

The Western Perspective & The Western Agenda

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June, 2015

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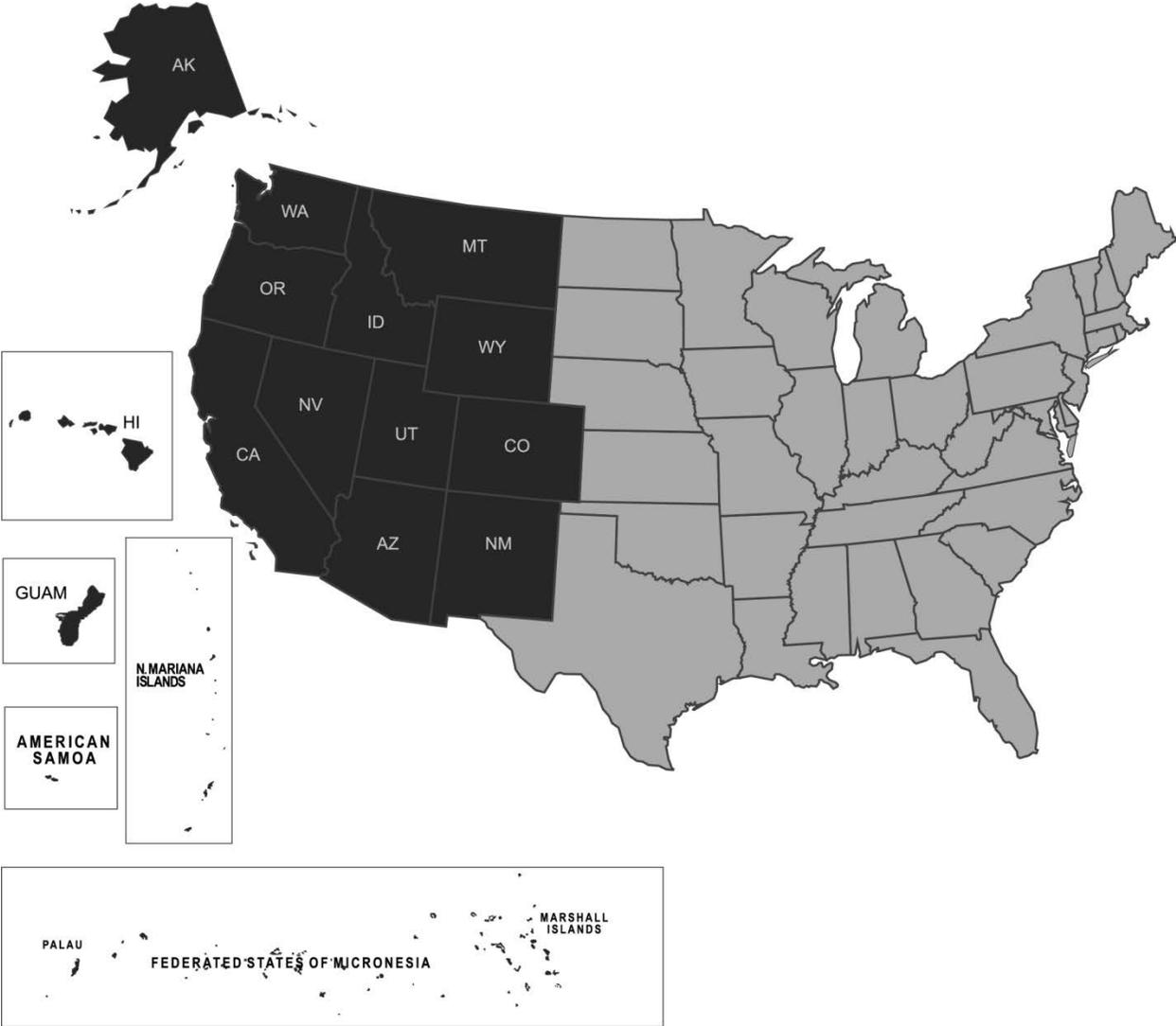
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Disclaimer: *The material contained in this document was written by many authors and compiled by Bret Hess, Bill Frost, and Barbara Allen-Diaz into one coherent document called the Western Perspective and Western Agenda. We gratefully acknowledge the use of written materials by those authors, generally excerpted in their original form, from various multi-author public documents listed in the references.*

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The Western Region



Part I: The Western Perspective

Introduction

The Western Region is large, diverse and dynamic, and the only certainty in its future is that of change. The region's diversity is not just in terms of its population, but also its natural setting and socio-economic structure (from agriculture to high-tech industries). Superposed on the changes of population density and diversity, economic engines, and natural resource conservation is climate change, which will alter the availability of fresh water and the entire fabric that supports, nurtures and sustains the Western Region.

For the region's natural and agricultural resources to be sustainable and for all its citizens to succeed and thrive in this state of dynamism and uncertainty, the Western Region's Land-grant Universities must anticipate and prepare for change, and develop and cultivate the capacity for adaptation—a capacity that must be flexible and nimble. To maintain the viability of the region's agricultural vitality and natural resources over time, the region must first have cutting edge research programs to understand and predict changes in the different sectors of the states and counties. Research programs must incorporate rapid and continuous information flow about all aspects of change as well as innovative methods to modify agricultural and natural resource systems and infrastructure in response to the information about changing conditions. The capacity for adaptation is itself constituted by the Western Region's citizen's access to information about change, by their social power to make decisions in response to this information and by their economic power to mobilize resources to act upon/enforce these decisions.

