

Chapter 3 : Šapátunxwít ~ Impacts and Adaptation Goals

“Páyš mún miyánašma pawá šapá’ituxta tananáwityaw.”
Maybe someday the children will turn to the Indian way.

3D. Šapánaknuwít ku K’wálanáwít
Human Health & Happiness

Climate Impacts for Physical Health

“Loss of traditional food resources exacerbates Tribal health issues including poor fitness, diabetes, and other health challenges. Research has shown that loss of traditional food resources is associated with lifestyle changes (e.g., increasing sedentary lifestyle while decreasing culturally-specific activities and food diversity) and health problems (increased diabetes, obesity, heart disease etc).

Thus, ensuring abundant First Foods across the landscape and restoring Tribal food resources

is likely to benefit the health and culture of the Tribal community by providing traditional food choices and promoting activities (e.g. hunting, digging, gathering, and fishing) that draw on tribal knowledge and skills (First Foods Upland Vision, 2019).”

Impacts from climate change create challenges for Tribal people from exposure and chronic events, as well as from complicating factors to negative health outcomes that currently exist.

1. Complications from Extreme Heat

Heat is an incredibly dangerous form of storm, and can take a devastating toll on both healthy and vulnerable community members. As extreme heat worsens health complications, especially for those chronically exposed such as outdoor workers and unsheltered persons, and those with existing health issues.

Extreme heat (at or above 90°F) has potential to cause health complications within humans in at least 27 different ways (Mora et al 2017), as seen in Figure 3D.1 (page 141).

2. Complications From Wildfire Smoke

Particle pollution has a very negative effect on health, especially for those who are chronically exposed, and who live with pre-existing illness. Complications from smoke will increase morbidity and mortality around each event.

Heavy smoke events result in a **9.0% increase in the odds of same-day respiratory mortality, and a 14.0% increase in the odds of same day COPD mortality** (Doubleday 2020). **Cardiac arrest risk increased 70%** as seen in Figure 3D.2 (page 142). There was also a **4.9% increase in lung cancer and 10% increase in brain cancer associated with smoke exposure** (Jones et al 2020).

3. Higher Potential for Biological Contamination of Surface Waters, Residential Wells, and Groundwater

Both fresh water and salt water bodies are at risk of contamination from different sources, as potential for harmful algal blooms (HABs) increases with temperature. **A 2°C air temperature increase results in an expanded HAB window of almost 70 days; a 4°C increase expands this window by 127 additional days; and 6°C increase expands these seasonal conditions by 191 more days** (Moore et al 2008) as seen in Figure 3D.3 (page 144).

“The longevity and constancy of the First Foods and serving rituals across generations, and their recognition through First Food ceremonies, demonstrate the cultural and nutritional value of First Foods to the CTUIR community.”

~First Foods Upland Vision, 2019

4. Complications from Mold, Infectious and Insect-vectored Disease, and Food-borne Illness

Contamination from many agricultural and persistent moisture sources has the potential to cause increasing health complications.

Large increases expected in particle and particle-associated contaminants in dust; particle, particle-associated, and soluble contamination in runoff and flooding; particle, particle-associated, and soluble contamination of groundwater, and in particle vector transmission (Boxall et al 2009), as seen in Figure 3D.4a (page 146).

5. Extended and More Potent Pollen Production and Allergy Season

Pollen production will be extended due to warmer temperatures, leading to longer durations when high pollen concentrations will affect those with asthma and severe allergies.

Ragweed pollen production increased 132% from historic to 2000's carbon dioxide levels, and a roughly 90% increase from 2000's to mid-century, or 2050 (Ziska and Caulfield, 2000). This combines for a 222% increase in ragweed pollen production estimated for 2050, as seen in Figure 3D.5 (page 149).

6. Uncertainty Around Ozone Production

Ozone can have negative effects on respiratory health for humans, and on plant matter in the affected area. The Columbia River basin will see greater ozone increases than the rest of the Pacific Northwest, likely due to the emitting industries located within it.

Columbia River Gorge will see 0.7-1.2 (70-120% increase) in ozone related mortality, while closer to the Blue Mountains is likely to experience 0.0044-0.02 (1-2%) increased mortality (Fann et al 2015) as seen in Figure 3D.6a (page 151).

Climate Impacts for Physical Health

1. Complications from Extreme Heat

Drought and extreme heat impact summer seasonal activities, disproportionately affecting those who lack access to adequate cooling, and those with existing cardiac, respiratory, or diabetic illness. In Umatilla County, frequency of days at or above 90°F is projected to increase by 29 days by the 2050s (doubling historical conditions of roughly 18 days on average) (Dalton et al 2020). Extreme heat events cause large disruptions in daily routine, and can have devastating impacts for those who spend large amounts of time outside, such as outdoor workers, unsheltered people, and subsistence cultural harvesters/practitioners. Prolonged exposure can cause morbidity and mortality for those who are struggling with a chronic illness, and even those who are healthy can succumb to heat stress and heat stroke.

Figure 3D.1 displays the number of ways that extreme heat can cause damage within the human body.

- Organs within the human body are listed vertically on the left, while heat-affected pathways within the body are positioned horizontally along the top; where harmful pathways exist are marked with an “x” (Mora et al, 2017).
- When exposed to extreme heat, the hypothalamus dilates blood vessels to redirect blood from the core to the periphery of the body, where heat can be dissipated. This leaves insufficient blood flow to organs, resulting in ischemia.
- Heat cytotoxicity occurs when body temperature surpasses cell thermal tolerance, causing cell death (necrosis) and break down of cell membranes.
- In the heart,

compounding factors of heat cytotoxicity, ischemia, and hypokalemia-- potassium deficiency caused by sweating and urination-- can lead to the fragmentation of the myocardium, and increases the risk of cardiac arrest and decreases the effectiveness of the body to regulate heart rate and blood pressure.

- Dehydration thickens the blood and causes vasoconstriction, increasing risks of coronary thrombosis and stroke.
- Cell damage can lead to other conditions, such as acute tubular necrosis in the kidneys, permanent loss of brain function, liver endotoxins in the blood, inflammation of the pancreas, not enough oxygen getting to the lungs and into the blood because of injury of the pulmonary endothelium, and increase permeability of organs to pathogens and toxins.
- With all these factors combined, **extreme heat can cause health complications in at least 27 different ways** (Mora et al, 2017).

Adaptations that address heat exposure, such as increased shading, access to cooling and air conditioning, and behavioral adjustments like staggered work schedules to avoid the peak heat could save lives and reduce chronic exposure annually.

Figure 3D.1: Potential Pathways of Complication from Heat

Organs	Mechanisms				
	Ischemia	Heat Cytotoxicity	Inflammatory Response	Disseminated Intravascular Coagulation	Rhabdomyolysis
Brain	X	X		X	
Heart	X	X			
Intestines	X	X		X	
Kidneys	X	X	X	X	X
Liver	X	X	X	X	X
Lungs		X	X	X	X
Pancreas	X		X		

Assessing vulnerabilities to heat exposure for different community groups could also strengthen heat exposure prevention, as some groups will have more or less needs when it comes to adaptation.

(Credit: Mora et al 2017)

Gaps in Knowledge/Data/Policy:

- Inventory and understanding of how heat disproportionately affects vulnerable community members.

2. Complications from Wildfire Smoke

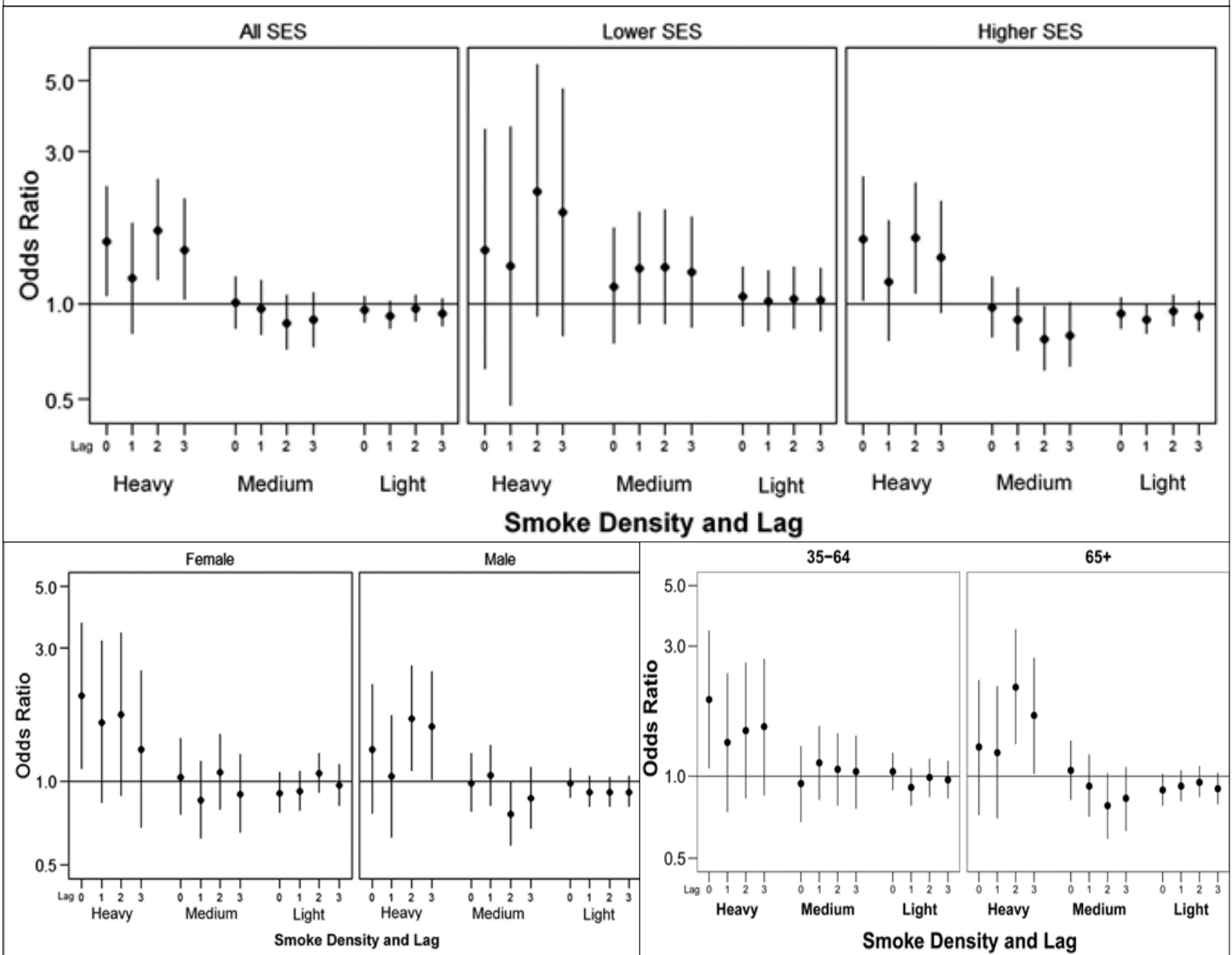
Wildfire smoke contains many compounds harmful to human health, including fine particulate matter (PM2.5), acrolein, benzene, carbon monoxide, and polycyclic aromatic hydrocarbons, threatening air

