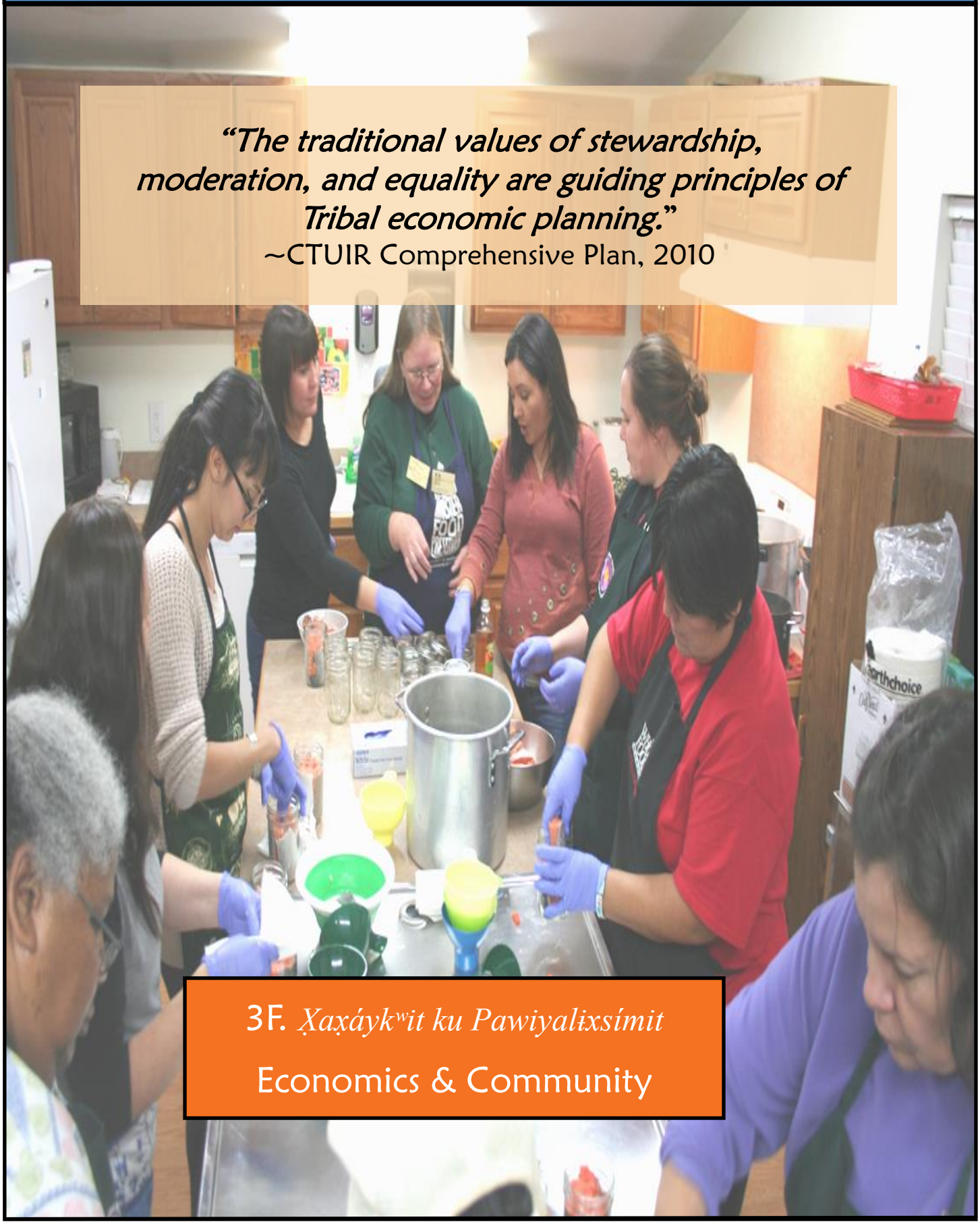


*"The traditional values of stewardship, moderation, and equality are guiding principles of Tribal economic planning."*
~CTUIR Comprehensive Plan, 2010

# 3F. *Xaxáykʷit ku Pawiyaɬixsímit*

# Economics & Community

# Climate Impacts for Economic Development

"Trade and barter was a significant aspect of Indian life on the Plateau, and essential for the survival of Indian people. Indians relied on other Indians to provide goods they themselves were not able to obtain. Often, groups from a single village community would travel different directions as part of their seasonal round. Through years of trade relationships, Elders knew exactly what other Indians needed in exchange for goods they needed (CTUIR Comprehensive Plan, 2010)."

While many current metrics of economies don't capture a number of different elements that make life worth living, economies are important for maintaining trade and the ability to fund different adaptation strategies. Indigenous people in North America have had thriving trade and commerce routes that pre-date European contact, and many of these economies are still thriving today. Diversified sources of income that can help buffer changes and losses that might occur in one or a few sectors, and training, education, and certification, can build resilient families and economies. A robust economy is one that is prepared for change, and one that supports the community in building equitable access to strategies that improve economic and income diversity.

## 1. Increased Household, Governance, and Emergency Expense

Acute and chronic climate impacts to health and emotional wellbeing will increase costs for healthcare, emergency treatment, insurance compensation, and cost of doing business for all sectors and communities.

**Heat exposure related emergency department visits alone will cost an additional $21.9-30.2 million dollars by 2050, and $30.1-69.2 million dollars by 2090 per year across the U.S.** (Lay et al 2018) as seen in Figure 3F.1 (page 216).

## 2. Impacts to Tourism from Disaster and Displacement

Tourism has a role to play in responding to climate impacts, but is also likely to see changes, due to increasing natural disasters locally and regionally.

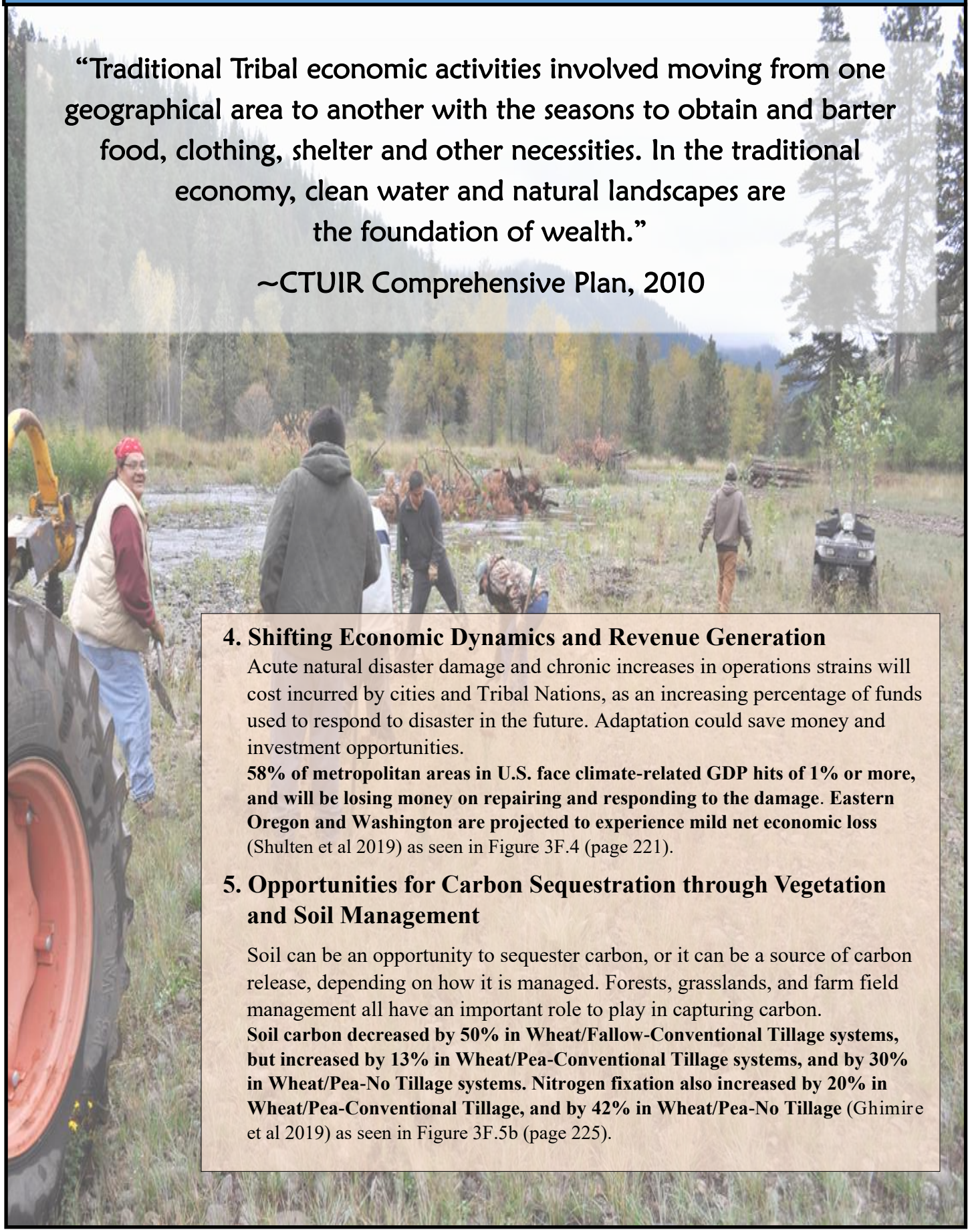
**Hotel occupancy increased 43.3% in the directly affected area during the Camp Fire (CA 2018), but decreased by 13.4% during the wildfire event, and by 15.8% post-fire in nearby metropolises** (Ward and Mattern 2020) as seen in Figure 3F.2 (page 218).

## 3. Increased Potential Disruption of Businesses and Supply Chains

Dependence on globally-integrated supply chains leaves communities vulnerable to climate impacts around the world, and even small events can cause direct and indirect risk to production and goods available.

**One single natural disaster event, Typhoon Haiyan in the Philippines in 2013, disrupted 6% of U.S. goods production directly, and posed a risk to 21% of all U.S. production indirectly** (Levermann 2014) as seen in Figure 3F.3 (page 220).

# Climate Impacts for **Economic Development** (cont.)



"Traditional Tribal economic activities involved moving from one geographical area to another with the seasons to obtain and barter food, clothing, shelter and other necessities. In the traditional economy, clean water and natural landscapes are the foundation of wealth."

~CTUIR Comprehensive Plan, 2010

### 4. Shifting Economic Dynamics and Revenue Generation

Acute natural disaster damage and chronic increases in operations strains will cost incurred by cities and Tribal Nations, as an increasing percentage of funds used to respond to disaster in the future. Adaptation could save money and investment opportunities.

**58% of metropolitan areas in U.S. face climate-related GDP hits of 1% or more, and will be losing money on repairing and responding to the damage. Eastern Oregon and Washington are projected to experience mild net economic loss** (Shulten et al 2019) as seen in Figure 3F.4 (page 221).

### 5. Opportunities for Carbon Sequestration through Vegetation and Soil Management

Soil can be an opportunity to sequester carbon, or it can be a source of carbon release, depending on how it is managed. Forests, grasslands, and farm field management all have an important role to play in capturing carbon.

**Soil carbon decreased by 50% in Wheat/Fallow-Conventional Tillage systems, but increased by 13% in Wheat/Pea-Conventional Tillage systems, and by 30% in Wheat/Pea-No Tillage systems. Nitrogen fixation also increased by 20% in Wheat/Pea-Conventional Tillage, and by 42% in Wheat/Pea-No Tillage** (Ghimire et al 2019) as seen in Figure 3F.5b (page 225).

## 1. Increased Household, Governance, and Emergency Expense

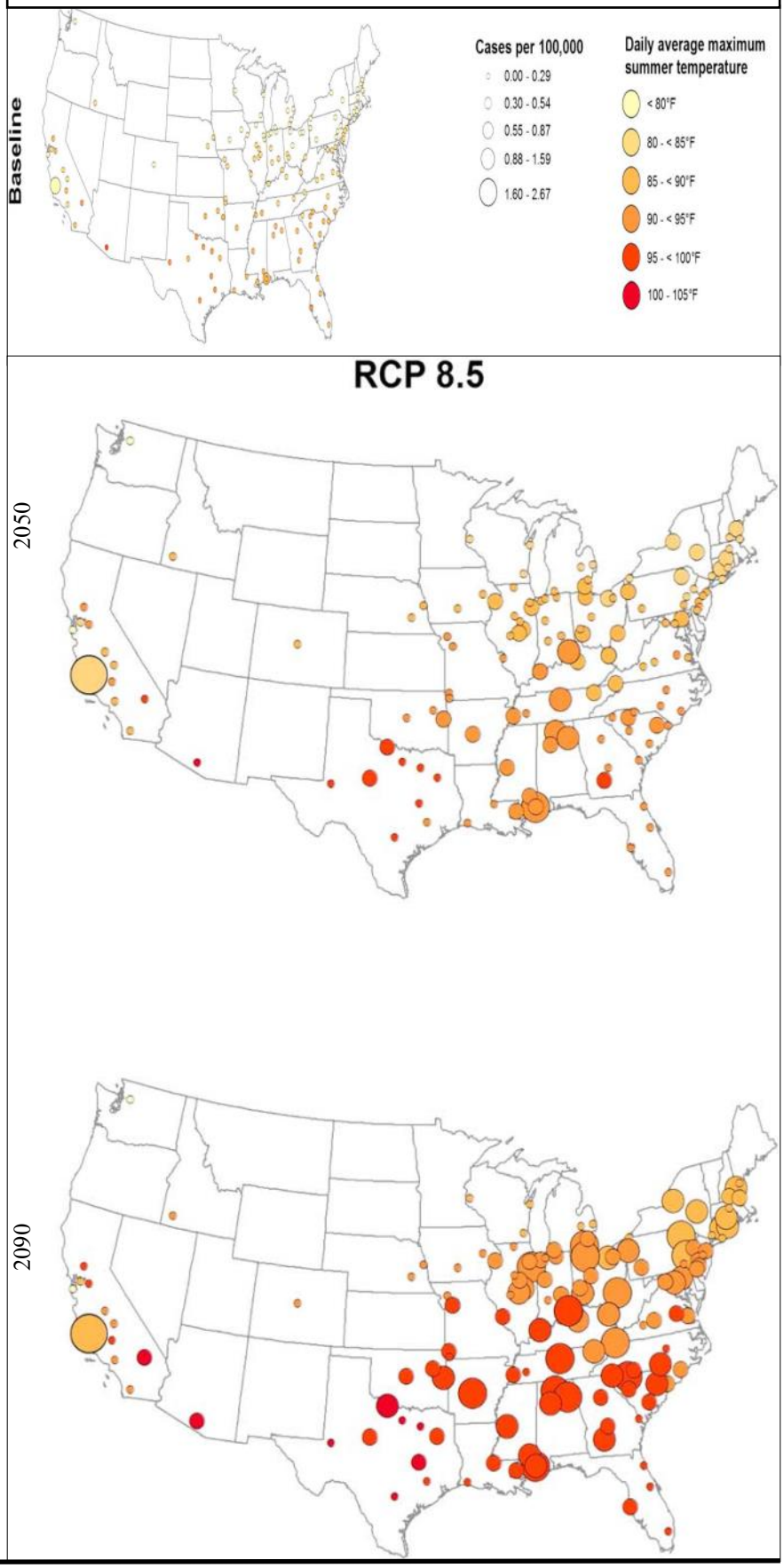
Natural disasters are disruptive events that cause morbidity and mortality, and incur a lot of financial costs in the form of response and recovery. These kinds of disasters are varied in nature, and each will have its own suit of challenges for communities and economies.

Some events like extreme heat can cause damage in many ways, causing complications for people with existing medical conditions, and an increase in urgent care appointments and emergency visits. While extreme heat is likely to have a more devastating effects for other parts of the U.S., atmospheric phenomena like the 2021 "heat dome" are likely to continue to occur, and present acute extreme heat challenges to the Pacific Northwest in the future.

**Figure 3F.1** shows the estimated increase in emergency room visits across the United States as a result of increasing extreme heat events in the future.

- Three timeframes are presented under an RCP 8.5 scenario projection: historic conditions are presented as "baseline" in the top map; mid-century (2050), and end-of-century (2090) are shown in the middle and bottom maps. Dot size indicates emergency department (ED) visits per 100,000 cases, while dot color indicates daily average maximum summer temperature in a red scale gradient.
- This research is focused on the effects of summer (May–September) temperatures on three categories of ED visits: hyperthermia, general cardiovascular disease, and myocardial infarctions (heart attacks), in a large portion of the U.S. population, age 64 years and

Figure 3F.1: Projected Increase in Extreme Heat in U.S.



younger, covered by employer-based insurance (Lay et al 2018).

- Heat increases under the RCP8.5 scenario would be associated with an **additional hyperthermia ED visits of 7,800 per year by 2050, and 36,800 per year by 2090,** across the United States (2010 population density). Monetized annual impact is estimated to be **$21.9-30.2 million dollars (2015 USD) by 2050, and $30.1-69.2 million dollars (2015 USD) by 2090** per year across the U.S., solely due to climate-increased heat exposure. These values are conservative and highly dependent on course of treatment and emissions scenarios (Lay et al 2018).
- Within this study, the Pacific Northwest (PNW) is anticipated to see less increase in ED visits due to heat than other regions, though atmospheric phenomena like the 2021 "heat dome" are likely to continue to occur periodically.
- Projections for Umatilla County find occurrences of 90˚F+ days will increase from historic 19 days per year to **29-31 days by early 21st century (2030), and to 39-48 days by mid-century (2050)** (Dalton et al 2020). This expands the seasonal window during which extreme heat is a concern to communities.

Construction workers take a break from work on the new Nixyaawii apartment buildings under extreme heat which will become more frequent.

These results are a conservative estimate of the true economic impact of heat, as it does not account for lost patient or caregiver productivity associated with the ED visit, or a patient's subsequent treatment. Data also do not include large segments of the population that may be vulnerable to hyperthermia and other temperature-related adverse health effects, such as rural residents ages 64 years and younger, all persons age 65+, and those lacking insurance.

Adaptation measures could reduce impacts from heat and other extreme events, especially if preventative public health is centered in response. Proactive adaptations include (but are not limited to): prioritizing natural and engineered shading for buildings and streets, rescheduling events and construction activities to avoid the hottest parts of the day, and ensuring equitable access to cooling, particularly for subsistence harvesters, outdoor workers like field and construction laborers, and for unsheltered community members.

Values presented for emergency department visits due to extreme heat are just one proxy estimate for the cost of responding to the climate crisis. Extreme heat events will occur alongside numerous other extreme weather events, each of which will carry their own additional response costs, and at times occurring simultaneously. Anticipating increasing costs in responding to these disasters will help Tribal families, communities, and governments to absorb impacts to emergency response as they are made worse in the future.

(Credit: Lay et al, 2017)

<u>Gaps in Knowledge/Data/Policy:</u>

- Occupational workers claiming workplace injury compensation as a result of heat exposure;
- Changing population dynamics and how influx of residents to the region might change;
- Effects of adaptation measures on reducing harm from heat exposure.

## 2. Impacts to Tourism from Disaster and Displacement

Tourism is an industry that brings revenue to the CTUIR businesses and community, with Interstate-84 creating a heavily used thoroughfare connecting densely populated coastal cities with inland wilderness recreation opportunities. Challenges to tourism are likely to occur as an indirect result from other natural disasters, as travel corridors and destinations experience climate impacts.

Not much data is available on how increasing extreme

weather events are likely to alter the ability of tourists to travel, but the hospitality industry can offer some insight into how increasing natural disasters may alter tourism impacts directly from disasters themselves, as well as through the displacement of communities affected. Hotels and other hospitality facilities often become displacement centers during disasters, much like the Wildhorse Resort and Casino (WRC) was able to shelter those who were displaced by the massive flooding event in February 2020.

