) and the expected economic value of Bristol Bay is **6 trillion dollars**. And guess what, to realize this value we don't have to generate and then manage (forever) any toxins, or restore any land or water. No, we will simply continue the sustainable management that has guided this fishery into being the salmon rock star of the planet. The value of Pebble Mine (400-600 billion dollars) pales in comparison—and the mine's development requires so much expensive and damaging effort, including constructing of miles of roads, a power plant, and otherwise unnecessary ports of call.

Can we conceive of a *plausible future* for the Columbia River Basin that we can generate and which gives us the realistic opportunity to recover our salmon so they can join Bristol Bay's in the planetary salmon jam band? Let's go beyond "hope so," and give it our all to make it so, barriers (clearly identified—all!) be damned.

* This title shows how many generations of children are in 7 Generations.

Thank you—Kevin Scribner

Five Sample *Columbia Basin Climate Scenarios* (*CBCS*)

1. **Tick-Tock—Banking On Slow Change**
2. **Readiness Is All—Time Is On Our Side**
3. **Time Is Nigh—Surfing Waves of Change Together**
4. **Torrents Of Change—Time For Triage**
5. ***Wild Card*: DeGrowth**

NOTE: these scenario summaries describe *plausible futures* of human behavior *adjustments* to the Basin's Social, Cultural, and Economic functions and practices in response to a range of climate-influenced changes in the Basin's hydrology. These sample summaries could be fleshed out, added to, and/or replaced at a workshop using the CBP SCE&E Condensed Table as the guiding framework. Accompanying scenario summaries, with accompanying detail, could/should also be developed to describe a range of *plausible futures* for salmon to *adapt* to the same or similar range of climate influenced changes in Basin hydrology. These salmon scenarios could/would use the Biology Table as the framework for drafting details of each scenario.

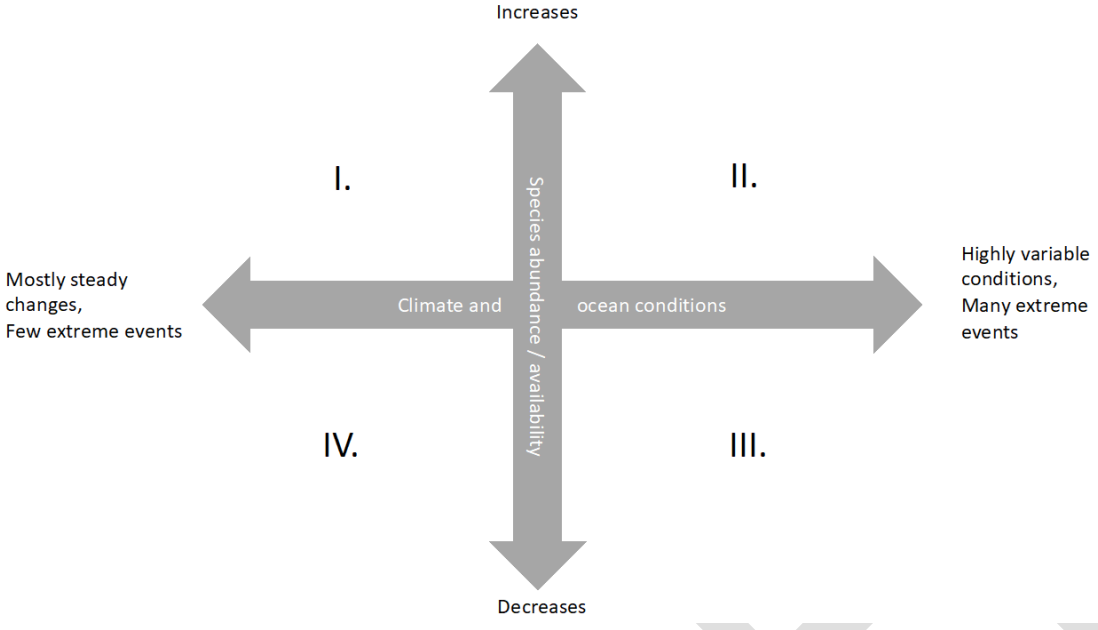
***Advice From*: Pacific Fishery Management Council's Developing Future Scenarios for Climate Change in the California Current System: Workshop Report**

This scenario creation workshop brought together more than 80 participants from different aspects of the fishing community and fisheries management, including scientists, fishery participants, marketers, conservation professionals, and others.

PFMC Workshop facilitators reminded participants of the following: Good scenario planners never assume that the future will be like the past - or even like the "expected future." Instead, they constantly ask, " 'what if?' and imagine a range of different, surprising, but plausible, situations that they might have to operate in.

Although scenarios are stories about the future, they are not predictions, nor are they descriptions of desired future states. They are created and designed to describe the range of plausible conditions that an organization or a community could face. By thinking about these ahead of time - essentially rehearsing the future - organizations can be far better prepared for the future uncertainty. Over the past decade, many organizations have begun to use scenario planning as a means to prepare for the uncertainties and surprises associated with climate change…

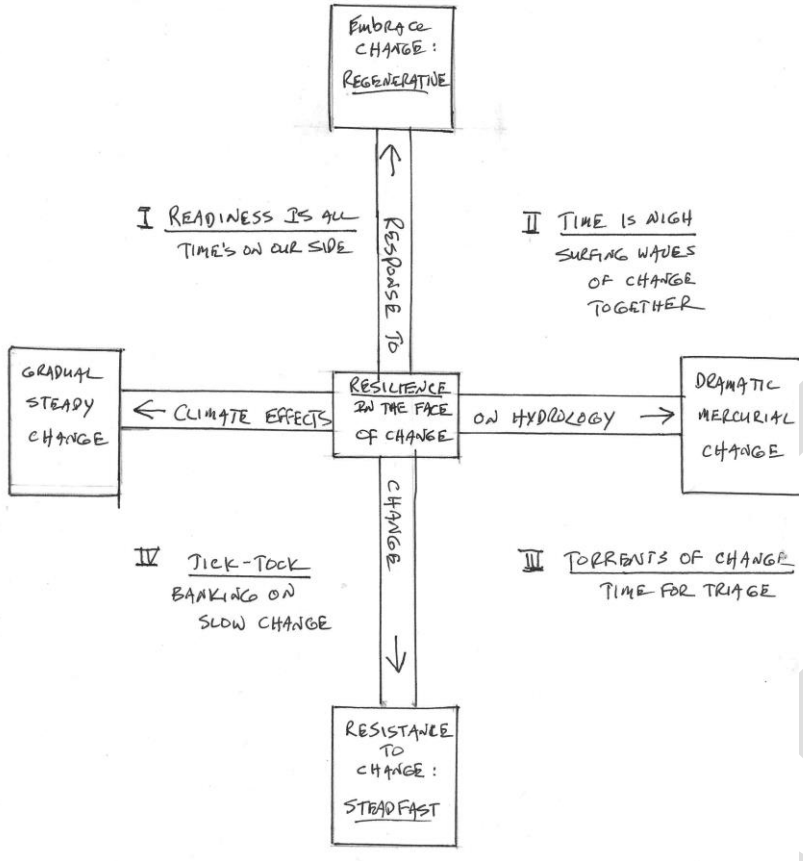
PFMC Matrix: This creates four quadrants, each of which describes a different set of conditions to be faced and managed. Given that working scenarios are not predictions or projections, but rather plausible future conditions, the next task for participants was to discuss whether these scenario quadrants were plausible, relevant, challenging and divergent."



The ***Columbia Basin Climate Scenarios*** (***CBCS***) use the following matrix framework:

- **Horizontal Axis**: Gradation of *Climate Effects on Basin Hydrology*, from *Gradual, Steady Change* on the left, to *Dramatic, Mercurial Change* on the right.

- **Vertical Axis**: Gradation of *Response to Climate Effects on Basin Hydrology*, from *Resistance to Change* on the bottom, to *Embracing Change: Becoming Regenerative* at the top, with *Experiencing Change with Resilience* at the midpoint.



Suggested Key Questions to Consider for each Scenario:

Over the course of 25/50/100 years:

- What are the projected changes to climate and environmental conditions that will affect the Basin's hydrology?
  - Annual Precipitation Levels and Patterns—more rain, less snow?
    - Timing?
      - Change in seasonal flows
      - Less time-release (snow-pack) cold water?
    - Erratic? Eccentric? Episodic? Gradual?
      - More floods—number and size?
      - More floods and droughts?
    - Uniform across the Basin?
  - Cold Water
    - Flow
    - Refugia
    - Floodplain Connectivity
    - Reservoirs
      - Surface
        - Snow
        - Impoundments

            - Soil
        - Sub-surface
            - Aquifers
                - Shallow
                - Deep
- Seasonal Heat Units
    - Longer, warmer Summers?
        - Daytime temperatures
        - Nighttime temperatures
    - Shorter, warmer Winters?
- Water Temperatures
    - Warmer rivers and streams?
    - Diminished cold-water refugia?
- Aridity
    - Forests
        - Fires increase—number and size?
        - How will plant community ecosystems change?
    - Agriculture
        - Change in crops and irrigation practices?
            - California-like temperature ranges?
        - Change in pests and disease?
- Ocean—changes in:
    - Acidity
    - Temperature
    - Currents
    - Trophic systems—*carrying capacities*
    - Ecosystems
    - Sea-level Rise

- What are the projected changes to human population levels that will affect the Basin's hydrology/water?

    - How will the change in population affect Basin hydrology?
        - How many Basin residents in:
            - 25 years
            - 50 years
            - 100 years
        - How and where will the Basin population be distributed?
        - How will the Basin population be differentiated?
            - Age/Generation/Gender
            - Income
            - Job Sector
            - Racial/Ethnic
            - Culture
            - Education Level
            - Born in the Basin
            - Immigrant: National; International
                - Quality of Life?

- *Climate Refugees?*
  - Dynamic Economy?
- What will be the aggregate affect of these numbers, and their distribution and differentiation?
- Will newcomers value salmon?

- How will changes in markets affect Basin SCE and hydrology?

- How will extreme events, such as a Pandemic, affect Basin SCE and hydrology?

- How will changes in Basin hydrology over time affect salmon ecology?

- How will the changes in Basin hydrology over time have ripple effects throughout all interconnected Basin ecosystems?

- How will changes in Basin hydrology over time affect SCE functions, including the interconnectivity and interdependence between these functions?

- How will the changes in Basin hydrology over time affect the interconnected and interdependent relationships between the SCE functions?

- How will the pace of change in Basin hydrology affect salmon ecology and SCE functions?

- What is the capacity of salmon to evolutionarily *adapt* to new conditions within a 100 year time span? What influences the capacity to adapt?

- What is the capacity of SCE functions to *adjust* to new conditions within a 100 year time span?

- What are the characteristics of human and community capacities to make adjustments, including responding to the pace of change?

  - What are the characteristics of communities and SCE functions that contribute to resistance or the hesitation to embrace change?

  - What are the characteristics of communities and SCE functions that contribute to the willingness to embrace change?

- What are the characteristics of SCE functions that will support/guarantee that salmon abundance remains a priority for the Basin while undergoing adjustments in response to slow and gradual change?

- What are the characteristics that will support/guarantee that salmon abundance remains a priority for the Basin while undergoing adjustments in response to swift and dramatic change?

- What SCE functions can slow the pace of climate changes—both drawdown/sequester legacy carbon and mitigate for current and future GHG emissions, i.e. healthy soils, forests, rangelands, sea grass/kelp, oysters shells?

SCENARIO SUMMARIES

Tick-Tock—Banking On Slow Change

The prevailing Basin perspective recognizes there are changes in climate and that these changes and their effects will proceed at a gradual and steady pace, gently rippling through the Basin's hydrology, ecology and SCE&E functions. This supports the attitude that *we have and will continue to have time to respond to these changes*. A notable percentage of residents and leaders question—with some disbelief or distrust—the science and modeling providing the signals of change. Some of these indicators seem remote (changes in the Pacific Ocean—*out there*) and many residents are buffered from direct experience with the effects. There is a failure of the Basin to realize the potential rapid increase of change—even with the exponential growth lessons available from the 2020 Pandemic—and how interconnected and interdependent the Basin's SCE&E functions are. The variety of attitudes and experiences support a posture that is resistant to a collective response to change. Place- and demographic specific-based ecological and SCE&E challenges are often seen by many as *their problems, not ours.*

The *Partnership* is able to maintain an influential voice for collaborative strategies and actions for salmon recovery, but is often drowned out by the cacophony of polarization. The lack of consensus or a substantial majority to commit to a singular strategy to salmon recovery burdens the sense of taking a balanced approach with glacial, divisive-dominated decision-making, binding salmon recovery to no more than a *steady as she goes* status in the face of change. Funding to support salmon recovery is hindered by a perception and reality that the mechanisms to generate revenue are not equitably shared by everyone throughout the Basin, and that current levels of funding are more than adequate.

The Basin's population increases, both from new births and from immigration, including migrants from other regions within the US as many search for increased quality of life, with more favorable climatic conditions desired. Salmon culture and its advocates gradually slide into a minority position. Many from the younger generations publicly cry for the older decision-makers *to wake up and smell the change*, but are marginalized. People tend to identify themselves by boundaries and differences, be they regional, political, economic, racial, cultural, generational. Social and cultural equity is acknowledged but does not widely influence policy and *false equivalencies* are allowed to influence decision-making.

Sample Projected Recovery Approaches and Actions:

Current Salmon Recovery Plans are considered sufficient, though constantly searching for increased funding and risk falling behind the curve due to inability to keep pace with changes in hydrology and SCE demands.

Salmon Recovery suffers from a fragmented approach, not integrated Basin-wide and Ocean-inclusive.

Salmon stocks on ESA *life support* relapse more and more, questioning the Basin's will to provide this support.

Yakima River Plan is championed as a model for watershed-level salmon recovery, but replication throughout the Basin is minimal and spotty

There is more leadership resistance than support for innovative experimentation, especially projects that are considered expensive, may require infrastructure modifications, and require multiple years for proof of concept.

Major infrastructure changes are relegated to more study.

Block areas introduction is relegated to more study.

Readiness Is All—Time Is On Our Side

The prevailing Basin perspective recognizes there are changes in climate and Basin hydrology, and that these changes and their effects will proceed throughout the Basin at a gradual and steady pace. This supports the attitude that *time is on our side, and Basin-wide, we need to be collectively preparing to be ready to embrace change*. A minimal and fading percentage of residents and leaders question—with some distrust and disbelief—the science and modeling providing the signals of change. Indicators of change, though they may seem remote (changes in the Pacific Ocean) and many residents are buffered from direct experience, are persuasive and serve to generate widespread agreement to be prepared, to be ahead of curve, to be pro-active instead of reactive. The *Partnership* is able to maintain an influential, prominent, if not dominant, voice for collaborative strategies and actions. The Basin has learned lessons from the 2020 Pandemic, including that change can rapidly increase and expand with ripple effects throughout the Basin's interconnected and interdependent hydrological, ecological and SCE&E functions.

The Basin's population gradually increases, both from new births and from immigration, including from other regions within the US, as many search for increased quality of life, including climate related conditions. The Partnership is a successful champion of the Basin incorporating Salmon Culture education into both formal and informal learning processes, ensuring newcomers of all ages learn about salmon. Caring for salmon is embedded into the Basin culture, and Tribal *Traditional Ecological Knowledge* is embraced. The Partnership has welcomed the younger generations into its functions and messaging, encouraging them to help demonstrate how to enthusiastically and creatively embrace change. Revenue to adequately support salmon recovery uses a variety of mechanisms that insure that opportunities to contribute are available and actualized by all Basin residents.