Difference in adaptive capacity is a primary influence on broader social, economic, and political disparities. These disparities can be manifest across space (between localities and regions), across populations (race, class and gender) and across time (inter-generational). As examples, low-income communities are likely to be particularly vulnerable to climate change-related flooding and other hazards because they lack the means to flee in an immediate disaster or to purchase homes on higher ground in the longer term. Other communities may lack the education, social networks and other resources needed to change jobs from declining to new sectors; lack the income to purchase increasingly expensive water or electricity; and lack the political agency to influence public policy to respond to these concerns.

Therefore, Western Region Land-grant Universities must position themselves as institutions that are sustainable, responsive to the changing needs of the west and a proactive force for economic energy and social justice. In addition to providing world-class research programs on agriculture, natural resources, nutrition and youth, and community development, Western Region Land-grant Universities must include a special focus on adaptation. This focus must involve both designing Land-grant Universities as adaptive institutions and orienting their programs and services to

build the adaptive capacity of their constituents, with special attention to the education and self-empowerment of typically under-served and under-represented populations.

Characteristics That Make the West the West

A Broad Geographic Expanse

The Western Region is comprised of 11 states in the continental U.S. (Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming), Alaska, Hawaii and the Pacific Islands and Territories (American Samoa, Guam, Micronesia and the Northern Marianas).

This vast geographical area covers one quarter of the earth. The region stretches 7,700 miles from the western most island of Palau in the Pacific Ocean to the eastern most state of Colorado; more than 3,300 miles from Fairbanks, AK at its northern end to American Samoa in the south; and more than 1,350 miles from the U.S.-Mexico border in California to the U.S.-Canada border.

A Very Diverse Region

The expansive area covered by the Western Region Land-grant Universities includes a diverse demographic distribution and extremes in climate.

The Western Region is a unique amalgamation of densely populated cities juxtaposed by large expanses of sparsely populated countryside. The west contains the oldest community in the U.S: Acoma, NM, and the smallest town: Buford, WY. Seven of the top 10 most ethnically diverse states in the U.S. are in the west.

The Western Region contains the highest elevation mountain peaks, in the highest mountain ranges in the U.S. and also contains the lowest spot in North America: Death Valley. The west is home to the coldest (Barrow, AK) and hottest (Lake Havasu City, AZ) environments in the United States. The public owns 47 percent of the land in the Western Region; it is an area where eight of the 10 most visited National Parks in the U.S. welcome more than 27 million visitors per year.

Many Western Region Land-grant Universities are located in high desert semi-arid (Great Basin) and arid desert (Mojave/Sonoran) environments while others either serve as the gateway to the Pacific, serving tropical agriculture, or extend to the arctic with agriculture/natural resources in sub-zero climates. The breadbasket state of California has rich soil and optimal growing conditions and produces a wide spectrum of agricultural products, while the states in the Pacific Northwest (Oregon and Washington) are characterized by abundant rainfall, producing a rich diversity of agricultural and forest products. Rangelands of the interior states support livestock and grain production.

A Glimpse of the Contributions to U.S. Agriculture

The Western Region produces more than 400 specialty crops—California alone produces more than 99 percent of the total value of almonds, artichokes, dates, figs, kiwi, nectarines, olives, cling peaches, pistachios, and walnuts in the U.S. Three Western states (CA, OR, WA) produce > 71 percent of all the fruit grown in the U.S. and total Western agriculture production accounts for 23.3 percent of the total U.S. farm gate value or \$87.7 billion.

Western states (CA, ID) produce > 50 percent of the total value of milk/dairy products in the U.S.; more than 40 percent of the total value of nursery, greenhouse, floriculture and sod production (CA, OR, ID); and account for more than 93 percent of the total value of wine production in the U.S. (CA). The Western Region produces 22 percent of the nation's total dry bean production; is home to four of the top 10 wheat producing states (MT, WA, ID, CO); and ranks fourth (CA) and 10th (MT) in sales of cattle and calves and ranks second (CO), third (CA), and sixth (WY) in sheep sales. Five of the top 10 potato producing states are located in the Western Region. The Western Region produces more than two-thirds of the nation's barley and the majority of the nation's hops.

Public Lands

Federal land ownership is concentrated in the west. On average, 47 percent of Western acreage is owned by the public as compared to only four percent of the remaining U.S. being publically owned.

Federal lands are managed by a variety of federal agencies including Bureau of Land Management (BLM), U.S. Forest Service (USFS), U.S. Fish and Wildlife Service (USFWS), National Park Service (NPS), Department of Defense (DOD), Department of Indian Affairs (DIA), Bureau of Reclamation and the Atomic Energy Commission. As an example of the magnitude of federal influence on the west, the USFS oversees 192.8 million acres in the U.S. of which 155.53 million acres (81%) are located in the Western Region.

Western Region agriculture depends on utilization of public land for livestock and forestry production and necessitates strong partnerships with federal agencies. This presents some challenges as federal policy dictates how and when public land is available for use by producers. Part of this challenge is the fact that federal regulations and control of Western natural resources are dependent on local federal management, which can be variable and in continual transition at different locations within the same agency and among agencies. Western states are home to many cherished natural resources that attract visitors from around the world, so recreation and visitations are important considerations for the use of public lands.