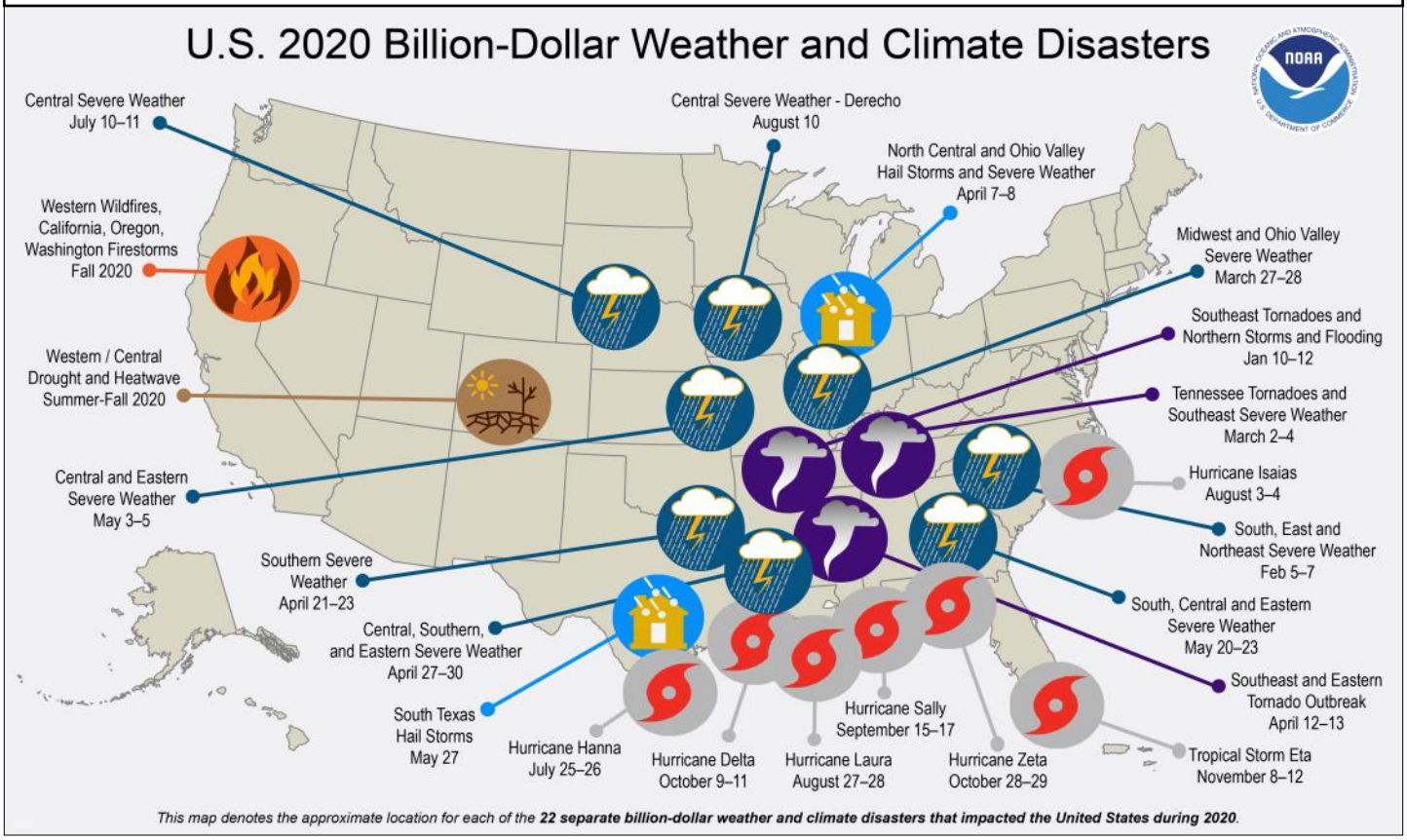
**Figure 3F.2** shows the locations of 22 extreme weather events that occurred in 2020 alone that caused at least $1 billion dollars in damage (NOAA, 2020). **The disaster events shown are for just one year, and created $22 billion dollars in damage**. If this trend continues into the future, response and recovery from natural disaster will present a massive drain on local and national economies.

Here in the Pacific Northwest, northern California's deadly 2018 Camp Fire (Nov 8th – 25th 2018) presents an opportunity to examine tourism impacts from a single wildfire event, as well as the response of the hospitality industry in meeting those disaster response needs.

- While Camp Fire had a negative impact on the broader hospitality industry, **demand for hotels increased 43.3% through November 7th to November 27th, 2018** (during the fire) (Ward and Mattern, 2020) in the area directly affected by the wildfire. It is unclear the extent to which this local demand for hotels was driven by displacement of residents, though it is likely to be significant.
- San Francisco, located about 165 miles away from the town of Paradise as the epicenter of the fire, experienced negative impacts due to poor air quality. Average occupancy rates in the San Francisco Bay area in October 2018 are typically 84.4%, but in November 2018, occupancy rates dropped to 71.0%, and by January 2019 (even though the wildfire was fully contained and smoke from the fires was gone), average occupancy rates in San Francisco dropped to 68.6%. This represents a **13.4% drop during the fire, and a 15.8% post-fire decrease in tourism.**

Capacity of the hospitality sector has played a role in emergency response. Many survivors of Camp Fire lost their homes and required immediate assistance, and the hospitality industry provided them with

Figure 3F.2: Number of Billion Dollar Weather Events in the Year 2020



various resources, such as free housing, free transportation service, leisure services, discounts for hotels, and free meals. Local hotels and vacation rentals offered special rates for rooms to Camp Fire evacuees, and were able to find shelter for over 2,500 people fleeing the Camp and other California state wildfires. Ridesharing services also provided discounted and free transportation to evacuees in reaching emergency shelters, hospitals, hotels, and food banks (Ward and Mattern, 2020). Tourism has also played a role in providing mutual aid by partnering with first responder organizations to encourage tourism in support of post-fire recovery efforts.

Wildfires are a significant risk for CTUIR Reservation and Ceded lands, especially if fire erupts in a highly populated and major gathering area like the Wildhorse Resort and Casino (WRC) (CTUIR EOP 2016). Previous wildfire events include a wheat field fire on Kanine Ridge behind WRC; a 2002 fire that burned from Riverside to Highway 331 across seven miles and required 15 responders to extinguish it; a 2002 lighting strike ignited fire near the Pendleton airport that burned almost 200 acres; 14 separate fires during the 2015 fire season, with the largest being the Rock Fire that burned 230 acres, and the Table Rock Fire which burned 218 acres (CTUIR EOM 2016).

Moving forward, communities might prioritize restoration and revitalization of popular tourist attractions to rebuild both community infrastructure and a sense of shared empowerment while actively promoting tourism. Positioning tourism, hospitality, recreation and culinary organizations as facilitators and responders to this process becomes increasingly compelling for linking sustainability, safety and security for guests, visitors and gatherings.

(Credit: NOAA 2020)

Gaps in Knowledge/Data/Policy:

- Detailed information about how tourism is shifting in response to disasters;
- Role that adaptation and mitigation may play in reducing impacts in the future;
- How disasters in other locations may impact local tourism to the UIR.

## 3. Increased Potential Disruption of Businesses and Supply Chains

Food, energy, and assembled goods are all heavily influenced by supply chain management, and their availability and affordability depend on reliability in production and distribution. Local reliance on globally-produced goods is vulnerable to disruptions in the supply chain, impacting availability and cost.

Fire burns along the Interstate 84 corridor during 2022 fire season, causing road closures that lasted for hours. Risk of fire close to travel infrastructure is likely to increase in the future.

Potential disruptions could be related to natural disasters, human conflict, labor shortages, and other kinds of production obstacles. Transportation is another point of vulnerability for supply chains, as many land and water shipping routes are impacted by the same climate impacts that threaten production.

**Figure 3F.3** demonstrates the interconnectedness and vulnerability of a typical supply chain.

- Upper and lower world maps shows how a single natural disaster event in one country can affect global supply chain continuity and availability. These maps show the impact to U.S. and other national supply chains from a single hurricane event that devastated the country of the Philippines in 2013.
- Direct impacts are shown in the top map, and include impacts to production resources sourced in the Philippines. As a direct impact from the

natural disaster, Philippines exports fell after the effects of Typhoon Haiyan in 2013. **6% of United States production relies on supplies from the Philippines,** and these industries were directly affected by supply disruption from one single natural disaster event (Levermann 2014).

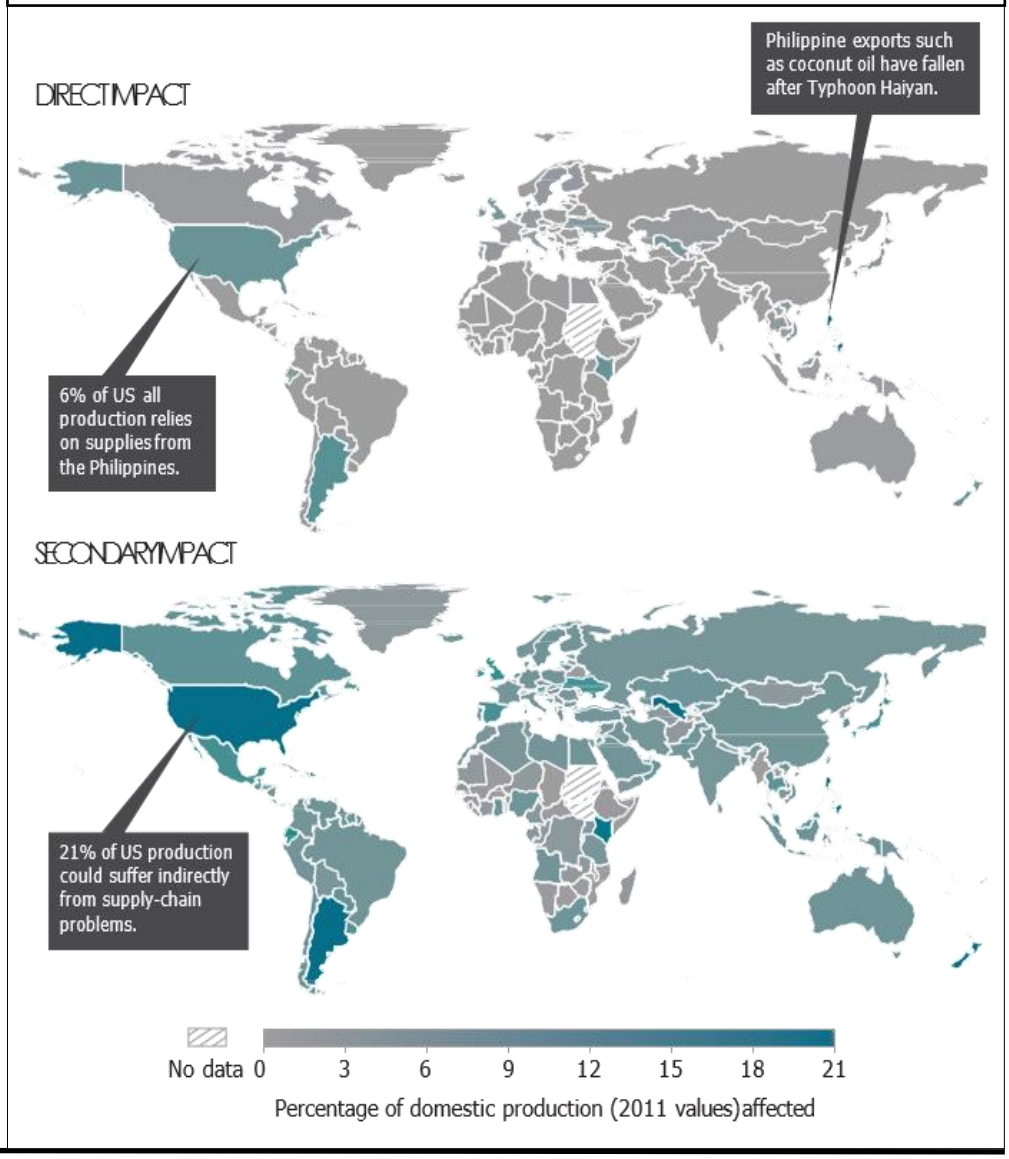
- Secondary impacts are downstream delays and shortages that are a result of direct impacts. Typhoon Haiyan posed an indirect **disruption risk to 21% of all U.S. production**, as a large number of manufacturers and other distribution companies rely on good produced within a globalized supply chain, and will experience greater harm from disasters that occur around the world (Levermann 2014).

Climate impacts to supply chain function and infrastructure are numerous. Sea ports are at risk from direct climate impacts like sea level rise, and ocean acidification that causes accelerated corrosion. Inland communities are also impacted by delays and disruptions, and tend to be reliant on a limited network of supply hubs. Disruption of supply chains has broad implications for both local and global economies, as direct damage to infrastructure and superstructure of ports and their supply chains. Indirect costs are incurred to employment sectors and taxpayers, hazards and unsafe conditions for outdoor workers, as well as intangible consequences like environmental degradation and reduced quality of life in communities near ports.

Additionally, other modes of transportation like railway and vehicle travel will also experience impacts from extreme weather events. Examples include extreme heat and smoke inundation events, which are likely to affect transportation worker productivity. Additionally, energy consumption of chillers and refrigeration units will climb with increasing temperature; flooding damage to Union Pacific railways on Meacham Creek during the Feb 2020 flood resulted in emergency and unpermitted streambank armoring construction work to rescue infrastructure, and may have had a negative impact on First Foods restoration in that area.

Complexity in supply chains -- including a higher number of nodes, links, networks, and redundancy -- will build resilience in the way goods can be sourced and delivered. To build resilience for food systems, diversified and adaptive trade relationships, and robust local production chains will need to be supported. Performing a region-wide inventory to assess which goods are available from local sources could help build redundancy in supply chains, and alleviate

Figure 3F.3: Supply Chain Interconnectivity Affected by a Single Extreme Event



some impacts from global uncertainty. Such an inventory would also allow Tribal businesses, enterprises, and governments to assess what things are being receiving from potentially vulnerable sources. It would also assess where there may be opportunities to support regional efforts to produce these goods locally.

(Credit: Levermann 2012)

Gaps in Knowledge/Data/Policy:

- Sourcing locations of essential goods and what impacts these are likely to experience;
- Uncertainty around global production of goods, currently and in the future.

## 4. Shifting Economic Dynamics and Revenue Generation

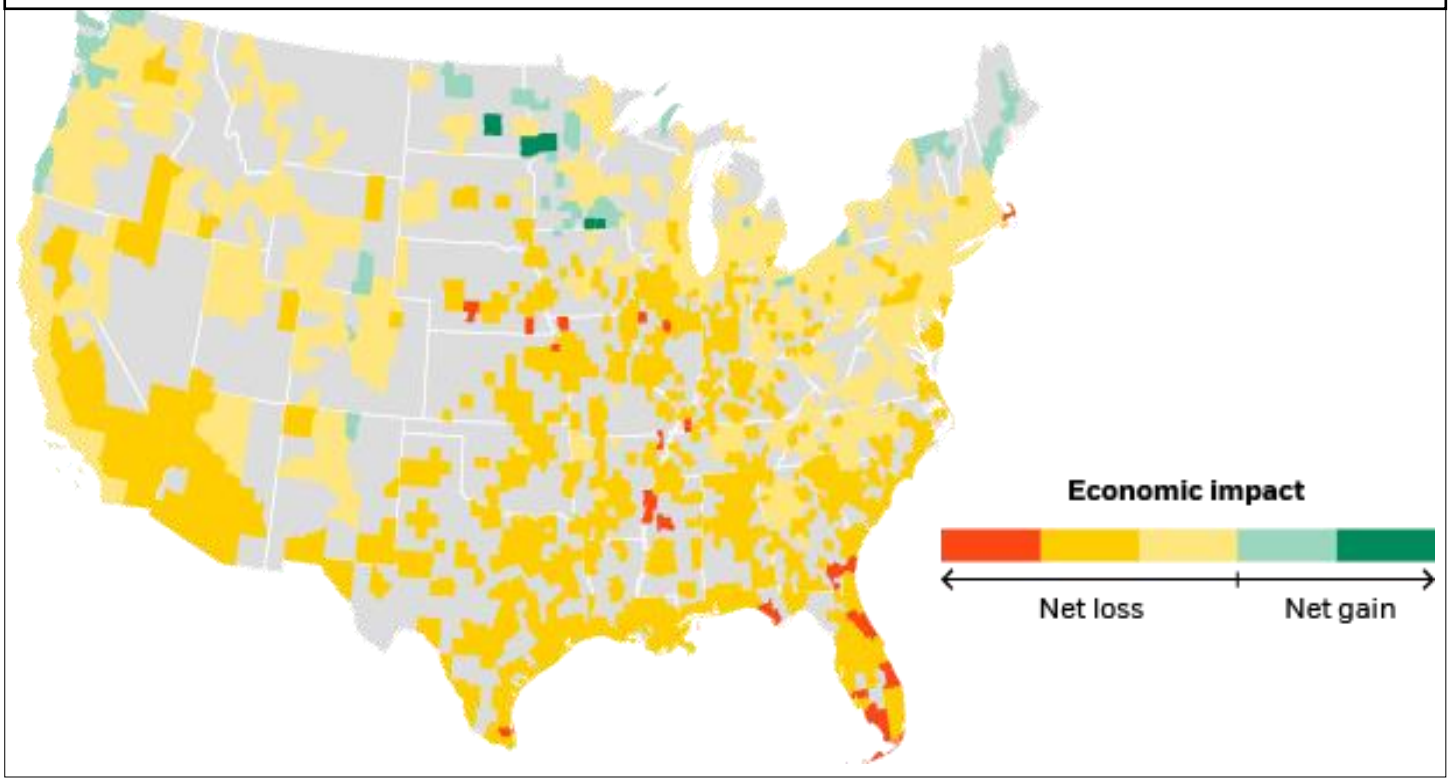
With the effects of the climate crisis, it becomes increasingly difficult to predict the severity and frequency of extreme events. This uncertainty comes with a sticker price to nations, companies, and investors who make up the Global Market.

Calculating investment opportunities is estimated using relatively stable options like municipal bonds, commercial mortgage-backed securities (CMBS), and electric utilities. These are often used to estimate the trajectory and volatility of investment opportunities at local and regional scales. These opportunities are often integrally tied to local communities and governments, and are a good way to analyze effects that proactive climate adaptation might have for securing financial stability in a region.

**Figure 3F.4** shows cumulative projections for these three investment options across the United States by the end of the century (2060-2080) under a RCP 8.5 scenario (Shulten et al 2019).

- This study examined climate change impacts to U.S. municipal bonds, commercial mortgage-backed securities (CMBS) and electric utilities across the country, and compared the price of these three market indicators between municipalities that were at higher and lower risk from various natural disasters
- This analysis breaks down the potential net economic impact, and it includes estimates of direct impacts (such as the expected losses from hurricane damage), as well as second-order effects such as changes in mortality rates, labor productivity, energy demand and crop yields.
- These values can be used as proxy estimates on the ability for cities to generate revenue, which sets

Figure 3F.4: Projected Economic Impact of Climate Adaptation on Investment Opportunities



their market value for trading municipal bonds which insure cities against disaster. Estimated economic impacts are indicated on a color gradient: green shades indicate a potential net gain from municipalities that are adapting and preparing for climate change, or are likely to benefit in some way. Yellow to red colors indicate a net loss of economic potential, due to scale of impact and/or a lack of preparation efforts.

- Within this map, **Eastern Oregon and Washington are projected to experience mild net economic loss** from climate change forces. This net loss is likely from a lack of preparation; reliance on vulnerable industries like farming and forestry; and effects from drought and wildfire. Of national large municipalities, Seattle, WA, shows the most resilience, with little projected damage to GDP over time (Schulten et al 2019).
- Across the United States, roughly **58% of metropolitan areas face climate-related GDP hits of 1%** or more, meaning that more than half of the U.S. will be **losing money on repairing and responding to the damage** being done by climate effects.