Maintaining social, cultural and environmental relationships are hard-wired into all strategies and actions. Balance means *we are all in this together,* traveling together into the future. People tend to identify themselves by their relationships, to others, to the landscape, to the planet. Commitment to the health and well-being of the Basin's salmon and SCEE is embedded in a robust regional identity, not requiring Federal rules and regulations, i.e. Endangered Species Act.

Sample Projected Recovery Approaches and Actions:

The Partnership successfully champions robust Basin-wide Recovery Plans, embracing and building upon all Recovery Plans-to-date. Recovery Plans will rely upon a certain amount of *luck* (Nature helping), but acknowledge, too, that adage that to a certain extent: *we make our luck*

The Partnership hosts Task Forces that meet regularly, developing effective, collaborative methods Basin decision-making to address Mitigation & Adaptation to climate change

- Biological
- SCEE
- Integration
- Design
- Adaptive Management

Salmon Recovery Plans include SCE&E Resilience Plans. SCE&E Resilience Plans rely upon *Life Cycle Assessment* methodology to evaluate *footprints* of practices, leading the Basin toward practices that support mitigation measures and support adaptation.

Sufficient, dedicated funding sources are identified and implemented.

Innovative Experimentation is a key strategy, embraced as the source of "vaccines" for future hydrological changes. The Basin *Brain* calmly and creatively approaches what are characteristically considered intractable issues. There are minor-to-major infrastructure changes and refinements.

The Yakima River Plan model is steadily adopted, with variations, throughout the Basin.

Elevated belief in equity endorses design and implementation for re-entry of salmon into blocked areas.

Time Is Nigh—Surfing Waves of Change Together

Effects from the changing climate are rampant throughout the Basin, showing in dramatic and mercurial ways. Rapid response is necessary. The Partnership has been instrumental in generating a Basin that is ready and prepared for this *future-become-present* of big waves of change. Small pockets of residents and leaders still question—with some distrust and disbelief—the science and modeling providing the signals of change, but have little-to-no influence regional decisions. Indicators of change are present everywhere, with all residents directly experiencing a/some/many effect/s of change. The Basin is incorporating pro-active strategies prepared from lessons learned from the 2020 Pandemic, including that change can increase rapidly, erratically, and have ripple effects throughout the Basin's interconnected and interdependent SCE&E functions. The *Partnership* is viewed by the Basin as the prominent voice for collaborative strategies and actions.

The Basin's population is increasing by leaps and bounds, both from new births and waves *climate refugees.* The Partnership has successfully championed integration of Salmon Culture and the caring for salmon into most, if not all, aspects of life. The younger generations are respected partners, providing insights, commitment and energy in helping the Basin surf these waves of change. Though challenged by more frequent, significant changes in hydrology, there is a deep, strong and pervasive commitment to the health and well-being to everybody and each of the Basin ecosystem's—*we are unwavering in our dedication to the interrelationships and interdependency between people and natural ecosystems in the Basin that identify who we are.* Salmon recovery funding is an essential priority and has a revenue stream that is basic to all households, similar to utilities like water and electricity. The recovery of salmon runs and sustaining of Basin SCE&E is considered to be a good *return on investment.*

Balance becomes gymnastic, with the Basin doing its best to not fall off *the balance beam* within pervasive dramatic, mercurial change, keeping upright together while surfing big waves.

Sample Projected Recovery Approaches and Actions:

Partnership convenes Integrated Task Forces to manage mobilization—*all hands on deck—declares, with Basin support, that Salmon are essential.*

VALUE OF CLEAN, COLD WATER—*priority appropriation* supercedes *prior appropriation; water-for-flow markets excelerate—when water is precious, we will use it with precision*

Strategies for Salmon Recovery and SCE&E Resilience strive to maintain characteristics of Living Rivers, and focus on actions to mitigate and adapt—*quickly!*

Strategies for a Normative River alternative are developed: interconnected and integrated basin plumbing system (many small impoundments and many spigots) + monitoring; dedicate quality water to where and when needed most for priority smolts and adults

YAKIMA RIVER PLAN is the compelling model, being replicated across the Basin—readying each watershed for Congressional infrastructure stimulus funding targeted on shovel-ready projects

Introduction of salmon in blocked areas is recognized as a top priority for expanding the essential habitat and fostering stock diversity.

The Basin prepares for inevitable grief from unavoidable losses.

Loss of California salmon stocks due to hydrological changes emphasizes the vulnerability of some/many Basin stocks

Torrents Of Change—Time For Triage

Effects from a changing climate are rampant throughout the Basin, showing in dramatic and mercurial ways. Rapid response is necessary. The Partnership has been relegated to a minority voice of preparation for big waves of mercurial change. Polarization has frozen the Basin's capacity to prepare for what is occurring, leaving the response to be reactive, not proactive—the Basin is constantly *behind the curve*. The failure of the Basin to realize the potential exponential growth of change—even with the lessons available from the 2020 Pandemic—and to realize the extent of interaction and interdependency between the Basin's SCE&E functions, also contribute to being *behind the curve*. Indicators of change are present everywhere, with all residents directly experiencing a/some/many effects of change.

The Basin's population is increasing by leaps and bounds, both from new births and an onslaught of *climate refugees.* Unable to successfully champion integration of Salmon Culture into Basin lives, there is clear and present danger that salmon will be considered non-essential as human survival-oriented responses to the mercurial waves of change dominate. The younger generations are extremely exasperated and would check out if they could. They express a significant distrust of Basin leadership. The Basin population becomes stratified and fragmented. Creating and/or maintaining a broad social and cultural safety net is judged to either be non- or less-essential than *taking care of one's own.*

Maintaining balance is wishful thinking. The global shock from the 2020 Pandemic is now viewed as a penetrating jab, now that the effect from changes in climate are felt *as a haymaker*.

Triage decisions dominate policy, with stark determinations of what is essential and what is expendable. In a policy framework dominated by human survival, salmon recovery is felt to be non- or less-essential until SCE&E functions regain resilient capacities—if they can. Funding for salmon recovery is woefully inadequate to support Basin-wide recovery and difficult decisions must be made on which number and location of stocks to support, and which stocks to be left on their own. This paucity of funding is exacerbated by the disruption in global and national economies and the evaporation of wealth from slumping stock markets.

Sample Projected Recovery Approaches and Actions:

The Partnership is in-affective.

Basin leadership is fractured, the population fragmented. The Basin *Brain* is harried, stressed, rationality is a luxury.

Survival of the fittest becomes a societal expectation.

Warm water species expand into more and more of the Basin.

Viable natural salmon ecosystems south of British Columbia look to be a fantasy.

Artificial "salmon ecosystems" are possible, but only where the Basin can be significantly re-plumbed—salmon are completely dependent upon human design and engineering. The Columbia Basin is re-designed as a Salmon Aquarium.

California salmon are history.

***Wild Card Scenario*: DeGrowth**

NOTE: this summary was submitted by Megan Seibert, megan@rndg.org, https://www.realgnd.org

The ***REAL Green New Deal Project*** (*RGND*) provides an *eyes wide open*, systems and evidence-based viability analysis of Basin functions.

RGND's core starting premises:

- Climate change is but one symptom of our overarching overshoot crisis.
- The commonly accepted narrative about renewable energy and sustainability is impossible to deliver. Its key flaws that motivate our work:
    - The notion that the system can remain the same and all we have to do is switch out one variable – replace fossil fuels with renewables – and voila, we'll have a sustainable world. As if changing the energetic basis of all of civilization is as simple as changing a battery. Quite the opposite – an energetic shift will transform everything, forcing us to re-think life as we know it.
    - There are massive limitations and impediments to the renewable energy technologies commonly put forth as solutions (e.g. solar PV, large-scale wind, batteries, hydrogen, etc.) which make them not very sustainable and likely not viable from a basic implementation perspective.
- No matter the technology considered, *renewable energy simply cannot supply the same quantity or quality of energy as fossil fuels, meaning that we face massive scale-back and restructuring*.

RGND hopes to re-direct the paradigm about renewable energy and sustainability away from magical, myopic thinking towards the type of sober, holistic thinking that might actually have a chance of veering us in the right direction.

Keeping in mind that energy underpins everything, from biological food webs to the human civilizations embedded within them, the mission of *RGND* is to:

- Concretely understand which renewable technologies are viable, how much energy they can supply, and what those supplies will mean for the type of world that's possible.
- Conduct all of the above within the context of restoring a thriving, biodiverse habitat for Earth's non-human creatures and fair, egalitarian social structures for its people.

RGND asserts that the key question for the Basin, and the planet, is "which renewable energy technologies are sustainable and viable in which contexts and how that can inform what the changes in our demand and behavior must be, keeping in mind that the two reduction levers to pull on are the number of people and the amount of energy we're each consuming."

RGND is unprecedented not just in scale and breadth, but in facing head-on subject matter that is typically considered taboo, uncomfortable, or outside the scope of energy and sustainability. A commitment to systems thinking and a genuine concern for the Earth and all its inhabitants requires nothing less than a full, honest look at the truth.

REFERENCE MATERIALS

- ***Plotting Your Scenarios***
- **Pacific Fishery Management Council's Developing Future Scenarios for Climate Change in the California Current System: *Workshop Report***
- **CBP BIO Table**
- **CBP Condensed SCEE Table**
- **SERA Workshop Report**
- **SERA Icons**
- **Real Green New Deal description (in Appendix), website: *https://www.realgnd.org***

APPENDIX

- **Fourth National Climate Assessment (excerpts): https://nca2018.globalchange.gov**
    - **Contents (below)**
        - **Overview**
            - **Key Messages**
        - **Scenarios**
            - **Emissions Scenarios**
            - **Climate Scenarios and Climate Models**
            - **Sea Level Rise Scenarios**
            - **Models and Sources of Uncertainty**
        - **Mitigation**
        - **Adaptation**
        - **Decision Support**
        - **Indigenous Peoples, Land, and Resources**
            - **Climate Change Impacts in the United States**
            - **Climate Change and Traditional Knowledge**
        - **Northwest Region**
            - **Observed Climate Change**
            - **Projected Climate Change**
            - **Water Related Challenges: Description of Observed and Projected Changes**
                - **Consequence and Likelihoods of Changes**
                - **Adaptive Capacity and Implications for Vulnerability**

- **Coastal Vulnerabilities**
  - **Description of Observed and Projected Changes**
  - **Consequence and Likelihoods of Changes**
  - **Adaptive Capacity and Implications for Vulnerability**
- **Impacts on Forests**
  - **Description of Observed and Projected Changes**
  - **Consequence and Likelihoods of Changes**
  - **Adaptive Capacity and Implications for Vulnerability**
- **Adapting Agriculture**
  - **Description of Observed and Projected Changes**
  - **Consequence and Likelihoods of Changes**
  - **Adaptive Capacity and Implications for Vulnerability**

- **THE REAL GREEN NEW DEAL PROJECT**

NATIONAL CLIMATE ASSESSMENT NOTES

Global climate is projected to continue to change over this century and beyond, but there is still time to act to limit the amount of change and the extent of damaging impacts. This report documents the changes already observed and those projected for the future. It is important that these findings and response options be shared broadly to inform citizens and communities across our nation. Climate change presents a major challenge for society. This report advances our understanding of that challenge and the need for the American people to prepare for and respond to its far-reaching implications.

OVERVIEW

Americans are noticing changes all around them. Summers are longer and hotter, and extended periods of unusual heat last longer than any living American has ever experienced. Winters are generally shorter and warmer. Rain comes in heavier downpours. People are seeing changes in the length and severity of seasonal allergies, the plant varieties that thrive in their gardens, and the kinds of birds they see in any particular month in their neighborhoods.

Other changes are even more dramatic. Residents of some coastal cities see their streets flood more regularly during storms and high tides. Inland cities near large rivers also experience more flooding, especially in the Midwest and Northeast. Insurance rates are rising in some vulnerable locations, and insurance is no longer available in others. Hotter and drier weather and earlier snow melt mean that wildfires in the West start earlier in the spring, last later into the fall, and burn more acreage. In Arctic Alaska, the summer sea ice that once protected the coasts has receded, and autumn storms now cause more erosion, threatening many communities with relocation.

Scientists who study climate change confirm that these observations are consistent with significant changes in Earth's climatic trends. Long-term, independent records from weather stations, satellites, ocean buoys, tide gauges, and many other data sources all confirm that our nation, like the rest of the world, is warming. Precipitation patterns are changing, sea level is rising, the oceans are becoming more acidic, and the frequency and intensity of some extreme weather events are increasing. Many lines of independent evidence demonstrate that the rapid warming of the past half-century is due primarily to human activities…

Over recent decades, climate science has advanced significantly. Increased scrutiny has led to increased certainty that we are now seeing impacts associated with human-induced climate change. With each passing year, the accumulating evidence further expands our understanding and extends the record of observed trends in temperature, precipitation, sea level, ice mass, and many other variables recorded by a variety of measuring systems and analyzed by independent research groups from around the world. It is notable that as these data records have grown longer and climate models have become more comprehensive, earlier predictions have largely been confirmed. The only real surprises have been that some changes, such as sea level rise and Arctic sea ice decline, have outpaced earlier projections.

What is new over the last decade is that we know with increasing certainty that climate change is happening now. While scientists continue to refine projections of the future, observations unequivocally show that climate is changing and that the warming of the past 50 years is primarily due to human-induced emissions of heat-trapping gases. These emissions come mainly from burning coal, oil, and gas, with additional contributions from forest clearing and some agricultural practices.

Global climate is projected to continue to change over this century and beyond, but there is still time to act to limit the amount of change and the extent of damaging impacts…

Prolonged periods of high temperatures and the persistence of high nighttime temperatures have increased in many locations (especially in urban areas) over the past half century. High nighttime temperatures have wide-spread impacts because people, livestock, and wildlife get no respite from the heat. In some regions, prolonged periods of high temperatures associated with droughts contribute to conditions that lead to larger wildfires and longer fire seasons. As expected in a warming climate, recent trends show that extreme heat is becoming more common, while extreme cold is becoming less common. Evidence indicates that the human influence on climate has already roughly doubled the probability of extreme heat events such as the record-breaking summer heat experienced in 2011 in Texas and Oklahoma. The incidence of record-breaking high temperatures is projected to rise.2

Human-induced climate change means much more than just hotter weather. Increases in ocean and freshwater temperatures, frost-free days, and heavy downpours have all been documented. Global sea level has risen, and there have been large reductions in snow-cover extent, glaciers, and sea ice. These changes and other climatic changes have affected and will continue to affect human health, water supply, agriculture, transportation, energy, coastal areas, and many other sectors of society, with increasingly adverse impacts on the American economy and quality of life.3..

…Water quality and quantity are being affected by climate change. Changes in precipitation and runoff, combined with changes in consumption and withdrawal, have reduced surface and groundwater supplies in many areas. These trends are expected to continue, increasing the likelihood of water shortages for many uses. Water quality is also diminishing in many areas, particularly due to sediment and contaminant concentrations after heavy downpours…

Climate change affects human health in many ways. For example, increasingly frequent and intense heat events lead to more heat-related illnesses and deaths and, over time, worsen drought and wildfire risks, and intensify air pollution. Increasingly frequent extreme precipitation and associated flooding can lead to injuries and increases in waterborne disease. Rising sea surface temperatures have been linked with increasing levels and ranges of diseases. Rising sea levels intensify coastal flooding and storm surge, and thus exacerbate threats to public safety during storms. Certain groups of people are more vulnerable to the range of climate change related health impacts, including the elderly, children, the poor, and the sick. Others are vulnerable because of where they live, including those in floodplains, coastal zones, and some urban areas. Improving and properly

supporting the public health infrastructure will be critical to managing the potential health impacts of climate change.