Urban-Rural Juxtaposition

Every Western state and territory has densely populated urban centers juxtaposed by large expanses of sparsely populated rural areas in a matrix that generally covers huge geographic distances. For example, Nevada is considered one of the most urban states (as a percent of total

population) with a huge proportion of rural, and in this case, federal land. Another example is Fresno County, CA which is no longer federally designated as rural because of the city of Fresno, yet it is the county that also ranks as the number one agricultural producing county in the entire United States.

Urban centers are the nexus of population growth, and the sheer number of people therein exert profound influence over statewide decisions on agricultural and natural resource issues, among other important topics. At the same time, the expanding metropolitan base encroaches on agricultural and natural resource lands throughout the west with several unintended consequences, including increased fire frequency and associated costs of fire suppression, increased numbers and kinds of invasive species, declines in the quality and quantity of wildlife habitat, and increased pressure on water quantity and quality.

Fire

Every year, thousands of wildfires burn millions of acres of forest and rangelands in the Western United States. Western Region fires have a significant impact on the federal budget, wildlife habitat, agricultural production and local and regional economies. For example, in 2013, federal firefighting costs, for suppression only, included dealing with 47,579 fires that burned over 4.3 million acres with a total suppression costs to USFS and DOI agencies of over \$1.7 billion.

According to the Western Forestry Leadership Coalition (WFLC), fire suppression activities only account for a small percentage of the costs of a wildfire event, a fact largely unrecognized by the public. The WFLC conducted several case studies that showed that fire suppression in six western fires represented from 5-53% of the total cost of a wildfire. They considered impacts to watersheds, ecosystems, infrastructure, businesses, individuals, and the local and national economy. Also factored in were property losses, post fire impacts, air and water quality damage, healthcare costs, injuries, fatalities, lost revenue to producers that lost grazing potential, lost revenue to residents that were evacuated, infrastructure shutdown and a series of ecosystem service and restoration costs that surpass initial costs as they could extend into the future.

Because of the large publicly owned land mass in the Western Region, the west is disproportionately affected by wildfires.

Critical Characteristics Affecting the West (& Everyone Else)

Water

Water is nothing less than the life blood of the people and economy of the Western Region. Eleven of the largest discharging rivers in the U.S. get their start in the west. Water supply and quality for agricultural, urban, and environmental systems are critical to the west. Key issues and trends are: 1) water supply will be limited for all users, in some cases severely; 2) competition for water will intensify among agricultural, urban and environmental users, with water being transferred from agriculture to the latter two groups; 3) short- and long-term climate trends will exacerbate problems associated with water availability; 4) degradation of water quality will

become more important as a major public issue; and 5) sudden legal and regulatory decisions will have significant impacts on water use and quality among all sectors.

Climate Change

Climate change is an overarching theme that affects agriculture, natural resources, and the quality of life for the citizens of the Western Region.

A combination of factors, including climate change, population growth, water availability, technological change and global demand will accelerate changes in the type and distribution of agricultural crops grown in the Western Region. Projected changes in temperature, rainfall and snowpack will result in geographical shifts in crop locations. Climate change will affect the quantity, quality and availability of water, primarily through expected reductions in snowpack and increased variability in the timing and amount of rainfall.

Climate change has been implicated in the increase in Western fire occurrence and magnitude and is predicted to contribute to rapid expansion of fire prone species like cheatgrass and medusahead in the Great Basin.

Hawaii and the Pacific Islands and Territories have keen interests in issues regarding climate change because the potential rising of oceanic water levels projected to result from climate change may completely cover most low lying atolls and cause salt water inundation into active farmlands.

Population Growth

Population growth is another overarching theme that affects agriculture, natural resources and the quality of life for the citizens of the Western Region. Growing and expanding human populations will continue to encroach on prime agricultural land and force production onto other, more marginal areas. Associated with population growth is the increasing municipal demand for water which will change water allocation in many areas. This will result in insufficient supplies available for current crop production, and will require relocation of many agricultural operations. Squeezing agricultural production onto smaller, marginalized areas will create an even greater need for increased crop production per unit area, requiring research and educational programs to address such issues as crop improvement, nutrient management, sustainable management systems, as well as pest and disease management strategies.

Endemic and Invasive Pests and Diseases

Pests and diseases affect agriculture, natural resources and the quality of life for all citizens. Endemic and exotic insects, nematodes, weeds, vertebrates and diseases have a dramatic direct impact on agricultural productivity and natural resources. The homogenization of our international travel and shipping has contributed to “biological pollution” through introductions of exotic pests and diseases. Human health is directly impacted by old and new diseases, both introduced and re-emerging.