CTUIR Board of Trustees and other representatives tour the DCFS Tutuilla Food Sovereignty Center under construction in 2021. New infrastructure developed to withstand historic conditions will be unprepared for future conditions with greater stress on systems.

Aging infrastructure tops the list of high costs impacts. This makes the national electric sector vulnerable to physical damage from hurricanes and wildfire, and will pose challenges for the necessary electrification of the transportation sector. Electric utilities exposured to extreme weather events typically suffer temporary price and volatility shocks in the wake of natural disasters, and the impacts of rising temperatures affect national crop yield, home and business insurance pricing, and create risk to the reliability and affordability of energy, and is likely to disrupt supply chain connectivity and shipping traffic stability. The rising incidence of extreme weather events over time might lead to spiking property and casualty insurance premiums, and reduced or denied coverage.

Extreme heat impacts to businesses include lowered productivity in regions that rely on outdoor labor, such as agriculture and construction work. Industries may experience rising mortality rates as the incidence of extreme heat rises, and greater energy expenditure is required to cool buildings. Agriculture is another sector that is vulnerable, as extreme heat reduces crop yields and drought threatens water availability for irrigation.

Taxes bases of municipalities could experience population migration as a result of frequent extreme weather events, and could create declining property values. A small number of northern states may see an influx of climate migration, due to their relative economic stability. Businesses may also relocate to other regions, further eroding local tax bases. Response after natural disasters plays a role in the current and future costs analyses, as many places are insured and repairs funded by the Federal Emergency Management Agency (FEMA), which could become less reliable if mounting disaster costs were to overwhelm FEMA's financial capacity or political will to respond.

Risks to municipal bond insurance include (Schulten et al 2019):

- Higher insurance premiums or decreased insurance coverage;

- Rising operational costs such as energy use for air cooling systems;
- Greater capital needs to make buildings more resilient (ex. backup generators, water-pumping systems and reinforcement of building exteriors);
- Increased delinquencies as tenants default or walk away from properties after extreme weather events;
- Potential hits to valuations and declining liquidity of properties in vulnerable areas.

Energy and utility expenses make up roughly 15% of operating expenses for commercial buildings, and is likely to rise as extreme heat events become more common. Acute climate shocks create impacts, such as damage to generating facilities. Chronic events tend to play out over longer time periods and wider areas of impact, and these estimates do not account for potential damages to transmission and distribution networks. The potential impact of climate events on power plants varies by location and fuel source: gas (35% of total U.S. generation capacity) and coal-fired power plants (27%) are exposed to a broader swath of climate risks, and though high temperatures pose a significant risk to almost all types of fuel sources (Schulten et al 2019). To prepare for risk management, suggestions include geo-locating power plants and determining their physical climate exposure to allow utilities investors to better assess exposures. This analysis can also provide information to CTUIR about future investments in acquiring and placing enterprises in locations with robust adaptation efforts.

(Credit: Schulten et al 2019)

Gaps in Knowledge/Data/Policy:

- Specific projected impacts to energy utilities in the CTUIR Ceded lands;
- Estimate of magnitude and frequency of events like drought and wildfire on economic prosperity.

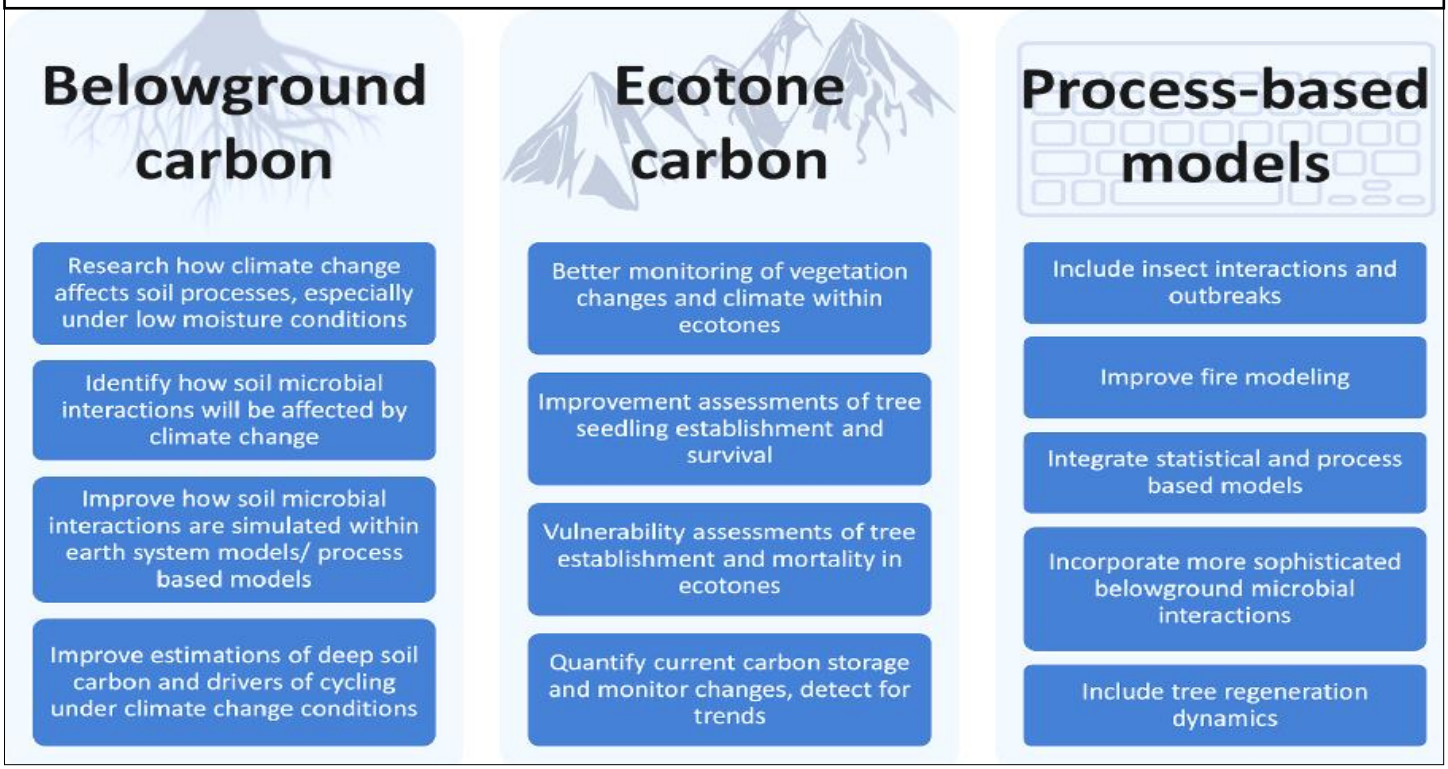
## 5. Opportunities for Carbon Sequestration Through Vegetation and Soil Management

Soil is an excellent storage sink for carbon. Carbon within soil organic matter (SOM) helps improve soil health and productivity, and there are ways to manage forests and grasslands that can maximize these carbon sequestration benefits. Globally, forests absorb 15–20% of annual human carbon emissions (Case et al 2021), and healthy forests have added benefits of promoting water infiltration and improving habitat conditions for First Foods. Detailed descriptions of forest types for the CTUIR Reservation and Ceded lands, as well as approaches to forest management that benefit First Foods, can be found in the First Foods Upland Vision (Endress et al 2019).

Damage to essential infrastructure from flooding, like to this railroad access bridge increases disaster recovery costs. Tribal Nations and local governments can reduce future costs by considering climate projections in current program and infrastructure development.

Human management of these lands has a large impact on whether soil is a carbon sink, where carbon is removed from the atmosphere through vegetation growth and organic matter accumulation. Or if it is a carbon source, soil disturbances like tillage can cause the rapid decay of soil organic matter into the atmosphere. Continued human disturbances, such as harvest, fire fuels reduction, construction, and land-use effects may decrease carbon storage and

Figure 3F.5a: Various Approaches to Forest Carbon Storage at Different Management Levels




adversely affect some ecosystem services. However, managing for multiple forest management objectives like economics, fire resilience, Treaty Rights access, and biodiversity, is challenging.

**Figure 3F.5a** illustrates opportunities that are available for managing forested lands to anticipate climate impacts and improve forest management for carbon storage (Case et al 2021).

- Potential for knowledge in management and monitoring of forest lands can be done at a "Belowground Carbon" level (left), which includes research opportunities into soil dynamics, microorganisms, and deep carbon storage; at an "Ecotone Carbon" level (center), which examines tree lifecycle patterns and migrating species impacts; and at a "Process-Based Models" level (right) in which modeling for forest disturbances is anticipated in projections.
- While some projections under increased atmospheric carbon scenarios indicate some dry forests may increase in productivity, decreased water availability and nutrient limitations may still limit growth, and increase tree mortality.
- Landscape-scale modeling in dry forests of Eastern Oregon suggest large shifts in tree species composition. This includes a decline in subalpine species and increases in lower-elevation species under future climate scenarios (Case et al 2021).
- Tree seedling establishment is hampered by hotter temperatures and lower snowpack, which results in lower water availability during the growing season. In these conditions, seeds may be unable to germinate, seedlings have increased mortality rates, and wildfire may create larger distances to seed sources, inhibiting vegetation establishment.
- Model simulations in the Blue Mountains of Eastern Oregon and Washington project a **longer growing season, more wildfire events, and a potential contraction of some forest types in dry areas** (Kim et al 2018).
- Snowmelt during the dry, summer months is critical for tree growth and seedling establishment at high elevations, and may eventually reduce potential gains in carbon sequestration.
- In general, future projections show potential carbon gains east of the Cascade Crest. This is largely due to increased productivity during non-summer months, and at high elevations, most likely driven by warming temperatures and a longer growing season.

Soils contain more carbon than plants and the atmosphere combined, and can comprise nearly three quarters of total ecosystem carbon. Many projections anticipate a net primary productivity increase for forests, due to a longer growing season, increased decomposition of forest duff and vegetation deposition, and microbial carbon respiration, which consumes older soil carbon (Case et al 2021). Soil microbes also play a large part in carbon sequestration, though microbial interactions and carbon release are difficult to quantify or predict.

When assessing areas at risk for species composition changes, intersection between two or more biomes/ ecosystems -- like upper and lower treelines, forest-grassland ecotones, and riparian corridors -- are crucial to examine due to their impact on the movement of animals and nutrient cycling. These are also likely to be areas of new colonization.

Farming activities can also make a big difference on whether soils are acting as a carbon storage or release source. Soils release more than 60 Gt of carbon dioxide annually, seven times more than the amount of carbon released from fossil fuel burning (Ghimire et al 2019). Soil disturbance like tillage often triggers soil organic carbon (SOC) loss because it increases soil biological activity, and brings organic residues in contact with decomposers. In contrast, reduced- and no-tillage minimize SOC loss.

Crop rotation, cropping intensification, and diversification increase microbial substrates, microbial biomass and activity. This ultimately increase SOC sequestration. Plots at the Columbia Basin Agricultural Research Center (CBARC) near Pendleton OR have long-term experiments on soil disturbance and carbon storage, some of which date back to 1931. This historical research site provides a wealth of knowledge on how cropping systems management influences soil organic carbon in dryland wheat production in the CTUIR Ceded lands.

Figure 3F.5b: Carbon Sequestration of Farming Techniques at Temperatures

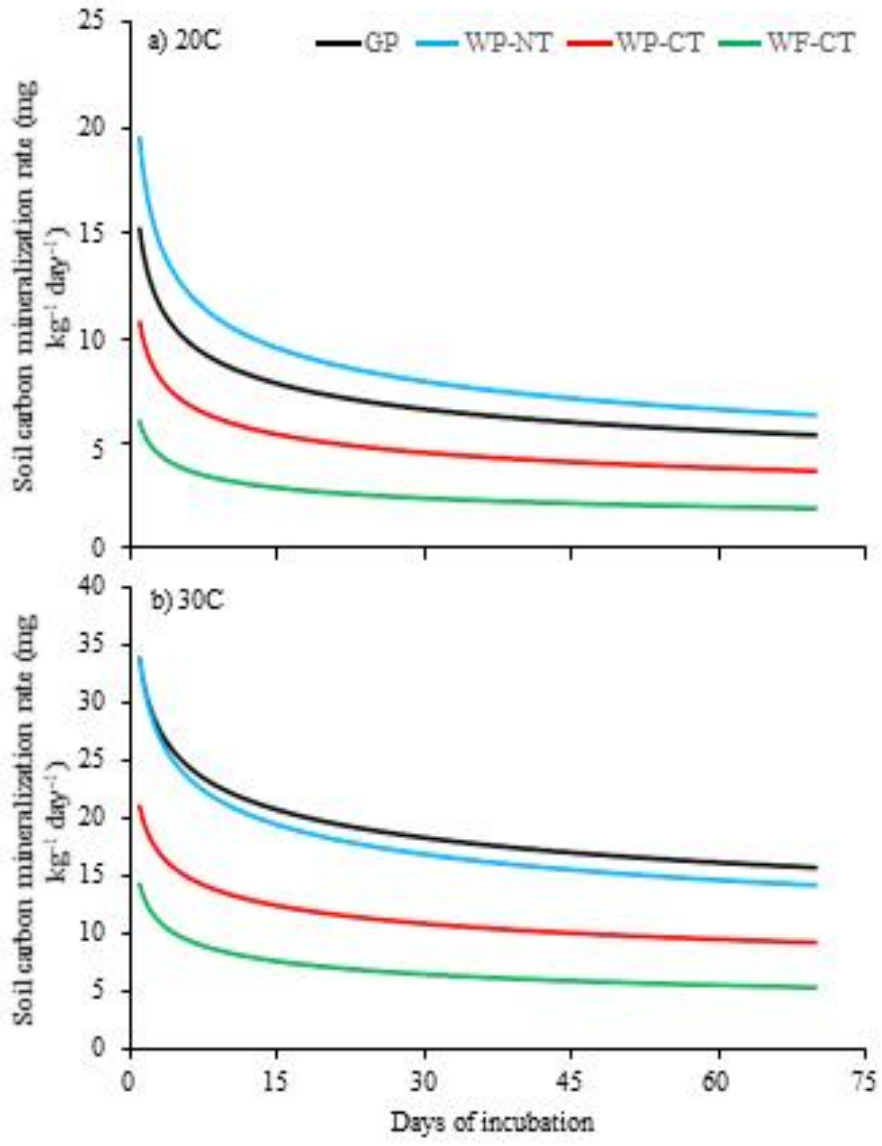



**Figure 3F.5b** shows results from these long term plots under different cropping systems.

- The top graph shows cropping systems' ability to store carbon under 20 °C (68˚F) and under 30 °C (86˚) in the bottom graph, to illustrate how increasing temperatures are likely to affect these kinds of systems. These graphs are measured in soil carbon mineralization rate (micrograms of carbon per kilogram per day) (Ghimire et al 2019).
- "GP" indicates perennial grass pasture (black line); "WP-NT" indicates a wheat-pea crop rotation under no-till conditions (blue line); "WP-CT" indicates a wheat-pea cropping

system under conventional tillage (red line); and "WF-CT" indicates a wheat-fallow rotation under conventional tillage (green line). All are measured by the carbon sequestration potential of each system over time.

- Through this comparison, it is shown under cooler conditions (top graph) that wheat-pea no-till systems create the most opportunity for carbon storage, with grass pasture opportunities surpassing these under warmer conditions (bottom chart). Typically, perennial grassland systems sequester more SOC than agricultural soils. SOC is sensitive to disturbance, so accrued SOC is easily lost when the grasslands are cultivated.

Small scale diversified and "regenerative" farming, such as the Yellowhawk Community Garden (pictured), is an opportunity to improve soil health for carbon sequestration, as well as provide fresh and healthy food to the Tribal community.

- SOC mineralization rate in elevated temperatures was lower in wheat-pea cropping rotations (both no-till and conventional tillage) than grassland or WF-CT.
- Long-term observations illustrate **loss of SOC stock by 50% in WF-CT systems**, while systems maintained for over 50 years **increased organic matter by 13% in WP-CT systems, and 30% WP-NT systems**. Organic matter also **increased 20% in WF-TN and 42% in WP-TN**, respectively (Ghimire et al 2019).
- SOC content was the **highest in GP**, the grassland system that has not been disturbed for more than 80 years, and **lowest in WF-CT**, an intensively tilled winter wheat-fallow system (Ghimire et al 2019).

Studies show that reduced tillage and higher cropping intensity lowers soil temperature and favors SOC sequestration. Cultivated soils in the dryland inland Pacific Northwest have already lost 30–60% of SOC in the past century. Soil warming could accelerate SOC loss, and combine with decreasing crop yields to negatively affect agricultural productivity. Increase in the fresh organic matter and quality due to improved management (e.g., no-tillage, legume integration) can affect microbial utilization of soil and changes in SOC storage. Some microorganisms are better adapted to climate change and variability than others, but there is evidence that mineralization is higher in diversified systems that retain more carbon than even grass-only systems (Ghimire et al 2019).

CTUIR's Department of Economic Community Development (DECD)'s Farm Program has historically generated revenue for the Tribal government to operate, and still farms 12,000 acres across the Umatilla Indian Reservation (UIR) today. Much of this dryland farming is wheat-fallow rotations, with a mix of conventional tillage and no-till cropping systems. To prevent a loss of soil carbon predicted by this study, DECD should consider:

- Transitioning farmed lands into grass pasture;
- Including legumes like peas into rotation schedules;
- Reducing acreage in conventional tillage;
- Perpetuating and expanding acreage in Conservation Reserve Program (CRP) stewardship.

Grasslands provide another land-area category for building SOC stocks. Over the lifetime of conservation practices, implementation can result in 0.01 - 0.20 tons of carbon per acre per year accrued on average a decade, especially on grazing and pasture lands treated with carbon-focused conservation practices (Chambers et al 2016).

Nitrogen sequestration can also benefit soil health as an essential nutrient for plants. In this study, more nitrogen was found in the wheat/pea no-till plot than all other treatments. This is because no-till farming maintains a consistent soil environment for microbial growth and activity, conserves soil moisture, and helps soil aggregation that improves nutrient storage and cycling. Additionally, other studies show that including legumes like peas in rotation support crop production through atmospheric nitrogen fixation.

Native plants will always be the best option for soil health and conservation. Native grasses and forbs of CTUIR's Ceded lands are especially efficient at creating deep root systems that hold soils in place, and create pathways for precipitation to infiltrate and be absorbed. In upland areas where invasive grasses like Cheatgrass has taken over, soil erosion is evident by large soil "slumps" that can be seen along the ridgetops after heavy precipitation events.

One example of these "slumps" is pictured here, located on the ridge line above the Meacham Creek Restoration Project.

Prioritizing land use that utilizes native and perennial plants will play an important role in climate adaptation. Many kinds of land uses can incorporate these kinds of plants into their regular functions. Examples include (but are not limited to) maintaining grazing public lands in a manner that reduces invasive grasses and prohibits grazing during sensitive life cycle phases for native plants, and to use the Conservation Reserve Program (CRP) practices and land leasing, especially in highly erodible lands and near riparian areas along streams and rivers.

(Credit: Case et al 2021, Ghimire et al 2019)

CTUIR Reservation and Ceded lands are topographically diverse, with many different soil types. Soil erosion, such as a the deep gully forming (center photo, dark brown) is a result of shallow-rooting invasive grasses. Revegetation efforts that prioritize native species with deep rooting systems benefit First Foods, increase water infiltration, and hold soil efficiently in place.

<u>Gaps in Knowledge/Data/Policy:</u>

- Quantified benefits that perennial and native grasslands for soil health and conservation;
- Grazing and fire disturbance optimum density for the Blue Mountain ecoregion;
- Seasonal shifts in native plant life cycles that may be impacted by land management activities;
- How farming is likely to adapt to changing environmental conditions.