Climate change also affects the living world, including people, through changes in ecosystems and biodiversity. Ecosystems provide a rich array of benefits and services to humanity, including habitat for fish and wildlife, drinking water storage and filtration, fertile soils for growing crops, buffering against a range of stressors including climate change impacts, and aesthetic and cultural values. These benefits are not always easy to quantify, but they support jobs, economic growth, health, and human well-being. Climate change driven disruptions to ecosystems have direct and indirect human impacts, including reduced water supply and quality, the loss of iconic species and landscapes, effects on food chains and the timing and success of species migrations, and the potential for extreme weather and climate events to destroy or degrade the ability of ecosystems to provide societal benefits.

Human modifications of ecosystems and landscapes often increase their vulnerability to damage from extreme weather events, while simultaneously reducing their natural capacity to moderate the impacts of such events. For example, salt marshes, reefs, mangrove forests, and barrier islands defend coastal ecosystems and infrastructure, such as roads and buildings, against storm surges. The loss of these natural buffers due to coastal development, erosion, and sea level rise increases the risk of catastrophic damage during or after extreme weather events. Although floodplain wetlands are greatly reduced from their historical extent, those that remain still absorb floodwaters and reduce the effects of high flows on river-margin lands. Extreme weather events that produce sudden increases in water flow, often carrying debris and pollutants, can decrease the natural capacity of ecosystems to cleanse contaminants. The climate change impacts being felt in the regions and sectors of the United States are affected by global trends and economic decisions. In an increasingly interconnected world, U.S. vulnerability is linked to impacts in other nations. It is thus difficult to fully evaluate the impacts of climate change on the United States without considering consequences of climate change elsewhere.

Response Options As the impacts of climate change are becoming more prevalent, Americans face choices. Especially because of past emissions of long-lived heat-trapping gases, some additional climate change and related impacts are now unavoidable. This is due to the long-lived nature of many of these gases, as well as the amount of heat absorbed and retained by the oceans and other responses within the climate system. The amount of future climate change, however, will still largely be determined by choices society makes about emissions. Lower emissions of heat-trapping gases and particles mean less future warming and less-severe impacts; higher emissions mean more warming and more severe impacts. Efforts to limit emissions or increase carbon uptake fall into a category of response options known as “mitigation,” which refers to reducing the amount and speed of future climate change by reducing emissions of heat-trapping gases or removing carbon dioxide from the atmosphere.

The other major category of response options is known as “adaptation,” and refers to actions to prepare for and adjust to new conditions, thereby reducing harm or taking advantage of new opportunities. Mitigation and adaptation actions are linked in multiple ways, including that effective mitigation reduces the need for adaptation in the future. Both are essential parts of a comprehensive climate change response strategy. The threat of irreversible impacts makes the timing of mitigation efforts particularly critical. This report includes chapters on Mitigation, Adaptation, and Decision Support that offer an overview of the options and activities being planned or implemented around the country as local, state, federal, and tribal governments, as well as businesses, organizations, and individuals begin to respond to climate change. These chapters conclude that while response actions are under development, current implementation efforts are insufficient to avoid increasingly negative social, environmental, and economic consequences.

Large reductions in global emissions of heat-trapping gases, similar to the lower emissions scenario (B1)

analyzed in this assessment, would reduce the risks of some of the worst impacts of climate change. Some targets called for in international climate negotiations to date would require even larger reductions than those outlined in the B1 scenario. Meanwhile, global emissions are still rising and are on a path to be even higher than the high emissions scenario (A2) analyzed in this report. The recent U.S. contribution to annual global emissions is about 18%, but the U.S. contribution to cumulative global emissions over the last century is much higher. Carbon dioxide lasts for a long time in the atmosphere, and it is the cumulative carbon emissions that determine the amount of global climate change. After decades of increases, U.S. CO2 emissions from energy use (which account for 97% of total U.S. emissions) declined by around 9% between 2008 and 2012, largely due to a shift from coal to less CO2-intensive natural gas for electricity production. Governmental actions in city, state, regional, and federal programs to promote energy efficiency have also contributed to reducing U.S. carbon emissions. Many, if not most of these programs are motivated by other policy objectives, but some are directed specifically at greenhouse gas emissions. These U.S. actions and others that might be undertaken in the future are described in the Mitigation chapter of this report. Over the remainder of this century, aggressive and sustained greenhouse gas emission reductions by the United States and by other nations would be needed to reduce global emissions to a level consistent with the lower scenario (B1) analyzed in this assessment.

With regard to adaptation, the pace and magnitude of observed and projected changes emphasize the need to be prepared for a wide variety and intensity of impacts. Because of the growing influence of human activities, the climate of the past is not a good basis for future planning. For example, building codes and landscaping ordinances could be updated to improve energy efficiency, conserve water supplies, protect against insects that spread disease (such as dengue fever), reduce susceptibility to heat stress, and improve protection against extreme events. The fact that climate change impacts are increasing points to the urgent need to develop and refine approaches that enable decision-making and increase flexibility and resilience in the face of ongoing and future impacts. Reducing non-climate-related stresses that contribute to existing vulnerabilities can also be an effective approach to climate change adaptation.

Adaptation can involve considering local, state, regional, national, and international jurisdictional objectives. For example, in managing water supplies to adapt to a changing climate, the implications of international treaties should be considered in the context of managing the Great Lakes, the Columbia River, and the Colorado River to deal with increased drought risk. Both “bottom up” community planning ning and “top down” national strategies may help regions deal with impacts such as increases in electrical brownouts, heat stress, floods, and wildfires.

Proactively preparing for climate change can reduce impacts while also facilitating a more rapid and efficient response to changes as they happen. Such efforts are beginning at the federal, regional, state, tribal, and local levels, and in the corporate and non-governmental sectors, to build adaptive capacity and resilience to climate change impacts. Using scientific information to prepare for climate changes in advance can provide economic opportunities, and proactively managing the risks can reduce impacts and costs over time.

There are a number of areas where improved scientific information or understanding would enhance the capacity to estimate future climate change impacts. For example, knowledge of the mechanisms controlling the rate of ice loss in Greenland and Antarctica is limited, making it difficult for scientists to narrow the range of expected future sea level rise. Improved understanding of ecological and social responses to climate change is needed, as is understanding of how ecological and social responses will interact.

A sustained climate assessment process could more efficiently collect and synthesize the rapidly evolving science and help supply timely and relevant information to decision-makers. Results from all of these efforts could continue to deepen our understanding of the interactions of human and natural systems in the context of a changing climate, enabling society to effectively respond and prepare for our future.20

The cumulative weight of the scientific evidence contained in this report confirms that climate change is affecting the American people now, and that choices we make will affect our future and that of future generations.

What's New?

Since the second National Climate Assessment was published in 2009, the climate has continued to change, with resulting effects on the United States. The trends described in the 2009 report have continued, and our understanding of the data and ability to model the many facets of the climate system have increased substantially.
Several noteworthy advances are mentioned below:

- Continued warming and an increased understanding of the U.S. temperature record, as well as multiple other sources of evidence, have strengthened our confidence in the conclusions that the warming trend is clear and primarily the result of human activities. For the contiguous United States, the last decade wasthe warmest on record, and 2012 was the warmest year on record.

- Heavy precipitation and extreme heat events are increasing in a manner consistent with model projections; the risks of such extreme events will rise in the future.

- The sharp decline in summer Arctic sea ice has continued, is unprecedented, and is consistent with human-induced climate change. A new record for minimum area of Arctic sea ice was set in 2012.

- A longer and better-quality history of sea level rise has increased confidence that recent trends are unusual and human-induced. Limited knowledge of ice sheet dynamics leads to a broad range for projected sea level rise over this century.

- New approaches to building scenarios of the future have allowed for investigations of the implications of larger reductions in heat trapping gas emissions than examined previously.

KEY MESSAGES

1. Global climate is changing and this is apparent across the United States in a wide range of observations. The global warming of the past 50 years is primarily due to human activities, predominantly the burning of fossil fuels.

Many independent lines of evidence confirm that human activities are affecting climate in unprecedented ways. U.S. average temperature has increased by 1.3°F to 1.9°F since record keeping began in 1895; most of this increase has occurred since about 1970. The most recent decade was the warmest on record. Because human-induced warming is superimposed on a naturally varying climate, rising temperatures are not evenly distributed across the country or over time.

2. Some extreme weather and climate events have increased in recent decades, and new and stronger evidence confirms that some of these increases are related to human activities.

Changes in extreme weather events are the primary way that most people experience climate change. Human-induced climate change has already increased the number and strength of some of these extreme events. Over the last 50 years, much of the United States has seen an increase in prolonged periods of excessively high temperatures, more heavy downpours, and in some regions, more severe droughts.

3. Human-induced climate change is projected to continue, and it will accelerate significantly if global

emissions of heat-trapping gases continue to increase.

Heat-trapping gases already in the atmosphere have committed us to a hotter future with more climate-related impacts over the next few decades. The magnitude of climate change beyond the next few decades depends primarily on the amount of heat-trapping gases that human activities emit globally, now and in the future.

4. Impacts related to climate change are already evident in many sectors and are expected to become increasingly disruptive across the nation throughout this century and beyond.

Climate change is already affecting societies and the natural world. Climate change interacts with other environmental and societal factors in ways that can either moderate or intensify these impacts. The types and magnitudes of impacts vary across the nation and through time. Children, the elderly, the sick, and the poor are especially vulnerable. There is mounting evidence that harm to the nation will increase substantially in the future unless global emissions of heat-trapping gases are greatly reduced.

5. Climate change threatens human health and well-being in many ways, including through more extreme weather events and wildfire, decreased air quality, and diseases transmitted by insects, food, and water.

Climate change is increasing the risks of heat stress, respiratory stress from poor air quality, and the spread of waterborne diseases. Extreme weather events often lead to fatalities and a variety of health impacts on vulnerable populations, including impacts on mental health, such as anxiety and post-traumatic stress disorder. Large-scale changes in the environment due to climate change and extreme weather events are increasing the risk of the emergence or reemergence of health threats that are currently uncommon in the United States, such as dengue fever.

6. Infrastructure is being damaged by sea level rise, heavy downpours, and extreme heat; damages are projected to increase with continued climate change.

Sea level rise, storm surge, and heavy downpours, in combination with the pattern of continued development in coastal areas, are increasing damage to U.S. infrastructure including roads, buildings, and industrial facilities, and are also increasing risks to ports and coastal military installations. Flooding along rivers, lakes, and in cities following heavy downpours, prolonged rains, and rapid melting of snowpack is exceeding the limits of flood protection infrastructure designed for historical conditions. Extreme heat is damaging transportation infrastructure such as roads, rail lines, and airport runways.

7. Water quality and water supply reliability are jeopardized by climate change in a variety of ways that affect ecosystems and livelihoods.

Surface and groundwater supplies in some regions are already stressed by increasing demand for water as well as declining runoff and groundwater recharge. In some regions, particularly the southern part of the country and the Caribbean and Pacific Islands, climate change is increasing the likelihood of water shortages and competition for water among its many uses. Water quality is diminishing in many areas, particularly due to increasing sediment and contaminant concentrations after heavy downpours.

8. Climate disruptions to agriculture have been increasing and are projected to become more severe over this century.

Some areas are already experiencing climate-related disruptions, particularly due to extreme weather events. While some U.S. regions and some types of agricultural production will be relatively resilient to climate change over the next 25 years or so, others will increasingly suffer from stresses due to extreme heat, drought, disease, and heavy downpours. From mid-century on, climate change is projected to have more negative impacts on crops and livestock across the country – a trend that could diminish the security of our food supply.

9. Climate change poses particular threats to Indigenous Peoples' health, well-being, and ways of life.

Chronic stresses such as extreme poverty are being exacerbated by climate change impacts such as reduced access to traditional foods, decreased water quality, and increasing exposure to health and safety hazards. In parts of Alaska, Louisiana, the Pacific Islands, and other coastal locations, climate change impacts (through erosion and inundation) are so severe that some communities are already relocating from historical homelands to which their traditions and cultural identities are tied. Particularly in Alaska, the rapid pace of temperature rise, ice and snow melt, and permafrost thaw are significantly affecting critical infrastructure and traditional livelihoods.

10. Ecosystems and the benefits they provide to society are being affected by climate change. The capacity of ecosystems to buffer the impacts of extreme events like fires, floods, and severe storms is being overwhelmed.

Climate change impacts on biodiversity are already being observed in alteration of the timing of critical biological events such as spring bud burst and substantial range shifts of many species. In the longer term, there is an increased risk of species extinction. These changes have social, cultural, and economic effects. Events such as droughts, floods, wildfires, and pest outbreaks associated with climate change (for example, bark beetles in the West) are already disrupting ecosystems. These changes limit the capacity of ecosystems, such as forests, barrier beaches, and wetlands, to continue to play important roles in reducing the impacts of these extreme events on infrastructure, human communities, and other valued resources.

11. Ocean waters are becoming warmer and more acidic, broadly affecting ocean circulation, chemistry, ecosystems, and marine life.

More acidic waters inhibit the formation of shells, skeletons, and coral reefs. Warmer waters harm coral reefs and alter the distribution, abundance, and productivity of many marine species. The rising temperature and changing chemistry of ocean water combine with other stresses, such as overfishing and coastal and marine pollution, to alter marine-based food production and harm fishing communities.

12. Planning for adaptation (to address and prepare for impacts) and mitigation (to reduce future climate change, for example by cutting emissions) is becoming more widespread, but current implementation efforts are insufficient to avoid increasingly negative social, environmental, and economic consequences.

Actions to reduce emissions, increase carbon uptake, adapt to a changing climate, and increase resilience to impacts that are unavoidable can improve public health, economic development, ecosystem protection, and quality of life.

Scenarios

Scenarios provide ways to help understand what future conditions might be. Each scenario provides an example of what might happen under particular assumptions, and is neither a prediction nor a forecast. Instead, scenarios provide scientifically rigorous and consistent starting points for examining questions about an uncertain future and help us to visualize alternative futures in human terms. The military and businesses frequently use these powerful tools for future planning in high-stakes situations. Scenarios are used to help identify future vulnerabilities as well as to support decision-makers who are focused on limiting risk and maximizing opportunities. Three types of scenarios are used within this assessment to help frame the impact analyses in a consistent way: emissions scenarios (including population and land-use components); climate scenarios; and sea level rise scenarios. Each is briefly described below.

Emissions Scenarios

Emissions scenarios quantitatively illustrate how the release of different amounts of climate-altering gases and particles into the atmosphere will produce different future climate conditions. Such emissions result from

human activities including fossil fuel energy production and use, agriculture, and other activities that change land use. These scenarios are developed using a wide range of assumptions about population growth, economic and technological development, and other factors. A wide range of assumptions is used because future trends depend on unpredictable human choices.

Perspectives on "plausible" emissions scenarios evolve over time. The Intergovernmental Panel on Climate Change (IPCC) has released three different sets of scenarios since 1990. In 2000, the IPCC released a Special Report on Emission Scenarios**1** that provided a set of scenarios, known as the SRES, which described a wide range of socioeconomic futures and resulting emissions. Near the higher end of the range, the SRES A2 scenario represents a world with high population growth, low economic growth, relatively slow technology improvements and diffusion, and other factors that contribute to high emissions and lower adaptive capacity (for example, low per capita wealth). At the lower end of the range, the SRES B1 scenario represents a world with lower population growth, higher economic development, a shift to low-emitting efficient energy technologies that are diffused rapidly around the world through free trade, and other conditions that reduce the rate and magnitude of climate change as well as increase capacity for adaptation. The SRES A2 and B1 scenarios are the foundation scenarios used in this assessment to evaluate future impacts.