quality near the fire source, as well as hundreds and thousands of kilometers away. As risk of wildfire increases due to climate change, more people will be exposed to chronic wildfire smoke from blazes locally and regionally.

Figure 3D.2 examines the association between wildfire smoke exposure, and the odds of cardiac arrest and hospitalization during and after wildfire smoke exposure, as measured for 14 counties in California from 2015-2017.

- Risk of out-of-hospital cardiac arrest (OHCA) incidences in relation to exposure to wildfire smoke is demonstrated for various categories of people: impact across “Socio-Economic Status” (SES) as measured generally (top left): marginalized classes (top middle), and privileged classes (top right). Risk ratios are also provided by gender (female

Figure 3D.2: Increased Risk of Out of Hospital Cardiac Arrest (OHCA) Due to Wildfire Smoke Over Time



versus male, bottom left), and by ages (ages 35-64 versus ages 65+, bottom right). All these risk ratios were measured for heavy, medium, and light smoke exposure, and in relation to same-day exposure (lag 0), and for 1-, 2-, and 3-days after exposure (lag 1, 2, and 3 respectively).

- Overall, although both SES groups had elevated risk with heavy smoke exposure, lower SES cases tended to have elevated effects at medium and possibly light smoke, while higher SES cases showed null results or deficits.
- Both men and women experienced increases in OHCA under heavy smoke conditions; risk in women was highest with heavy smoke on the same day as exposure, and highest in men two days after heavy smoke exposure.
- The 35- to 64-year age group experienced highest risk on the same day as smoke exposure, with elder patients experiencing a greater risk 2-3 days after heavy smoke exposure.
- Results of higher risk to women and younger ages may relate to lower awareness of their potential risk, causing them to continue activities involving exertion and exposure during wildfire smoke episodes (Jones et al 2020).
- Overall, **cardiac arrest risk increased on days of heavy smoke exposure and for several days afterward, peaking at 70% higher on the second day after smoke exposure** (Jones et al 2020).

Another study of wildfire smoke exposure and the odds of non-traumatic mortality (meaning death was not related to an injury) for respiratory associated illness, was measured in Washington State over a recent 12 year period.

- It is estimated a 1% increase in the odds of all same-day exposure, and a 1.3% increase in the odds of non-traumatic mortality on the previous day of wildfire smoke exposure for those without pre-existing respiratory illness (Doubleday, 2020).

- **9% increase in the odds of same-day respiratory mortality, and a 14% increase in the odds of same day COPD mortality (Doubleday, 2020).**

- Among ages 65–84 specifically, a 2% increase in the odds of all same-day non-traumatic mortality was observed. With previous day exposure, there was a 2% increase in the odds of all non-traumatic mortality observed, and a 5% increase in the odds of respiratory mortality (Doubleday, 2020).

Risk of cancer has also been found to have a connection with wildfire exposure. Study shows that people living within 50-kilometer of wildfires over the past 10 years had a **10% higher incidence of brain tumors and 4.9% higher incidence of lung cancer**, compared to people



Because of their chronic close proximity to smoke, wildland firefighters are at greater risk for adverse health effects.

living further away (Korsiak et al 2022).

Chronic smoke can have a negative impact on respiratory health for everyone, but can cause potentially life-threatening worsening of existing illness for those with respiratory, cardiac, and diabetic illness. It is predicted that the number of people exposed to wildfire smoke yearly will grow by 43% to over 82 million by midcentury across the United States (Jones et al 2020). With summers expected to be inundated with smoke regularly in coming years, ways of coping with long periods of smoke without losing connection will be required. Additional precautions and response is likely to be necessary for those whose occupations bring them into close contact with wildfire smoke, such as wildland firefighters and prescribed burning practitioners.

(Credit: Jones et al 2020)

Gaps in Knowledge/Data/Policy:

- Future wildfire risk reduction adaptations and impact this will have on air quality;
- Understanding of risk of smoke impacts among those most vulnerable.

3. Higher Potential for Biological Contamination of Water, and Incidences of Harmful Algal Blooms (HABs)

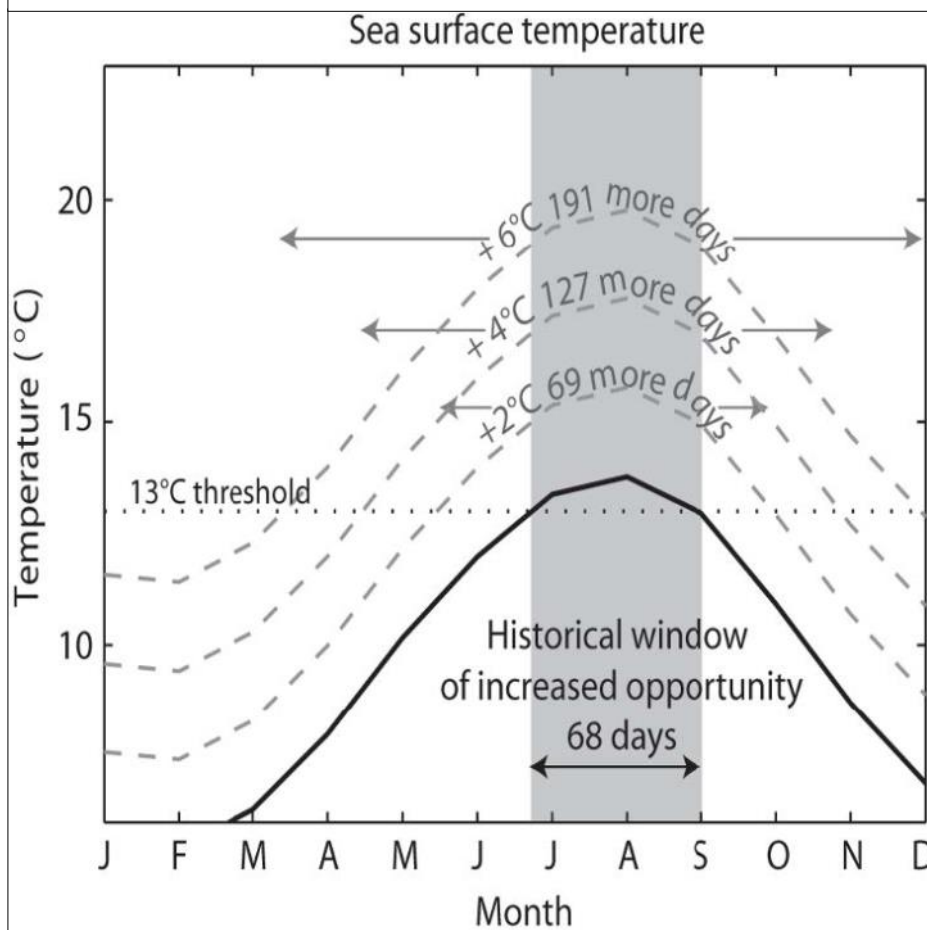
Water contamination creates human health issues, and climate change is likely to make these conditions more frequent. Water quality issues arise when water is warm and stagnant, creating conditions for algal growth and insect vectors to thrive. CTUIR has been proactive with addressing flooding issues that affect residential wells and sewage systems, however there are more adaptations, skills, and information networks that could reduce the potential for this source of health hazard.

Occurrences of mold due to damp conditions in Tribal housing are addressed by CTUIR Housing, which has worked to identify residences affected by chronic flooding, and relocated essential ventilation systems from foundations (where they were being inundated) to the attic space of residences. This adaptation has been done to reduce optimal growing conditions for mold in these spaces, which threatens health by contributing to respiratory infection.

Other biological health hazards are connected to water quality and temperature, most often impacting large and relatively still bodies of water like lakes, reservoirs, and pools. While most algae are not harmful, some species in high density can cause toxicity problems. These harmful algae blooms (HABs) produce potent natural toxins that are bio-accumulated (meaning they become more concentrated as species complexity increases) in some shellfish and other organisms that form the basis of food chains. Many of these can be toxic to touch or ingest for humans and other animals.

In freshwater, the most important HABs are caused by certain species of cyanobacteria (blue green algae) from the genera *Anabaena*, *Microcystis*, and *Aphanizomenon*, causing cyanobacterial poisoning. In

Figure 3D.3: Harmful Algal Bloom Seasonal Window in the Salish Sea (Puget Sound) as Temperatures Rise



both marine and freshwater systems, exposure to HAB toxins results from eating contaminated fish or shellfish, drinking contaminated water, inhaling contaminated aerosol, or by contacting contaminated water.