The Purpose of This Effort: Moving the Western Perspective to the Western Agenda

Recognizing the critically important role that their institutions have played, and will continue to play in the development of robust agricultural and natural resource economies, the directors of the Land-grant University Cooperative Extension Service (CES) and the Agricultural Experiment Station System (AES) across the Western Region came together to summarize the key issues impacting the region, and to document and demonstrate the value of the assets of the Western Region and the critical supporting role that the Land-grant University system plays. There are five goals of this report:

1. Increase the visibility of the Western Region with elected officials and other key external and internal audiences. Enhance public support for campus, county, state and regionally-based programs and initiatives consistent with the broad mission related to western Land-grant University programs.
2. Highlight the contributions of the Western Region Land-grant Universities by documenting the economic, environmental, consumer and other tangible benefits delivered to the people of region through their research, teaching and extension programs.
3. Increase funding (state, federal, local and private) for mission related research and public service programs provided by the Western Land-grant Universities including, but not limited to, the Agricultural Experiment Station system, Cooperative Extension Service system and Academic Programs.
4. Identify gaps in the Western Land-grant University infrastructure so that better delivery of research, extension and academic programs can be achieved for people and communities in the Western Region.
5. Build capacity in the Land-grant University system to support healthy food systems, healthy environments, healthy families, healthy communities through research, outreach and education.

Part II: The Western Agenda

In the preceding pages, the Western Perspective set the stage for understanding the complex and often unique features of the Western Region. The Western Perspective allows for the development of a Western Agenda to lead the Western Region into the 22nd century.

Sustainable Production Systems

Food Production

The Western Region is uniquely positioned to address the shifts in crop production that will need to occur because of land use, climate change, and changing consumer demand. Western Region Land-grant Universities have the capacity to investigate the suitability of areas for growing crops not previously produced in similar climates and to alter or develop production systems to create sustainable systems in these new environments. Both short- and long-term research can be conducted under controlled situations (e.g., research and extension centers) not always available when utilizing cooperators' commercial operations.

The Land-grant University system and its unique research and education programs offers the opportunity to respond to local needs for increased food products and value, as well as the opportunity to test varieties that will respond to global food and marketing needs. The Western Region's network of Research and Extension Centers provides opportunities for testing and evaluation of plant and animal varieties as well as systems of production. Opportunities abound for field testing of biotechnology developed in campus labs, and evaluation of methods for reducing the impact of invasive species, including biological, new pesticides, and cultural practices through a continuum of county and campus-based academics. Industry needs and requirements can be discussed, applied and tested in soil, water and weather conditions throughout the west.

In food production systems, the Western Region Land-grant Universities are:

- Developing crop and livestock systems for high latitude regions;
- Engineering crops to benefit human and animal health;
- Using breeding and genetics to improve wheat, potato, strawberry and many other crops;
- Developing plant and animal food safety protocols;
- Creating new innovations in irrigation technology, animal facilities and food tracking;
- Developing new crop varieties;
- Responding with new products to meet consumer demand;
- Creating technology to improve environmental safety; and
- Creating advancements in precision agriculture using advance technologies for on-farm management and improved farm productivity and economic viability.

Food Safety

Older people, young children, pregnant women and those with chronic illnesses will continue to be at heightened risk for contracting food-borne illness. Food-borne illness outbreaks will place a burden on a medical system with an inadequate workforce. Globalization of the food supply, combined with the lack of international food inspections, increases the risk to the nation's food systems. The food supply, particularly international sources for food ingredients, will result in increased food-borne illness resulting in food recalls and food allergies.

People expect a food supply that is safe. Three related concerns predominate:

- Inadvertent microbial contamination of food products, such as *E. coli* or *Salmonella*;
- Chemical contamination, such as the recent tainting of imported products with melamine; and
- The impacts of potential terrorist attacks on our vulnerable food system.

Increasingly, consumers are concerned about food allergies and sensitivities. These concerns will lead to increased demand for better product labeling information on food products in the supermarket, school lunch and restaurants.

In response to these issues, Western Region Land-grant Universities have:

- Developed protocols/measures to ensure food safety;
- Developed food safety training programs for students, industry, schools and others;
- Provided safe food handling strategies throughout the food production system, from production to consumption, to minimize contamination and the risk of food-borne illness;
- Developed food tracking programs for animal production systems;
- Developed interdisciplinary food safety programs for undergraduate and graduate students designed to provide skilled, knowledgeable workers for the future;
- Developed courses on microbiology, chemistry and management options to prevent food borne pathogens.

Food Security

Food security is the state of having reliable access to a sufficient quantity of affordable, nutritious food. States and local communities are affected as nutrition is directly related to numerous human diseases with increased health care costs as well as performance on the job and at school. Food insecurity, which currently affects one in ten California households, for example, will continue to challenge millions of Californians and others in the Western Region as the populations proven to be the most vulnerable to food insecurity are also projected to grow more rapidly than those who are not. Only an interdisciplinary approach can effectively address the severe challenges to social and environmental justice, including the inability to achieve food security.

In response to these issues, Western Region Land-grant Universities are:

- Developing community- and family-based nutrition education programs;
- Working with policy makers to address the issues around food deserts;
- Developing community garden programs; and
- Developing K-12 school garden programs in conjunction with classroom nutrition education.

Forestry

Forests have been a cornerstone of the health, well-being and quality of life of all Americans. Forests provide essential resources for building construction, paper and other manufacturing, energy for heat and fuel, as well as forage for livestock. Forests also provide environmental benefits: clean drinking water, carbon sequestration, air filtration, outdoor recreation and wildlife habitat.

Significant forestland losses are projected over the next five decades as a result of increased urbanization, changes in land use and changing climate. Forestry producers, land managers and others need information and decision-support tools developed through research projects to help them with adaptation strategies and greenhouse gas mitigation.