Recently, a new set of scenarios (Representative Concentration Pathways – RCPs) has been prepared and released by scientists who study emissions, climate, and potential impacts.**2** This new set incorporates recent observations and research and includes a wider range of future conditions and emissions. Because climate model results are just now being released using the new scenarios, and there are few impact studies that employ them, the RCP climate scenarios are used sparingly in this assessment.

Scientists cannot predict which, if any, of the scenarios in either the SRES set or the RCP set is most likely because the future emissions pathway is a function of human choices. A wide range of societal decisions and policy choices will ultimately influence how the world's emissions evolve, and ultimately, the composition of the atmosphere and the state of the climate system.

Two SRES global emissions scenarios were recommended for use by the authors of this report for impact studies. One is a higher emissions scenario (the A2 scenario from SRES) and the other is a lower emissions scenario (the B1 scenario from SRES). These two scenarios do not encompass the full range of possible futures: emissions could change less than those scenarios imply, or they could change even more. Recent carbon dioxide emissions have, in fact, been higher than in the A2 scenario. Whether this trend will continue is not possible to predict because it depends on societal choices.

Climate Scenarios and Climate Models

Global models that simulate the Earth's climate system are used, among other things, to evaluate the effects of human activities on climate. This assessment incorporates a new set of model simulations that have higher resolution and enhanced representation of Earth system physics, chemistry, and biology. These models use the new set of RCP emissions scenarios described above to project expected climate change given various assumptions about how human activities and associated emissions levels might change.

The range of potential increases in global average temperature in the newest climate model simulations is wider than earlier simulations because a broader range of options for human behavior is considered. For example, the lowest of the new RCP scenarios assumes rapid emissions reductions that would limit the global temperature increase to about 3.7°F, a much lower level than in previous scenarios. The emissions trajectory in RCP 8.5 is similar to SRES A2 and RCP 4.5 is roughly comparable to SRES B1 (see Figure 1). These similarities between specific RCP and SRES scenarios make it possible to compare the results from different modeling efforts over time.

Sea Level Rise Scenarios

After at least two thousand years of little change, global sea level rose by roughly 8 inches over the last century, and satellite data provide evidence that the rate of rise over the past 20 years has roughly doubled. In the United States, millions of people and many of the nation's assets related to military readiness, energy, transportation, commerce, and ecosystems are located in areas at risk of increased coastal flooding be-cause of sea level rise and associated storm surge.

Global sea level is rising and will continue to do so beyond the year 2100 as a result of increasing global temperatures. This occurs for two main reasons. First, when temperatures rise, ocean water heats up, causing it to expand. Second, when glaciers and ice sheets melt in response to hotter conditions, additional water flows into the oceans. Sea level is projected to rise an additional 1 to 4 feet in this century. Scientists are unable to narrow this range at present because the processes affecting the loss of ice mass from the large ice sheets are dy-namic and still the subject of intense study.

Some impact assessments in this report use a set of sea level rise scenarios within this range, while others consider a wider range. Four scenarios (8 inches, 1 foot, 4 feet, and 6.6 feet of rise by 2100), along with explanations regarding how to use this information, are included in a guidance document on sea level rise that was provided to the National Climate Assessment (NCA) authors to use as the basis of impact assessments in coastal areas.

Models and Sources of Uncertainty

There are multiple well-documented sources of uncertainty in climate model simulations. Some of these uncertainties can be reduced with improved models. Some may never be completely eliminated. The climate system is complex, including natural variability on a range of time scales, and this is one source of uncertainty in projecting future conditions. In addition, there are challenges with building models that accurately represent the physics of multiple interacting processes, with the scale and time frame of the available historical data, and with the ability of computer models to handle very large quantities of data. Thus, climate models are necessarily simplified representations of the real climate system.

One of the largest sources of uncertainty in projecting future conditions involves what decisions society will make about managing the emissions of greenhouse gases. By later this century, very different conditions would result from higher emissions scenarios (such as A2) than from lower ones (like B1).

Over the last decade, concerted efforts in climate modeling have focused on understanding and better quantifying the uncertainties inherent in model simulations of climate change and on improving model resolution and representations of physical and biological processes important to the climate system. It is very clear that progress is being made in the accuracy of models in representing the physics of the climate system at smaller scales. This is demonstrated, for example, by the ability of these models to replicate observed climate.

To understand and better quantify uncertainty, multiple models generated by different modeling groups around the world are being used to identify common features in projections of climate change. The Third Coupled Model Intercomparison Project (CMIP3), and more recently CMIP5, established formalized structures that enable model evaluations against the climate record of the recent past. New elements of the CMIP5 effort include a major focus on near-term, decade-length projections designed for regional climate change and on pre-dictions from the new class of Earth system models that include coupled physical, chemical, and biogeochemical climate processes. CMIP3 findings are the foundation for most of the impact analyses included in this assessment. Newer information from CMIP5 was largely unavailable in time to serve as the foundation for this report and is primarily provided for comparison purposes.

The breadth and depth of these analyses indicate that the modeling results in this report are robust. There is an important distinction to be made, however, between a "prediction" of what "will" happen and a "projection" of what future conditions are likely given a particular set of assumptions. All of the model results presented in this report are the latter: projections based on specified assumptions about emissions. The new regional projections provided in this report represent the state of the science in climate change modeling.

MITIGATION

The amount of future climate change will largely be determined by choices society makes about emissions. Lower emissions of heat trapping gases mean less future warming and less severe impacts. Emissions can be reduced through improved energy efficiency and switching to low-carbon or non-carbon energy sources.

Land Use, Forestry, and Agriculture

The main stocks of carbon in its various biological forms (plants and trees, dead wood, litter, soil, and harvested products) are estimated periodically and their rate of change, or flux, is calculated as the average annual difference between two time periods. Estimates of carbon stocks and fluxes for U.S. lands are based on land inventories augmented with data from ecosystem studies and production reports.

U.S. lands were estimated to be a net sink of between approximately 640 and 1,074 million tons CO -e in the late 2000s. Estimates vary depending on choice of datasets, models, and methodologies (see Ch. 15: Biogeochemical Cycles, "Estimating the U.S. Carbon Sink," for more discussion). This net land sink effect is the result of sources (from crop production, livestock production, and grasslands) and sinks (in forests, urban trees, and wetlands). Sources of carbon have been relatively stable over the last two decades, but sinks have been more variable. Longterm trends suggest significant emissions from forest clearing in the early 1900s followed by a sustained period of net uptake from forest regrowth over the last 70 years. The amount of carbon taken up by U.S. land sinks is dominated by forests, which have annually absorbed 7% to 24% (with a best estimate of about 16%) of fossil fuel CO emissions in the U.S. over the past two decades.

The persistence of the land sink depends on the relative effects of several interacting factors: recovery from historical land-use change, atmospheric CO and nitrogen deposition, natural disturbances, and the effects of climate variability and change – particularly drought, wildfires, and changes in the length of the growing season. Deforestation continues to cause an annual loss of 877,000 acres (137,000 square miles) of forested land, offset by a larger area gain of new forest of about 1.71 million acres (268,000 square miles) annually. Since most of the new forest is on relatively low-productivity lands of the Intermountain West, and much of the deforestation occurs on high-productivity lands in the East, recent land-use changes have decreased the potential for future carbon storage. The positive effects of increasing carbon dioxide concentration and nitrogen deposition on carbon storage are not likely to be as large as the negative effects of land-use change and disturbances. In some regions, longer growing seasons associated with climate change may increase annual productivity. Droughts and other disturbances, such as fire and insect infestations, have already turned some U.S. land regions from carbon sinks into carbon sources (see Ch. 13: Land Use & Land Cover Change and Ch. 15: Biogeochemical Cycles). The current land sink may not be sustainable for more than a few more decades, though there is a lack of consistency in published results about the relative effects of disturbance and other factors on net land-use emissions.

Preparation for Potential Future Mitigation Action

To meet the emissions reduction in the lower (B1) scenario used in this assessment (Ch. 2: Our Changing Climate) under reasonable assumptions about managing costs, annual global CO emissions would need to peak

at around 44 billion tons within the next 25 years or so and decline steadily for the rest of the century. At the current rate of emissions growth, the world is on a path to exceed the 44 billion ton level within a decade (see "Emissions Scenarios and RCPs"). Thus achievement of a global emissions path consistent with the B1 scenario will require strenuous action by all major emitters.

Achieving the B1 emissions path would require substantial decarbonization of the global economy by the end of this century, implying a fundamental transformation of the global energy system. Details of the energy mix along the way differ among analyses, but the implied involvement by the U.S. can be seen in studies carried out under the U.S. Climate Change Science Program and the Energy Modeling Forum. In these studies, direct burning of coal without carbon capture is essentially excluded from the power system, and the same holds for natural gas toward the end of the century – to be replaced by some combination of coal or gas with carbon capture and storage, nuclear generation, and renewables. Biofuels and electricity are projected to substitute for oil in the transport sector. A substantial component of the task is accomplished with demand reduction, through efficiency improvement, conservation, and shifting to an economy less dependent on energy services.

… The challenge is great enough even starting today, but delay by any of the major emitters makes meeting any such target even more difficult and may rule out some of the more ambitious goals. A study of the climate change threat and potential responses by the U.S. National Academies therefore concludes that there is "an urgent need for U.S. action to reduce greenhouse emissions." The National Research Council (NRC) goes on to suggest alternative national-level strategies that might be followed, including an economy-wide system of prices on greenhouse gas emissions and a portfolio of possible regulatory measures and subsidies. Deciding these matters will be a continuing task, and U.S. Administrations and Congress face a long series of choices about whether to take additional mitigation actions and how best to do it. Two supporting activities will help guide this process: opening future technological options and development of ever-more-useful assessments of the cost effectiveness and benefits of policy choices.

Many technologies are potentially available to accomplish emissions reduction. They include ways to increase the efficiency of fossil energy use and facilitate a shift to low-carbon energy sources, sources of improvement in the cost and performance of renewables (for example, wind, solar, and bioenergy) and nuclear energy, ways to reduce the cost of carbon capture and storage, means to expand terrestrial sinks through management of forests and soils and increased agricultural productivity, and phasing down HFCs. In addition to the research and development carried out by private sector firms with their own funds, the Federal Government traditionally supports major programs to advance these technologies. This support is accomplished in part by credits and deductions in the tax code, and in part by federal expenditure. For example, the 2012 federal budget devoted approximately $6 billion to clean energy technologies. Success in these ventures, lowering the cost of greenhouse gas reduction, can make a crucial contribution to future policy choices.

Because they are in various stages of market maturity, the costs and effectiveness of many of these technologies remain uncertain: continuing study of their performance is important to understanding their role in future mitigation decisions. In addition, evaluation of broad policies and particular mitigation measures requires frameworks that combine information from a range of disciplines. Study of mitigation in the near future can be done with energy-economic models that do not assume large changes in the mix of technologies or changes in the structure of the economy. Analysis over the time spans relevant to stabilization of greenhouse gas concentrations, however, requires Integrated Assessment Models, which consider all emissions drivers and policy measures that affect them, and that take account of how they are related to the larger economy and features of the climate system. This type of analysis is also useful for exploring the relations between mitigation and measures to adapt to a changing climate.

Continued development of these analytical capabilities can help support decisions about national mitigation and

the U.S. position in international negotiations. In addition, as shown above, mitigation is being undertaken by individuals and firms as well as by city, state, and regional governments. The capacity for mitigation from individual and household behavioral changes, such as increasing energy end-use efficiency with available technology, is known to be large. Although there is capacity, there is not always broad acceptance of those behavioral changes, nor is there sufficient understanding of how to design programs to encourage such changes. Behavioral and institutional research on how such choices are made and the results evaluated would be extremely beneficial. For many of these efforts, understanding of cost and effectiveness is limited, as is understanding of aspects of public support and institutional performance; so additional support for studies of these activities is needed to ensure that resources are efficiently employed.

Research Needs

- Engineering and scientific research is needed on the development of cost effective energy use technologies (devices, systems, and control strategies) and energy supply technologies that produce little or no CO or other greenhouse gases.

- Better understanding of the relationship between emissions and atmospheric greenhouse gas concentrations is needed to more accurately predict how the atmosphere and climate system will respond to mitigation measures.

- Processes controlling the land sink of carbon in the U.S. require additional research, including better monitoring and analysis of economic decision-making about the fate of land and how it is managed, as well as the inherent ecological processes and how they respond to the climate system.

- Uncertainties in model-based projections of greenhouse gas emissions and of the effectiveness and costs of policy measures need to be better quantified.

- Exploration is needed of the effects of different model structures, assumptions about model parameter values, and uncertainties in input data. Social and behavioral science research is needed to inform the design of mitigation measures for maximum participation and to prepare a consistent framework for assessing cost effectiveness and benefits of both voluntary mitigation efforts and regulatory and subsidy programs.

[DRAWDOWN—carbon sinks]

ADAPTATION

Adaptation refers to action to prepare for and adjust to new conditions, thereby reducing harm or taking advantage of new opportunities. Adaptation planning is occurring in the public and private sectors and at all levels of government but few measures have been implemented.

Explore adaptation to climate change.

Adaptation Key Terms Definitions—Definitions adapted from (IPCC 2007; 15 NRC 2007, 16 20104).

- **Adapt, Adaptation**: Adjustment in natural or human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects.

- **Adaptive Capacity**: The potential of a system to adjust to climate change (including climate variability

and extremes) to moderate potential damages, take advantage of opportunities, and cope with the consequences.

- **Mitigation**: Technological change and substitutions that reduce resource inputs and emissions per unit of output. Although several social, economic, and technological actions would reduce emissions, with respect to climate change, mitigation means implementing actions to reduce greenhouse gas emissions or increase the amount of carbon dioxide absorbed and stored by natural and man-made carbon sinks (see Ch. 27: Mitigation).

- **Multiple Stressors**: Stress that originates from different sources that affect natural, managed, and socioeconomic systems and can cause impacts that are compounded and sometimes unexpected. An example would be when economic or market stress combines with drought to negatively impact farmers.

- **Resilience**: A capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment.

- **Risk**: A combination of the magnitude of the potential consequence(s) of climate change impact(s) and the likelihood that the consequence(s) will occur.

- **Vulnerability**: The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Over the past few years, the focus moved from the question "Is climate changing?" to the equally important question: "Can society manage unavoidable changes and avoid unmanageable changes?" Research demonstrates that both mitigation (efforts to reduce future climate changes) and adaptation (efforts to reduce the vulnerability of society to climate change impacts) are needed in order to minimize the damages from human-caused climate change and to adapt to the pace and ultimate magnitude of changes that will occur.

Adaptation and mitigation are closely linked; adaptation efforts will be more difficult, more costly, and less likely to succeed if significant mitigation actions are not taken. The study and application of adaptation in the climate change realm is nascent compared to the many analyses of mitigation policies and practices to reduce emissions. Uncertainties about future socioeconomic conditions as well as future climate changes can make it difficult to arrive at adaptation decisions now. However, the pace and magnitude of projected change emphasize the need to be prepared for a wide range and intensity of climate impacts in the future.

Planning and managing based on the climate of the last century means that tolerances of some infrastructure and species will be exceeded. For example, building codes and landscaping ordinances will likely need to be updated not only for energy efficiency but also to conserve water supplies, protect against disease vectors, reduce susceptibility to heat stress, and improve protection against extreme events. Although there is uncertainty about future conditions, research indicates that intelligent adaptive actions can still be taken now. Climate change projections have inherent uncertainties, but it is still important to develop, refine, and deploy tools and approaches that enable iterative decision-making and increase flexibility and robustness of climate change responses.