Figure 3D.3 demonstrates how warming water temperatures create additional opportunity for HABs to arise with the Salish Sea (Puget Sound) in Washington.

- This graph shows how water temperature over the course of the year creates conditions where it is possible for HABs to grow in concentrations that cause health problems. The black line represents the historical conditions for this saltwater inlet; checked lines projected this same seasonal window for increasing water temperatures. The temperature threshold for when planktonic dinoflagellate *Alexandrium catenella* (which is associated with paralytic shellfish poisoning) begins to form is shown as a vertical dotted line at 13 °C

(23.4°F).

- Scenarios for warmer water conditions by 2, 4, and 6°C (3.6, 7.2, and 10.8°F increase respectively) are shown in gray with the associated widening of the window of increased opportunity for *A. catenella* growth.
- **From the graph, a now almost-certain 2°C (3.6°F) results in an expanded HAB window of almost 70 days; a 4°C (7.2°F) increase increases this window by 127 additional days; and 6°C (10.8°F) increase expands these seasonal conditions by 191 more days** (Moore et al 2008).

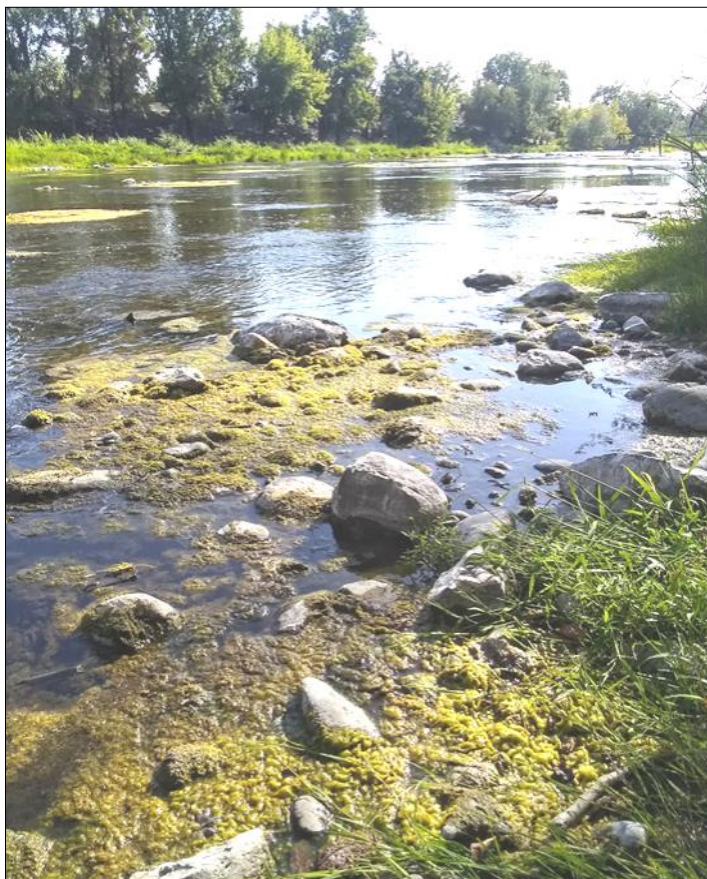
Toxic algae is emerging as a contamination concern for CTUIR's Ceded lands, as HABs in the Richland, WA area of the Columbia River have already resulted in the death of several domestic animals. Contact with the water was heavily discouraged during these blooms, decreasing Tribal Member access to the river. These proxy estimates were conducted for a saltwater environment, as information is lacking about how HABs in freshwater environments are likely to change. This is due to the complexity of watersheds, as well as the highly variable and integral component of land use management in the surrounding basin.

Both harmful and nontoxic algal blooms arise from over enriching of waterways with agricultural chemicals like nitrogen and phosphorus. Controlling for contamination of water sources with these chemicals could have a large impact on the formation of algal blooms, now and in the future.

(Credit: Moore et al 2008)

Gaps in Knowledge/Data/Policy:

- How water acidity will affect this seasonal potential for HABs to form;
- Relationships between HABs and aspects of the local and large-scale climate;
- Assessment of how human health effects from HABs are changing as more people come in contact with HABs, especially in reservoirs and rivers;
- How land use management might reduce or worsen conditions for HABs, especially in freshwater conditions.



Algal blooms in slow moving water are not always toxic, though many can have negative effects on aquatic organisms by reducing visibility and dissolved oxygen. Blooms are typically the result of agricultural fertilizer runoff.

4. Complications from Biological Contaminations (Mold, Infectious Disease, Insect-vectored, and Food borne Illness)

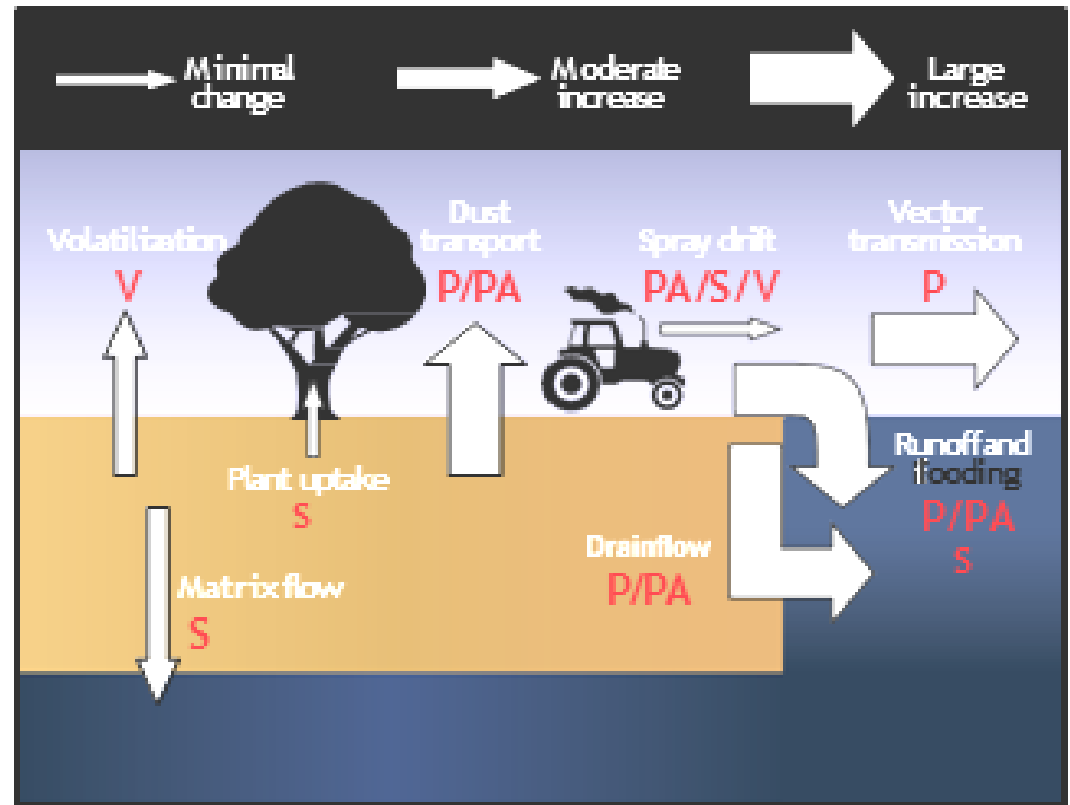
Life cycles and reproductive rates of biological organisms like bacteria, fungi, protozoa, and other rapidly reproducing organisms will be affected by warmer air temperatures, and are likely to experience an accelerated rate of reproduction as a result. Some of these organisms cause human health concerns, especially when they are found in drinking water, indoor air, and in food processing and consumption.

This is especially true in agricultural environments, like the croplands that makes up much of the CTUIR Ceded territory. In these settings, humans may be exposed to agriculturally derived chemicals and pathogens in the environment (i.e., air, soil, water, sediment) by a number of routes. This includes consuming contaminated plants and animals, breathing in harmful particles, and through contaminated drinking water.

Figure 3D.4a illustrates the number of pathways through which exposure to agricultural contamination can occur, and the impact that climate change is likely to have on these contamination pathways.

- White text identifies pathways of exposure to contamination. Volatilization means chemicals become airborne. Plant uptake means plants absorb chemicals as they grow. Matrix flow means chemicals flow into groundwater. Dust transport means chemicals attach to soil particles and become airborne. Spray drift means chemicals are blown by winds as they are applied. Drainflow indicates chemicals flow into nearby surface waters through shallow aquifers. Vector transmission means chemicals are moved by vehicles, wind, animals, or other mobile entities. Runoff and flooding indicate chemicals flow into nearby surface waters through overland flow and erosion.
- Letters indicate which contaminant classes are likely to be transported via an individual pathway: P is “**particulate**” (e.g., bacteria, viruses, spores, engineered nanoparticles); PA is “**particle-associated**” (e.g., hydrophobic organics, ammonium, heavy metals); S is “**soluble contaminant**” (nitrates, reactive phosphorus, hydrophilic pesticides); V for “**volatile contaminants.**”
- Three arrow sizes are provided along the top of the graphic: smallest arrows indicate a minimal impact of climate change on this element, while larger arrows demonstrate a moderate increase, and largest arrows indicating a large increase is anticipated.
- Little change is expected in S plant uptake and in

Figure 3D.4a: Pathways of Contamination in Agriculture for Air, Water, and Soil



PA/S/V spray drift; moderate increases are projected in volatilization of contaminants and in soluble contaminants in matrix flow.

- **Large increases are expected in particle and particle-associated contaminants in dust transportation; particle, particle-associated, and soluble contamination in runoff and flooding; particle, particle-associated, and soluble contamination of drainflow (groundwater transport), and in particle vector transmission** (Boxall et al 2009).