## A. Diversify Economic Opportunities, Trainings, and Options

"One goal of economic development efforts is to provide economic opportunity for all CTUIR members. Another primary goal is to provide resources to maintain the CTUIR and Tribal lands forever. A key component of long-term economic strategies is to create diversified revenue sources for the CTUIR (CTUIR Comprehensive Economic Development Strategy, CEDS, 2017)."

### i. Continue to Update and Adapt Business Services

As seasonal variability fluctuates and technology advances, keeping pace with changes will help CTUIR retain its competitive edge in promoting its businesses and opportunities. These kinds of changes could be virtual, physical, and social, and should promote capacity to embrace future uncertainty. Coyote Business Park is a continuing example of business services being adaptive in meeting changing needs.

Short Term:

- **Build capacity in online infrastructure for providing services,** including internet vending capability, attractive and accessible websites, social media outreach options, and friendly interfaces, among others. Access to virtual infrastructure will assist in creating viable business opportunities for Tribal enterprises and nonprofits. Initiatives to build online infrastructure would pair well with DECD efforts to expand broadband internet access on the Umatilla Indian Reservation (UIR).

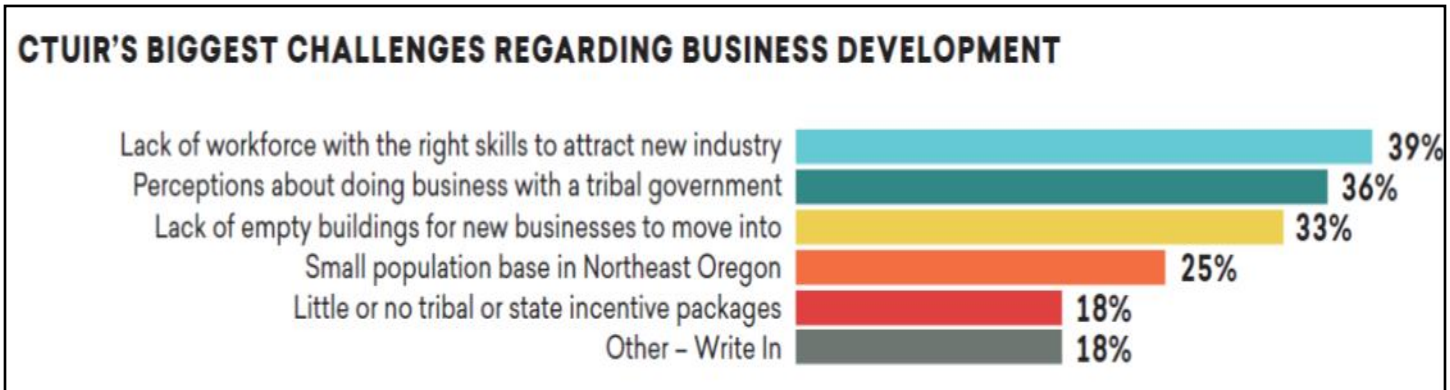
Long Term:

- **Promote resilience in physical infrastructure like offices and landscaping**, by incorporating engineered water infiltration, utilizing drought tolerant native plants, and developing minimal use irrigation systems, among other strategies. This would align with efforts to reduce water use in irrigation demand across Tribal businesses and facilities. See Ch 3A pages 50, and 61-62 for additional details.

- **Support and expand frameworks that promote flexible work and living schedules** to accommodate for seasonal disruptions, (ex: natural disasters etc), and opportunities (ex: First Foods harvest etc). As emergencies and economic instability alter reliability of many aspects of life, allowing families to live flexibly will improve their ability to meet modern living requirements, work/life balance, and quality of life. See Ch 3D pages 171-172 for additional details.

### ii. Expand and Support Small Business Development Services

Economic resilience is based in access and availability of diversified job and revenue opportunities for families and Tribal nations. Job training and business start-up support could help Tribal families build capacity to adjust to changing revenue generation. These services




Graphic from CTUIR Comprehensive Economic Development Strategies (2017) highlighting barriers to business development on the UIR. Lack of skills is ranked highest with 39% of respondents feeling it was a barrier.

help by filling needs and gaps in the community, and providing essential services currently conducted off-reservation.

Short Term:

- **Organize and facilitate diverse training and education events** to provide connection and certifications for emerging fields like renewable energy, First Foods procurement and safety, and information technology, among others. Educational initiatives complement those found in other focus areas; see Ch 3B pages 88-90, Ch 3D pages 153-155, Ch 3E pages 194-195 and 207, and Ch 3G pages 288-289 for additional detail.

- **Continue to support and expand the Credit Loan program within NCFS** to provide access to fair capital for Tribal Members and families. This program would ideally also support other disaster relief and patient capital approaches that promote flexibility in repayment. Access to flexible capital for families and businesses will reduce climate impacts to economic services and address financial barriers.

Long Term:

- **Conduct economic opportunity listening sessions and mapping exercises** to identify and update changing and emerging needs in services for the Tribal community and government. A listening session was conducted as part of the CEDS (2017) document development, and sustained conversations will capture shifting and emerging needs of the community into the future.

### iii. Encourage and Support "Regenerative" and Alternative Farming for Soil and Community Health

Farming is an engineering activity that can either provide carbon sequestration or release, depending on land management approaches. Global food security will experience challenges in production due to climate impacts, therefore boosting local food production and utilization will build economic and community resilience to buffer food shortages and supply chain interruptions.

Short Term:

- **Continue to support and implement gardening, home food production, safety, and nutrition classes** for the Tribal community to build capacity to provide food for families, like the kind offered by Yellowhawk Community Wellness Program. Improving production of healthy foods and processing regionally can reduce disruptions on local accessibility from global disasters; see Ch 3D pages 167-170 for additional detail.

- **Build capacity to provide composting opportunities and nutrient cycling information** for soil carbon sequestration to various audiences, with a focus on carbon recapture and storage. An initiative to reduce food waste would complement increased capacity for biological waste management through DECD, with the Tribal Environmental Recovery Facility (TERF); see Ch 3C pages 132-133 for additional detail.

- **Advocate for and develop diversified processing options for alternative dryland cropping systems,** like incorporating other grains and legumes like peas, barley, sorghum, hemp, and other potential dryland crops. Increasing processing and marketing options for these crops will improve their viability for agricultural producers.

TCI gift shop (pictured) and Kinship Café are a great place for local artisans and food producers to connect with retailing options.

Long Term:

- **Promote opportunities for diverse vending opportunities for Tribal businesses** of all kinds, and especially for those providing fresh and local produce, and/or textiles. Collaboration with community conversations on commonly used goods that experience supply chain disruptions could improve the focus of these efforts; see Ch 3C page 120 for additional detail.

- **Collaborate with and support diversified and small scale farming operations on the UIR and the Ceded lands**, with a focus on providing fresh food procurement for the Tribal community. Access to irrigation water from Columbia River tributaries is likely to be a complication to this effort.

### iv. Update CTUIR Policies and Codes to Support Renewable Energy

Policies and social frameworks must also be adaptable and create protocols to incorporate changing needs and conditions. Land development codes, energy metering requirements, and guiding policies must incorporate the potential for small scale renewable energy generation (as appropriate) into building, land use, and community growth plans. See Ch 3E page 186-192 for additional details.

Short Term:

- **Continue to include permissions for renewable energy capability future developments**, as appropriate. DECD and Tribal Planning Office (TPO) coordinated to ensure the new Nixyaawii community/subdivision land development code is zoned. A number of renewable energy generating initiatives are in early phases, and could inform expanded generating projects; see Ch 3E pages 186-192 for additional information.

- **Promote online resources and information on Tribal Planning websites and other outreach avenues about renewable energy financing, installation, networks, and opportunities** that UIR businesses and residents could utilize. See Ch 3C pages 119-121 for additional detail.

Long Term:

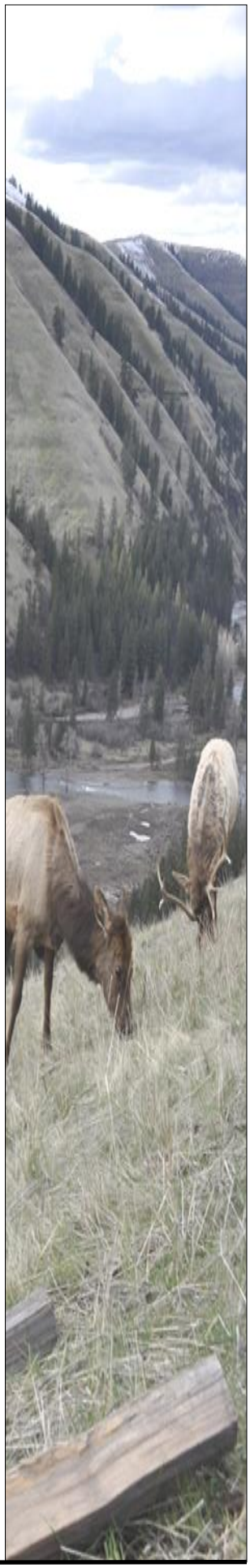
- **Update CTUIR Energy Policy to include information and outreach about emerging renewable energy technologies** as they come available; see Ch 3E pages 186-193 for additional detail.

### v. Cultivate Partnerships to Support Diverse Opportunities

Regional prosperity is a priority for CTUIR governance, and is necessary for economic resilience. CTUIR builds many partnerships for natural resource, infrastructure and emergency response management needs, and to promote social connection and commerce.

Long Term:

- **Continue to build partnerships with other Tribal economic and community development initiatives**, such as Oregon Native American Chamber of Commerce, Intertribal Agriculture Council, and other Native Community Development Financial Institutions (CDFIs) like Quinault, Colville, and Nez Perce Tribes, plus many others.



## B. Build Capacity to Address Economic Challenges

"Economic volatility on the national level is a threat to economic stability in the community. It is difficult to plan for unwanted contingencies when externalities can be unpredictable…The CTUIR priorities of managing assets wisely, offering worker training and education to its members, diversifying CTUIR revenue sources, and being stewards of the environment are sound responses to these unknown impacts that can occur from the national level (CTUIR CEDS 2017)." Capacity to respond to challenges and opportunities will rely on a trained and flexible workforce, community, and government.


4th of July Powwow participant keeps hold of a tent pole against high winds and heavy rains which interrupted one evening of the event. Vendors lost out on sales and some had damaged goods from the storm that cancelled that evening.

Short Term:

- **Continue to proactively fund food security and aid initiatives** such as DCFS's food and supply distributions, Dept of Natural Resources (DNR) fish and bison distribution events, and a First Foods ceremonial and subsistence "pantry" to meet community need.

Long Term:

- **Continue to address and adapt to ongoing challenges identified by Dept of Economic and Community Development (DECD)**, including (but not limited to):
  - ◊ Land ownership and fractionation issues;
  - ◊ Workforce skills, business funding, and affordable housing availability;
  - ◊ Permitting and land development restrictions (as appropriate);
  - ◊ External misconceptions of working with Tribes and Tribal regulations;
  - ◊ Infrastructure availability and transportation interruptions.
- **Address policy and infrastructure barriers for food assistance programs, identified by Department of Child and Family Services (DCFS)**. These include (but are not limited to):
  - ◊ Equipment and infrastructure needs such as freezers, coolers, and storage space;
  - ◊ Transportation and skills needs for distributing and providing access to food;
  - ◊ Policy flexibility to allow food assistance supplies from Food Distribution Program on Indian Reservations (FDPIR) "commodities" and other community donations to occur in shared spaces like freezers and pantries.

## C. Expand NCFS Capacity to Provide Small Business Support

"In addition to continuing marketing efforts to attract tenants, there is potential to help CTUIR members create new Native-owned businesses with the Business Service Center, a Community Development Financial Institution (CDFI), and significant training for small business development. The Business Service Center provides services that assist entrepreneurs at all stages of the business lifecycle, from pre-start-up to exit strategy, including business counseling, computers with business software, marketing, and access to capital. A Community Development Financial Institution, or CDFI, is a non-profit financial institution that can make a wide range of loans and provide development services such as education, training, and technical assistance (CTUIR CEDS 2017)."

Disruptions from natural disasters and supply chain wrinkles create challenges for businesses working to

finance their operations; flexible and patient capital services can ease this burden.

Short Term:

- **Support and expand Nixyaawii Community Financial Services (NCFS) operations and lending capacity** to provide Tribal Members, UIR residents, and other eligible entities and businesses with Flexible Lending, Patient Capital, and Fair Credit, now and into the future.

- **Continue to provide (and expand where appropriate) technical assistance capacity for Tribal businesses** as "risk reducer" for financial planning, with an aim to increase operations success. Risk for businesses will increase due to supply chain disruptions and extreme weather events, and increasing access to climate-informed credit planning can mitigate for many of these concerns.

- **Collaborate with NCFS and other Native/local CDFIs to develop a coordinated plan for mitigating market abnormalities** and stabilizing supply chains to buffer climate impacts to customers and communities. Building regional networks of credit can reduce challenges to accessing financial services.


Staff with Nixyaawii Community Financial Services (NCFS), a Native CDFI, raise awareness of financial options available to Tribal Members for personal and business support at the annual Community Picnic.

- **Organize and facilitate community education and engagement opportunities for diverse audiences** focused on self-sufficiency practices and defining what "wealth" means for CTUIR. Reducing dependence on global supply and demand can insulate CTUIR and the region from instability.

- **Support and expand Tribal youth finances education opportunities**, like the Summer Youth Entrepreneur Camp, education loans, and financial literacy courses. Tribal youth are leaders in climate adaptation, and Tribal businesses have a large role to play in implementing many of these strategies.

Long Term:

- **Expand NCFS and CTUIR credit service capacity to provide assistance to clients in planning for uncertainty** through short term payment flexibility, and incorporating climate crisis planning into business plans.

- **Advocate for and provide support to NCFS for its operations and lending expenses,** in order to building economic resilience for Tribal families. CDFIs are "an overnight success 30 years in the making," and CTUIR has a great advantage in credit services through this burgeoning Native CDFI.

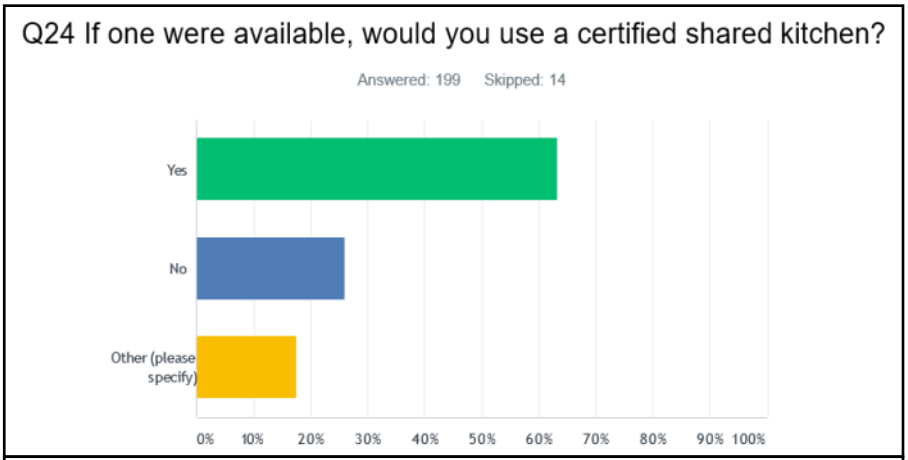
- **Expand NCFS capacity to offer programs of lending**. This includes: small business, food sovereignty, education, land leasing, and land acquisition lending, plus new types for renewable energies. As lending capacity grows, services that support local food and renewable energy will be necessary in implementing adaptation for families and businesses.

## D. Build Interest and Capacity in First Foods Stewardship, Procurement, and Processing

"Closing the supply chain gap for manufactured products in food and transportation equipment manufacturing has the potential

to add great value to the economy. Although there is a larger share of supply chain requirements already being met for in-region services, additional revenue could be generated through expanding services such as wholesale trade, finance and insurance, and the healthcare industries (CTUIR CEDS 2017)."

Food security and availability from global supply chains is likely to continue to experience interruptions. Building local and family capacity to produce and process food will mitigate for these impacts and build Tribal resilience rooted in First Foods.




Yellowhawk First Foods Assessment (2020) surveyed the CTUIR community about food access. Many were supportive of shared kitchen infrastructure if available, with almost 200 survey responses.

## i. Promote Traditional / First Foods Cuisine and Tourism

Traditional and Indigenous foods are finally beginning to be recognized for their sustaining power that has succeeded for millennia. Because First Foods are "pre-fossil fuel foods" that existed before the burning of carbon, they provide an essential opportunity to return to foodways that are closely connected to land, water, people, and culture.

Short Term:

- **Organize and facilitate opportunities for Tribal community conversations around First Foods access and knowledge**. These opportunities could be similar to the First Foods Forums, and aim to identify barriers, opportunities, and networks that exist in availability and access of First Foods. Engaging the community in developing adaptations will improve their success and relevance to the Tribe.

- **Develop and distribute a First Foods Cookbook and food processing recipes** as it is permitted by the Tribal community and cultural knowledge keepers. Cultural Resources Protection Program (CRPP) and CTUIR Culture Committee should be heavily consulted during any development, and sensitivity to cultural information that should not be shared is essential.

- **Continue and expand existing technical support for "food truck" training and financial assistance**. This service was previously through the Wildhorse Small Business Development Center, and can be continued with NCFS. Mobile food vending establishments have boomed in recent years, and can provide flexibility in offering local food and Tribal business opportunities.

Long Term:

- **Reflect on and examine previous Indigenous foods events and competitions** which CTUIR has hosted or participated with, such as "Rez Kitchen Tours" and Top Chef, to determine if there is interest or potential to organize similar events for Tribal regional audiences.

## ii. Develop and Implement Shared Food Processing Infrastructure

Safe spaces and access to processing equipment are two barriers that communities often encounter as a challenge to implementing a desired food system. Food for resale or community consumption especially requires additional levels of policy and equipment support that can be provided by certified commercial kitchen availability and infrastructure.

Short Term:

- **Fund and conduct a CTUIR Community/**

**Shared Kitchen feasibility study** that examines the infrastructure and equipment needs of the community, and develops a plan (including potential funding sources) to implement necessary shared kitchen capacity. See Ch 3C page 120 for

- **Develop and implement community sharing programs to increase access to food processing equipment**. Examples include a Kitchen Equipment Library and borrowing protocol, among others. Increased access to equipment like pressure canners, oil presses, mixers, blenders, and many other pieces of kitchen equipment, and could improve home food processing options for those with cost of equipment barriers.

Long Term:

- **Organize and support community-scale purchasing clubs, networks, and/or cooperatives** to facilitate bulk purchasing on the Umatilla Indian Reservation (UIR). Purchasing in bulk reduces costs of staple goods for Tribal families that are interested and able to participate. Purchasing household staples in bulk often reduces costs for these products significantly, but can be difficult to afford in chunked payments, experience transportation issues, and be difficult to store in large quantities. Coordinating household needs and administering strategic bulk purchasing and distribution would improve access to goods at affordable prices.

### iii. Expand Food Safety and Processing Knowledge for Fresh and First Foods

Broad understanding of food safety issues and best handling practices will be important for community protection against climate impacts like rising temperatures and unreliable electrical grids. Education and access to sanitation supplies also provides risk reduction for food borne illness.

Short Term:

- **Expand capacity to offer educational programs for food production for youth**, like 4H, Future Farmers of America Program (FFA), and other agricultural skills-building supported by NCFS loans and Nixyaawii Community School (NCS). In recent years there has been interest in establishing a Tribal 4H program (or something similar) for NCS, though staff capacity, funding, and consistent partnerships have been a barrier to implementation.

NCFS Youth Entrepreneur Camp (2019) provides Tribal youth an opportunity to develop products, business plans, and marketing skills.