Climate change affects human health, natural ecosystems, built environments, and existing social, institutional, and legal arrangements. Adaptation considerations include local, state, regional, national, and international

issues. For example, the implications of international arrangements need to be considered in the context of managing the Great Lakes, the Columbia River, and the Colorado River to deal with drought. Both "bottom up" community planning and "top down" national strategies may help region deal with impacts such as increases in electrical brownouts, heat stress, floods, and wildfires. Such a mix of approaches will require cross-boundary coordination at multiple levels as operational agencies integrate adaptation planning into their programs.

Adaptation actions can be implemented reactively, after changes in climate occur, or proactively, to prepare for projected changes. Proactively preparing can reduce the harm from certain climate change impacts, such as increasingly intense extreme events, shifting zones for agricultural crops, and rising sea levels, while also facilitating a more rapid and efficient response to changes as they happen. This chapter highlights efforts at the federal, regional, state, tribal, and local levels, as well as initiatives in the corporate and non-governmental sectors to build adaptive capacity and resilience in response to climate change. While societal adaptation to climate variability is as old as civilization itself, the focus of this chapter is on preparing for unprecedented human-induced climate change through adaptation.

Key Message 2

Barriers to implementation of adaptation include limited funding, policy and legal impediments, and difficulty in anticipating climate-related changes at local scales.

Federal agencies can be particularly helpful in facilitating climate adaptation by:

- fostering the stewardship of public resources and maintenance of federal facilities, services, and operations such as defense, emergency management, transportation, and ecosystem conservation in the face of a changing climate;
- providing usable information and financial support for adaptation;
- facilitating the dissemination of best practices and supporting a clearinghouse to share data, resources, and lessons learned;
- dealing with and anticipating impacts that cross geopolitical boundaries, assisting in disaster response, and supporting flexible regulatory frameworks;
- ensuring the establishment of federal policies that allow for "flexible" adaptation efforts and take steps to avoid unintended consequences; and
- building public awareness.

States

States have become important actors in national climate change related efforts. State governments can create policies and programs that encourage or discourage adaptation at other governance scales (such as counties or regions) through regulation and by serving as laboratories for innovation. Although many of these actions are not specifically designed to address climate change, they often include climate adaptation components.

Many state-level climate change-specific adaptation actions focus on planning. As of 2013, fifteen states had completed climate adaptation plans; four states were in the process of writing their plans; and seven states had made recommendations to create state-wide adaptation plans.

In addition to formal adaptation plans, numerous states have created sector-specific plans that consider long-term climate change. For example, at least 16 states have biodiversity conservation plans that focus on preparing for long-term changes in climate. In addition to planning, some states have created legislation and/or programs that are either directly or indirectly targeted at reducing climate vulnerabilities (Table 28.2).

Tribal Governments

Tribal governments have been particularly active in assessing and preparing for the impacts of climate change. For example:

- Adaptation planning in Point Hope, Alaska, emphasizes strategies for enhancing community health.
- In Newtok, Alaska, the village council is leading a land-acquisition and planning effort to relocate the community, because climate change induced coastal erosion has destroyed essential infrastructure, making the current village site unsafe.
- The Tulalip Tribes in Washington State are using traditional knowledge gleaned from elders, stories, and songs and combining this knowledge with downscaled climate data to inform decision-making. Also in Washington State, the Swinomish Indian Tribal Community integrated climate change into decision-making in major sectors of the Swinomish Community, such as education, fisheries, social services, and human health.
- The Haudenosaunee Confederacy in the northeastern U.S. is addressing climate impacts by preserving a native food base through seed-banking.

Local and Regional Governments

Most adaptation efforts to date have occurred at local and regional levels. Primary mechanisms that local governments are using to
prepare for climate change include land-use planning; provisions to protect infrastructure and ecosystems; regulations related to the design and construction of buildings, roads, and bridges; and emergency preparation, response, and recovery.

According to a recent survey of 298 U.S. local governments, 59% indicated they are engaged in some form of adaptation planning. Local adaptation planning and actions are unfolding in municipalities of varying sizes and in diverse geographicalareas. Communities such as Keene, New Hampshire; New York City, New York; King County, Washington; and Chicago, Illinois are vanguards in the creation of climate adaptation strategies. In addition to local government action,regional agencies and regional aggregations of governments are becoming significant climate changeadaptation actors.

There is no one-size-fits-all adaptation solution to the challenges of adapting to climate change impacts, as solutions will differ depending on context, local circumstance, and scale as well as on local culture and internal capacity.

Non-governmental and Private Sector

Many non-governmental entities have been significant actors in the national effort to prepare for climate change by providing assistance that includes planning guidance, implementation tools, contextualized climate information, best practice exchange,
and help with bridging the science-policy divide to a wide array of stakeholders. The Nature Conservancy, for example, established the Canyonlands Research Center in Monticello, Utah, to facilitate research and developconservation applications for resource issues under the multi-stresses of climate change and land-use demands in the Colorado Plateau region.

With regard to the private sector, evidence from organizations such as the Carbon Disclosure Project (CDP) and the Securities and Exchange Commission's (SEC) Climate Change 10-K Disclosure indicate that a growing number of companies are beginning to actively address risks from climate change (Table 28.5). The World Business Council for Sustainable Development (WBCSD) and the Center for Climate and Energy Solutions (C2ES) have identified three types of risks driving private sector adaptation efforts, including risks to core operations, the value chain, and broader changes in the economy and infrastructure (see Figure 28.2).

This analysis is supported by responses to the 2011 CDP, and suggests that companies are concerned about how changes in the climate will impact issues suchas feedstock, water supply and quality, infrastructure, core operations, supply chains, and customers' ability to use (and their need for) services. Some companies are taking action to not only avoid risk, but to explore potential opportunities that may emerge in a changing climate, such as developing new products and services, developing or expanding existing consulting services, expanding into new operational territories, extending growing seasons and hours of operation, and responding to increased demand for existing products and services.

Adaptation Process

- Identifying and Understanding Risk, Vulnerabilities, and Opportunities
- Planning, Assessing, and Selecting Options
- Implementation
- Monitoring and Evaluation
- Revise Strategies/Processes and Information Sharing

Barriers to Adaptation

Despite emerging recognition of the necessity of climate change adaptation, manybarriers still impede efforts to build local, regional, and national-level resilience. Barriers are obstacles that can delay, divert, or temporarily block the adaptation process, and include difficulties in using climate change projections for decision-making; lack of resources to begin and sustain adaptation efforts; lack of coordination and collaboration within and across political and natural system boundaries as well as within organizations; institutional constraints; lack of leadership; and divergent risk perceptions/cultures and values. Barriers are distinguished from physical or ecological limits to adaptation, such as physiological tolerance of species to changing climatic conditions that cannot be overcome (except with technology or some other physical intervention).

Next Steps

Adaptation to climate change is in a nascent stage. The Federal Government is beginning to develop institutions and practices necessary to cope with climate change, including efforts such as regional climate centers within the U.S. Department of Agriculture, the National Oceanic and Atmospheric Administration (a division of the U.S. Department of Commerce), and the U.S. Department of the Interior. While the Federal Government provides financial assistance in federally-declared disasters, it is also enabling and facilitating early adaptation within states, regions, local communities, and the public and private sectors. The approaches include working to limit current institutional constraints to effective adaptation, funding pilot projects, providing useful and usable adaptation information – including disseminating best practices and helping develop tools and techniques to evaluate successful adaptation.

Despite emerging efforts, the pace and extent of adaptation activities are not proportional to the risks to people, property, infrastructure, and ecosystems from climate change; important opportunities available during

the normal course of planning and management of resources are also being overlooked. A number of state and local governments are engaging in adaptation planning, but most have not taken action to implement the plans. Some companies in the private sector and numerous non-governmental organizations have also taken early action, particularly in capitalizing on the opportunities associated with facilitating adaptive actions. Actions and collaborations have occurred across all scales. At the same time, barriers to effective implementation continue to exist.

One of the overarching key areas of focus for global change research is enabling research and development to advance adaptation across scales, sectors, and disciplines. This includes social science research for overcoming the barriers identified in Section 2, such as strategies that foster coordination, better communication, and knowledge sharing amongst fragmented governing structures and stakeholders. Research on the kinds of information that users desire and how to deliver that information in contextually appropriate ways and research on decision-making in light of uncertainty about climate change and other considerations will be equally important. In addition to these areas, emerging areas of emphasis include:

- ***Costs and Benefits of Adaptation***: Methodologies to evaluate the relevant costs of adaptation options, as well as the costs of inaction, need to be developed.

- ***A Compendium of Adaptation Practices***: A central and streamlined database of adaptation options implemented at different scales in space and time is needed. Information on the adaptation actions, how effective they were, what they cost, and how monitoring and evaluation were conducted should be part of the aggregated information.

- ***Adaptation and Mitigation Interactions***: Research and analysis on the growing and competing demands for land, water, and energy and how mitigation actions could affect adaptation options, and vice versa.

- ***Critical Adaptation Thresholds***: Research to identify critical thresholds beyond which social and/or ecological systems are unable to adapt to climate change. This should include analyzing historical and geological records to develop models of "breakpoints".

- ***Adaptation to Extreme Events***: Research on preparedness and response to extreme events such as droughts, floods, intense storms, and heat waves in order to protect people, ecosystems, and infrastructure. Increased attention must be paid to how extreme events and variability may change as climate change proceeds, and how that affects adaptation actions.

Effective adaptation will require ongoing, flexible, transparent, inclusive, and iterative decision-making processes, collaboration across scales of government and sectors, and the continual exchange of best practices and lessons learned. All stakeholders have a critical role to play in ensuring the preparedness of our society to extreme events and long-term changes in climate.

Decision Support: Connecting Science, Risk Perception, and Decisions

Decision support processes need to take account of the values and goals of stakeholders, evolving scientific information, and perceptions of risk. Available tools can enable decision-makers to identify and assess response options and clarify tradeoffs.

After a long period of relative stability in the climate system, climate conditions are changing and are projected to continue to change (Ch. 2: Our Changing Climate). As a result, historically successful strategies for managing climate-sensitive resources and infrastructure will become less effective over time. Although decision-makers

routinely make complex decisions under uncertain conditions, decision-making in the context of climate change can be especially challenging due to a number of factors. These include the rapid pace of changes in some physical and human systems, long time lags between human activities and response of the climate system, the high economic and political stakes, the number and diversity of potentially affected stakeholders, the need to incorporate uncertain scientific information of varying confidence levels, and the values of stakeholders and decision-makers. The social, economic, psychological, and political dimensions of these decisions underscore the need for ways to improve communication of scientific information and uncertainties and to help decision-makers assess risks and opportunities.

Extensive literature and practical experience offer means to help improve decision-making in the context of climate variability and change. The decision support literature includes topics such as decision-making frameworks, decision support tools, and decision support processes. These approaches can help evaluate the costs and benefits of alternative actions, communicate relative amounts of risk associated with different options, and consider the role of alternative institutions and governance structures. In particular, iterative decision processes that incorporate improving scientific information and learning though periodic reviews of decisions over time are helpful in the context of rapid changes in environmental conditions. Some of the approaches described in this chapter can also help overcome barriers to the use of existing tools and improve communications among scientists, decision-makers, and the public.

What are the decisions and who are the decision-makers?

Decisions about climate change adaptation and mitigation are being made in many settings. For example:

- The Federal Government is engaged in decisions that affect climate policy at the national and international level; makes regulatory decisions (for example, setting efficiency standards for vehicles); and makes decisions about infrastructure and technologies that may reduce risks associated with climate change for its own facilities and activities.

- State, tribal, and local governments are involved in setting policy about both emissions and adaptation activities in a variety of applications, including land use, renewable portfolio and energy efficiency standards, and investments in infrastructure and technologies that increase resilience to extreme weather events.

- Private-sector companies have initiated strategies to respond both to the risks to their investments and the business opportunities associated with preparing for a changing climate.

- Non-governmental organizations have been active in supporting decisions that integrate both adaptation and mitigation considerations, often in the context of promoting sustainability within economic sectors, communities, and ecosystems.

- Individuals make decisions on a daily basis that affect their contributions to greenhouse gas emissions, their preparedness for extreme events, and the health and welfare of their families.

Many decisions involve decision-makers and stakeholders at multiple scales and in various sectors. Effective decision support must link and facilitate interactions across different decision networks.

INDIGENOUS PEOPLES, LAND, AND RESOURCES

The peoples, lands, and resources of indigenous communities in the United States, including Alaska and the

Pacific Rim, face an array of climate change impacts and vulnerabilities that threaten many Native communities. The consequences of observed and projected climate change have and will undermine indigenous ways of life that have persisted for thousands of years. Key vulnerabilities include the loss of traditional knowledge in the face of rapidly changing ecological conditions, increased food insecurity due to reduced availability of traditional foods, changing water availability, Arctic sea ice loss, permafrost thaw, and relocation from historic homelands.

Climate change impacts on many of the 566 federally recognized tribes and other tribal and indigenous groups in the U.S. are projected to be especially severe, since these impacts are compounded by a number of persistent social and economic problems. The adaptive responses to multiple social and ecological challenges arising from climate impacts on indigenous communities will occur against a complex backdrop of centuries-old cultures already stressed by historical events and contemporary conditions. Individual tribal responses will be grounded in the particular cultural and environmental heritage of each community, their social and geographical history, spiritual values, traditional ecological knowledge, and worldview. Furthermore, these responses will be informed by each group's distinct political and legal status, which includes the legacy of more than two centuries of non-Native social and governmental institutional arrangements, relationships, policies, and practices. Response options will be informed by the often limited economic resources available to meet these challenges, as well as these cultures' deeply ingrained relationships with the natural world.

CLIMATE CHANGE IMPACTS IN THE UNITED STATES

The history and culture of many tribes and indigenous peoples are critical to understand before assessing additional climate change impacts. Most U.S. Native populations already face adverse socioeconomic factors such as extreme poverty; substandard and inadequate housing; a lack of health and community services, food, infrastructure, transportation, and education; low employment; and high fuel costs; as well as historical and current institutional and policy issues related to Native resources.**7,11,12,13** The overwhelming driver of these adverse social indicators is pervasive poverty on reservations and in Native communities, as illustrated by an overall 28.4% poverty rate (36% for families with children) on reservations, compared with 15.3% nationally.**13** Some reservations are far worse off, with more than 60% poverty rates and, in some cases, extremely low income levels (for example, Pine Ridge Reservation has the lowest per capita income in the U.S. at $1,535 per year).**14**

These poverty levels result in problems such as: a critical housing shortage of well over two hundred thousand safe, healthy, and affordable homes;**15** a homeless rate of more than 10% on reservations;**16** a lack of electricity (more than 14% of reservation homes are without power, ten times the national average, and, on the Navajo Reservation, about 40% of homes have no electricity**17**); lack of running water in one-fifth of all reservation homes and for about one-third of people on the Navajo Reservation (compared with 1% of U.S. national households);**18,19,20** and an almost complete lack of modern telecommunications – fewer than 50% of homes have phone service, fewer than 10% of residents have Internet access, and many reservations have no cell phone reception.**21** In addition, Native populations are also vulnerable because their physical, mental, intellectual, social, and cultural well-being is traditionally tied to a close relationship with the natural world, and because of their dependence on the land and resources for basic needs such as medicine, shelter, and food.**22,23** Climate changes will exacerbate many existing barriers to providing for these human needs, and in many cases will make adaptive responses more difficult.