There are still many unknown factors to how changing agricultural conditions will affect water, lands, food, and people. Examples of these kinds of exposure pathways include but are not limited to (Boxall et al 2009):

- Wetter seasons increase contamination of mycotoxins in grain and row crops;
- Livestock populations increasingly subjected to heat stress may lead to increased indoor housing of animals, enhancing the need to store and

- dispose of manures;
- Higher temperatures facilitate introduction of new pathogens, vectors, or hosts in livestock, leading to increased use of biocides and veterinary medicines in meats and other animal products;
- Workers may be in more frequent contact with livestock, so transmission of zoonotic diseases may increase;
- Flood events can transport pathogens, dioxins, heavy metals, cyanide, and hydrocarbons from a contaminated areas to a non-contaminated ones through runoff and groundwater movement;
- Drier summers create high soil moisture deficits, resulting in hydrophobicity of soil surfaces and contaminants become airborne through spray drift applied to agricultural fields, volatilization and dispersion from treated surfaces (e.g., plants and soils), and wind-blown dust particles from soil surfaces;
- Dust released during soil tilling and crop harvesting can carry particle-associated contaminants like bacteria, fungal and bacterial spores, steroids, pesticides, and poly cyclic aromatic hydrocarbons;
- Increases in tick populations (*Ixodidae* and *Argasidae* species) may occur, which could increase incidences of Lyme disease (though there are large gaps in knowledge about how this range will change);
- Pesticides application will likely increase as crop diseases become more prevalent, thus loadings of pesticides in the environment and rates of pesticide applied to food items will also increase.

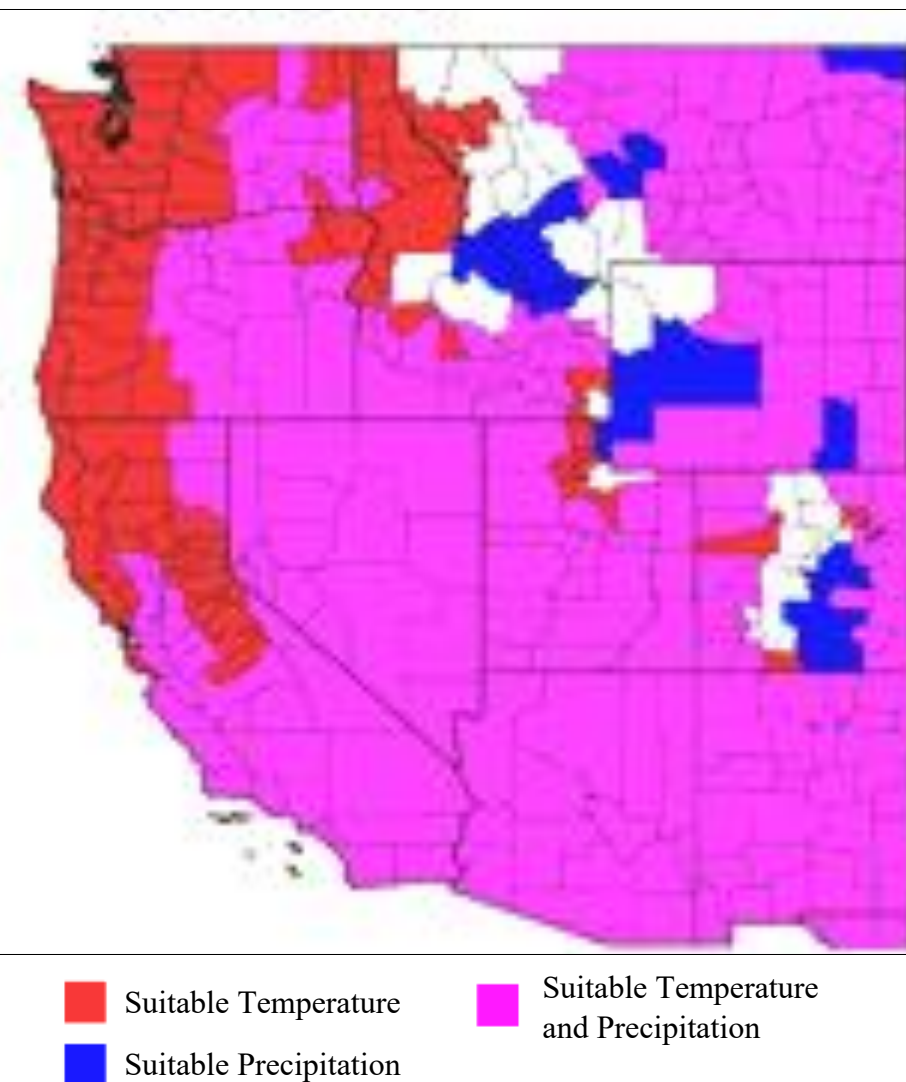
Air-borne contaminants from agricultural soils particularly have the risk of introducing biological health issues, such as Valley Fever. Caused by the inhalation of *Coccidioides spp.* fungal spores that live in dry soils, these fungal species are known to

proliferate during wet seasons, and to become brittle as soils dry under extreme heat following warm wet periods (Gorris et al 2019). When soils are disturbed by agricultural tillage or construction activity, these spores can become air-borne and affect human health in various ways for those who inhale this contaminant.

The U.S. Center for Disease Control (CDC) identifies the *Coccidioides spp* that causes Valley Fever as endemic in three counties in Washington State within the CTUIR Ceded lands: Benton, Franklin, and Walla Walla Counties are all identified as having existing *Coccidioides spp* fungi in these soils (Gorris et al 2019). These counties were the site of an outbreak of these fungal species in 2010-2011, and underwent soil treatment to eradicate the fungus (Gorris et al 2019).

Figure 3D.4b provides an projection of the spread

Figure 3D.4b: Projected Distribution of *Coccidioides spp* by 2100 (RCP 8.5)



of *Coccidioides spp* by 2100 under an RCP 8.5 scenario.

- Risk of endemicity (meaning fungi can persist in soils) depends on two factors: temperature and precipitation. Across the western U.S., warm temperatures and enough precipitation will facilitate the endemicity of the fungi that cause Valley fever, though both high temperatures and sufficient precipitation and moisture are required for the fungi to persist.
- Within this map, risk for endemicity for the fungi are indicated by color for each county: areas in red are where there is sufficiently warm temperatures; areas in blue indicate regions that will get enough precipitation; and areas in magenta/purple are where both temperature and precipitation will permit endemicity, and are at risk of developing Valley Fever fungi (Gorris et al 2019).

- The area endemic to Valley Fever will extend farther north in future decades, especially in the rain shadows of the Sierra Nevada and Rocky Mountain Ranges. Within the map, much of the CTUIR Ceded lands can be seen existing in the area at risk of developing *Coccidioides spp* in agricultural soils.
- By the end of the 21st century, the **area endemic to Valley Fever will increase by 113%**: the number of states with Valley Fever endemicity will increase from 12 to 17; the number of counties with endemicity will increase from 217 to 476, and the number of people living within the endemic region will increase by 17% across the U.S. (Gorris et al 2019).

Mold is another rapidly-growing, temperature-dependent indoor air quality concern affected by climate impacts. Currently, it is approximated that half of U.S. homes have visible evidence of a dampness problem or mold contamination, and this number is likely to rise in the future. Health risks from indoor mold are numerous: development of asthma with chronic exposure; triggering of asthma attacks; increased respiratory infections, allergic rhinitis, wheeze, cough, difficulty breathing, and other symptoms. Children are more sensitive to dampness and mold than adults, as are those with existing respiratory illness.

- Building dampness and mold is associated with 30-50% increases in a variety of respiratory and asthma-related health outcomes (ELI 2016).
- An estimated 21 percent of current U.S. asthma cases (and an associated \$3.5 billion in treatment costs), as well as an estimated 8-10% of respiratory infections and bronchitis were attributable to dampness and mold in homes (ELI 2016).

Adaptations to indoor mold issues include tracking and correcting the sources of moisture that promote microbial growth, rapid drying or prompt removal of damp materials, and cleaning/removal of mold and moldy materials, as rapidly and safely as possible. Having a training/licensing program or other policies in place before the next severe storm can assist in ensuring mold assessment and cleanup services are performed adequately, safely, and responsibly. Proactive land zoning and permitting policies to avoid developing in flood-prone areas,



Judy Beers, a UIR resident, surveys damage to her home and property from the Feb 2020 flood. Inundated homes are at a greater risk for developing mold issues.

or establishing design and construction requirements that make new homes less susceptible to moisture problems would also assist in reduce future complications from mold (ELI 2016).

(Credit: Boxall et al, 2009; Gorriss et al 2019)

Gaps in Knowledge/Data/Policy:

- How tick and mosquito populations are likely to change in the Columbia River Plateau area, and what disease dynamics are associated;
- Need for surveillance schemes to track presence and health effects of pathogens and chemicals arising from agriculture and other polluting sectors.