Long Term:

- **Support and expand community-scale food safety classes and certifications**, such as the kind offered by Tribal Planning Office (TPO) to food producers. TPO currently offers periodic food handlers certification courses to those operating food businesses on the UIR. Increasing frequency, offering alternative formats (such as virtual or by mail), and expanding hands-on learning could improve Tribal community access to food safety knowledge and certifications for Tribal businesses and families.

## E. Develop Land Acquisition Plan and Implement Strategies

"Multiple ownership of trust allotments continues to hinder individual Tribal Member efforts to use their lands to meet their individual needs. Exchanging interests in land to achieve consolidation or single owner control seldom occurs. Much of the land in multiple ownerships is in small interest, or in lands of low value not suitable for making exchanges for useable lands. Many of the lands on the UIR are in interests held by members of other Tribes who may not want to improve their performance. CTUIR continues to purchase fee lands and interests in allotted trust in amounts that have out grown the Tribes' management capacity (CTUIR Comprehensive Plan 2010)."

Closing the "checkerboard" is a high priority for building resilience on the UIR, and returning land to Tribal stewardship should be paramount.

Short Term:

- **Fund dedicated efforts to develop a "Land Acquisition Plan"** through community-identified and driven strategies to return reservation boundaries to pre-theft borders, and to increase regional land acreage under Tribal stewardship. Such a plan would include information on when, and by which entities, lands have been dispossessed from the Tribe historically, and propose long term strategies for their return.

- **Develop a community-identified approach to "Land Back" efforts from a CTUIR perspective and approach, that emphasize and strengthen Tribal land ownership**. Examples include schemes like the "Real Rent Duwamish" initiative created by the Duwamish Tribal Community to collect revenue voluntarily from non-Tribal occupants of Duwamish lands (more information can be found at the website: www.realrentduwamish.org). Other examples include work conducted by Naknuwithlama Tiichamna (Caretakers of the Land) with the Episcopal Diocese at the Ascension School in Cove, Oregon, and the donation of 2600 acres of land at McCoy Meadows Ranch to CTUIR by Mark Tipperman and Lorna Williams in 2019, currently co-managed by Blue Mountain Land Trust.

Long Term:

- **Support and expand credit and borrowing capability through NCFS and the Credit Program to address land fractionation** of ownership that many families encounter in land planning and financial assistance. Addressing credit barriers to returning lands to Tribal management aids in expanding Indigenous stewardship across the region.

Events like the annual 4th of July Powwow (pictured) bring crowds to CTUIR's land, providing an opportunity for economic benefit to Tribal enterprises and small business vendors, and gathering to connect with different communities. These events are likely to experience disruption into the future. An example of one such disruption was a severe thunderstorm that forced one day's cancellation of this event with heavy rains and wind.

## How Do We Measure the Success of These Adaptations?

"Resiliency is rapidly becoming an important focus of economic development professionals and community leaders. Regional resiliency, as commonly described in economic development efforts, refers to a region's capacity to cope with, and recover from, unexpected challenges. The phrase refers to both economic capacity and environmental resiliency. These two concepts merge, for example, during an environmental disaster. In such cases, the affected region must garner the economic resources to recover from the environmental event and take action to mitigate or prevent future threats (CTUIR CEDS 2017)."

- **CTUIR Comprehensive Economic Development Strategies (CEDS) (2017) Part 5, Objective 2**: Create a comprehensive program to retain and expand existing businesses located on CTUIR industrial/commercial properties. (Page 25-27);
- **CTUIR CEDS (2017) Part 5, Objective 5**: Identify and evaluate opportunities for new CTUIR enterprises, acquisitions, and/or partnerships. (Page 25-27);
- **CTUIR CEDS (2017) Part 5, Objective 6**: Establish and fund an Economic Development Capital Investment Fund that can be used to invest in infrastructure development, building construction, business startups, and other business opportunities. (Page 25-27);
- **CTUIR CEDS (2017) Part 5, Objective 9**: Support and promote programs that assist Tribal entrepreneurs, including the proposed CDFI (Page 25-27);
- **CTUIR CEDS (2017) Part 5, Objective 10**: Increase CTUIR staff involvement and collaboration with regional, state, and other workforce development programs. (Page 25-27);
- **CTUIR CEDS (2017) Part 5, Objective 11**: Collaborate with other economic development organizations to create a regional economic development partnership – leverage resources to promote regional economic development interests. (Page 25-27).
- **CTUIR Comprehensive Plan Objective 5.2.1:** Diversify the Tribes' public sector economy by creating and strengthening CTUIR-owned enterprises both on and off-Reservation see (Comp Plan page 62 for benchmarks);
- **CTUIR Comprehensive Plan Objective 5.2.2**: Expand and diversify job opportunities for Tribal Members on the Reservation (Comp Plan page 62 for benchmarks);
- **CTUIR Comprehensive Plan Objective 5.2.3:** Strengthen the tribes' private (small business) economy by creating suitable conditions for Tribal members to start and expand businesses and social enterprises (Comp Plan page 62 for benchmarks);
- **CTUIR Comprehensive Plan Objective 5.2.5:** Plan for long-term economic security in the face of changing global environmental and economic conditions (Comp Plan page 72 for benchmarks);
- **Comprehensive Plan Objective 5.3.1**: Acquire lands that can be used to enhance the cultural, natural resource and economic development needs of the Tribes (Comp Plan page 67 for benchmarks);
- **Comprehensive Plan Objective 5.3.5:** Reduce fractionated interest land ownership (Comp Plan page 67 for benchmarks);
- **CTUIR Comprehensive Plan Objective 5.4.2:** Expand and diversify job opportunities for Tribal Members on the Reservation (Comp Plan page 62 for benchmarks);
- **CTUIR Comprehensive Plan Objective 5.4. 6:** Restore the Umatilla Indian Reservation land base to the 1855 Treaty Reservation boundary (Comp Plan page 95 for benchmarks);
- **CTUIR Comprehensive Plan Objective 5.15. 9:** Incorporate the values of environmental responsibility into all CTUIR educational, workforce and community activities; reduce, reuse, recycle (Comp Plan page 127 for benchmarks).
- Department of Economic Community Development (DECD) Annual Work Plans

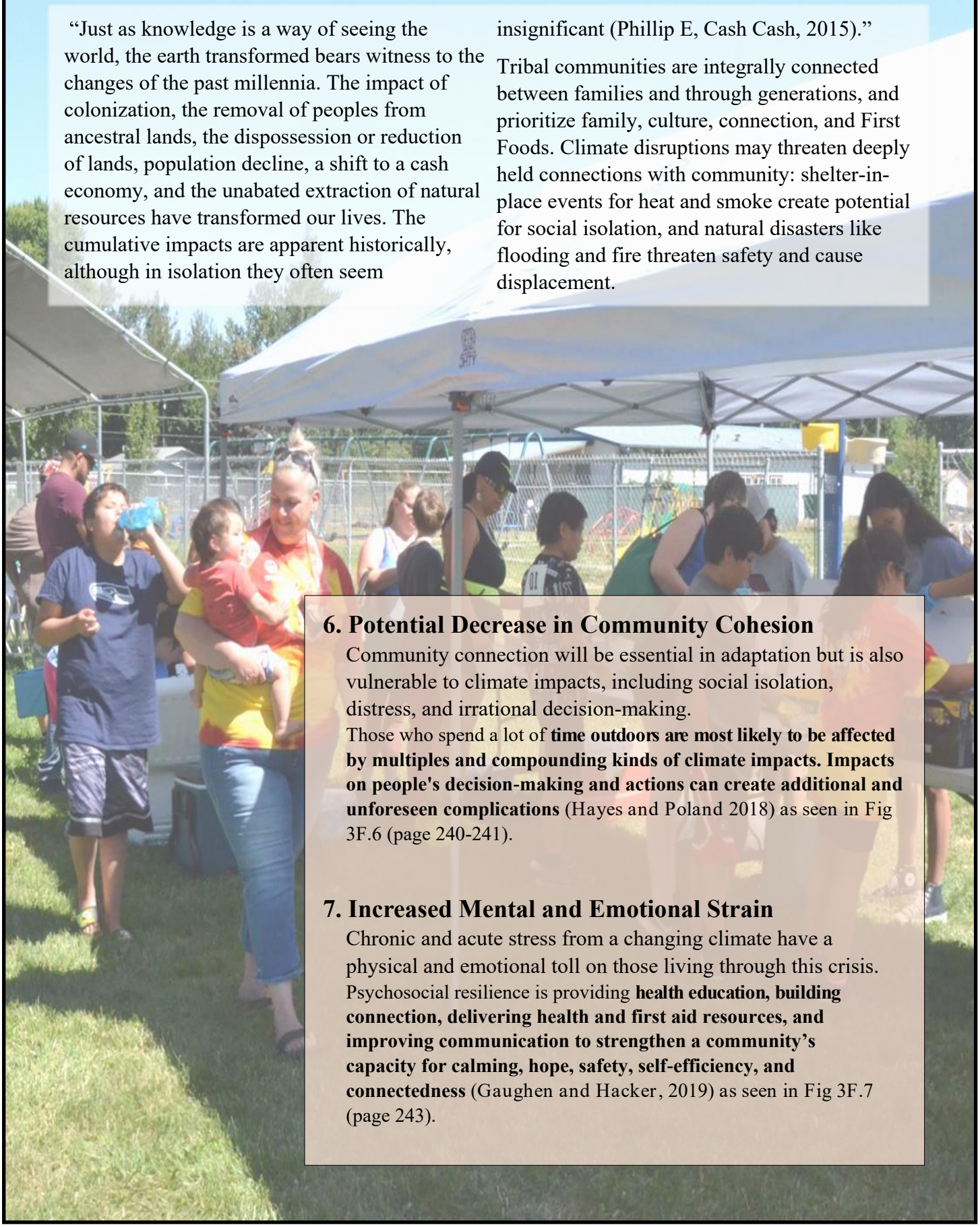
## What Gaps in Knowledge, Policy, Capacity, or Education Exist?

- Changing economic revenue generating patterns, and urban/rural differences;
- Population dynamics change and climate migration models.

# Climate Impacts to **Community Support**

"Just as knowledge is a way of seeing the world, the earth transformed bears witness to the changes of the past millennia. The impact of colonization, the removal of peoples from ancestral lands, the dispossession or reduction of lands, population decline, a shift to a cash economy, and the unabated extraction of natural resources have transformed our lives. The cumulative impacts are apparent historically, although in isolation they often seem insignificant (Phillip E, Cash Cash, 2015)."

Tribal communities are integrally connected between families and through generations, and prioritize family, culture, connection, and First Foods. Climate disruptions may threaten deeply held connections with community: shelter-in-place events for heat and smoke create potential for social isolation, and natural disasters like flooding and fire threaten safety and cause displacement.



## 6. Potential Decrease in Community Cohesion

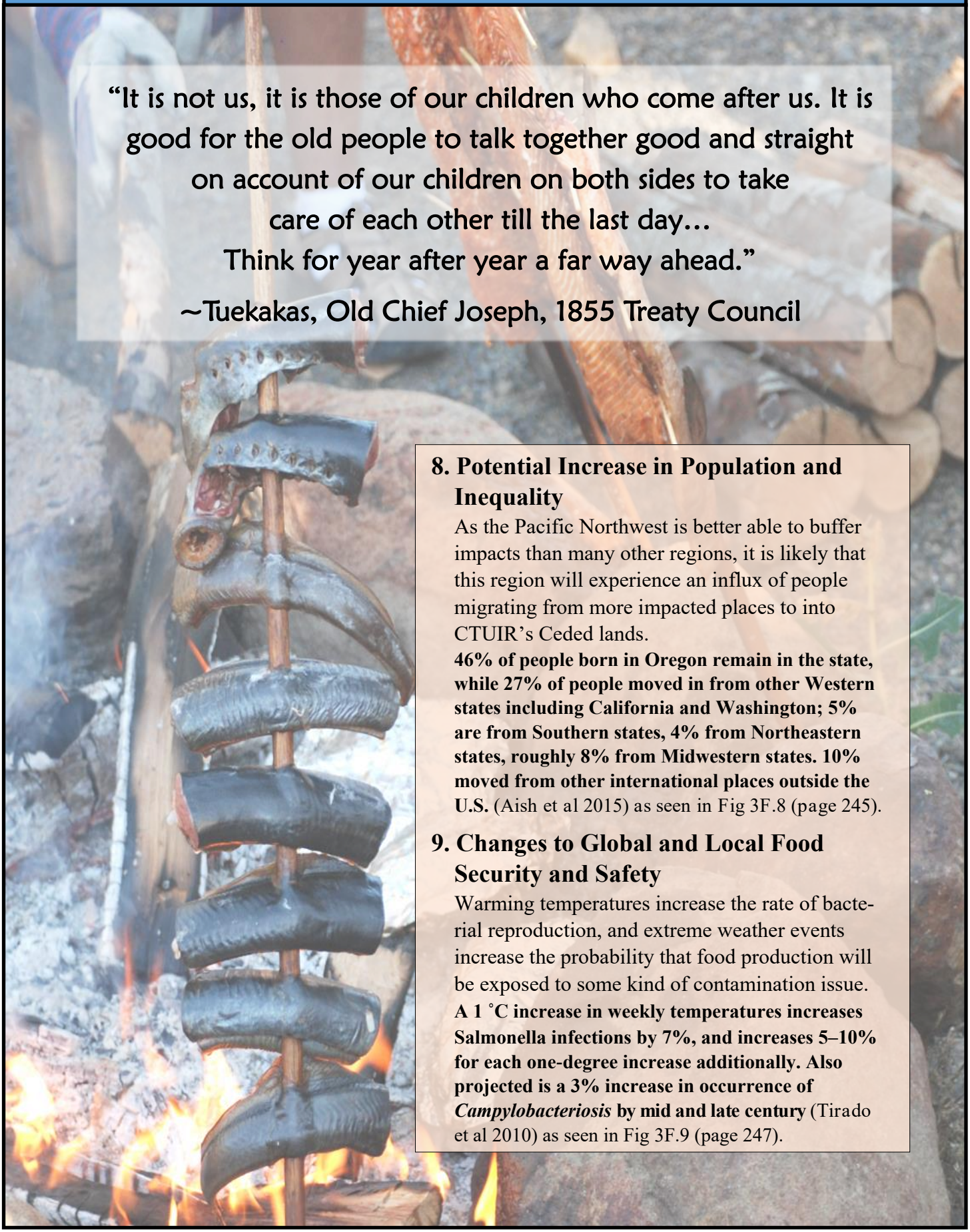
Community connection will be essential in adaptation but is also vulnerable to climate impacts, including social isolation, distress, and irrational decision-making.

Those who spend a lot of **time outdoors are most likely to be affected by multiples and compounding kinds of climate impacts. Impacts on people's decision-making and actions can create additional and unforeseen complications** (Hayes and Poland 2018) as seen in Fig 3F.6 (page 240-241).

## 7. Increased Mental and Emotional Strain

Chronic and acute stress from a changing climate have a physical and emotional toll on those living through this crisis.

Psychosocial resilience is providing **health education, building connection, delivering health and first aid resources, and improving communication to strengthen a community's capacity for calming, hope, safety, self-efficiency, and connectedness** (Gaughen and Hacker, 2019) as seen in Fig 3F.7 (page 243).



"It is not us, it is those of our children who come after us. It is good for the old people to talk together good and straight on account of our children on both sides to take care of each other till the last day…
Think for year after year a far way ahead."

~Tuekakas, Old Chief Joseph, 1855 Treaty Council

### 8. Potential Increase in Population and Inequality

As the Pacific Northwest is better able to buffer impacts than many other regions, it is likely that this region will experience an influx of people migrating from more impacted places to into CTUIR's Ceded lands.

**46% of people born in Oregon remain in the state, while 27% of people moved in from other Western states including California and Washington; 5% are from Southern states, 4% from Northeastern states, roughly 8% from Midwestern states. 10% moved from other international places outside the U.S.** (Aish et al 2015) as seen in Fig 3F.8 (page 245).

### 9. Changes to Global and Local Food Security and Safety

Warming temperatures increase the rate of bacterial reproduction, and extreme weather events increase the probability that food production will be exposed to some kind of contamination issue.

**A 1 ˚C increase in weekly temperatures increases Salmonella infections by 7%, and increases 5–10% for each one-degree increase additionally. Also projected is a 3% increase in occurrence of *Campylobacteriosis* by mid and late century** (Tirado et al 2010) as seen in Fig 3F.9 (page 247).

## 6. Potential Decrease in Community Cohesion

Extreme weather events, and long term emotional and financial strain in emergency response can strain community connection. When public health authorities initiate “shelter in place” advisories, many who have mobility issues, who are homebound, or who are otherwise isolated can suffer from this restriction in contact with their communities.

**Figure 3F.6** is a table overview of climate crisis impacts to vulnerable groups of people, and some ways these impacts could be measured as part of routine public health assessments (Hayes and Poland 2018).

- Community-scale mitigation strategies could alleviate negative mental and behavioral health impacts of distress, and community public health can play an important role in monitoring and intervening in adaptation.
- Dedicated healthcare staff time to make routine check-ins during prolonged events are essential to preserving community connection, and should be supported. One example are the services provided to Tribal Elders by Dept of Child and Family Services (DCFS) staff during the Covid-19 epidemic.
- **Those who spend a lot of time outdoors are most likely to be affected by multiples and compounding kinds of climate impacts**. Most at risk are people who make their living outdoors like laborers, fire responders, construction and farm workers, those who spend time on the land such as Tribal harvesters and outdoor recreationists, and under- and unhoused people due to lack of shelter and access to services.
- For Indigenous people, spending time on the land is part of keeping connection and reciprocity, and must be prioritized in physical and emotional health adaptation.
- **Impacts on people's decision-making and actions can create additional and unforeseen complications.**
- Transportation infrastructure is also affected; many CTUIR Kayak Transit system route stops are open air and unsheltered, and riders can be exposed to inclement conditions during their wait times.

Often, Tribal communities are tight-knit, and are able to come together in times of crisis to provide mutual aid to those affected, such as the outpouring of community support during the Feb 2020 flooding event. Communication networks between responding Tribal departments like Public Safety and Public Works internally, as well as with community volunteers and other mutual aide partners externally, is integral to coordinating first responders and ensuring safety. This service would be additionally improved through dedicated Tribal staff capacity and coordination.