In response to these issues, Western Region Land-grant Universities are working to:

- Retain and expand markets for wood-based products;
- Develop new products, improve raw material utilization and eliminate market access restrictions;
- Address the use of forest products in green building materials and design, wood-to-energy, advanced pulping technology, forest restoration and forest inventory and analysis;
- Develop new products through nanotechnology;
- Utilize technology to accelerate forest restoration;
- Explore new markets for low-value woody fiber;
- Investigate the potential for forests to serve as carbon sinks and to reduce greenhouse gas emissions;
- Improve the application of agroforestry practices and principles in protecting water and soil resources;
- Build landscape-level resiliency to weather variability and extremes;
- Provide innovative and sustainable bioenergy production systems, including new technology to develop cost-effective, waste-to-energy systems that use forest residues;
- Create multipurpose landscapes that can produce food, fiber and energy while protecting natural resources; and
- Incorporate biomass and feedstock crops into existing forestry and agroforestry systems to help increase diversity of the rural economy and promote sustainable land management.

Horticulture

While the Western Region is certainly known for its role in food production, the nursery and ornamentals sector of the agricultural economy often goes unnoticed. According to the 2014 NASS Data, the region accounts for some \$4.7 billion in annual production of nursery, greenhouse, floriculture, sod, Christmas trees and other short rotation woody plants. This amount exceeds 22 of 50 (44 percent) of states' agricultural production value, underscoring the importance of this sector. The economic importance of this sector to Western agriculture typically accounts for 10-15 percent of the crop production value in each state, but may be as high as 40-50 percent in Alaska owing to the high value of peonies grown there.

Including Christmas trees and related woody plants, seven western states rank in the top 15 in terms of value in the nursery and ornamentals sector. California is the nation's leader in the production of horticultural and related crops and Oregon is the top producer of Christmas trees. In Hawaii, the nursery and ornamentals sector accounts for nearly 15 percent of the total value of crop production. Even in Alaska where the growing season is limited, the production of peonies dominates the over-all production system earning as much as \$200,000 an acre. The Alaska production system provides a niche market for peonies during July through September when no other producers are in the market anywhere in the world.

In response to these issues, Western Region Land-grant Universities have:

- Developed protocols for monitoring and responding to pest and disease problems;
- Developed methods to reduce run-off from nursery sites;
- Developed and evaluated new plant varieties;
- Conducted analyses on new niche markets; and
- Developed irrigation techniques to conserve water and utilize poor-quality water.

Natural Resources

Water

Water is a scarce commodity in the Western Region and is projected to be a limiting resource for Western agriculture and natural resource management in the future, particularly in light of ongoing climate change. A reliable source of clean water is critical to maintaining strong communities, sustaining and developing rural economies, supporting agricultural productivity, sustaining ecosystem function and wildlife habitat and maintaining a high quality of life. We are facing significant challenges to meet future water demands as population grows and water supplies become more limited. Population growth, economic development, extreme weather fluctuations and expansive wildfires place challenges on future water resources. Targeted research and education will play an important role in addressing those challenges by exploring new plant biology to develop more water efficient plants, improving water efficient management systems and developing collaborative solutions for water distributions.

Several issues are paramount:

- The supply of water will be limited for all users. Competition for water will intensify among agricultural, urban and environmental users, with water being transferred from agriculture to the latter two groups;
- Short- and long-term climate trends will exacerbate the problems associated with water availability;
- Degradation of water quality will become more important as a major public issue; and
- Legal and regulatory decisions will have significant impacts on water use and quality among all sectors.

The availability of traditionally relied upon sources of water is expected to decrease. For example, California will have to reduce its use of Colorado River water by about 20 percent. The current drought has severely decreased reserves, and climate change is expected to reduce the Sierra Nevada snowpack. Coupled with the aging infrastructure for water delivery, it will take a coordinated effort at regional, state and local levels to meet the projected increases in water demand.

In response to these issues, Western Region Land-grant Universities are:

- Developing innovative scientific techniques, products and processes improving water use efficiency and water conservation management practices;
- Developing and promoting the adoption of management practices that prevent degradation of watersheds and water resources caused by pesticides, salinity, chemicals, animal wastes, nutrients, sediments and pathogens;
- Providing econometric, hydrological and policy expertise to help communities develop flexible and effective water policies and strategies; and
- Conducting research and promoting educational approaches to address water issues in partnerships with others, including agricultural groups, environmental groups and regulatory entities.

Wildlife

Large, intact functional ecosystems, healthy fish and wildlife populations and public access to natural landscapes make a significant contribution to the economy and quality of life in the Western Region. The wildlife recreation economy in the 19 western states exceeds \$65 billion annually, emphasizing the need to ensure that wildlife habitat is protected, re-established as necessary and sustained to maintain healthy and diverse populations and prevent dysfunction leading to the listing of endangered species. One species that is currently under scrutiny is the Greater sage-grouse, which currently or historically occupied sagebrush habitats in 10 continental Western states. Current threats to sagebrush ecosystems and other wildlife habitat include establishment of invasive plant species, increased fire frequency, encroachment of human development and extraction of oil and gas.