5. Extended and More Potent Pollen Production, Allergy and Dust Seasons

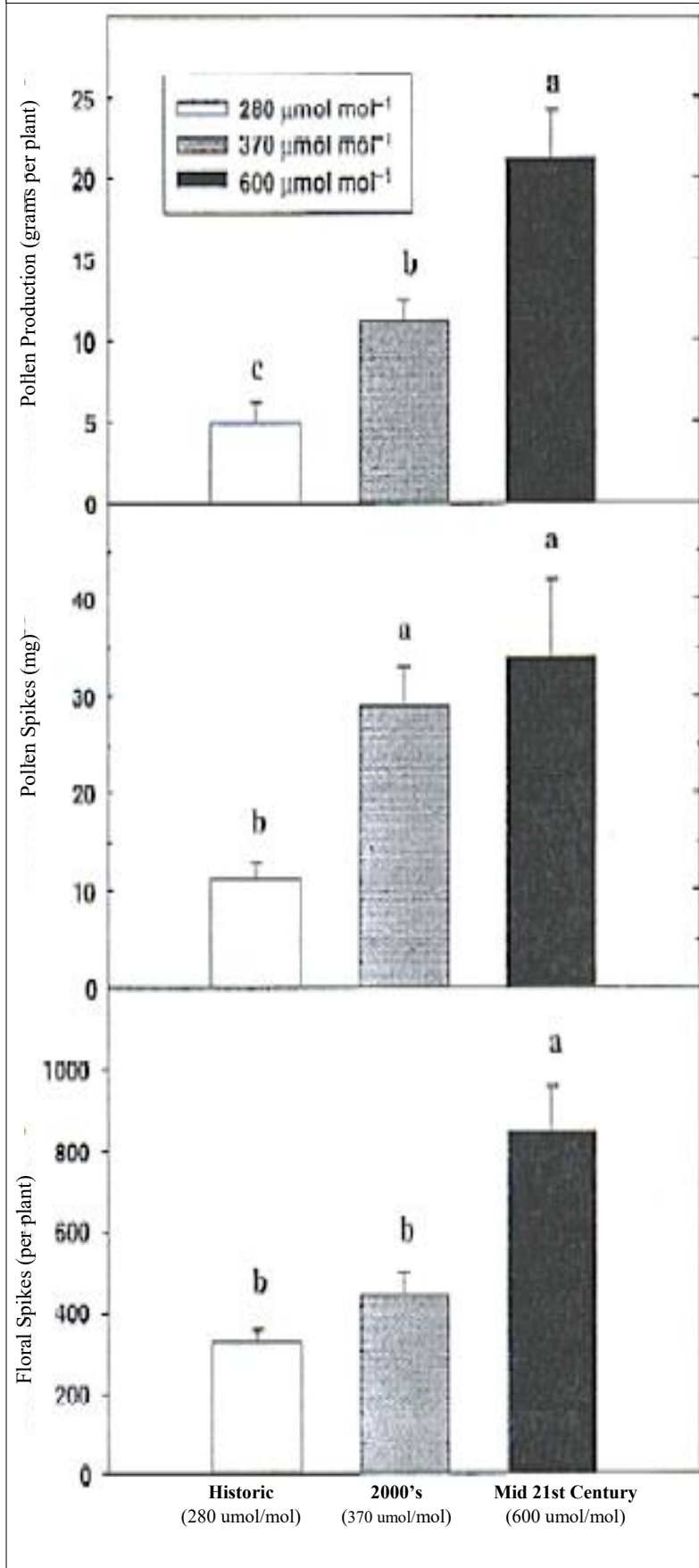
Seasonal air quality concerns come from many different sources, and climate impacts are likely to extend these sources to greater severity and for longer periods of time. Higher temperatures and carbon availability means some plants will experience an extended pollen production and growing season, affecting those with severe allergic or respiratory illness.

While information about Columbia Plateau-specific plant responses is lacking, proxy projections can be used to approximate this impact for the region. Ragweed (*Ambrosia artemisiifolia*) pollen is a common allergy, as a 2000 survey of the US general population documented roughly 70% of respondents had a noticeable allergic relationship with this invasive plant (Ziska and Caulfield, 2000).

Figure 3D.5 shows the relationship of ragweed pollen production and increasing concentrations of carbon dioxide, which can be used to project impacts for different future carbon scenarios.

- In the three-part graph is a comparison of ragweed plant attributes under different carbon dioxide concentrations (Ziska and Caulfield, 2000).
- Carbon concentrations of 280 micromols per mol represent Historic (1880’s) conditions, and is shown by the white-fill bar on the

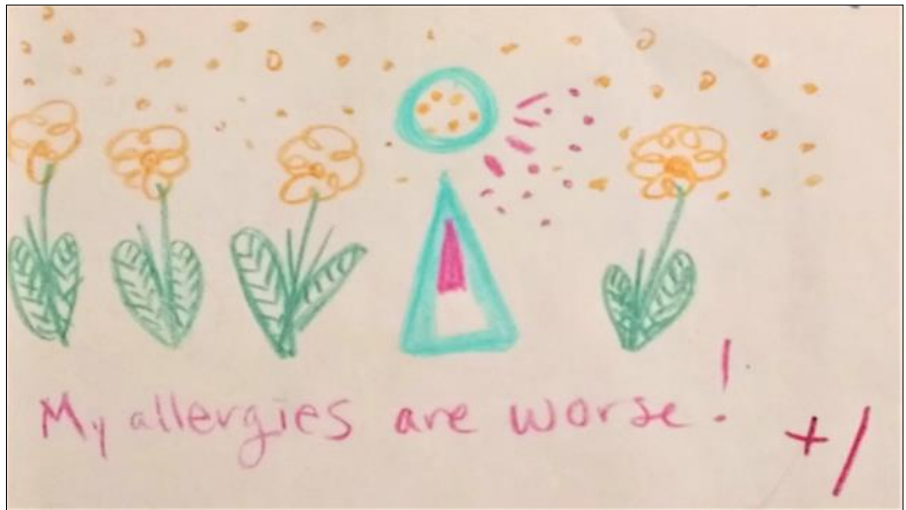
Figure 3D.5: Response of Ragweed Pollen to Increasing Carbon Dioxide Concentrations



left in the graph; 370 micromols per mol represent the present 2000's conditions, and is shown as the grayscale bar in the middle on the graph; and 600 micromols per mol of carbon represent potential future conditions circa 2050, shown as the black bar on the right in the graph.

- The top graph displays pollen production in grams per plant for three points of carbon dioxide concentration. The middle graph shows the number of pollen spikes at the three time points, while the bottom graph illustrates the number of floral spikes per plant.
- Pollen production was observed to **increase 132% from historic to 2000's carbon dioxide levels, and roughly 90% increase from 2000's to mid-century, or 2050** (Ziska and Caulfield, 2000). **This combines for a 222% increase in ragweed pollen production estimated for 2050.**
- Pollen production per flower spikelet has increased since historic conditions, and the number of flower spikes per plant is projected to jump dramatically into the 21st Century as carbon dioxide increases. Essentially, **each plant will be producing more flowers, each of which will be able to produce more pollen than under historic conditions** (Ziska and Caulfield, 2000).
- Additionally, a separate study conducted on ragweed pollen's antigen, Amb A 1 (Antigen E), is estimated to **increase 120% at 2000's current levels from historic levels, and 180% greater concentration into the mid-century** (Singer et al, 2005). This means that any pollen that is produced will have an increased potential to incite a histamine response in humans.

Since ragweed pollen production peaks between late August and November in North America, mitigation and preparation strategies focusing on that time period to reduce pollen exposure could prevent unnecessary morbidity or reduction in quality of life. Inventory of other high allergen-producing plants should be conducted to assess additionally increasing sources of allergens and their seasonal occurrences. Additionally, dust and other air-borne particles can also be a hazard



Extended and more potent pollen and allergy seasons are already contributing to quality of life issues for the CTUIR community. Allergies are identified as a factor affecting families in outreach exercises (pictured).

for human health and safety. Severe dust storms can cause impaired vision to motor vehicle operators, resulting in traffic collisions, and can often carry biological contaminations that cause respiratory illness.

It is difficult to know how dust conditions are likely to change, as wind can be difficult to model accurately. There is evidence that for the CTUIR Ceded lands, precipitation affects dust event frequency in the spring, but air-borne particles are most affected by vegetation cover in the summer. Both of these determining factors will be affected by climate impacts. Early projections show a possible decrease in dust events in summer due to an anticipated increase in summer vegetation growth, and little change in other seasons (Dalton et al 2020), though more refined modeling for this region is necessary. More research is also needed to predict how wind storms are likely to change over the century as well.

(Credit: Ziska and Caulfield, 2000)

Gaps in Knowledge/Data/Policy:

- Region-specific information about allergen-producing plants for the CTUIR Ceded lands, and how these populations are likely to respond to changing conditions;
- How changing land management practices will affect soil erosion and vegetation cover;
- Little to no information on how wind conditions will change; refining of dust event modeling for this region is also required.

6. Uncertainty around Ozone Effects

Ozone (O₃) is a gas pollutant made of three oxygen molecules, and is a product of various atmospheric conditions and volatile precursors. At earth's surface, ozone is created by chemical reactions between oxides of nitrogen (NO_x) and volatile organic compounds (VOCs), which are released when pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources chemically, react in the presence of sunlight (EPA 2021).