Places like the CTUIR Longhouse provide consistent gathering space for the Tribal community. Numerous events for cultural, religious, and outreach purposes are regularly scheduled there, including celebrations like Treaty Day (pictured).

| Figure 3F.6: Overview of Climate Hazard Impacts to Community and Progress Indicators | | | |
|---|---|---|---|
| **Climate Hazard** | **Populations of Concern** | **Potential Mental Health Outcomes** | **Indicators and Measurement Tools** |
| **Extreme Heat** | • People with pre-existing mental health conditions.<br>• People taking psychotropic medications that affect thermoregulation.<br>• Elderly (who have poor thermoregulation).<br>• People with substance abuse problems<br>• People living in urban heat islands<br>• Urban poor without access to air conditioning<br>• Those living on the street<br>• Outdoor laborers | • Exacerbated mood or behavioral disorders<br>• Violence<br>• Aggression<br>• Suicide<br>• Other | • Monitor emergency department visits after heat waves for an increase in patients reporting mood or behavioral disorders.<br>• Monitoring mortality statistics following extreme heat events—look for co-morbidities related to mental health and incidents of suicide.<br>• Interviews or questionnaires with people who experienced heat waves or extreme heat events to ask about their mental health in relation to heat events.<br>• Review of police records following extreme heat events to monitor elevated incidences of violence or aggression |
| **Extreme Weather Event**<br>(Flood, hurricane, drought, mudslides, etc.) | • Gender (Female, particularly pregnant women)<br>• Age (children, infants, seniors)<br>• Race and ethnicity (non-Caucasian, non-white)<br>• Immigrants<br>• People with pre-existing health conditions<br>• People with low-socioeconomic status<br>• The under and non-insured (health care & home insurance)<br>• The under-housed and homeless<br>• Outdoor laborers<br>• First responders | • Post-traumatic stress disorder (PTSD)<br>• Depression (including major depressive disorders)<br>• Anxiety<br>• Suicidal ideation<br>• Aggression<br>• Substance abuse and addiction<br>• Violence<br>• Survivor guilt<br>• Vicarious trauma<br>• Altruism & Compassion<br>• Post-traumatic growth<br>• Other | • Surveys<br>-General Health Questionnaire (GHQ)<br>Self-report surveys of mental illness and mental problems:<br>- Disaster-PAST; the Generalized Anxiety Disorder Scale (GAD-7); the Post-Traumatic Stress Disorder Checklist (PCL); The Center for Epidemiologic Studies Depression Scale (CES-D); the Kessler Psychological Distress Scale (K6)<br>Self-report surveys of affirmative mental health.<br>Consider using:<br>- Stress-Related Growth Scale (SRGS); Post-Traumatic Growth Index (PTGI); Benefit Finding Scale (BFS)<br>• Patient Records<br>• Monitor emergency department visits after extreme weather events for an increase in patients reporting mental health problems or illness.<br>• Review of new prescription use for mental health and behavioral disorders after an extreme weather events. |

Figure 3F.6 (cont.): Overview of Climate Hazard Impacts to Community and Progress Indicators

| Climate Hazard | Populations of Concern | Potential Mental Health Outcomes | Indicators and Measurement Tools |
|---|---|---|---|
| **Extreme Weather Event (cont.)**<br>(Flood, hurricane, drought, mudslides, etc.) | | | • Interviews<br>-Interviews with primary care physicians and mental health care providers about any surges in patients reporting mental health issues following extreme weather events.<br>-Interviews with people who experienced an extreme weather event about their perceptions regarding their mental health related to the extreme weather event. |
| **Vector-borne disease (VBD)**<br>(e.g., Lyme Disease, West Nile Virus, Ticks) | • Under-housed and homeless people<br>• People with pre-existing mental health conditions<br>• Outdoor workers | • VBD disease (particularly: Lyme Disease or West Nile Virus) w/compounded mental health problems (e.g., cognitive or neurological impairment, behavioral disorders) | • Interviews or questionnaires with patients who have been diagnosed with VBDs to ask about perceptions of their mental health.<br>• Interviews with primary care physicians and mental health care providers about any mental health co-morbidities for patients diagnosed with VBDs. |
| **Sea-Level Rise or Melting Permafrost** | • People who work or live near the ocean (sea-level rise) or in the arctic<br>• Outdoor laborers<br>• Indigenous people | • Anxiety, worry, or fear of displacement<br>• Anxiety, worry, or fear of job loss<br>• Loss of place (grief, solace) | • Interviews or questionnaires with residents who have or are experiencing sea-level rise or prolonged drought in their communities. Interview questions may focus on the mental health implications of: displacement, job loss associated with sea-level rise, infrastructure damage, agricultural or resource loss and resource scarcity, food and water safety and security. |
| **Climate Change (in general)**<br>(i.e., awareness of climate change threats to human and planetary health and survival) | • People at greater risk from & exposure to climate change<br>• Researchers investigating climate change & Environmental studies students<br>• Environmental and climate change activists<br>• Outdoor recreationalists<br>• Indigenous peoples | • Anxiety<br>• Worry<br>• Stress<br>• Fear | • Interviews or questionnaires with people who experience concern, anxiety, worry, related to awareness of climate change threats.<br>• The Generalized Anxiety Disorder Scale (GAD-7) |

Communication between knowledgeable authorities and target audiences is key to conveying information necessary for decision making (Hayes and Poland 2018). CTUIR Emergency Operations Plan (2016) Section 3 (pages 49-73) assigns roles and responsibilities to various departments within the Tribal government, and outlines how these departments are meant to function together to respond to emergency situations.

February 2020 flooding event (pictured) required first responders from CTUIR departments and volunteers from the Tribal community, as Dept of Public Safety, Public Works, and the Incident Command Team coordinated operations and responders.

Alerts and warnings communications are the responsibility of CTUIR Dept of Public Safety, Office of Information Technology (OIT), and the Dept of Communications (CTUIR EOP 3.2.3.2). These departments should be involved in climate adaptations that involve improved communication at an intergovernmental and intragovernmental level, and to the Tribal community. In anticipation of future events, emergency response should gain a firm sense of: 1) how a climate stressor may impact infrastructure, and 2) how a disruption to certain components may affect people's decisions/behavior. Poor judgement and irrational decisions due to distress can create unwanted feedbacks, especially for communities who are already impacted by historical and generational trauma.

Stress tests provide health authorities with the opportunity to examine resilience of components of health systems like health facilities, specific organizations or departments. These scenarios also examine how these components interact in emergency scenarios, such as integrated disease surveillance and warning, pharmacies, community care, and health insurance services, among others. This planning tool can be used by decision-makers responsible for broad health system functions, like CTUIR Health Commission, Yellowhawk Health Center leadership, CTUIR Incident Command System, and other community health teams. Scenario-based emergency management exercises are mandatory components of all-hazard risk planning, including the CTUIR Hazard Mitigation Plan. Introducing or augmenting existing activities with climate stress testing would add value to these efforts, and would enhance preparedness planning for a climactically different and potentially more dangerous future.

(Credit: Hayes and Poland 2018)

Gaps in Knowledge/Data/Policy:

- How simultaneously-occurring climate crises may worsen one another;
- Capacity of regional health care system to handle physical and mental crises;
- How updates to CTUIR Emergency Operations Plan (EOP) can integrate climate crisis projections and planning.

## 7. Increased Mental and Emotional Strain

Challenges from the climate crisis will increase long-term and acute stress, which will affect mental and emotional health through many mechanisms. Learning productive ways of handling stress requires finding positive coping mechanisms. The concept of “psychosocial resilience” may be a resource to families and communities.

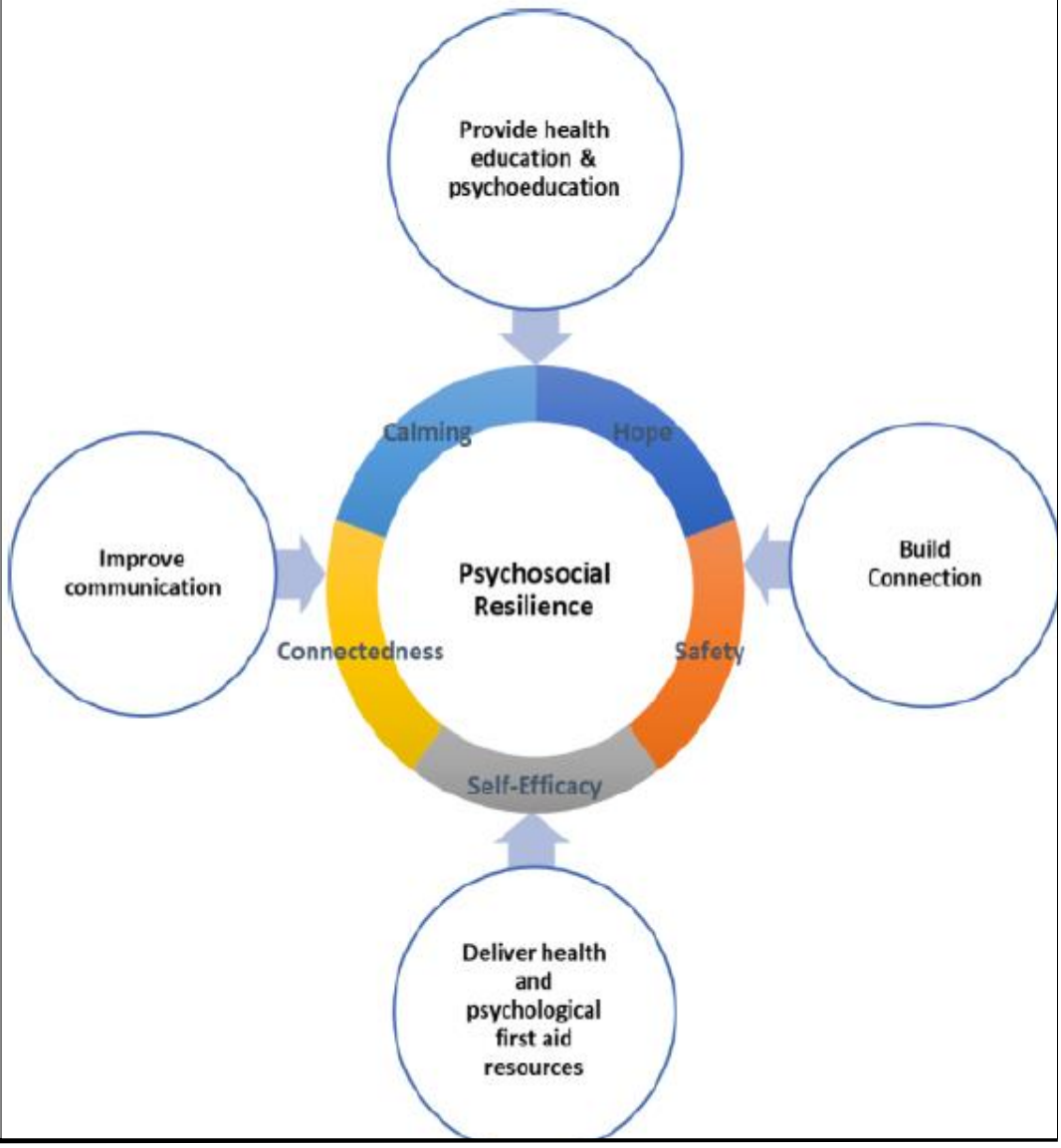
One goal of psychosocial recovery and resilience frameworks is to achieve greater independence and wellbeing before, during, and after trauma, without

the need for formal mental health treatment. It also prioritizes community connection as an integral part of that resilience. Knowing one's neighbor is an important way community members can build resilience, and Tribes have long-standing traditions and cultural ways that support community cohesion and increase their ability to cope with traumatic changes (Gaughen and Hacker, 2019).

**Figure 3F.7** provides a diagrammatic overview of the Psycho-social Resilience Framework developed by the Pala Band of Mission Indians (California), to build capacity for social networks and community to withstand prolonged distress.

- Response frameworks contribute to building emotional coping and psychosocial resilience. **Providing health education, building connection, delivering health and first aid resources, and improving communication** can strengthen a **community's capacity for calming, hope, safety, self-efficiency, and connectedness** (Gaughen and Hacker, 2019).
- Psychosocial strategies can include: providing health education and psychoeducation to train adults, youth, and organizations to recognize and mitigate health risks; stabilize, and assist community members who are struggling; and promote positive coping and problem-solving strategies.
- Education to facilitate recognition of illness symptoms, avoid risks (including food/water dangers), and build skills to psychologically cope would empower families and individuals. Trainings to recognize exposures and related illness and mental health impacts for nurses, coaches, school and employee counselors, and other decision makers and to act preventatively. Collaboration with other Treaty Tribes enhances training and capacity of emergency Tribal response teams.
- Health and psychological first aid resources will be necessary to meet immediate needs, and provide rapid and practical help during/after climate events. Developing collaborative referral systems to ensure access to available resources and services should include psychological first aid resources. This also includes emergency-, disaster

Figure 3F.7: Pala Indian Community Psycho-Social Resilience Framework



response-, and/or health management plans that anticipate and prepare public services and evacuation plans for exposure risks. Typically these include procedures for post-disaster repairs, and post-health incident continuity of care for vulnerable people.

- This could also involve identifying existing community assets, like the Tribal fire station and Tutuilla Food Sovereignty Center, businesses, and other entities that can play a role in preparedness and recovery.
- Initiatives for helping communities cope with psychosocial spiritual stress, reconnect with purpose and hope, and achieve post-traumatic personal growth will build psychological flexibility for families. Developing preventative initiatives before the next disaster occurs builds resilience skills, as does expanding social support networks like learning groups, community mapping and other story-telling events.
- Community dinners, Tribal cultural events, or conversations in places where neighbors already gather (like schools, libraries, Longhouse, General Council etc.) to build connection can be much more effective than bringing in unfamiliar new strategies or technologies. Increasingly, digital connection can provide flexibility and access to information, and Department of Economic Community Development (DECD)'s Broadband project is expanding access to internet services on the Reservation.
- Improving communication channels through access to clear and reliable information helps reduce danger and stress, and increase safety and trust in responders and decision makers. To do this, provide early, real-time warnings and clear emergency notifications before and during exposure events. Use diverse tools like websites, text, social media, TV, radio, and other media, like the CayUmaWa Camp Crier smart phone online application tool. Notifications should include: relevant safety tips (e.g. limit outdoor activities, don't drive through flooded roads, limit water usage, evacuation zones, boil advisories, etc.), and how to access additional information or help.


New communications technologies like social media and online applications such as the CayUmaWa Camp Crier tool (pictured) can help spread communications to communities in times of emergency.

For the CTUIR Tribal community, many of the culture, religion, and foodways build opportunities for psychosocial resilience into the fabric of practices. In Longhouse religious ceremony, worshipers are customarily encouraged to share their thoughts, feelings, and perspectives with their community as a regular part of rituals.

Building social connection to increase trusted, compassionate, and helpful relationships with emotionally supportive community members creates improved circumstances for community assist each other through challenging times. Examples include working together, community dinners/discussions, etc. The Tribe's Department of Child and Family Services (DCFS) organizes and coordinates many of these events, and other Tribal departments also host community outreach events to build intercommunity connection. These events and programs are beneficial to increasing community cohesion and building trust, though tend to lack a coordinated plan and goal for these efforts, and may benefit from long term integration

of these services.

(Credit: Gaughen and Hacker, 2019)

Gaps in Knowledge/Data/Policy:

- Understanding of how federal funding for preventative mental health services might change;
- How technological advances are likely to alter/ improve the ability to communicate within the Tribal community.

## 8. Potential Increase in Population and Inequality

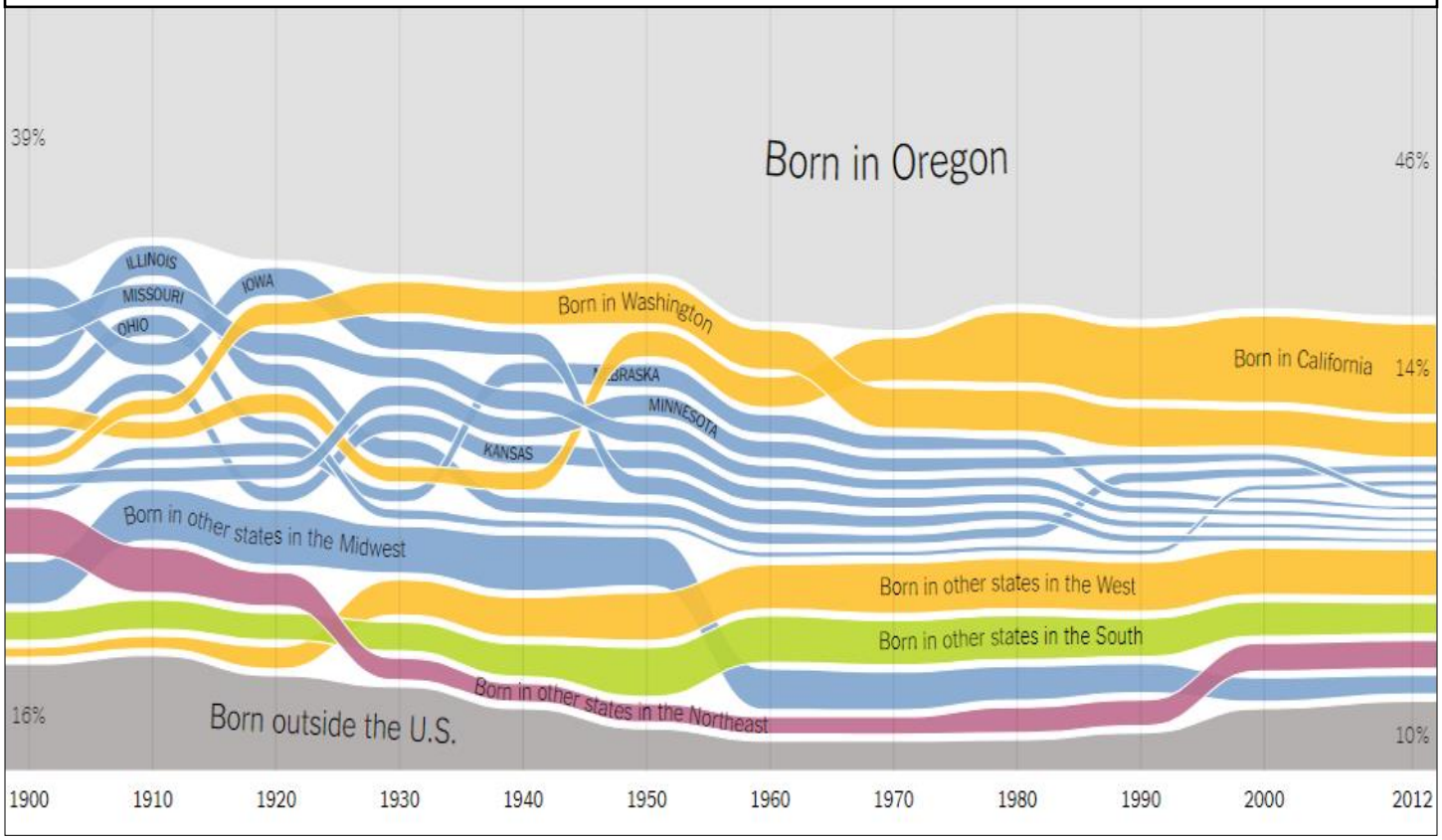
While the Pacific Northwest (PNW) will experience milder climate impacts compared to other regions, people fleeing harsh and increasingly hostile environments around the world may see the this area as a desirable destination. Long-term planning for transportation, public health, utilities, and other public services requires population forecasts and demographic trends to account for the possible impacts of climate change on population flows.

Changing population dynamics are difficult to model, and there are large gaps in current approaches to predicting shifts in population migration. Early estimates indicate people are most likely to move in established patterns globally and domestically, and are likely to relocate to an area where they have existing family, others of similar heritage/culture, or access to economic opportunity (Saperstein 2015).

**Figure 3F.8** illustrates trends in population changes in Oregon State, based on where migrants emigrate from, and the percentage change of those population dynamics over time.

- Color coded population dynamics represent different groups of people, and percentage of Oregon's population they comprise: light gray on top indicates a large portion of Oregonians remain in the state; other blue lines show migrants from other regions in the United States; yellow lines indicate those moving from other western states; purple indicates those from Northeastern states; charcoal grey shows those moving to Oregon from other countries (Aisch et al 2015).

Figure 3F.8: Historic Migration Patterns of People Living in Oregon State from Domestic and International Locations



- In 2012, **46% of people born in Oregon remain in the state, while 27% of people moved in from other Western states, including California and Washington. 5% were from Southern states, 4% from Northeastern states, roughly 8% from Midwestern states and 10% moved from other international places outside the U.S.** (Aish et al 2015).
- California is the greatest source of net in-migrants to Oregon, while the largest out-migration was to Washington State, many of them seeking lower cost housing in urban areas (Nelson, 2020).
- "Push factors" related to the place of origin, including: lack of economic opportunity, political/ religious persecution, and environmental risks and dangers. "Pull factors" related to the place of destination: demand for labor, attractive wages, or climate-related amenities. "Intervening factors" that aid or hamper migration, include: existence of social networks, immigration policies, trade relationships, access to resources and capital (Saperstein 2015).