Population growth is one of the most important issues that will affect the Western Region's natural resources. Future development will move into what are now forest, grassland and sagebrush habitats. As urban areas expand into wildlands, conflicts between humans and wildlife will also increase. Development reduces and fragments wildlife habitat and wildlands, threatening biodiversity and decreasing water quality, impacting fisheries resources in oceans, coasts and rivers and making the communities that depend on them more vulnerable.

Land-grant Universities provide fundamental and applied research and information to help sustain ecosystems in the Western Region for future generations by addressing issues related to the provision of ecosystem services, such as wildlife habitat and clean air and water, and to the sustainable provision of products such as fish, food for grazing animals and wood products. Future research and educational efforts will need to address land use planning, restoration of degraded ecosystems and the sustainable supply of natural resource-based products.

In response to these issues, the Western Region Land-grant Universities are:

- Developing ecosystem management systems to guide land use planning that provides for clean air, carbon sequestration, water, wildlife and plant habitat;
- Determining ecosystem restoration methods for degraded natural ecosystems;
- Researching fire resilient ecosystems;
- Developing new production and harvest techniques and practices that provide for sustainable supplies of products while preserving environmental quality; and
- Evaluating methods for determining the impacts of climate change on natural ecosystems and resulting changes in the provision of ecosystem services and products.

Wildfires in the West

Wildfire is a normal part of forest, grassland and sagebrush ecosystems in the Western U.S. However, rising temperatures and drought conditions resulting from climate change, prevalence of invasive species, and decades of fire suppression have now resulted in disrupted fire regimes and trends toward more massive wildfires.

Every year, thousands of wildfires burn millions of acres of forest and rangelands in the Western United States, having a significant impact on the federal budget, wildlife habitat, agricultural production, local and regional economies and community safety. For example, in 2013 federal firefighting costs solely for the suppression of wildfires across more than four million acres were over \$1.7 billion. This does not account for the losses associated with habitat destruction, impacts on water quality or agricultural production, etc. When impacts to watersheds, ecosystems, infrastructure, businesses, individuals and local and national economies were considered, case studies by the Western Forestry Leadership Coalition showed that the cost of fire suppression represented only between five and 53 percent of the total impact. Due to the large publicly owned land mass of the Western states, the west is disproportionately affected by wildfires.

In response to these issues, the Western Region Land-grant Universities are:

- Developing new strategies to address more effective fuel management practices to help reduce the occurrence of catastrophic fires;
- Effectively utilizing fire as a tool in managing ecosystems and mitigating the intensity of wildfire; and
- Providing innovative ways to stabilize and reclaim rangelands, forests and other natural resources following wildfires.

Invasive Species, Pests, and Diseases

The invasion of exotic and noxious weeds, destructive insects and disease causing organisms is an issue facing every state in the Western Region. Cheatgrass and medusahead have invaded the Great Basin, disrupting fire cycles, crowding out native plants and destroying wildlife habitat. In the Lake Tahoe region of Nevada, an invasive aquatic plant called milfoil is fouling the lake and associated rivers by crowding out native plant species, destroying wildlife habitat and interfering with recreational activities. Invasive species have moved from Southeast Asia and the South Pacific into fragile island ecosystems on Guam and other Pacific islands and territories, and have the potential to further expansion to subtropical Hawaii and coastal climates in southern California.

A variety of pests and diseases affect agriculture, natural resources and the quality of life of the people in the Western Region. Pests, including native and exotic insects, nematodes, plants and vertebrates have a dramatic, and often negative, impact on agriculture and natural resource productivity and ecosystem function. Diseases, including those associated with viruses, bacteria, protozoans, fungi and other agents decrease production efficiency and product quality, adding significantly to the cost of production. Exotic diseases, those that are not native to the U.S. or those that have been eradicated, pose a huge threat to the region's vulnerable livestock and poultry resources.

The speed and frequency of international travel, combined with the volume of imported food, commodities and materials has increased the introduction of invasive pests and diseases into the Western Region. As global climate patterns shift the distribution of endemic pests will change, and many habitats will become more susceptible to new threats. To ensure the sustainability of the region's food and agricultural production and its natural resources, as well as the health of the economy, the Western Region and the world must constantly update the exclusion, detection, eradication and control of invasive pests and diseases.

Economic impacts from endemic and invasive pests and diseases can include direct and indirect costs to agriculture, fisheries and water delivery systems. In the U.S., annual estimated invasive species damage and control costs are estimated to be in excess of \$138 billion. This does not take into account the equally important impacts to natural ecosystems. Biotic invasion is one of the

top five causes of global biodiversity loss and it is increasing because of tourism and globalization.

Human health threats associated with pest and disease organisms are also of serious concern. This includes the direct introduction of invasive species such as poisonous plants, rodents, insects and waterborne diseases, and the indirect introduction of invasive organisms as vectors of other species, such as West Nile virus and highly pathogenic avian influenza.

In response to these issues, Western Region Land-grant Universities' are:

- Providing science-based information to support exclusion strategies and policy, including knowledge of invasion biology to better assess risk, prediction and intervention;
- Developing innovative techniques for rapid identification through surveillance and detection systems;
- Developing effective and economical technologies and tactics for use in diverse agricultural, natural and urban systems to mitigate or control organisms for reduced environmental impact; and
- Using and furthering integrated pest management, an ecosystem-based strategy developed by Land-grant University scientists that focuses on long term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices and use of resistant varieties.