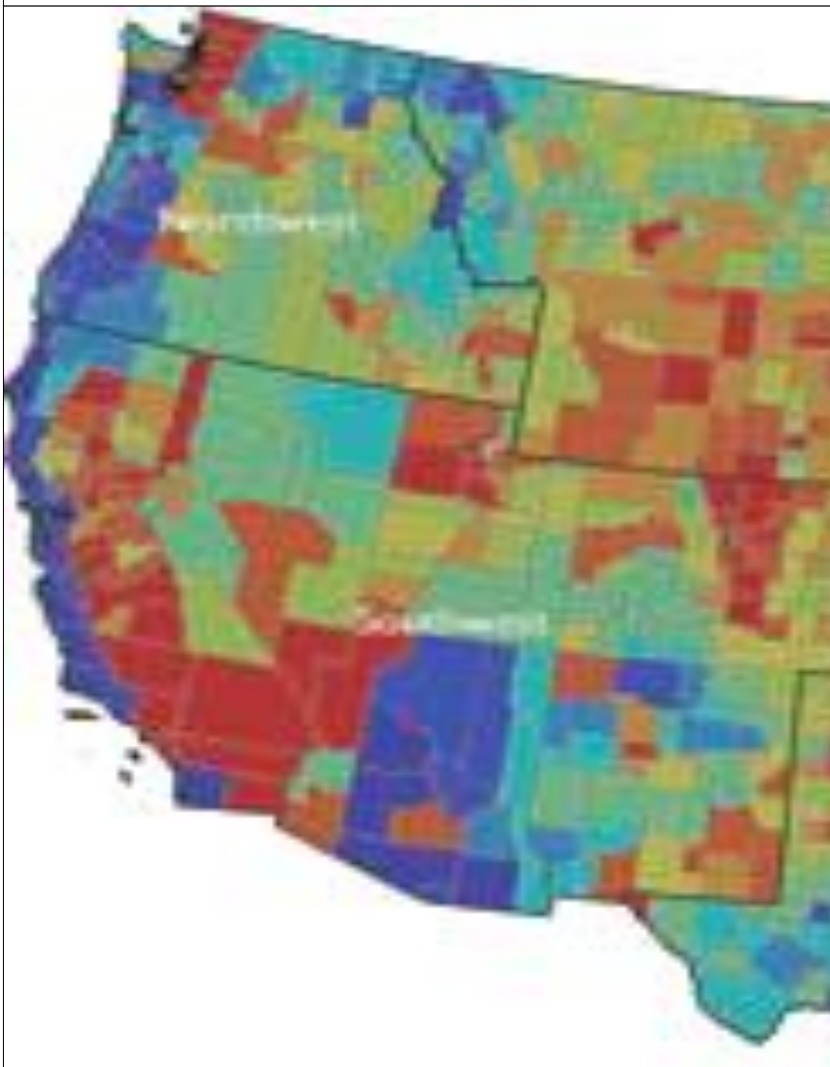
Ozone concentrations are dependent on heat and air temperature, two things affected by climate change. Ozone is also associated with health and environmen-

tal impacts, and exposure to high levels of O₃ can damage terrestrial ecosystems, including First Foods, grasslands, and forests, leading to negative consequences for Tribal Members harvesting and consuming traditional and locally produced plant foods.

Figure 3D.6a show the mapped results of ozone-related mortality and morbidity in the near future.

- On the map, severity of annual ozone impacts are shown on a color gradient: least impacted locations shown in blue may experience a decrease in ozone impacts, while moderate impacts are in yellow scale, and most severe in red as a percentage of additional mortality.

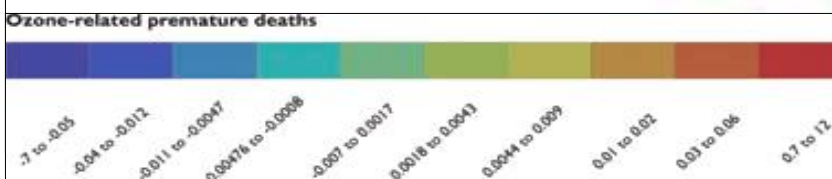
Figure 3D.6a: Annual Ozone-Related Premature Deaths by 2030 (RCP 8.5)



- This study predicts average temperature increases of 1- 4°C and climate-driven mean daily 8-hr maximum ozone increases of 1–5 ppb (Fann et al 2015), with seasonal (May–September) mean increases in ozone levels of 1–5 ppb RCP 8.5 scenario, resulting in more exceedances of the 75-ppb ozone than historical.
- The Northwest, the Great Plains, and the Southwest regions are projected to incur few ozone related health impacts, while the Northeast and Midwest regions are projected to have increases in ozone-related deaths (i.e., reductions in mortality avoided) for most of the years.
- Within the resolution of the map, it can be seen that CTUIR ceded lands are projected to experience more ozone impacts that other places in the Pacific Northwest. At this resolution, **Columbia River Gorge will see 0.7-1.2 (70-120% increase) in ozone related mortality, while closer to the Blue Mountains is likely to experience 0.0044-0.02 (1-2%) increased mortality** (Fann et al 2015);

Additional ozone-related premature deaths and illnesses attributable to climate change under an RCP 8.5 across the U.S., including emergency department visits, hospital admissions, acute respiratory symptoms, and lost school days, and estimate the economic value of these impacts, as seen in **Figure 3D.6b**:

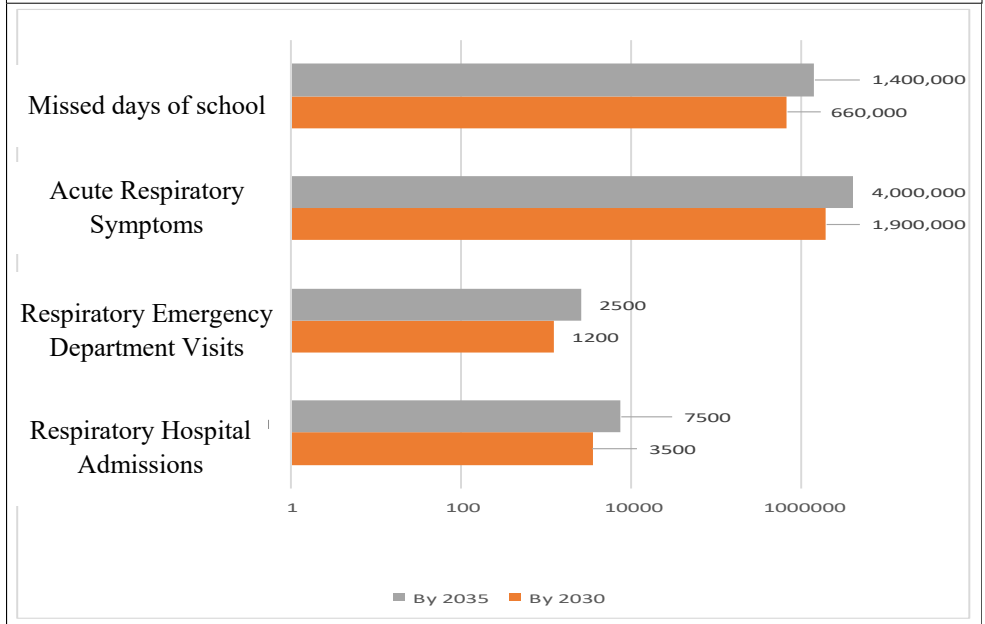
- By 2030, an additional average of: 3,500



respiratory hospital admissions; 1,200 respiratory emergency department visits; 1.9 million acute respiratory symptoms, and 660,000 missed days of school are anticipated nationally.

- By 2035, an additional average of: 7,500 respiratory hospital admissions; 2,500 respiratory emergency department visits; 4 million acute respiratory symptoms; and 1.4 million missed days of school (ages 5-17) are anticipated nationally (Fann et al 2015).

Figure 3D.6b: Annual Additional Ozone-Related Impacts in U.S. (RCP 8.5)



While the Western U.S. is not likely to see the dramatic increase in ozone projected for the rest of the country, inland areas along the Columbia River can be seen to be more affected than other parts of the Pacific Northwest. It is likely these areas are going to be more affected because of the

industries located along the Columbia River: Arlington landfill/incinerator, and the Port of Morrow, among others, are highly likely to be emitters of ozone precursors.

Ozone is complex to model, and globally-shared air circulation patterns can move these ozone and precursor pollutants far from their sources. In the Pacific Northwest, air patterns moving over the Pacific Ocean from Asia affects the creation of ozone within the Columbia River basin. Over recent decades, springtime ozone concentrations have increased by 30%, along the U.S. West Coast, an increase attributed to increase emissions in Asia that have traveled across the ocean (Jaffe et al 2003). Since “airsheds” (regional patterns of air movement) are shared across oceans and continents, ozone may be better controlled by reducing both ozone precursor emissions NOx and VOC, as well as greenhouse gases emissions globally.

(Credit: Fann et al 2015)

Gaps in Knowledge/Data/Policy:

- Higher spatial resolution to more finely resolve relevant areas regionally for CTUIR Ceded lands;
- Inventory and assessment of precursor emissions sources locally, and how these might change with increasing temperatures;
- How regulatory changes for air quality and greenhouse gas emissions will affect concentrations of precursor pollutants.



Tribal harvesters that fish, hunt, and gather in Zone 6 of the Columbia River are likely to experience more adverse health effects from ozone-emitting industries located along these same river reaches.

Adaptation Goals for Physical Health

A. Support and Expand Community Health Capacity and Education

“Children used to learn much of this from their extended families in the great outdoor classroom. Fishing, hunting, digging, picking, trapping, grazing stock – all rights reserved in the Treaty of 1855 – cannot be taught indoors. Outdoor interaction with the everyday occurrences of changing weather and encounters with wildlife and the physical challenges of navigating the terrain teach how to live in, and how to solve problems in, our world. This is the kind of knowledge that bound our ancestors together over time and over space and that strengthened our kinship with the land (Morning Owl et al 2015).”

“Health” for Tribal communities is a rich and complex concept, interconnected with generational and historical trauma that adds additional consideration for healthcare practitioners. Tribal families from these impacted communities are best equipped to navigate this intricacies, thus expanding culturally competent health education will help improve healthcare response to climate impacts.

i. K12 Blended Science, Technology, Engineering, Math (STEM) with Culture

Beginning from an early age, children learn about culture and First Foods through participating with community and ceremony. CTUIR is already creating culturally competent lessons for Tribal children in different ways, but a dedicated curriculum that connects earth and physiological sciences to culture, and encourages family participation, would boost these efforts.

Short Term:

- **Support existing First Foods and**

cultural education that is occurring:

- ◊ Cultural knowledge keeper and educator Linda Sampson has been teaching cultural STEM (Science, Technology, Engineering, Math) lessons to kids as part of the CTUIR Afterschool Program;
- ◊ Nixyaawii Community School (NCS) educator Althea Huesties-Wolf created her First Foods Academy curriculum, an observation-based learning experiences centered around cultural activities for high school students;
- ◊ CTUIR Education’s Language Program’s Tamayct (pit/earth oven) revitalization and outdoor learning connects language and culture with First Foods, earth science, and Indigenous knowledge.