Of the 5.2 million American Indians and Alaska Natives registered in the U.S. Census, approximately 1.1 million live on or near reservations or Native lands, located mostly in the Northwest, Southwest, Great Plains, and Alaska. Tribal lands include approximately 56 million acres (about 3% of U.S. lands) in the 48 contiguous states and 44 million acres (about 42% of Alaska's land base) held by Alaska Native corporations.**5** Most reservations are small and often remote or isolated, with a few larger exceptions such as the Navajo Reservation in Arizona, Utah, and New Mexico, which has 175,000 residents.

Native American, Alaska Native, and other indigenous communities across the U.S. share unique historical and cultural relationships with tribal or ancestral lands, significantly shaping their identities and adaptive opportunities.**11** Some climate change adaptation opportunities exist on Native lands, and traditional knowledge can enhance adaptation and sustainability strategies. In many cases, however, adaptation options are limited by poverty, lack of resources, or – for some Native communities, such as those along the northern coast of Alaska constrained by public lands or on certain low-lying Pacific Islands – because there may be no land left to call their own. Conversely, for these same reasons, Native communities – especially in the Arctic – are also increasingly working to identify new economic opportunities associated with climate change and development activities (for example, oil and gas, mining, shipping, and tourism) and to optimize employment opportunities.

Climate Change and Traditional Knowledge

Indigenous traditional knowledge has emerged in national and international arenas as a source of rich information for indigenous and non-indigenous climate assessments, policies, and adaptation strategies. Working Group II of the Intergovernmental Panel on Climate Change Fourth Assessment Report recognized traditional knowledge as an important information source for improving the understanding of climate change and other changes over time, and for developing comprehensive natural resource management and climate adaptation strategies.**29**

Traditional knowledge is essential to the economic and cultural survival of indigenous peoples, and, arguably, cultures throughout the world.**30,31** Traditional knowledge has been defined as "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment."**1,12,32** From an indigenous perspective, traditional knowledge encompasses all that is known about the world around us and how to apply that knowledge in relation to those beings that share the world.**12,33** As the elders of these communities – the "knowledge keepers" – pass away, the continued existence and viability of traditional knowledge is threatened. Programs are needed to help preserve the diverse traditional teachings and employ them to strive for balance among the physical, the spiritual, emotional, and intellectual – all things that encompass "wolakota," meaning to be a complete human being.**34**

Many, if not all, indigenous resource managers believe their cultures already possess sufficient knowledge to respond to climate variation and change.**30,35** However, there are elements of traditional knowledge that are increasingly vulnerable with changing climatic conditions,**4** including cultural identities, ceremonies, and traditional ways of life.**36** The use of indigenous and traditional knowledge to address climate change issues in Indian country has been called "indigenuity" – indigenous knowledge plus ingenuity.**33**

Native cultures are directly tied to Native places and homelands, reflecting the indigenous perspective that includes the "power of place."**6,36,37** Many indigenous peoples regard all people, plants, and animals that share our world as relatives rather than resources. Language, ceremonies, cultures, practices, and food sources evolved in concert with the inhabitants, human and non-human, of specific homelands.**1,33** The wisdom and knowledge of Native people resides in songs, dances, art, language, and music that reflect these places. By regarding all things as relatives, not resources, natural laws dictate that people care for their relatives in responsible ways. As climate change increasingly threatens these Native places, cultural identities, and practices, documenting the impacts on traditional lifestyles would strengthen adaptive strategies.

Traditional knowledge has developed tangible and reliable methods for recording historic weather and climate variability and their impacts on native societies.**40** For example, tribal community historians (winter count keepers) on the northern Great Plains recorded pictographs on buffalo hides to remember the sequence of events that marked each year, dating back to the 1600s. These once-reliable methods are becoming increasingly

more difficult to maintain and less reliable as time passes.**41**

There are recent examples, however, where traditional knowledge and western-based approaches are used together to address climate change and related impacts. For example, the Alaska Native Tribal Health Consortium chronicles climate change impacts on the landscape and on human health and also develops adaptation strategies.**1** This Consortium employs western science, traditional ecological knowledge, and a vast network of "Local Environmental Observers" to develop comprehensive, community-scaled climate change health assessments.**42** During a recent drought on the Navajo Reservation, traditional knowledge and western approaches were also applied together, as researchers worked with Navajo elders to observe meteorological and hydrological changes and other phenomena in an effort to assess and reduce disaster risks.**43**

Key Message 1: Forests, Fires, and Food

Observed and future impacts from climate change threaten Native Peoples' access to traditional foods such as fish, game, and wild and cultivated crops, which have provided sustenance as well as cultural, economic, medicinal, and community health for generations.

Climate change impacts on forests and ecosystems are expected to have direct effects on culturally important plant and animal species, which will affect tribal sovereignty, culture, and economies.**2,4** Warmer temperatures and more frequent drought are expected to cause dieback and tree loss of several tree and plant species (such as birch, brown ash, and sweet grass) important for Native artistic, cultural, and economic purposes, including tourism.**22** Tribal access to valued resources is threatened by climate change impacts causing habitat degradation, forest conversion, and extreme changes in ecosystem processes.**44**

Observed impacts from both the causes and consequences of climate change, and added stressors such as extractive industry practices on or near Native lands, include species loss and shifts in species range.**1,45,46,47** There have also been observed changes in the distribution and population density of wildlife species, contraction or expansion of some plant species' range, and the northward migration of some temperate forest species.**4,48** For example, moose populations in Maine and similar locations are expected to decline because of loss of preferred habitat and increased winter temperatures, which are enabling ticks to survive through the winter and causing damage from significant infestation of the moose.**22**

Loss of biodiversity, changes in ranges and abundance of culturally important native plants and animals, increases in invasive species, bark beetle damage to forests, and increased risk of forest fires have been observed in the Southwest, across much of the West, and in Alaska (see also Appendix 3: Climate Science Supplement, Figure 31; Ch. 7: Forests; Ch. 8: Ecosystems).**4,30,48,49** Changes in ocean temperature and acidity affect distribution and abundance of important food sources, like fish and shellfish (Ch. 2: Our Changing Climate; Ch. 24: Oceans).

Rising temperatures and hotter, drier summers are projected to increase the frequency and intensity of large wildfires (see Ch. 7: Forests).**44** Warmer, drier, and longer fire seasons and increased forest fuel load will lead to insect outbreaks and the spread of invasive species, dry grasses, and other fuel sources (see Ch. 7: Forests). Wildfire threatens Native and tribal homes, safety, economies, culturally important species, medicinal plants, traditional foods, and cultural sites.

In interior Alaska, rural Native communities are experiencing new risks associated with climate change related wildfires in boreal forests and Arctic tundra (see also Ch. 22: Alaska).**1,51** Reliance on local, wild foods and the isolated nature of these communities, coupled with their varied preparedness and limited ability to deal with wildfires, leaves many communities at an increased risk of devastation brought on by fires. While efforts are being made to better coordinate rural responses to wildfires in Alaska, current responses are limited by organization and geographic isolation.**48**

Indigenous peoples have historically depended on the gathering and preparation of a wide variety of local plant and animal species for food (frequently referred to as traditional foods), medicines, ceremonies, community cohesion, and economic health for countless generations.**2,52** These include corn, beans, squash, seals, fish, shellfish, bison, bear, caribou, walrus, moose, deer, wild rice, cottonwood trees, and a multitude of native flora and fauna.**2,45,47,49,52,53,54,55,56,57** A changing climate affects the availability, tribal access to, and health of these resources.**1,2,4,47,57,58,59,60** This in turn threatens tribal customs, cultures, and identity.

Medicinal and food plants are becoming increasingly difficult to find or are no longer found in historical ranges.**2,56** For example, climate change and other environmental stressors are affecting the range, quality, and quantity of berry resources for the Wabanaki tribes in the Northeast.**2,61** The Karuk people in California have experienced a near elimination of both salmonids and acorns, which comprise 50% of a traditional Karuk diet.**62** In the Great Lakes region, wild rice is unable to grow in its traditional range due to warming winters and changing water levels, affecting the Anishinaabe peoples' culture, health, and well-being.**54**

Subsequent shifts from traditional lifestyles and diet, compounded by persistent poverty, food insecurity, the cost of non-traditional foods, and poor housing conditions have led to increasing health problems in communities, also increasing the risk to food and resource security.**1,2,16** Climate change is likely to amplify other indirect effects to traditional foods and resources, including limited access to gathering places and hunting grounds and environmental pollution.

Key Message 2: Water Quality and Quantity

A significant decrease in water quality and quantity due to a variety of factors, including climate change, is affecting drinking water, food, and cultures. Native communities' vulnerabilities and limited capacity to adapt to water-related challenges are exacerbated by historical and contemporary government policies and poor socioeconomic conditions.

Native communities and tribes in different parts of the U.S. have observed changes in precipitation affecting their water resources. On the Colorado Plateau, tribes have been experiencing drought for more than a decade.**63,64** Navajo elders have observed long-term decreases in annual snowfall over the past century, a transition from wet to dry conditions in the 1940s, and a decline in surface water features.**20** Changes in long-term average temperature and precipitation have produced changes in the physical and hydrologic environment, making the Navajo Nation more susceptible to drought impacts, and some springs and shallow water wells on the Navajo Nation have gone dry.**43** Southwest tribes have observed damage to their agriculture and livestock, the loss of springs and medicinal and culturally important plants and animals, and impacts on drinking water supplies.**63,64,65,66** In the Northwest, tribal treaty rights to traditional territories and resources are being affected by the reduction of rainfall and snowmelt in the mountains, melting glaciers, rising temperatures, and shifts in ocean currents.**52,58,67** In Hawai'i, Native peoples have observed a shortening of the rainy season, increasing intensity of storms and flooding, and a rainfall pattern that has become unpredictable.**38** In Alaska, water availability, quality, and quantity are threatened by the consequences of permafrost thaw, which has damaged community water infrastructure, as well as by the northward extension of diseases such as those caused by the *Giardia* parasite, a result of disease-carriers like beavers moving northward in response to rising temperatures.**68** The impact of historical federal policies, such as the late 1800s allotment policy and practices regarding Native access to treaty-protected resources,**69** reverberate in current practices, such as states and the government permitting oil drilling and hydraulic fracturing on lands in and around reservations but outside of tribal jurisdiction (for example, a 2013 pipeline spill upstream of tribal reservations in Western North Dakota, and others). Such policies and practices exacerbate the threat to water quality and quantity for Native communities.

Native American tribes have unique and significant adaptation needs related to climate impacts on water.**66** There is little available data to establish baseline climatic conditions on tribal lands, and many tribes do not have

sufficient capacity to monitor changing conditions.**63** Without scientific monitoring, tribal decision-makers lack the data needed to quantify and evaluate current conditions and emerging trends in precipitation, streamflow, and soil moisture, and to plan and manage resources accordingly.**10,64,66** However, some existing efforts to document climate impacts on water resources could be replicated in other regions to assess hydrologic vulnerabilities.**58**

Water infrastructure is in disrepair or lacking on some reservations.**43,70** Approximately 30% of people on the Navajo Nation are not served by municipal systems and must haul water to meet their daily needs.**19,43** Longer-term impacts of this lack of control over water access are projected to include loss of traditional agricultural crops.**19,43** Furthermore, there is an overall lack of financial resources to support basic water infrastructure on tribal lands.**63** Uncertainty associated with undefined tribal water rights make it difficult to determine strategies to deal with water resource issues.**70** Potential impacts to treaty rights and water resources exist, such as a reduction of groundwater and drinking water availability and water quality decline, including impacts from oil and natural gas extraction and sea level rise-induced saltwater intrusion into coastal freshwater aquifers (see also Ch. 3: Water).**7** New datasets on climate impacts on water in many locations throughout Indian Country, such as the need to quantify available water and aquifer monitoring, will be important for improved adaptive planning.

DRAFT

NORTHWEST

Changes in the timing of streamflow reduce water supplies for competing demands. Sea level rise, erosion, inundation, risks to infrastructure, and increasing ocean acidity pose major threats. Increasing wildfire, insect outbreaks, and tree diseases are causing widespread tree die-off.

Snow accumulates in mountains, melting in spring to power both the region's rivers and economy, creating enough hydropower (40% of national total) to export 2 to 6 million megawatt hours per month. Snowmelt waters crops in the dry interior, helping the region produce tree fruit (number one in the world) and almost $17 billion worth of agricultural commodities, including 55% of potato, 15% of wheat, and 11% of milk production in the United States.

Seasonal water patterns shape the life cycles of the region's flora and fauna, including iconic salmon and steelhead, and forested ecosystems, which cover 47% of the landscape. Along more than 4,400 miles of coastline, regional economic centers are juxtaposed with diverse habitats and ecosystems that support thousands of species of fish and wildlife, including commercial fish and shellfish resources valued at $480 million in 2011. Adding to the influence of climate, human activities have altered natural habitats, threatened species, and extracted so much water that there are already conflicts among multiple users in dry years. More recently, effort have multiplied to balance environmental restoration and economic growth while evaluating climate risks. As conflicts and tradeoffs increase, the region's population continues to grow, and the regional consequences of climate change continue to unfold. The need to seek solutions to these conflicts is becoming increasingly urgent.

The Northwest's economy, infrastructure, natural systems, public health, and vitally important agriculture sector all face important climate change related risks. Those risks – and possible adaptive responses – will vary significantl across the region. Impacts on infrastructure, natural systems, human health, and economic sectors, combined with issues of social and ecological vulnerability, will play out quite differently in largely natural areas, like the Cascade Range or Crater Lake National Park, than in urban areas like Seattle and Portland (Ch. 11: Urban), or among the region's many Native American tribes, like the Umatilla or the Quinault (Ch. 12: Indigenous Peoples). As climatic conditions diverge from those that determined patterns of development and resource use in the last century, and as demographic, economic, and technological changes also stress local systems, efforts to cope with climate change would benefit from an evolving, iterative risk management approach.

Observed Climate Change

Temperatures increased across the region from 1895 to 2011, with a regionally averaged warming of about 1.3°F. While precipitation has generally increased, trends are small as compared to natural variability. Both increasing and decreasing trends are observed among various locations, seasons, and time periods of analysis (Ch. 2: Our changing Climate, Figure 2.12). Studies of observed changes in extreme precipitation use different time periods and definitions of "extreme," but none find statistically significant changes in the Northwest. These and other climate trends include contributions from both human influences (chiefly heat-trapping gas emissions) and natural climate variability, and consequently are not projected to be uniform or smooth across the country or over time (Ch. 2: Our Changing Climate, Key Message 3). They are also consistent with expected changes due to human activities

Projected Climate Change

An increase in average annual temperature of 3.3°F to 9.7°F is projected by 2070 to 2099 (compared to the period 1970 to 1999), depending largely on total global emissions of heat-trapping gases. The increases are projected to be largest in summer. This chapter examines a range of scenarios, including ones where emissions increase and then decline, leading to lower (B1 and RCP 4.5) and medium (A1B) total emissions, and scenarios where emissions continue to rise with higher totals (A2, A1FI, and RCP 8.5 scenarios). Change in annual average precipitation in the
Northwest is projected to be within a range of an 11% decrease to a 12% increase for 2030 to 2059 and a 10% decrease to an 18% increase for 2070 to 2099 for the B1, A1B, and A2 scenarios (Ch. 2: Our Changing Climate).