- Material and political wealth is a large factor in individual decisions to relocate or remain in place and adapt to climate extremes. Wealthy people may choose to remain in place and adapt or protect themselves, people of medium wealth may be driven and able to relocate, and people of very low wealth may become trapped, with the desire to relocate but without the ability to do so.

- Storms and flooding often result in short term migration/displacement. Droughts are associated with an increase in permanent migration.

- Wildfire was not found to inspire migration for most, though populations who migrated away from fire-prone areas had a higher wildfire risk perception, and migrants tended to make short-distance moves to places where they had existing social ties.

- Washington State ranks 8th in U.S. states in receiving international refugees, with the largest share of people currently coming from countries in **South and Southeast Asia, Sub-Saharan Africa, and the Middle East** (Saperstein 2015, Fathi 2015). These connections with Pacific Northwest migrant, asylum seeker, and refugee communities are existing social connections that could also provide a conduit for climate migration into the future.

- Oregon has retained a healthy share of its instate-born population. Additionally, and Washington and Oregon originators leave, it's almost always for another Western state (Aish et al 2015).

- Growing sectors of employment could also be examined, as economic trends are likely to impact migration opportunity.

Climate migration is generally split into voluntary and forced migration, based on population motives. For those that are able to undertake it, migration can be thought of as an adaptation strategy, though many barriers make this impossible for other groups of people. Within CTUIR's community, family connections between Tribes could prove to be a pathway for migration support, as Tribal Members with family that live on reservations and in Tribal communities in other Western states could see the need to migrate. Connections to the Pacific Northwest providing migration opportunities to the CTUIR Ceded lands.

**Drought is likely to be a factor in the magnitude and direction of migration**. Various agricultural practices are threatened by a changing climate, and could alter overall economic projections for any of the three states, as well as shift employment opportunities for farm workers (Saperstein et al 2015). Research that seeks to understand how and why people are migrating could provide insight into how these changes might be magnified over time. Creating structured channels to facilitate migration and smooth transitions for new arrivals could help CTUIR anticipate for changing population dynamics.

(Credit: Aish et al 2015)

<u>Gaps in Knowledge/Data/Policy:</u>

- Understanding of how and why people are migrating over time;
- Economic projections for major industries in the future, and how adaptation could alter this.

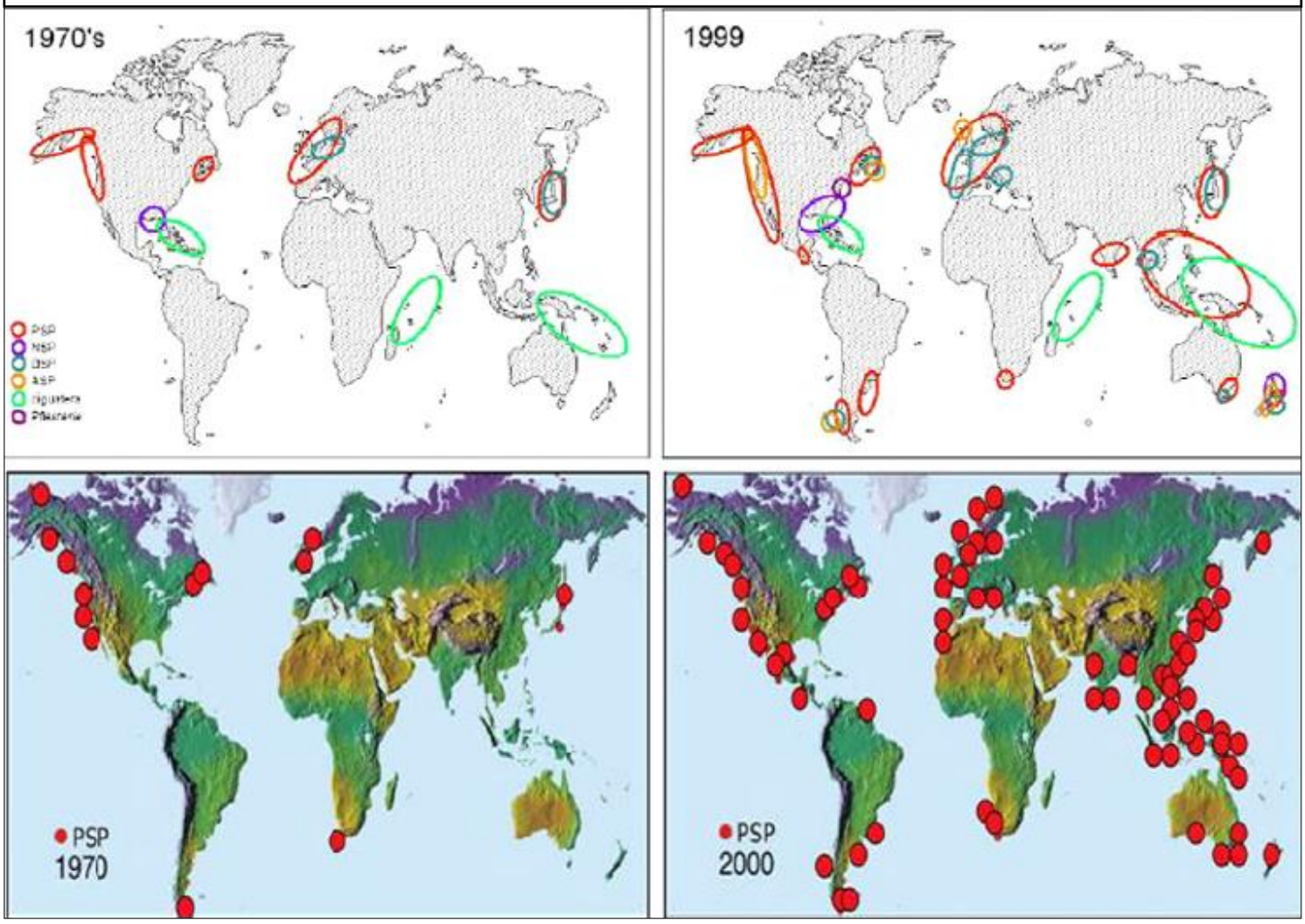
## 9. Changes to Global and Local Food Security and Safety

Variability and extreme weather events across the world are likely to have an impact on the food that is provided to, and consumed by CTUIR's Tribal community. Hazards to food safety will occur at various stages of the food production and distribution chain, and can have food-borne illness impacts to communities and families. While these threats to food safety come in many, focusing on one area of potential contamination as a proxy estimate can serve as an entry point for a larger food systems examination.

**Figure 3F.9** shows the shifting impact on the food safety of marine foods, as harmful algal blooms (HABs) show a changing distribution into waters not previously impacted (Tirado et al 2010).

- From primary production through to consumption, changes in temperature and precipitation patterns, frequency and intensity of extreme weather events, ocean warming and acidification, changes in contaminants' transport pathways, agricultural practices, animal production, global trade, demographics and human behavior, all influence food safety.
- Temperature increases and changes in rainfall patterns have an impact on the occurrence of bacteria, viruses, parasites and fungi, and their corresponding foodborne diseases. These changes can have an impact on microbial ecology and growth, plant and animal physiology and host susceptibility, which may create changes in the incidence and intensity of plant and animal diseases and pest infestations.
- Harmful algal blooms (HABs) also threaten the food safety of coastal shellfish harvests, as the temporal period during which HABs occur annually may also expand. Modeling for the Puget Sound (WA) projects the period of optimal growth of the

Figure 3F.9: Harmful Algal Bloom Density Changes Globally (1970-1999)



toxic dinoflagellate *Alexandrium catenella*, which produces paralytic shellfish toxins that can cause death if consumed by humans. See Ch 3D pages 145-149 for additional information. Bloom period for this algal species will expand from its historical length of **68 days to up to 259 days by 2100** due to warmer water temperatures, and would have severe implications to regional food safety, as shellfish farming is an important industry in Puget Sound (Tirado et al 2010).


Dept. of Child and Family Services (DCFS) organized and implemented near-monthly food distributions for the CTUIR community during the Covid-19 pandemic to provide for those who had additional need.

- Studies of climate impacts to food safety focus on food microbiological and chemical contamination and associated foodborne diseases, including biotoxins like marine toxins and mycotoxins. Foodborne diarrheal diseases are a priority for routine monitoring. Priorities include *salmonellosis, campylobacteriosis, vibriosis, listeriosis*, other bacterial infections, parasitic infections, viral diarrheal syndromes.

- A potential **1°C (1.8°F) increase in weekly mean maximum temperature increases Salmonella infections in cities by 7%** (Tirado et al 2010). One study anticipates **salmonellosis will increase 5–10% for each 1°C increase in weekly temperature.** Studies for Australian communities predict a **doubling of the morbidity associated with salmonellosis in South Australia by the year 2050**, and a study from Ireland predicted a **3% increase in the occurrence of campylobacteriosis** by mid and late century (Tirado et al 2010).

Elevated temperature during the week preceding the onset of the food-borne disease suggests inappropriate storage temperature and food handling may be important factors in the transmission. Most foodborne bacterial pathogens can grow at room temperature, but reproduce faster at elevated temperatures. So increases in ambient temperatures speed up the rate of pathogen proliferation across the food system. Increasing frequency of severe weather events also compound threats to food safety, including (but not limited to):

- Flooding causes overflow of untreated human sewage, increasing likelihood of enteric virus contamination during the production of fresh produce and molluscan shellfish.
- Parasitic foodborne and water-borne diseases are transmitted by protozoan parasites like cryptosporidiosis and giardiasis, and can be transmitted by contaminating foods through irrigation or wash-water (Tirado et al 2010).
- Emerging zoonotic (transmitted from animals to humans) diseases may increase due to survival of pathogens in the environment, changes in migration pathways, carriers and vectors and changes in the natural ecosystems. Climate change affects animals' living conditions, which are favorable to pathologies such as parasitic diseases, nutritional disorders, sunstroke or dehydration.
- Increasing disease pressure may result in an increased use of veterinary drugs, and possibly unacceptable levels of veterinary drugs in foods of animal origin.

Infection of crops by fungi could encourage production of mycotoxins in food crops, especially grains. Mycotoxins are naturally-occurring substances produced by toxin-producing fungi that grow in food crops, and cause adverse health outcomes when

consumed by humans and animals. Mycotoxins exist as a concern in a number of ways, including (Tirado et al 2010):

- Direct human dietary exposure to mycotoxins occurs through consumption of contaminated crops. Mycotoxins can also reach the human food supply indirectly through animal products (e.g. milk), from livestock that have consumed contaminated feed.
- At high doses, mycotoxins produce acute symptoms and deaths. At lower doses, particular mycotoxins may possess carcinogenic, cytotoxic, immunosuppressive, neurotoxic, estrogenic or teratogenic activity.
- Adverse plant growing conditions like drought stress, temperature stress, pest attack, poor nutrient status, and others, encourages mycotoxins to develop. Changes in the geographical range of crops produced could provide opportunity for new fungus plant associations to arise.
- **Storage of dry grains also contribute to fungal contamination, if the fungus is present in grains when they are harvested and stored in damp conditions**. Future variation of conditions in the harvest/post-harvest period threatens stability of the crop between harvesting and marketing, and could be adversely affected.
- Mycotoxins are not generally understood by the public, and are difficult to publicize effectively being an 'invisible threat.' Informing the public about risks of exposure and the nature of the food that carries these risks might help to reduce use of substandard food in times of need.

Food safety risks during disasters and emergencies are mainly linked to unsafe food storage and cross contamination from the environment, or from people during food handling and preparation. Cooking foods may be impossible in emergency situations because of lack of electricity, facilities or fuel, and poor sanitation, including lack of safe water and toilet facilities. Close personal contact can compound the risks of illness among already susceptible groups.

Changing climate patterns have increased the urgency to invest in disaster risk reduction, preparedness and response plans. Such plans should address food safety risks in the aftermath of natural disasters along the whole food chain. Strategic and effective food safety management requires understanding microbiological hazards, and how their presence in foods can be prevented or maintained within tolerable levels. There is a need for improved epidemiological surveillance for early identification of emerging food and water-borne diseases, and for monitoring of zoonosis and other animal diseases and rapid investigation of unusual outbreaks.

(Credit: Tirado et al 2010)

<u>Gaps in Knowledge/Data/Policy:</u>

- Detailed information on how dryland wheat agriculture is likely to produce myotoxins;
- Security and safety of global food supplies that are consumed by Tribal community;
- How these agricultural diseases may affect First Foods and other native plants and animals;
- Policies and guidance on food safety concerns that occur during disaster events.

Community events that serve foods, like the annual Community Picnic (pictured), will need to account for to prevent food-borne illness, which could include having a pre-planned protocol for serving.

## F. Expand and Support Tribal Stewardship Training and Education Opportunities

"The ancestors visited their relatives and trading partners in other groups beyond the homeland to maintain kinship, nurture protective alliances, obtain new trade items, and tend to reciprocal relationships. Because these peoples relied on nature's gifts for continued survival, there was variation in travel and they knew alternative areas for gathering and hunting (Hunn and Haug, 2015)."

Disaster preparedness, emergency response, and community capacity all depend on networks of communication and information sharing. Education for self-sufficiency skills, first aid and first responder training, community and volunteer organizing, and many other knowledge-building opportunities strengthen frameworks for the passing of information between generations and across experiences.

### i. Workforce and Craft Skills

Training and certification for carpentry, electrical, plumbing, construction, textiles production, clothing and goods crafting, and many other technical skills are necessary to maintain community function and quality of life, especially in disaster response. Over 80% of CTUIR CEDS respondents identified "Job Training (lack of necessary skills)" as a barrier for Tribal Members in finding employment (CTUIR CEDS 2017, Ch 3F page 227). Skills and services training would not only improve economic mobility and flexibility of Tribal families, but would also build local and regional capacity to produce basic necessary goods and services, buffer global supply chain impacts, and improve local response to community need.

Short Term:

- **Support and expand DCFS Workforce Development and Building Our Life Skills, Training, and Employment Readiness (BOLSTER) Programs** in providing accessible service and trade education opportunities.

- **Organize and facilitate community-led discussions of additional trade and craft services education that could improve regional production of essential goods and services**. These have previously been noted to include building a culture center for master craftsmen to teach making bows, weaving, beading, building a library, small assembly plants, clothing manufacturing, and others. See Ch 3F pages 227-233 for additional detail.

Long Term:

- **Conduct preparedness exercises that examine impacts on availability and supply of construction and operations materials**. Impacts such as flooding, wildfire smoke, extreme heat, and drought on essential materials for Tribal operations should be anticipated to build additional regional capacity, including ways to provide mitigation support. These exercises could be paired with community conversations about changing need; see Ch 3B pages 97-98, Ch 3C pages 114-116 and Ch 3D pages 156-158 for additional detail.

### ii. Treaty Rights and Tribal Sovereignty

"The three Tribes worked in alliance to regain and rebuild their self-sufficiency from the government. The traditional leadership of chiefs and headmen at the head of table as key negotiators evolved into a new form of leadership. This leadership was intertwined with the negotiations not only for the Tribal people and their wellbeing, but also with decision making that would develop into the economic stimulus that

would enable the Tribes to acquire the financial sustainability that would give them a new found independence (CTUIR Comprehensive Plan 2010)." First Foods and the Peoples' reciprocal promise are the core of Tribal climate resilience. Therefore the governance and stewardship of Tribal communities is an essential element in adaptation.

Education on the scope and complexity of Treaty Rights is necessary for both Tribal Members engaging in those rights, as well as for non-Tribal agencies and landowners who may attempt to either restrict or enhance those rights in various capacities.

Treaty Rights education for both Tribal and non-Tribal audiences will expand the number of people who are willing to prioritize Indigenous stewardship.

Short Term:

- **Support dedicated Treaty Rights enforcement through retention of Conservation Officers** within Tribal and non-Tribal law enforcement agencies. These officials are important for following through on regulatory policy set by the Tribe, and by other entities like the Columbia River Inter-Tribal Fish Commission (CRITFC), and by states.

- **Continue to support and implement Tribal-focused Treaty Rights education opportunities**, such as the Hunters and Fishers Forums, CRITFC's camps and outreach initiatives, and many others being conducted. Educational opportunities for understanding of First Foods life cycles, harvesting and processing practices, first aid and safety, and other topics could easily be paired with education on rights and legal protections that Tribal Members have secured; see Ch 3B pages 89-90, 99-100 and Ch 3G pages 285-288 for additional detail.

Long Term:

- **Support and expand Tribal Treaty Rights education to appropriate non-Tribal audience**s, through participation in regional events, college and university courses, state and federal work groups, and other outreach opportunities. Education of this nature could expand opportunities for Treaty Rights exercise through network building, and improving understanding the role of Indigenous stewardship in climate adaptation. See Ch 3B pages 89-90, 99-100 for additional detail.

## iii. Financial Literacy and Management

Financing resilience will also require the sharing of information for financial understanding, particularly where it can reduce borrower "risk" and improve access to fair and equitable credit. Nixyaawii Community Financial Services (NCFS) offers education and technical assistance for businesses in different phases, and additionally provide education to youth and school education opportunities as well.

Short Term:

- **Support and expand K-12 and young adult financial preparedness efforts,** such as the Youth Entrepreneur Summer Camp and the NCS youth outreach financial fairs. Preparing Tribal youth to be leaders requires understanding financial implications of decisions; see Ch 3F pages 230-233 for additional detail.

Long Term:

- **Continue and expand adult financial literacy and management courses,** such as "The One,"

homeowner program, and other credit and borrowing education courses offered. Improving understanding and access to financial knowledge builds resilience for individuals and families. See Ch 3F pages 230-233 for additional detail.

## iv. Community Organizing

Strengthening community capacity to respond to need will help Tribal communities be there to care for each other in times of disaster, and identify and address gaps in government services as they emerge. Training community members on event and direct action organization, facilitation, grant proposal development, and sharing networks for supplies and equipment (among others) could expand CTUIR capacity to respond to changing conditions, and support any gaps in Tribal government services.

Short Term:

- **Build capacity to support community response initiatives and events**, like the Earth Day Clean Up, Community Picnics, disaster response volunteers, and other initiatives of grassroots organizing within the Tribal community.

- **Organize and implement recycling and repurposing education opportunities**, especially around goods, clothing, and equipment that could be repurposed for community benefit. See Ch 3C pages 132-133 for additional detail.

Long Term:

- **Organize and facilitate community education opportunities to learn about Tribal government and nonprofit initiatives**. This would involve building space to learn about how the community may want to support or supplement these initiatives to expand the responsiveness of CTUIR, and of Indian Country, in times of crisis.

## v. Native Vegetation and First Foods

Landscaping and gardens are excellent places to encourage the use of native plants instead of non-native and invasive ornamental plants, which use greater amounts of water. Native plants support native pollinators and unique soil microorganisms to preserve local biodiversity, and can help educate families about earth science, plant and animal life cycles, and benefits of native plants.

Short Term:

- **Support and expand programs and learning opportunities with Indian Lake Recreational Area**, which annually hosts the annual Fish Derby, and provides an excellent space to be immersed in nature and engage with native plants and animals. These opportunities increase understanding and awareness of native species and the importance of Indigenous stewardship. See Ch 3 B pages 89-90, 99-100 for additional detail.

- **Continue to utilize native plants for landscaping of Coyote Business Park**, as well as for developing new facilities, and provide water efficient irrigation systems for these. Native plants are used in landscaping for most of CTUIR facilities, including at Wildhorse Resort and Casino (WRC), Tamástslikt Cultural Institute (TCI), Nixyaawii Governance Center (NGC), Nixyaawii Education Center (NCS), and many others. See Ch 3A pages 60-61 for additional detail.