Long Term:

- **Develop additional curriculums and lessons that use culture and First Foods to teach science**, for use at Tribal schools like NCS, with other Education activities, and with non-Tribal schools with Tribal students. Activities that engage parents and families would have a greater impact within the community.
- ii. **Trainings, Scholarships, and Internships for Youth and Decision Makers** Encouraging opportunities for Tribal Members to pursue technical and healthcare sciences education will expand the capacity for culturally centered public health and medical services.

Short Term:

- **Create opportunities for paid internships** within CTUIR’s departments, and with external organizations and universities. A large barrier to increasing Tribal participation in public health is availability of supportive funding. Education



support funding, like Nixyaawii Community Financial Services (NCFS)’s Education Loan, as well as grants, stipends, and honorariums, would provide more flexible funding for Tribal Members of all ages to participate in public health education. See Ch 3F pages 230-231 and 249 for additional detail.

- **Provide routine trainings about climate change impacts** for decision makers within the Tribal community, and as members on CTUIR’s Commissions, committees, and advisory boards. Officials making climate impact-informed decisions will be able to more accurately plan and prepare for the CTUIR community.

Long Term:

- **Expand support of scholarships for Tribal Members** to pursue natural resource and medical sciences, as well as public health and policy education. Preparing for climate impacts will require decentralized understanding and action, and empowering Tribal families around adaptation will ensure greater success.

iii. Identify Needs and Gaps in Health Services with the Community

Improving healthcare service for Tribal communities is a constant process, and anticipating climate change

impacts is another part of growing to suit changing needs. Creating frameworks that facilitate bi-directional flow between Yellowhawk Tribal Health Center programs, practitioners, patients, and the community will assist in meeting needs as they change due to climate impacts.

Short Term:

- **Prioritize feedback and suggestions from Tribal Members who are employees**, as they often have unique perspectives to observe gaps and opportunities. Providing mechanisms to prioritize and implement feedback from these unique perspectives can assist in equitable adaptation strategies.

- **Develop formal and informal channels of feedback** for patients, staff, family, and community members to identify possible improvements and alternative approaches. These could include:
 - ◊ Regular gathering groups that share information informally, such as Yellowhawk’s Weavers Group, and Culture Night;
 - ◊ CRPP Excursions that offer a unique opportunity to identify where there may be gaps that exist, specifically when out exercising Treaty Rights;
 - ◊ Potentially developing policy and frameworks similar to a “No Wrong Door” approach in Tribal services, which facilitates inquiries and comments reach staff and providers with ability to address them.



Community events like the Yellowhawk Annual Fun Run (pictured) can provide an opportunity to solicit community observations and feedback.

Long Term:

- **Invite community to be part of evaluation and planning process** in ways that are accessible to those with different communication and engagement capabilities (internet access, mobility issues, housing status etc). Building community across communication obstacles will ensure more people are included with climate adaptation efforts.

iv. Build Capacity to Engage with Legislative Opportunities

Continue to engage with state, federal, international, and inter-Tribal discussions about health in Indian Country, and approaches that center Indigenous knowledge.

Invitations for consultation and other levels of Tribal participation are unending, and limited only by Tribal capacity to engage.

Short Term:

- **Improve CTUIR’s Office of Legal Counsel (OLC) capacity to engage with governmental funding and rulemaking.** OLC already participates with legislative affairs coordination on relevant House and Senate bills in Oregon and Washington, as well as with CTUIR’s Health Commission and CTUIR Community Wellness Improvement Collaboration (CCWIC) interdisciplinary work group.

Long Term:

- **Support CTUIR Health Commission capacity to assign members to agency committees.** As these members are knowledge about unique issues facing this Tribal community, as well as the intricacies of healthcare management and government policy.

v. Credited Continuing Education (CCE), and Community Education

Knowledge about climate impacts changes rapidly as technology advances and new effects begin to emerge. CTUIR will need to train and educate staff and patients regularly on updated and new information related to climate change and health.

Short Term:

- **Facilitate patient-centered climate impacts education** that can help Yellowhawk healthcare practitioners be proactive in anticipating worsening health complications. There are many trainings that exist and can provide required CCE credits for

practitioners, like the EPA’s “Particle Pollution and Your Patient’s Health,” among others.

- **Map out CTUIR-specific Indigenous understanding of health**, like the Swinomish Indigenous Health Indicators (IHI) (2016) as it is unique for the Columbia River Plateau and Blue Mountains region and Tribal culture. Mapping a concrete understanding of the role that health plays in cultural connection provides a framework for its protection.

Long Term:

- **Build community knowledge and empowerment** around identifying and implementing wellness and prevention opportunities. This could include organizing group learning opportunities, including review of the Swinomish IHI (2016) online modules, and climate impacts and science community curriculum.

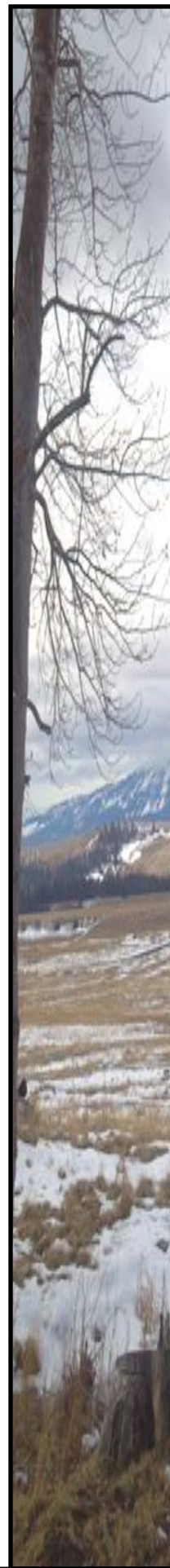
vi. Develop Dedicated Climate Adaptation Capacity

Implementing climate adaptation strategies requires tremendous effort from communities, governments, and families, and cannot be done by any one of these alone.

Building capacity at individual, family, community, and government levels will be necessary for adaptation implementation. Governments can empower families and communities through education, providing for needs, and creating decentralization of response that spreads capacity out.

Short Term:

- **Facilitate organizing of regular community engagement events**, like discussion groups/talking circles, and webinars to discuss ongoing climate impacts and adaptation; opportunities to gather – both virtually and in-person – can create spaces for community members to share their



experiences, observations, and learned knowledge to address both physical and emotional components of health impacted by the climate crisis. Efforts should be interdisciplinary, culturally accountable, and accessible to diverse audiences and education levels.



CTUIR Dept of Economic and Community Development (DECD) facilitates the annual Earth Day Community Clean Up to empower families around civic responsibility, community service, and caring for lands and water.

Long Term:

- **Build capacity to organize and implement projects** that improve adaptation and resiliency. This may include securing funding for additional field staff dedicated to observation and response, administrative positions that can respond to community need and project interest, and coordinative services that bridge connection between departments and with the community.
- **Provide a liaison for project implementation** between Tribal government and community, UIR residents, and non-Tribal stakeholders and organizations. Additional capacity should focus on being responsive to community interest and need, as well as to state and federal governmental initiatives being proposed.

B. Approach Public Health Holistically with Cultural Connection

“First Foods have sustained Tribal people since time immemorial and the relationship between First Foods and the Tribes is essential to the ongoing culture of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). The First Foods serve a fundamental role in the health, well-being and cultural identity of the Tribes. In 2007, to convey the important role of First Foods to the Tribes, the CTUIR’s Department of Natural Resources (DNR) adopted a mission based on First Foods ritualistically served at Tribal meals.

“The CTUIR DNR considers First Foods to constitute

the minimum ecological products necessary to sustain CTUIR subsistence and cultural needs. The mission was developed in response to long-standing and continuing community expressions of First Foods traditions and community member requests that all First Foods be restored for their respectful use, now and in the future (First Foods Upland Vision, 2019).”

Intentional re-envisioning of public health from a Tribal community perspective (an effort similar to the DNR First Foods Mission development) could build understanding of the holistic intersections of health for both Tribal Members and community, as well as non-Natives who work with Tribal patients, students, and families.

i. **Develop Systems to Begin Tracking Tribally Unique Harm Exposure Pathways**

Tribal Members and their families have many unique pathways of exposure to environmental contamination and climate change impacts not represented in conventional public health inventories.

Short Term:

- **Conduct an assessment with the Tribal community to inventory potential exposure pathways** Tribal Members encounter when exercising Treaty Rights, and how these are projected to change in

future scenarios. This is likely to include surveying the CTUIR community to gather anecdotes of harms and challenges encountered while harvesting First Foods.

- **Identify gaps in data collection and information** on unique exposure sources, remediation actions, and progress evaluation of these to monitor improvements. CTUIR’s Hanford NRDA and Injury Assessment process could be helpful in developing this protocol. See Ch 3E pages 193-194 for additional detail.

Long Term:

- **Expand capacity of DNR Energy and Environmental Science Program (EESP) and Yellowhawk laboratories, and Tribal enterprise/business capacity to collect data** to provide information about changes in disease and contamination trends. These kinds of testing capacities could include water coliform testing, First Foods contamination of metals and other chemicals, insect-vectored illness, biological samples from humans, animals, plants and soil to determine the presence of bacterial, fungal, or viral contamination, among others.
- **Develop various exposure threshold points for policy action** based in public health and science, and with a knowledge of cultural practices and additional complications Tribal communities face. These could be strengthened to use in legal defense of rights and remuneration if necessary.
- **Expand Tribal data collection and monitoring for ozone precursors** and other relevant air pollutants across Ceded lands. These are likely to be distinct for CTUIR among Pacific

Northwest Tribes, and could provide additional context and information on adverse health effects from poor air quality.

- ii. **Address Climate Impacts that Compound Lifetime Illness Factors**
Health is built over a lifetime, but much of conventional medical science is focused on treating symptoms once a disease has already occurred. Preventative public health intervenes at points throughout a lifetime to reduce burdens of illness worsened by climate change.