For every season, some models project decreases and some project increases (Ch. 2: Our Changing Climate, Key Message 5), yet one aspect of seasonal changes in precipitation is largely consistent across climate models: for scenarios of continued growth in global heattrapping gas emissions, summer precipitation is projected to decrease by as much as 30% by the end of the century (Ch. 2: Our Changing Climate). Northwest summers are already dry and although a 10% reduction (the average projected change for summer) is a small amount of precipitation, unusually dry summers have many noticeable consequences, including low streamflow west of the Cascades and greater extent of wildfires throughout the region. Note that while projected temperature increases are large relative to natural variability, the relatively small projected changes in precipitation are likely to be masked by natural variability for much of the century.

Ongoing research on the implications of these and other changes largely confirms projections and analyses made over the last decade, while providing more information about how climate impacts are likely to vary from place to place within the region. In addition, new areas of concern, such as ocean acidification, have arisen.

Water-related Challenges: Description of Observed and Projected Changes

Observed regional warming has been linked to changes in the timing and amount of water availability in basins with significant snowmelt contributions to streamflow. Since around 1950, area-averaged snowpack on April 1 in the Cascade Mountains decreased about 20%, spring snowmelt occurred 0 to 30 days earlier depending on location, late winter/early spring streamflow increases ranged from 0% to greater than 20% as a fraction of annual flow, and summer flow decreased 0% to 15% as a fraction of annual flow, with exceptions in smaller areas and shorter
time periods.

Hydrologic response to climate change will depend upon the dominant form of precipitation in a particular watershed, as well as other local characteristics including elevation, aspect, geology, vegetation, and changing land use. The largest responses are expected to occur in basins with significant snow accumulation, where warming increases winter flows and advances the timing of spring melt. By 2050, snowmelt is projected to shift three to four weeks earlier than the 20 century average, and summer flows are projected to be substantially lower, even for an emissions scenario that assumes substantial emissions reductions (B1). In some North Cascade rivers, a significant fraction (10% to 30%) of late summer flow originates as glacier melt; the consequences of eventual glacial disappearance are not well quantified. Basins with a significant groundwater component may be less responsive to climate change than indicated here.

Changes in river-related flood risk depends on many factors, but warming is projected to increase flood risk the most in mixed basins (those with both winter rainfall and late spring snowmelt-related runoff peaks) and remain largely unchanged in snow-dominant basins. Regional climate models project increases of 0% to 20% in extreme daily precipitation, depending on location and definition of “extreme” (for example, annual wettest day).

Averaged over the region, the number of days with more than one inch of precipitation is projected to increase 13% in 2041 to 2070 compared with 1971 to 2000 under a scenario that assumes a continuation of current rising emissions trends (A2), though these projections are not consistent across models. This increase in heavy downpours could increase flood risk in mixed rain-snow and rain-dominant basins, and could also increase stormwater management challenges in urban areas.

Consequences and Likelihoods of Changes

Reservoir systems have multiple objectives, including irrigation, municipal and industrial use, hydropower production, flood control, and preservation of habitat for aquatic species. Modeling studies indicate, with near 100% likelihood and for all emissions scenarios, that reductions in summer flow will occur by 2050 in basins with significant snowmelt (for example, Elsner et al. 2010). These reduced flows will require more tradeoffs among objectives of the whole system of reservoirs, especially with the added challenges of summer increases in electric power demand for cooling and additional water consumption by crops and forests. For example, reductions in hydropower production of as much as 20% by the 2080s could be required to preserve in-stream flow targets for fish in the Columbia River basin. Springtime irrigation diversions increased between 1970 and 2007 in the Snake River basin, as earlier snowmelt led to reduced spring soil moisture. In the absence of human adaptation, annual hydropower production is much more likely to decrease than to increase in the Columbia River basin; economic impacts of hydropower changes could be hundreds of millions of dollars per year.

Region-wide summer temperature increases and, in certain basins, increased river flooding and winter flows and decreased summer flows, will threaten many freshwater species, particularly salmon, steelhead, and trout. Rising temperatures will increase disease and/or mortality in several iconic salmon species, especially for spring/summer Chinook and sockeye in the interior Columbia and Snake River basins. Some Northwest streams and lakes have already warmed over the past three decades, contributing to changes such as earlier Columbia River sockeysalmon migration and earlier blooms of algae in Lake Washington. Relative to the rest of the United States, Northwest streams dominated by snowmelt runoff appear to be less sensitive, in the short term, to warming due to the temperature buffering provided by snowmelt and groundwater contributions to those streams. However,
as snowpack declines, the future sensitivity to warming is likely to increase in these areas. By the 2080s, suitable habitat for the four trout species of the interior western U.S. is projected to decline 47% on average, compared to the period 1978-1997. As species respond to climate change in diverse ways, there is potential for ecological mismatches to occur – such as in the timing of the emergence of predators and their prey.

Adaptive Capacity and Implications for Vulnerability

The ability to adapt to climate changes is strengthened by extensive water resources infrastructure, diversity of institutional arrangements, and management agencies that are responsive to scientific input. However, over-allocation of existing water supply, conflicting objectives, limited management flexibility caused by rigid water allocation and operating rules, and other institutional barriers to changing operations continue to limit progress towards adaptation in many parts of the Columbia River basin. Vulnerability to projected changes in snowmelt timing is probably highest in basins with the largest hydrologic response to warming and lowest management flexibility – that is, fully allocated, mid-elevation, temperature sensitive, mixed rain-snow watersheds with existing conflicts among users of summer water. Regional power planners have expressed concerns over the existing hydroelectric system's potential inability to provide adequate summer electricity given the combination of climate change, demand growth, and operating constraints. Vulnerability is probably lowest where hydrologic change is likely to be smallest (in rain-dominant basins) and where institutional arrangements are simpleand

current natural and human demands rarely exceed current water availability.

The adaptive capacity of freshwater ecosystems also varies and, in managed basins, will depend on the degree to which the need to maintain streamflows and water quality for fish and wildlife is balanced with human uses of water resources. In highly managed rivers, release of deeper, colder water from reservoirs could offer one of the few direct strategies to lower water temperatures downstream. Actions to improve stream habitat, including planting trees for shade, are being tested. Some species may be able to change behavior or take advantage of cold-water refuges.

Key Message 2: Coastal Vulnerabilities: In the coastal zone, the effects of sea level rise, erosion, inundation, threats to infrastructure.

Coastal Vulnerabilities

With diverse landforms (such as beaches, rocky shorelines, bluffs, and estuaries), coastal and marine ecosystems, and human uses (such as rural communities, dense urban areas, international ports, and transportation), the Northwest coast will experience a wide range of climate impacts.

Description of Observed and Projected Changes

Global sea levels have risen about 8 inches since 1880 and are projected to rise another 1 to 4 feet by 2100 (Ch. 2: Our Changing Climate, Key Message 10). Many local and regional factors can modify the global trend, including vertical land movement, oceanic winds and circulation, sediment compaction, subterranean fluid withdrawal (such as groundwater and natural gas), and other geophysical factors such as the gravitational effects of major ice sheets and glaciers on regional ocean levels.

Much of the Northwest coastline is rising due to a geophysical force known as “tectonic uplift,” which raises the land surface. Because of this, apparent sea level rise is less than the currently observed global average. However, a major earthquake along the Cascadia subduction zone, expected within the next few hundred years, would immediately reverse centuries of uplift and, based on historical evidence, increase relative sea level 40 inches or more. On the other hand, some Puget Sound locations are currently experiencing subsidence (where land is sinking or settling) and could see the reverse effect, witnessing immediate uplift during a major earthquake and lowered relative sea levels.

Taking into account many of these factors and considering a wider range of emissions scenarios than are used in this assessment (Appendix 5: Scenarios and Models), a recent evaluation calculated projected sea level rise and ranges for the years 2030, 2050, and 2100 (relative to 2000) based on latitude for Washington, Oregon, and California. In addition to long-term climate-driven changes in sea level projected for the Northwest, shorter-term El Niño conditions can increase regional sea level by about 4 to 12 inches for periods of many months. Northwest coastal waters, some of the most productive on the West Coast, have highly variable physical and ecological conditions as a result of seasonal and year-to-year changes in upwelling of deeper marine water that make longer-term changes difficult to detect. Coastal sea surface temperatures have increased and summertime fog has declined between 1900 and the early 2000s, both of which could be consequences of weaker upwelling winds. Projected changes include increasing but highly variable acidity, increasing surface water temperature (2.2°F from the period 1970 to 1999 to the period 2030 to 2059), and possibly changing storminess. Climate models show inconsistent projections for the future of Northwest coastal upwelling.

Consequences and Likelihoods of Changes

In Washington and Oregon, more than 140,000 acres of coastal lands lie within 3.3 feet in elevation of high tide. As sea levels continue to rise, these areas will be inundated more frequently. Many coastal wetlands, tidal flats, and beaches will probably decline in quality and extent as a result of sea level rise, particularly where habitats cannot shift inland because of topographical limitations or physical barriers resulting from human development. Species such as shorebirds and forage fish (small fish eaten by larger fish, birds, or mammals) would be harmed, and coastal infrastructure and communities would be at greater risk from coastal storms.

Ocean acidification threatens culturally and commercially significant marine species directly affected by changes in ocean chemistry (such as oysters) and those affected by changes in the marine food web (such as Pacific salmon). Northwest coastal waters are among the most acidified worldwide, especially in spring and summer with coastal upwelling combined with local factors in estuaries. Increasing coastal water temperatures and changing ecological conditions may alter the ranges, types, and abundances of marine species. Recent warm periods in the coastal ocean, for example, saw the arrival of subtropical and offshore marine species from zooplankton to top predators such as striped marlin, tuna, and yellowtail more common to the Baja area. Warmer water in regional estuaries (such as Puget Sound) may contribute to a higher incidence of harmful blooms of algae linked to paralytic shellfish poisoning, and may result in adverse economic impacts from beach closures affecting recreational harvesting of shellfish such as razor clams. Toxicity of some harmful algae appears to be increased by acidification.

Many human uses of the coast – for living, working, and recreating – will also be negatively affected by the physical and ecological consequences of climate change. Erosion, inundation, and flooding will threaten public and private property along the coast; infrastructure, including wastewater treatment plants; stormwater outfalls; ferry terminals; and coastal road and rail transportation, especially in Puget Sound. Municipalities from Seattle and Olympia, Washington, to Neskowin, Oregon, have mapped risks from the combined effects of sea level rise and other factors.

Adaptive Capacity and Implications for Vulnerability

Human activities have increased the vulnerability of many coastal ecosystems, by degrading and eliminating habitat and by building structures that, along with natural bluffs, thwart inland movement of many remaining habitats. In Puget Sound, for example, seawalls, bulkheads, and other structures have modified an estimated one-third of the shoreline, though some restoration has occurred. Human responses to erosion and sea level rise, especially shoreline armoring, will largely determine the viability of many shallow-water and estuarine ecosystems. In communities with few alternatives to existing coastal transportation networks, such as on parts of Highway 101 in Oregon, sea level rise and storm surges will pose an increasing threat to local commerce and livelihoods. Finally, there are few proven options for ameliorating projected ocean acidification.

Key Message 3: Impacts on Forests

The combined impacts of increasing wildfire, insect outbreaks, and tree diseases are already causing widespread tree die-off and are virtually certain to cause additional forest mortality by the 2040s and long-term transformation of forest landscapes. Under higher emissions scenarios, extensive conversion of subalpine forests to other forest types is projected by the 2080s.

Impacts on Forests

DRAFT

Evergreen coniferous forests are a prominent feature of Northwest landscapes, particularly in mountainous areas. Forests support diverse fish and wildlife species, promote clean air and water, stabilize soils, and store carbon. They support local economies and traditional tribal uses and provide recreational opportunities.

Description of Observed and Projected Changes

Climate change will alter Northwest forests by increasing wildfire risk and insect and tree disease outbreaks, and by forcing longer-term shifts in forest types and species. Many impacts will be driven by water deficits, which increase tree stress and mortality, tree vulnerability to insects, and fuel flammability. The cumulative effects of disturbance – and possibly interactions between insects and fires – will cause the greatest changes in Northwest forests. A similar outlook is expected for the Southwest region. Although wildfires are a natural part of most Northwest forest ecosystems, warmer and drier conditions have helped increase the number and extent of wildfires in western U.S. forests since the 1970s. This trend is expected to continue under future climate conditions. By the 2080s, the median annual area burned in the Northwest would quadruple relative to the 1916 to 2007 period to 2 million acres
(range of 0.2 to 9.8 million acres) under the A1B scenario. Averaged over the region, this would increase the probability that 2.2 million acres would burn in a year from 5% to nearly 50%. Within the region, this probability will vary substantially with sensitivity of fuels to climatic conditions and local variability in fuel type and amount, which are in turn a product of forest type, effectiveness of fire suppression, and land use. For example, in the Western Cascades, the year-to-year variability in area burned is difficult to attribute to climate conditions, while fire in the eastern Cascades and other specific vegetation zones is responsive to climate. How individual fires behave in the future and what impacts they have will depend on factors we cannot yet project, such as extreme daily weather and forest fuel conditions.

Higher temperatures and drought stress are contributing to outbreaks of mountain pine beetles that are increasing pine mortality in drier Northwest forests. This trend is projected to continue with ongoing warming. Between now and the end of this century, the elevation of suitable beetle habitat is projected to increase as temperature increases, exposing higher-elevation forests to the pine beetle, but ultimately limiting available area as temperatures exceed the beetles' optimal temperatures. As a result, the proportion of Northwest pine forests where mountain pine beetles are most likely to survive is projected to first increase (27% higher in 2001 to 2030 compared to 1961 to 1990) and then decrease (about 49% to 58% lower by 2071 to 2100). For many tree species, the most climatically suited areas will shift from their current locations, increasing vulnerability to insects, disease, and fire in areas that become unsuitable. Eighty-five percent of the current range of three species that are host to pine beetles is projected to be climatically unsuitable for one or more of those species by the 2060s, while 21 to 38 % currently existing plant species may no longer find climatically appropriate habitat in the Northwest by late this century.

Consequences and Likelihoods of Changes

The likelihood of increased disturbance (fire, insects, diseases, and other sources of mortality) and altered forest distribution are very high in areas dominated by natural vegetation, and the resultant changes in habitat would affect native species and ecosystems. Subalpine forests and alpine ecosystems are especially at risk and may undergo almost complete conversion to other vegetation types by the 2080s (A2 and B1; A2; Ensemble A2, B1, B2). While increased area burned can be statistically estimated from climate projections, changes in the risk of very large, high intensity, stand-replacing fires cannot yet be predicted, but such events could have enormous impacts for forest-dependent species. Increased wildfire could exacerbate respiratory and cardiovascular

illnesses in nearby populations due to smoke and particulate pollution (Ch. 9: Human Health).

These projected forest changes will have moderate economic impacts for the region as a whole, but could significantly affect local timber revenues and bioenergy markets.

Adaptive Capacity and Implications for Vulnerability

Ability to prepare for these changes varies with land ownership and management priorities. Adaptation actions that decrease forest vulnerability exist, but none is appropriate across all of the Northwest's diverse climate threats, land-use histories, and management objectives. Surface and canopy thinning can reduce the occurrence and effects of high severity fire in currently low severity fire systems, like drier eastern Cascades forests, but may be ineffective in historically high severity fire forests, like the western Cascades, Olympics, and some subalpine forests. It is possible to use thinning to reduce tree mortality from insect outbreaks, but not on the scale of the current outbreaks in much of the West.

Key Message 4: Adapting Agriculture

While the agriculture sector's technical ability to adapt to changing conditions can offset some adverse impacts of a changing climate, there remain critical concerns for agriculture with respect to costs of adaptation, development of more climate resilient technologies and management, and availability and timing of water.