Ecosystem Services

In addition to the sustainable production of plant and animal foods, plant materials (primarily pharmaceuticals), forest products and other products for human use, the Western public needs to be able to count on the increasingly important ecosystem services provided by coastal, forest, rangeland and wildland environments, such as:

- Regulating climate and moderating weather extremes and their impacts
- Supplying clean drinking and irrigation water
- Sequestering carbon and purifying the air
- Detoxifying and decomposing wastes
- Generating, preserving and renewing soils
- Preventing erosion
- Protecting stream and river channels and coastal shores
- Dispersing and cycling nutrients
- Dispersing seeds and pollinating crops and natural vegetation
- Maintaining biodiversity
- Controlling agricultural pests and regulating disease carrying organisms

In response to these issues, Western Region Land-grant Universities are:

- Developing simple and effective tools for monitoring and assessing the effects of resource management practices on ecosystem services;
- Developing practical management and restoration solutions to problems once identified;
- Developing quantifiable measures of ecosystem service components;
- Increasing awareness, understanding and acceptance of sustainable management strategies by all stakeholders; and
- Conducting research to quantify the economic value of ecosystem services

Economic Opportunities for Natural Resources

To ensure the sustainability of the Western Region's increasingly threatened natural resources, the west recognizes the need to enhance the economic value realized from natural ecosystems, including ecosystem services as well as products derived from forest, rangeland, wildland and coastal habitats.

In response to these issues, Western Region Land-grant Universities are:

- Developing research and extension programs that provide innovative new products from natural ecosystems such as mushrooms, worms and agri-tourism;
- Developing systems and mechanisms that provide economic rewards and/or incentives to public and private land and coastal resource managers for the services provided by the ecosystem;
- Creating systems that not only certify the sustainability of ecosystem products but ensure economic rewards for their production;
- Evaluating ways to more fully monetize the reservoir of genetic traits present in wild varieties and traditionally grown landraces important in improving crop performance; and
- Developing and implementing forest management strategies that will preserve their economic value in the face of ongoing climate changes that are altering both ecological and economic dynamics of the forest.

Energy

The Western Region faces diminishing and more costly supplies of energy while the demand for energy continues to rise as a result of population growth and continued urban development. Innovative management of the region's natural and agricultural resources is needed to help bring the west's energy supply and demand into balance. In particular:

- Agriculture needs new production technologies and practices that minimize energy consumption and utilize renewable energy sources.
- The West needs technology, marketing and policy advancements to enable expanded use of forest, range and agricultural resources for renewable energy production.
- The public needs comprehensive policies and strategies for expansion solar, wind and hydro-power technologies.

In response to these issues, Western Region Land-grant Universities are:

- Developing inventories of regional bioenergy feedstocks: varieties, availability and usefulness;
- Conducting research on supply chains to match bioenergy feedstocks with conversion technologies;
- Working on development and design of regional bioenergy feedstock production systems;
- Providing technical assistance and information for ensuring regional supply chain components are considered together so that ensuing systems are productive, profitable and sustainable;
- Conducting research on intensification management of existing cropping systems for biofuel production;
- Conducting research and education efforts on solar and wind power systems;
- Researching the economic, environmental and sociological impacts of energy use with useful translation for policy makers;
- Developing technologies to reduce emissions from large industrial engines, including innovative electric grids and clean energy solutions;
- Developing assessment and monitoring tools to evaluate multiple outcomes of alternative fuel sources and impacts on natural resource sustainability;
- Looking for concurrent research and education efforts with business development efforts to connect bioenergy feedstock producers and rural economic development interests with biorefinery developers and business and financial institutions;
- Preparing the Pacific Northwest for the introduction of a 100% infrastructure-compatible biofuels industry that meets the region's Renewable Fuel Standard targets using sustainable and regionally appropriate woody crops; and
- Researching the manipulation of fermentation pathways to enhance biofuel production.

Community and Economic Development

Rural communities face an array of challenges. Resource-based economies are vulnerable to the impacts of commodity prices, technological changes, land value dynamics, and other market influences. Some communities whose economies are contracting are experiencing unemployment, poverty, population loss, the aging of their workforces and increasing demands for social services with fewer dollars to pay for them. In some rural areas, these are not new trends, but generations-old issues. Additionally, residents of remote communities have limited access to jobs, services and transportation options. Long, expensive commutes to distant employment centers can consume a large percentage of the family budget, or families must live sparingly on the small amount of local work available. People who do not have access to personal vehicles or who do not drive, such as low-income residents and senior citizens, lack mobility and have even less access to jobs, healthcare and other services.

The recent recession brought laser focus to the issue of community sustainability and economic opportunity. The west is unique in its geographical isolation and spatially distributed population, which results in extreme urban areas surrounded by isolated rural areas where connectivity and access to information lacking. The rural West is also unique in that federally owned public lands dominate the local economies and tax bases, and a lower level of economic diversity hinders the sustainability of communities.

Community and economic development research and extension programs in the LGUs must broadly encompass programs designed to enhance opportunities for growth, development and prosperity of communities and individuals.