Long Term:

- **Support and expand Department of Natural Resources (DNR) Tribal Native Plant Nursery (TNPN) operations**. TNPN capacity to provide plants to restoration projects, and to landscaping and retail demands is robust, and would be excellent partners in developing educational capacity to provide information to local outreach groups. See Ch 3B pages


Native plants are used in landscaping for many of CTUIR's facilities, reducing water demand needed to irrigate these greenspaces. Paired with the potential for renewable energy to power these operations, there is much Tribal businesses can do to conserve.

88-90 for additional detail.

## G. Continue to Develop and Implement Safe and Energy Efficient Tribal Housing and Community

"Where development is located and the type of materials used in building construction are important factors in determining the risks facing a jurisdiction. The housing-type and date of construction are also important factors in assessing the risk from certain hazard. Certain housing types tend to be less disaster resistant and warrant special attention. For example, manufactured homes are generally more prone to wind and water damage than standard stick-built homes… For these reasons, having information about the date and type of buildings found on the reservation will be useful in developing and prioritizing hazard mitigation actions (CTUIR Hazard Mitigation Plan 2016)."

Developing safe and energy efficient homes for Tribal communities strengthens families to be prepared. Homes can be constructed with strategies that build resilience to acute natural disasters, and to long term negative environmental trends, like smoke inundation or mold contamination of indoor air. Installing renewable energy technologies on new and existing housing would mitigate against rising energy costs and transmission interruptions to electrical service.

Short Term:

- **Develop, design, and continue to implement zoning and permitting for mixed-use community planning**, which concentrates residences with other retail and other appropriate commercial spaces to facilitate non-motorized transportation. The new Nixyaawii subdivision neighborhood is an excellent example. See Ch 3C pages 119-120, and Ch 3E pages 204-206 for additional detail.

- **Support and expand business tenant access and leasing options for renewable energy options for Coyote Business Park,** as implemented by DECD. Conversations within DECD highlight the potential for business tenants to see sustained benefits from reduction in energy use and irrigation demand as part of leasing agreements.

Long Term:

- **Support and expand renewable energy installation and leasing options for housing within the Nixyaawii Subdivision,** as implemented by Tribal Planning Office (TPO) and DECD. Continue to amend and update zoning and permitting processes to further encourage renewable energy leasing where appropriate. See Ch 3E pages Ch 3E pages 204-206 for additional detail.

- **Continue to support home capital lending and borrowing capacity for Tribal families**, such as the homeowner and land leasing courses facilitated by Nixyaawii Community Financial Services (NCFS). See Ch 3F pages 230-233 for additional detail.

## H. Support Use of Tutuilla Food Sovereignty Center for Community Need

"Trade and barter was a significant aspect of Indian life on the Plateau and essential for the survival of Indian people. Indians relied on other Indians to provide goods they themselves were not able to obtain. Often,

groups from a single village community would travel different directions as part of their seasonal round. Through years of trade relationships, elders knew exactly what other Indians needed in exchange for goods they needed (CTUIR Comprehensive Plan 2010)."

Funds made available to Tribes during the Covid-19 pandemic were used by CTUIR to construct the Tutuilla Food Sovereignty Center, a facility to be used to store and distribute food assistance and other community needs in an efficient and effective way. Department of Child and Family Services (DCFS) has been utilizing this building to store food supplies from federal and nonfederal assistance sources, and the building could be used in the future to facilitate additional community assistance supply distributions.

Short Term:

- **Fund and hire a dedicated staff position within DCFS or another related department to coordinate the current and future use potential of the Tutuilla Food Sovereignty Center**. This position would ensure that uses are consistent with funding requirements, as well as providing as much usefulness as possible to Tribal departments and the community.

- **Support and expand DCFS's capacity to partner with Tribal and non-Tribal organizations** to provide food and household supply distributions, as well as the Tutuilla Food Sovereignty Center's ability to provide storage to other departments, such as Public Works and DECD's Broadband project's servers and infrastructure.

Long Term:

- **Develop strategies or a coordinated plan to expand food storage and additional infrastructure within the Tutuilla Food Sovereignty Center**. The goal would be to accommodate both federally provided food assistance, as well as locally donated fresh produce and First Foods, since shared infrastructure is prohibited.

- **Continue to support DCFS food distributions and other assistance needs deliveries** that can be effectively and efficiently conducted at the Tutuilla Food Sovereignty Center site.

## I. Provide for Needs of Community in Crisis and Non-Crisis

"Testimony has served and still serves a purpose in Tribal life. Following the oral tradition, it is a way to pass down information in a public forum to those bearing witness to an event. This testimony teaches life lessons, morality, and consequences of actions… In this tradition, what is spoken is the truth of the world, a proclamation. Testimony is a deliberate thoughtful form of speech that carries gravity in the fewest words possible (Caw Pawa Laakini | They Are Not Forgotten, 2015)."

Often crisis situations present unique opportunities or funding sources that can strengthen community response to crisis in the short term. With additional planning, these benefits can be extended into non-crisis times to provide expanded community support networks. Current needs for the Tribal community have been identified below, though the list is not exhaustive.

Short Term:

- **Celebrate and support the CTUIR Longhouse as a community gathering location,** both for regular worship services as well as for other community needs. These include kitchen and meal preparation space, and public outreach like the Dept of Natural Resources Open House educational events. Places for gathering and sharing testimony will be essential in building community psycho-social

resilience. See Ch 3D pages 167-169 for additional detail.

- **Expand community action and mutual aid networks for the CTUIR community**. These could include supporting Tribal Member grassroots initiatives like the Pendleton Community Action Coalition (PCAC), Tribal government services like the Tribal Youth Council and Nicht-Yow-Way Senior's Center, or aspirational programs that would improve Tribal community access to knowledge, equipment, or transportation.

DCFS offers programming that provides for community need for access to food and supplies. During the Covid-19 pandemic, this included organizing fresh food boxes, personal protective equipment, and school supplies (pictured).

- **Support and expand youth education and engagement as future Tribal leaders.** This includes continuing to support the CTUIR Tribal Youth Council, immersive earth sciences camps and outdoor schools like CRITFC's Salmon Camp, and other formal and non-formal community organizing education options. See Ch 3G page 277 for additional detail.

- **Develop and facilitate consumer purchasing networks/collectives**, and community and family storage options, to provide families with opportunities to source supplies at cost-effective prices and share with other community members and across the region. See Ch 3F page 251 for additional detail.

Long Term:

- **Support monetary and non-monetary needs of Elders and vulnerable people in the Tribal community**. These needs include access and availability of food, funds for utilities, and emergency services such as medical and disaster response.

- **Develop support for children and families to continue to be provided food assistance** as needed, both in and away from school as situations require. Flexibility and opportunity to increase cultural connection through these foods services should be prioritize, with examples including providing First Foods to the CayUmaWa Head Start program, pursuing Tribal harvester eligibility for USDA vendor certification, and others. See Ch 3 D pages 170-171, and Ch 3F pages 250-251 for additional detail.

- **Expand CTUIR community internet access and broadband infrastructure across the Umatilla Indian Reservation (UIR)** to ensure community members have access to digital age services and communication channels. Access to communication networks improves emergency response, and builds capacity for flexible governance. See Ch 3C pages 123-126, and Ch 3D pages 171-172 for additional detail.

## How Do We Measure the Success of These Adaptations?

"The three Tribes worked in alliance to regain and rebuild their self-sufficiency from the government. The traditional leadership of chiefs and headmen at the head of table as key negotiators evolved into a new form of leadership. This leadership was intertwined with the negotiations not only for the Tribal people and their wellbeing, but also with decision making that would develop into the economic stimulus that would enable the Tribes to acquire the financial sustainability that would give them a new found independence (CTUIR Comprehensive Plan 2010)."

- **CTUIR Comprehensive Economic Development Strategies (CEDS) (2017) Part 5, Objective 21**: Identify opportunities to support CTUIR culture and the reservation community that are consistent DECD's mission.
- **CTUIR Comprehensive Plan Objective 5.5.5:** Develop programs for assisting Tribal Members to become financially stable; such as maintaining good credit ratings and family resilience (Comp Plan page 76 for benchmarks);
- **CTUIR Comprehensive Plan Objective 5.5.6**: Provide effective community protection; life-saving rescue, emergency medical, fire protection, emergency management and natural hazard mitigation (Comp Plan page 76 for benchmarks);
- **CTUIR Comprehensive Plan Objective 5.10.2:** A CTUIR education system that has a progressive delivery structure with a responsive adaptable administration (Comp Plan page 101 for benchmarks);
- **CTUIR Comprehensive Plan Objective 5.10.4:** Provide educational services to all tribal-member students within Umatilla and Morrow Counties (Comp Plan page 101 for benchmarks);
- **CTUIR Comprehensive Plan Objective 5.13.3**: Develop economically and ecologically sound transportation opportunities (Comp Plan page 114 for benchmarks);
- **CTUIR Comprehensive Plan Objective 5.14.4:** Develop a comprehensive emergency management program through cooperative relations with other Tribes, federal, state and local agencies (Comp Plan page 121 for benchmarks);
- **CTUIR Comprehensive Plan Objective 5.14.5:** Provide effective emergency services to the CTUIR community including lifesaving rescue services, emergency medical service, fire protection services and HAZMAT response (Comp Plan page 121 for benchmarks);
- **CTUIR Comprehensive Plan Objective 5.14.6:** Encourage fire safety through fire prevention and public education (Comp Plan page 121 for benchmarks);
- **CTUIR Comprehensive Plan Objective 5.14.11:** Maintain mutual aide agreements in all areas of emergency response preparedness (Comp Plan page 121 for benchmarks);
- **CTUIR Comprehensive Plan Objective 5.14.14:** Implement projects and programs identified in the CTUIR Hazard Mitigation Plan (Comp Plan page 121 for benchmarks).
- **CTUIR Mission Community Plan (1993) Part C: Land Use Element 4.11** Redevelop the Lucky Seven Trailer Park to create a modern mobile home park with improved infrastructure and amenities;
- **CTUIR Mission Community Plan (1993) Part C: Land Use Element 4.12** Provide residential areas with safe bicycle / pedestrian connections to Tribal employment, shopping, and community facilities.
- **CTUIR Mission Community Plan (1993) Part C: Land Use Element 7.4** Open spaces should be improved and maintained with native plants and vegetation where possible.
- **CTUIR Mission Community Plan (1993) Part D: Tribal Services Element 6.6** Develop opportunities for all Tribal youth to have traditional recreational experiences such as horseback riding, hunting, gathering, and fishing.
- **CTUIR Hazard Mitigation Plan (2021) Section 3**: Hazard Identification and Risk Assessment Results (page 68-190).
- Department of Economic Community Development (DECD) Annual Work Plans
- Department of Child and Family Services (DCFS) Annual Work Plans

### What Gaps in Knowledge, Policy, Capacity, or Education Exist?

- Changing community needs with emerging climate impacts;
- Population dynamics impacts anticipated
- Supply chain and services needs currently and how these are changing

## Economics & Community Summary

### Economic Development Adaptations

**A. Diversify Economic Opportunities, Trainings, and Options**

**B. Build Capacity to Address Economic Challenges**

**C. Expand NCFS to Provide Small Business Support**

**D. Build Interest and Capacity in First Foods Stewardship, Procurement, and Processing**

**E. Develop Land Acquisition Plan and Implement Strategies**

Economic resilience means having access to flexible credit opportunities, being financially knowledgeable, and able to buffer impacts through diversification of revenue and capital sources.

Measures of Success:

- CTUIR Comprehensive Economic Development Strategies (CEDS) (2017) Objectives 2, 5, 6, 9, 10, and 11
- DECD and DCFS Annual Work Plans and Benchmarks
- CTUIR Comprehensive Plan Objectives 5.2.1, 5.2.2, 5.2.3, 5.2.5, 5.4.2, 5.4.6, 5.3.1, 5.3.5, 5.15.9
- Tribal family and community financial prosperity

### Community Support Adaptations

**F. Expand and Support Tribal Stewardship Training and Education Opportunities**

**G. Continue to Develop and Implement Safe and Energy Efficient Tribal Housing and Community**

**H. Support Use of Tutuilla Food Sovereignty Center for Community Need**

**I. Provide for Needs of Community in Crisis and Non-Crisis**

A connected and interdependent community is a resilient one. Networks and support systems that strengthen existing mutual aid initiatives should be pursued in crisis and non-crisis.

Measures of Success:

- CTUIR Comprehensive Economic Development Strategies (CEDS) (2017) Objective 21
- CTUIR Comprehensive Plan Objectives 5.5.5, 5.5.6, 5.10.2, 5.10.4, 5.13.3, 5.14.6, 5.14.11, 5.14.14
- CTUIR Hazard Mitigation Plan (2021) Section 3
- Mission Community Plan (1993) Parts C: Land Use and Part D; Tribal Services
- DECD and DCFS Annual Work Plans and Benchmarks

## Literature References


Aisch, Gregor; Gebeloff, Robert; and Quealy, Kevin. May 2015. "Where we came from and where we went, state by state." The New York Times.

Case, Michael J.; Johnson, Brittany G.; Bartowitz, Kristina; and Hudiburg, Tara W. 2021. "Forests of the future: Climate change impacts and implications for carbon storage in the Pacific Northwest, USA." *Forest Ecology and Management* 482 (2021) 118886

Confederated Tribes of the Umatilla Indian Reservation (CTUIR) EMERGENCY OPERATIONS PLAN. 2016. Prepared by CTUIR Public Safety Director.

Dalton, Meghan. 2020. "Future Climate Projections for Umatilla County: A Report to the Oregon Dept of Land Conservation and Development." Prepared by the Oregon Climate Change Research Institute.

Deehr, R. 2016. "Oregon: Changing Climate, Economic Impacts, & Policies for Our Future. Environmental Entrepreneurs (E2)." Available at www.e2.org.

Ebi, Kristie L.; Berry, Peter; Hayes, Katie; Boyer, Christopher; Sellers, Samuel; Enright, Paddy M.; and Hess, Jeremy J. 2018. "Stress Testing the Capacity of Health Systems to Manage Climate Change-Related Shocks and Stresses." *Int. J. Environ. Res. Public Health* 2018, 15, 2370; doi:10.3390/ijerph15112370

Fathi, Sahar. 2015. "Demystifying barriers for immigrants and refugees: A case study." PowerPoint slides. Received by email.

Gaughen, Shasta; and Hacker, Angie. Pala Band of Mission Indians. June 2019. "Chemşhúun Pe'ícháachuqeli (When our Hearts are Happy): Tribal Psychosocial Climate Resilience Framework."

Ghimire, Rajan; Bista, Prakriti; and Machado, Stephen. 2019. "Long-term Management Effects and Temperature Sensitivity of Soil Organic Carbon in Grassland and Agricultural Soils. Scientific Reports" | (2019) 9:12151 | https://doi.org/10.1038/s41598-019-48237-7.

Hayes, Katie; and Poland, Blake. 2018. "Addressing Mental Health in a Changing Climate: Incorporating Mental Health Indicators into Climate Change and Health Vulnerability and Adaptation Assessments." *Int. J. Environ. Res. Public Health* 2018, 15, 1806; doi:10.3390/ijerph15091806

Lay, C. R., Mills, D., Belova, A., Sarofim, M. C., Kinney, P. L., Vaidyanathan, A., et al. 2018. "Emergency department visits and ambient temperature: Evaluating the connection and projecting future outcomes." *GeoHealth*, 2, 182–194. https://doi.org/10.1002/2018GH000129

Levermann, Anders. 2014. "Make supply chains climate-smart." VO L 5 0 6 | N AT U R E | 2 7 Macmillan Publishers Limited. All rights reserved

Nelson, Jessica. 2020. "Migration Patterns in the Past Five Years." State of Oregon Employment Department. https://www.qualityinfo.org/-/migration-patterns-in-the-past-five-years

Saperstein, A. 2015. "Climate Change, Migration, and the Puget Sound Region: What We Know and How We Could Learn More." Report prepared for the University of Washington Climate Impacts Group. The Daniel J. Evans School of Public Policy and Governance, University of Washington, Seattle.

Schulten, Ashley; Bertolotti, Andre; Hayes, Peter; Madaan, Amit. APRIL 2019. "Getting physical: Scenario analysis for assessing climate-related risks." GLOBAL INSIGHTS

Tirado, R M.C.; Clarke, L.A. Jaykus, McQuatters-Gollop, A.; and Frank, J.M. 2010. "Climate change and food safety: A review." *Food Research International* 43 (2010) 1745–1765.

Ward, V., & Mattern, A. 2020. "Sustainability, safety and security: A case for hospitality industry response to natural disasters." *Journal of Tourism, Hospitality*

*& Culinary Arts*, 12(1), 289-304.

## Photo Credits

- Part F Cover Photo, "Salmon Canning Workshop with Yellowhawk." Umatilla County OSU Extension Service 2017
- Background Photo, "Cattails and reeds on Indian Lake," CTUIR DECD Indian Lake Staff
- Background Photo, "Crews planting native trees at Meacham Creek." CTUIR DNR
- Inset Photo, "Construction crew of Nixyaawii apartment site," CTUIR DNR FFPP 2022
- Inset Photo, "Brushfire burns along I-84 highway closure," East Oregonian 2022
- Inset Photo, "CTUIR Representatives Tour Construction." CTUIR DECD 2021
- Inset Photo, "Feb 2020 Flood Damage to Critical UIR Infrastructure." CTUIR DNR Fisheries
- Inset Photo, "Yellowhawk Community Garden and Gardener." Umatilla County OSU Extension Service 2017
- Inset Photo, "Upland Soil Slumps Resulting from Heavy Rain." CTUIR DNR Fisheries
- Inset Graphic, "Graphic from CTUIR CEDS Community Survey." CTUIR DECD CEDS
- Inset Photo, "Displays at TCI Gift Shop," CTUIR Confederated Umatilla Journal (CUJ) 2022
- Panel Photo, "Elk Browse Grass above Meacham Creek." CTUIR DNR CRPP
- Inset Photo, "4th of July Powwow participant buffers thunderstorm," CTUIR CUJ 2022
- Inset Photo, "NCFS staff table booth at Community Picnic," CTUIR CUJ 2022
- Inset Graphic, "Graphic from Yellowhawk Food Systems Assessment." Yellowhawk 2020
- Inset Photo, "NCFS Youth Entrepreneur Camp." CTUIR NCFS 2019
- Inset Photo, "Participants dance at annual 4th of July Powwow," CTUIR CUJ 2022
- Background Photo, "Participants engage with each other at Yellowhawk Fun Run 2022," CTUIR CUJ 2022
- Background Photo, "Lamprey cook in traditional method over fire," CTUIR DNR CRPP
- Inset Photo, "Drummers at Longhouse celebrate CTUIR Treaty Day," CTUIR CUJ 2022
- Inset Photo, "Tribal Fire Crews Navigate Floodwaters." CTUIR DNR Fisheries Feb 2020
- Inset Photo, "CUJ Promo for CayUmaWa Camp Crier App," CTUIR CUJ 2022
- Inset Photo, "DCFS Staff and Volunteers Prepare Food Distribution." CTUIR DNR FFPP
- Inset Photo, "CTUIR Community enjoys a celebration together at Community Picnic," CTUIR CUJ 2022
- Panel Photo, "Lupine and snowy ridgetop Blue Mountains." Craig Kvern
- Inset Photo, "Tribal youth learn about First Foods," CTUIR DNR CRPP
- Panel Photo, "Snowy Trees in Blue Mountain Forests." CTUIR DNR FFPP 2019
- Inset Photo, "Native landscape plants outside Wildhorse Resort," CTUIR DNR FFPP 2022
- Panel Photo, "CTUIR Grain Elevators in Smoky Summer." CTUIR DNR FFPP 2018
- Inset Photo, "DCFS School Supply Distribution to Community," CTUIR CUJ 2022
- Summary Photo, "Sailboat travels on Indian Lake in Summer," CTUIR DECD Indian Lake staff
- Panel Photo, "Overlooking CTUIR Ceded Lands from Ridge." CTUIR DNR CRPP