Adapting Agriculture

Agriculture provides the economic and cultural foundation for Northwest rural populations and contributes substantively to the overall economy. Agricultural commodities and food production systems contributed 3% and 11% of the region's gross domestic product, respectively, in 2009. Although the overall consequences of climate change will probably be lower in the Northwest than in certain other regions, sustainability of some Northwest agricultural sectors is threatened by soil erosion and water supply uncertainty, both of which could be exacerbated by climate change.

Description of Observed and Projected Changes

Northwest agriculture's sensitivity to climate change stems from its dependence on irrigation water, a specific range of temperatures, precipitation, and growing seasons, and the sensitivity of crops to temperature extremes. Projected warming will reduce the availability of irrigation water in snowmelt-fed basins and increase the probability of heat stress to field crops and tree fruit. Some crops will benefit from a longer growing season and/or higher atmospheric carbon dioxide, at least for a few decades. Longer-term consequences are less certain. Changes in plant diseases, pests, and weeds present additional potential risks. Higher average temperatures generally can exacerbate pest pressure through expanded geographic ranges, earlier emergence or arrival, and increased numbers of pest generations (for example, Ch. 6: Agriculture). Specifics differ among pathogen and pest species and depend upon multiple interactions (Ch. 6: Agriculture) preventing regionwide generalizations. Research is needed to project changes in vulnerabilities to pest, disease, and weed complexes for specific cropping systems in the Northwest.

Consequences of Changes

Because much of the Northwest has low annual precipitation, many crops require irrigation. Reduction in summer flows in snow-fed rivers (see Figure 21.2), coupled with warming that could increase agricultural and other demands, potentially produces irrigation water shortages. The risk of a water-short year – when Yakima basin junior water rights holders are allowed only 75% of their water right amount – is projected to increase from 14% in the late 20 century to 32% by 2020 and 77% by 2080, assuming no adaptation and under the A1B scenario.

Assuming adequate nutrients and excluding effects of pests, weeds, and diseases, projected increases in average temperature and hot weather episodes and decreases in summer soil moisture would reduce yields of spring and winter wheat in rain-fed production zones of Washington State by the end of this century by as much as 25% relative to 1975 to 2005. However, carbon dioxide fertilization should offset these effects, producing net yield increases as great as 33% by 2080. Similarly, for irrigated potatoes in Washington State, carbon dioxide fertilization is projected to mostly offset direct climate change related yield losses, although yields are still projected to decline by 2% to 3% under the A1B emissions scenario. Higher temperatures could also reduce potato tuber quality.

Irrigated apple production is projected to increase in Washington State by 6% in the 2020s, 9% in the 2040s, and 16% in the 2080s (relative to 1975 to 2005) when offsetting effects of carbon dioxide fertilization are included. However, because tree fruit requires chilling to ensure uniform flowering and fruit set and wine grape varieties have specific chilling requirements for maturation, warming could adversely affect currently grown varieties of these commodities. Most published projections of climate change impacts on Northwest agriculture are limited to Washington State and have focused on major commodities, although more than 300 crops are grown in the region. More studies are needed to identify the implications of climate change for additional cropping systems and locations within the region. The economic consequences for Northwest agriculture will be influenced by input
and output prices driven by global economic conditions as well as by regional and local changes in productivity.

Adaptive Capacity and Implications for Vulnerability

Of the four areas of concern discussed here, agriculture is perhaps best positioned to adapt to climate trends without explicit planning and policy, because it already responds to annual climate variations and exploits a wide range of existing climates across the landscape. Some projected changes in climate, including warmer winters, longer annual frost-free periods, and relatively unchanged or increased winter precipitation, could be beneficial to some agriculture systems. Nonetheless, rapid climate change could present difficulties. Adaptation could occur slowly if substantial investments or significant changes in farm operations and equipment are required. Shifts to new varieties of wine grapes and tree fruit, if indicated, and even if ultimately more profitable, are necessarily slow and expensive. Breeding for drought and heat-resistance requires long-term effort. Irrigation water shortages that necessitate shifts away from more profitable commodities could exact economic penalties.

THE REAL GREEN NEW DEAL PROJECT

Mission

Energy underpins everything, from biological food webs to the human civilizations embedded within them.

As we embark on the transition away from fossil fuels, it's crucial to understand just how much energy can be

supplied from renewables alone.

Renewables simply can't deliver the same quantity and versatility of energy as fossil fuels, but how much energy can they generate, and what will that mean for what the new world will look like?

REALgnd Project is setting out to:

Replace the fantasy narrative of a technological fix with the realistic narrative of scale-back and transformation.

Concretely understand which renewable technologies are viable, how much energy they can supply, and what those supplies will mean for the type of world that's possible.

All within the context of restoring a thriving, biodiverse habitat for Earth's non-human creatures and fair, egalitarian social structures for its people.

How We're Different

<u>We call for a complete abolition of fossil fuels, not "net zero."</u>

Net zero says that we should reduce CO2 emissions as much as possible, and where we “can’t” (in “hard-to-treat” sectors such as aviation and manufacturing), we can remove CO2 from the atmosphere either through engineered or natural means. Engineered means include carbon capture and storage (CCS), bioenergy with carbon capture and storage (BECCS), and direct air capture (DAC). Natural means include afforestation, reforestation, and soil sequestration.

Notwithstanding the energetic, resource, and ecological problems with engineered means, we view a total cessation of fossil fuels as a prerequisite for sustainability on the grounds that the environmental impacts of extracting and transporting them and the moral-political consequences of vying for them are too severe to warrant their continued usage.

Not only that, but natural means of sequestration should be undertaken in addition to fossil fuel abolition, not just as a means to sequester CO2 but as a necessary step on the long road to restoring the integrity of our degraded ecosystems.

<u>We recognize it's crucially important to understand which renewable technologies are even viable before embarking on the transition.</u>

Renewable technologies presently enjoy the benefit of fossil fuels to subsidize their entire life cycle. But are renewables viable without fossil fuel subsidies?

Viability is determined in two ways. Does the technology generate a minimum energy return on energy invested (EROI)? And is the technology tenable - and acceptable - from a holistic life cycle perspective, from mining and transporting metals to manufacturing to installation and maintenance? Current scientific studies, combined with just plain common sense, point in the direction of grave uncertainty for some technologies.

DRAFT

Just as it wouldn't be wise to start a business without first running financial break-even projections, it's unfathomably dangerous to advocate for a wholesale switch-out of energy regimes for all of civilization without understanding not even the implications, but the foundational viability, of the new regime.

We recognize the inescapable reality of total societal scale-back and transformation.

Renewables simply can't deliver the same quantity and versatility as fossil fuels, which means that the task before us is not a switch-out of variables, but a massive restructuring of life as we know it. We seek to concretely understand the biophysical constraints we're up against, how those constraints will shape a world without fossil fuels, and how we can get there.

Commitment to the Truth

REALgnd Project is unprecedented not just in scale and breadth, but in facing head-on subject matter that is typically considered taboo, uncomfortable, or outside the scope of energy and sustainability. A commitment to systems thinking and a genuine concern for the Earth and all its inhabitants requires nothing less than a full, honest look at the truth. We'll address:

overpopulation

ending U.S. empire

restoring democracy while shifting to new political systems that match the decentralized future we face

economic de-growth

what aspects of modern life can be retained in an energy de-intensified world

taking action outside the system now

WHAT WE DO

Research, Recommendations, and Engagement (engagement not covered here).

Research

We're creating a first-of-its kind planning product with two main parts: a *Biophysical Analysis* and an *Action Plan*.

The *Biophysical Analysis* will examine which renewable energy technologies are viable given the widely overlooked constraints shaping an all-renewable energy landscape; how much net energy those technologies can deliver, and in what form; and what those energy supplies will mean for population sizes, infrastructure, and way of life. We'll do this by analyzing existing data and consulting Subject Matter Experts as necessary.

This analysis will then inform a holistic *Action Plan* containing policy and other recommendations for the transformation that all levels of society can pursue.

The widely overlooked constraints shaping an all-renewable energy landscape include:

- Less than 20% of total energy consumption is in the form of electricity; the rest is in the form of liquid fuels used for transportation and heat. Solar panels, wind turbines, and nuclear only produce electricity.
- The energy return on energy invested (EROI) of renewable technologies. A minimum threshold must be met for a technology to even be viable and a greater threshold must be met for the technology to accommodate energy-consuming activities that characterize modern life.
- The dwindling supply of metals - widely depleted throughout the Industrial Age - that go into building renewable and storage technologies, along with the ecological impacts of mining and recycling them
- The energy inputs required to mine and transport those metals
- The feasibility of generating the high temperatures required for all manufacturing processes - including renewables - in the absence of fossil fuels
- The enormous toxicity of manufacturing processes (solar panels, for example, often dubbed "clean and green," use and produce highly toxic substances)
- The energy required to transport and install renewable technologies (large wind turbines, for example, require huge fossil-fueled cranes - that can't be powered electrically - to be erected)
- The efficiencies, age, and ecological impacts of hydroelectric dams with implications for modifications and/or closures
- The feasibility of generating liquid fuels in a post-Green Revolution agricultural world

Our first research document shows that the narrative of business-as-usual with a technological fix is not possible and that scale-back, transformation, and a re-assessment of renewable energy options is needed.

Recommendations (policies and individual action)

REALgnd Project advocates for both a top-down and bottom-up approach to the energy descent transformation, covering actions that governments and individuals can take.

We focus predominantly on policy recommendations for government since creating change from within the system would be the most impactful and effectual and since individual behavior is constrained to such a large degree by the current system.

But we simultaneously recognize that it is the actions of everyday people that influence the governments we institute, whether through who we vote for, what information or rhetoric we chose to accept and act upon,

DRAFT

what we do or don't push back against, or how we respond on an individual level to the chronic psychological afflictions imposed by today's dysfunctional world.

Population

"It is intellectually dishonest to talk about saving the environment without stressing the obvious fact that stopping population growth is a necessary condition for sustainability." - Dr. Albert Bartlett

"Unlike plagues of the dark ages or contemporary diseases which we do not yet understand, the modern plague of overpopulation is soluble by means we have discovered and with resources we possess. What is lacking is not sufficient knowledge of the solution, but universal consciousness of the gravity of the problem and the education of the billions who are victims." - Dr. Martin Luther King, Jr.

"Democracy cannot survive overpopulation. Human dignity cannot survive overpopulation. As you put more and more people into the world, the value of life not only declines, it disappears. The more people there are, the less one individual matters." - Isaac Asimov

"Once it was necessary that the people should multiply and be fruitful if the race was to survive. But now to preserve the race it is necessary that people hold back the power of propagation." - Hellen Keller

"If we don't halt population growth with justice and compassion, it will be done for us by nature, brutally and without pity - and will leave a ravaged world." - Nobel Laureate Henry W. Kendall

While our research will pinpoint sustainable population ranges as best as possible, best estimated optimum global sizes of one to three billion indicate that populations virtually everywhere need to be reduced. Given our sheer size of eight billion, reductions will take a very long time. Even if a global one-child policy were enacted immediately, we would still have roughly the same number of people on the planet at the end of the century as we do now. Our recommendations are made in light of this daunting reality and out of a commitment to reduce suffering.

- Enact a national one-child policy, encouraging the global community to do the same
- Make all forms of birth control (including those for men) free, and in the case of non-surgical forms, available over the counter
- Make abortion free and widely available
- Pay women/couples a significant financial incentive to have one child or none
- Educate children and adults alike about the harmful impacts of overpopulation and its central role in our overshoot crisis, shifting from a human-centric view of the world to an inclusive view that honors and respects all life
- Replace the taboo surrounding population with a moral imperative to make it a front-and-center social topic
- Given our moral responsibility for global restitution, provide financial assistance to countries who seek it in order to help enact similar policies

Empire

- Close all overseas military bases
- Cease all overseas military operations

- Cease military funding to foreign countries
- Close unnecessary domestic military bases
- Reduce the size of our armed forces
- Abandon the use of Authorization for the Use of Military Force (AUMFs) in exchange for official declarations of war by Congress, as is its constitutional responsibility
- Dissolve NATO
- Cease coup d'etats and election meddling in foreign countries
- Abandon sanctions as a political tool
- End contracting of military and defense-related products and services to private companies

Democracy

- GET MONEY OUT OF POLITICS and establish 100% publicly funded elections at all levels of government
- Enact ranked-choice-voting
- End voter discrimination laws and constitutional eviscerations
- Undo gerrymandering
- Increase voting access (e.g. Automatic Voter Registration in every state, mail-in ballots in every state, national holidays for elections)
- Ban electronic voting machines
- Repeal the Patriot Act
- Eliminate the Electoral College
- Eliminate the Senate (as it violates the "one person, one vote" principle)
- Move to proportional representation
- Establish 100% public funding for the media

Equality of treatment and opportunity

- Make corporations actually pay their taxes, potentially increasing their rates
- Shut down overseas tax havens
- End subsidies to harmful industries
- Break up monopolies
- Enact a fairer tax code in which average people pay less and the very wealthy pay more
- Increase the minimum wage to $25/hour
- Enact Medicare-for-All
- Forgive all student loans and make higher education free
- End the war on drugs, pardon all drug-related offenders in prison, and decriminalize low-level possession of all illegal drugs
- Issue financial reparations to the African American and Native American communities
- Enact a 4-day work week

Money & finance

- Put an end to interest-bearing debt

DRAFT

- Ban the financial markets (i.e. the stock, bond, commodities, futures, and foreign exchange markets) that "Wall Street" has become a symbol for, allowing instead for community-level capital raising
- Ban private, for-profit banking institutions and shift to nationalized banks
- Terminate the Federal Reserve (a private corporation accountable to no one) and absorb its functions back into Congress, as dictated by the Constitution

Infrastructure

- Place a moratorium on major infrastructure projects in light of:
  - The uncertainty of renewable technology viability, namely solar and large-scale wind
  - The need to re-design infrastructure in a highly decentralized, self-sufficient way with all life cycle needs (energy production, water acquisition, and waste treatment) handled on-site
  - The probability that many technologies and conveniences we enjoy today (e.g. mobile smart phones, TVs, personal computers for all, cars for all, commercial air travel) will not be possible in the energy and resource constrained future we imminently face

Consumption & pollution

- Nationalize fossil fuel companies and establish a plan for phase-out
- Ban the exploration of new fossil fuel reserves (i.e. oil, shale, gas) and the development of new extraction sites
- Fine heavily toxic industrial processes
- Ban factory farming
- Offer significant financial incentives for the conversion of monoculture operations to polyculture regimes that are small-scale, humane, free of fossil fuel inputs, and implement rigorous water conservation methods
- Provide legal and financial incentives to ensure seed conservation and ban activities that threaten it
- Offer financial incentives for the expansion of hemp farming
- Offer financial incentives to businesses that source local products
- Fine major businesses that don't make easily repairable products
- Place a tax on companies that extract metals and water
- Terminate so-called free trade agreements
- Invest in sailing ship companies and financially incentivize their use for international transportation

Ecosystem Health

- Endorse and begin implementing the Nature Needs Half proposal, which calls for protecting 50% of the planet by 2030 using an ecoregion approach
- Significantly increase funding for ecosystem restoration projects

Individual action

- Engage in the inner transformation that goes hand-in-hand with transforming the outer world, for example:
  - Self-realization and development
  - Cultivating critical, independent thinking that inoculates against propaganda and manufactured consent
  - Questioning/examining one's mental models and changing them when confronted with compelling information

DRAFT

- Learn as many self-sufficiency skills as possible, doing whatever you can to become more so, whether on a household or community level.
- Develop and take part, as compelled, in strategic, non-violent actions that will force the system to capitulate to specific demands that further the well-being of everyday people and the planet.

DRAFT