In response to these issues, Western Region Land-grant Universities have developed research and education programs to address:

- Local governance
- Poverty reduction
- Tourism
- Strategic planning
- Entrepreneurship
- Workforce development
- Incubator programs
- Food systems
- Community health
- Conflict management: facilitation and mediation
- Small business development, retention and expansion
- Agribusiness
- Food processing, safety and marketing for families and industry
- Diversification of income sources
- Energy efficiency/conservation
- Grant writing
- In/out migration
- Community change
- Credit/non-credit opportunities for non-traditional audiences
- Leadership education for individuals and governments
- Develop under-utilized resources or regional unique opportunities
- Strengthen regional networks and partnerships to more fully leverage resources
- Provide resources and expertise to create sustainable rural communities
- Utilize the Western Rural Development Center more effectively to strengthen Western states community economic development partnerships

Youth Development

Today's youth are tomorrow's voters, leaders, entrepreneurs and innovators. In the Western Region, the major challenge for the development of youth into positive, engaged citizens is the establishment of *resilient* systems. The systems concept of *resilience* refers to the human capacity to adapt in the face of threat and stressors, to be flexible in the midst of challenge and change, to transform risk into positive development.

In response to these issues, Western Region Land-grant Universities are:

- Developing new approaches to school readiness (pre-K) especially among low income and underrepresented populations;
- Through 4-H Youth Development, providing alternative academic pathways and promoting leadership development and citizenship opportunities to keep youth engaged in their educational pursuits; and
- Complementing the K-12 school system and reinforcing the development of skill sets to prepare youth for higher education and participation in future career opportunities.

Science Literacy around Agriculture, Nutrition, and Natural Resources

Accurate science-based information is the cornerstone of sound personal decisions and public policy. The U.S. needs a public with greater understanding of science, so that they can make informed personal choices and develop public policies regarding food production, diet, health and the natural and human-made environment.

In response to these issues, Western Region Land-grant Universities are:

- Providing accessible science information so that people can adapt to ever-changing physical, social and economic conditions;
- Delivering field programs, tours, etc. to provide hands-on experiences in farms, fields and labs to enrich personal connections with the science base in agriculture, natural resources and nutrition;
- Educating graduate and undergraduate students in classroom and field courses in agricultural and natural resource production systems, diet, health and the environment;
- Forming partnerships with other educational, state and federal entities to develop curriculum and deliver programs;
- Utilizing distance learning opportunities to better connect communities with Land-grant University resources.

Nutrition and Health: Innovation in Foods for Health

Recognition of the importance of nutrition as a major positive impact on human health continues to grow. In addition to the essential roles of vitamins and minerals in maintaining health, the contributions of fiber, antioxidants and other micronutrients in disease prevention are becoming clearer. Land-grant University research discoveries and education outreach help people

understand the many benefits of selecting the right combinations of whole foods in their diets. Appreciating how diet complements exercise in health promotion can both add to quality and length of life (i.e., healthspan), and reduce healthcare expenses. Applying current and future technologies including genomics, metabolomics and proteomics to rigorously demonstrate links between nutrient profiles of whole foods, consuming appropriate amounts of them and the healthspan can provide educators the information to influence choices that improve public health.

Agriculture's competitiveness in producing specialty crops and other highly nutritious whole foods will depend most crucially on continued expansion of the knowledge base and development and adoption of innovations derived from that new knowledge in agriculture and natural resources. Investments in agricultural research and development have yielded benefits worth 20 times the cost.

The alarming frequency of childhood obesity, inactivity, food insecurity and poor food choices affect all segments of the population. The future health impacts of these issues will be staggering unless we can reverse this trend. Childhood obesity can best be prevented with a multifaceted approach: a coordinated, comprehensive school health, nutrition and physical activity programs, created through partnerships among school site personnel, regional growers and the Land-grant Universities to meet this need. Land-grant University campus- and county-based researchers and educators are making inroads into developing science-based strategies to prevent childhood obesity and diabetes and to promote wellness.

The Western Region is the nation's major producer of vegetables, fruits and nuts. While these are healthy food choices, they are under-consumed sources of nutrition. Recent advances in the biological, agricultural and medical sciences, including genomics, proteomics and metabolomics, have made it possible to improve the nutrient profiles in plants and animals. At the same time, promising breakthroughs have been made in recognizing an individual's specific nutrient needs and potential adverse reactions such as food allergies. Efforts will be made to take advantage of Land-grant University discoveries and ongoing developments to help find solutions to problems including human allergies, disease prevention and designer foods.

Working with producers, the Land-grant University system can improve the nutritive value of plant and animal commodities. The Western Region's agriculture will benefit by the value added to its commodities and its competitive advantage in national and international markets. This enhanced agricultural economic viability will lead to improvements in the quality of life, education, and other services in the rural west and contribute to the region's overall economy as well.

In response to these issues, the Western Land Grant Universities are:

- Conducting fundamental and applied research to provide healthy whole foods that play a key role in extending the healthspan;

- Forming collaborations among Land-grant University scientists, industry, school personnel and state and county agencies to deliver nutrition education programs;
- Identifying effective strategies for preventing obesity and chronic diseases related to food; and
- Equipping consumers with the tools to make informed decisions about food choices, nutrition, food safety and food handling.

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The material contained in this document was written by many authors and compiled by Bret Hess, Bill Frost, and Barbara Allen Diaz into one coherent document called the Western Perspective and Western Agenda. We gratefully acknowledge the use of written materials by those authors, generally excerpted in their original form, from various multi-author public documents listed below.

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