Short Term:

- **Reduce potential for climate-affected factors that contribute to poor health**, and proactively address social determinants of health. Examples include (but are not limited to):
 - ◇ Improving indoor and outdoor air quality all year around;
 - ◇ Preventing mold and bacteria growth, and moisture issues in homes and buildings;
 - ◇ Reducing heat exposure, and ensure access to cooling capacity;
 - ◇ Reducing barriers to accessing public transit, knowing increased exposure potential for riders and operators is likely;
 - ◇ Controlling for chemical contaminants in land management to prevent harmful algal blooms;
 - ◇ Mitigating for social isolation during shelter-in-place warnings.
- **Ensure Tribal Members have access to air purification and personal protection equipment.** This includes residential filtering capacity like HVACs and Central air, supplementary air purifiers, personal protective equipment like N95/99 and P100 masks, and access to real-time air quality information.



- **Conduct a cultural health mapping exercise with Yellowhawk staff and Tribal community** using the Indigenized Building Resilience Climate Impacts (BRACE), or with the Swinomish IHI module to identify those unique exposure pathways, and how these are likely to change.

Long Term:

- **Encourage frameworks that allow for wellbeing and connection**, such as Yellowhawk’s physical fitness and healthy First Foods-based diet classes, Cultural Resource Protection Program (CRPP) First Foods Excursions with the Dept of Child and Family Services (DCFS), gathering and discussion groups, talking circles, and many other current and planned wellness and connection opportunities.
- **Strengthen and support mutual aid networks within communities**, not just in times of emergency response, but routinely. Some examples of non-emergency mutual aid includes tool libraries, seed saving networks, bulk purchasing groups, and wellness check telephone trees, and screening for food security and mental health in wellness checks, among others. See Ch 3F page 255 for additional detail.

iii. Center Elders, Two-Spirit, Disabled, and other Marginalized Identities in Emergency Planning and Response

There are a number of subgroups within communities that are likely to have different needs unique from the majority, thus it is essential to place these groups in the center of health policy and emergency planning efforts.

Short Term:

- **Actively seek opinions and perspectives of those voices not already involved** in planning and engage those perspectives intentionally. These perspectives are likely to demonstrate where there



Cultural knowledge keeper Linda Sampson demonstrates how to separate tomato seedlings during Yellowhawk Tribal Health Center’s “Seed to Supper” gardening class.

are gaps and unmet needs within the CTUIR community. This is likely to involve working with the Nicht-Yow-Way Senior Center, Cmuytpàma Warming Station, and many others.

- **Conduct air quality sampling and monitoring with marginalized people directing the study.** Those who work or live outside are most likely to experience negative physical and mental health outcomes. Actively seeking guidance and participation of these community members to participate in air quality initiatives, especially in a leadership capacity, will greatly improve poor air quality adaptation.
- **Collaborate with the Cmuytpàma Warming Station and other regional shelters** to identify how unsheltered community members specifically are affected. Unsheltered community members utilizing these services should be actively consulted on the climate impacts they are experiencing, and empowered to participate in guiding the planning and implementation of adaptation, particularly for heat and smoke response. This should also involve creating a plan for housing/caring for these community members under changing conditions.

Long Term:

- **Prioritize feedback and needs of elders and marginalized people** as they are often unique from the general population. Often the barriers to implementing or accessing climate adaptation are

routine things like internet access, lack of transportation, or other factors that complicate life for those who are multiply-marginalized. Seeking guidance from those in the community who experience unique adverse circumstances will greatly improve equity of climate adaptation implementation, including people who are unsheltered or undersheltered (“couch surfing,” living in a vehicle etc), neurodivergent people and those with complex trauma, disabled people, those who routinely experience racism, homophobia, transphobia, or other forms of hate; and others of priority.

C. Expand Organizational Cooperation on Health Needs of Tribal Community

“What a beautiful sight, look at this healing that this has. We need to come out as a whole community because this does something for us in a whole different way. The beauty within us working together, gathering our Foods and that reconnection in the air, and putting everything into that work (Randy Minthorn, Rocky Ridge CRPP Excursion, 2017).”

i. Develop Community Science Reporting Tools, Education, and Protocol

Changes in landscape and First Foods are best monitored by the cultural practitioners and subsistence harvesters, who are constantly engaged with the Foods, and have ecological knowledge about seasonal indicators and patterns that are changing. Supporting them in acting as observers and reporters of change will help build capacity for monitoring.

Short Term:

- **Develop reporting protocols and**

platform for community identification of changes in issues, indicators, First Foods, health observations, and other relevant information to be collected. This is likely to include (but not be limited to) locations of accessibility for various First Foods harvest opportunities; timing of harvest windows and range; density of presence of predatory insects like ticks; air quality and visibility at frequented harvest locations; voluntarily reported incidences of heat or smoke illness; degraded access infrastructure like roads and bridges; presence of harmful algal blooms and/or fish die-offs; and many other notable observations.

Long Term:

- **Organize and facilitate community trainings on using the developed protocol, reporting tools, and other monitoring science** information that would be key in receiving accurate and useful reporting of health related observations over time.
- ii. **Develop Climate Change-Specific Internships with Yellowhawk**
Expanding capacity to address climate health impacts in a culturally connected way would increase the ability to implement adaptation and resilience projects.

Short Term:

- **Develop and fund health and climate change-specific paid internships for Tribal youth** within the organization, with an aim of connecting CTUIR and Yellowhawk climate adaptation efforts. Engaging youth in climate planning will increase knowledge and skills around climate impacts, and build CTUIR capacity to implement adaptation.



Long Term:

- **Support and expand training and internship opportunities for Tribal students and community with public health and research partners**, particularly with Oregon State University (OSU) School of Public Health, and other institutions. Initiatives that focus on incorporating Indigenous knowledge into public policy, supporting and expanding mechanisms of Tribal sovereignty, and Tribal-led research would ideally be prioritized for internship placement.

iii. Collaborate with Oregon State University Superfund Research Program (SRP) Work Group and Other Agencies

Tribal students and researchers are in a unique position to improve understanding of health from an Indigenous perspective, and to have a closer relationship with what changes in First Foods means for Tribal communities.

Short Term:

- **Collaborate with university research**

consortiums that understand Tribes' data sovereignty concerns; 'data sovereignty' is an important component of Free, Prior, and Informed Consent (FPIC) necessary for Tribal consultation and research, and placing the community in control of data collected about the Tribe is a component of sovereignty. CTUIR's Central Data Management System (CDMS) provides secure data storage and portal access for not only CTUIR, but for other Tribal Nations as well.

Long Term:

- **Participate with Indigenous-led research efforts** at Tribal colleges and organizations.

iv. Actively Incorporate Climate Change Impacts in Health Assessments, Services Evaluation, and Project Planning

CTUIR Health Commission and Yellowhawk leaders regularly conduct formal and informal evaluations of their health services to ensure they are keeping up to date with changing community needs.

Short Term:

- **Modify community health assessments to include measures of climate change impacts**, especially as they impact existing chronic health issues. These additional measures could include an inventory of access to cooling and air filtration, connection to community, and water contamination/septic system issues, among others.

Long Term:

- **Include evaluation of climate change impacts in other Tribal assessment and planning processes**, such as transportation, land development, housing planning efforts, economic development, assistance services, and energy production, among others.



Tribal knowledge keepers work with outside and non-Tribal partners to facilitate educational opportunities, including with Oregon State University work groups and county Extension Services to offer Master Food Preserver and Master Gardener classes, like the Bread & Butter Pickles workshop pictured.

How Do We Measure the Success of These Adaptations?

“These disruptions have intensified into a new kind of ecological awareness about the growing impacts of human activity on the environment. For example, traditional fishing practices and salmon biodiversity have been significantly transformed due to modern dam-building on major tributaries and elsewhere. Decisions on how salmon fisherman accessed traditional fishing sites were commonly made based on the availability and distribution of key salmon runs.

The same is true for many of our traditional food-gathering sites, where our once naturally abundant wild foods are beginning to show signs of fading away due to human impacts and climate change. Our ecological knowledge makes us especially sensitive to changing conditions in the surrounding global environment; and our ongoing, common historical experience suggests that these changing conditions will continue unabated.” (Phillip E. Cash, 2015)

- Yellowhawk Community Health Assessment Benchmarks (2016, 2022)
- Yellowhawk Annual Plan Goals and Objectives
- **Comprehensive Plan Objective 5.4.3:** Implement educational programs to increase employability of Tribal Members (see Comp Plan page 74 for benchmarks);
- **Comprehensive Plan Objective 5.5.7:** Enable Tribal members to pursue excellence in education, become self-reliant and to contribute to the Tribal community (see Comp Plan page 76 for benchmarks);
- **Comprehensive Plan Objective 5.7.9:** Promote wellness awareness and education toward the prevention of drug and alcohol abuse, diabetes and other preventable health issues as well as all forms of violence (see Comp Plan page 76 for benchmarks);
- **Comprehensive Plan Objective 5.11.3:** Aggressively promote chronic illness and diabetes prevention and early detection with focus on cardiac illness (see Comp Plan page 108 for benchmarks);

- **Comprehensive Plan Objective 5.11.6:** Expand Tribal and clinical services to address health, wellness, case management and quality of life services for CTUIR Elders
- **Comprehensive Plan Objective 5.11.11:** Provide a positive educational learning experience for Tribal youth to enable them to be successful adults while promoting cultural learning experiences (see Comp Plan page 108 for benchmarks);
- **Comprehensive Plan Objective 5.13.1:** Develop and maintain a transportation system that is safe and promotes the public health (see Comp Plan page 117 for benchmarks);
- **Comprehensive Plan Objective 5.12.3:** Assure that community facilities are maintained in a safe and sanitary condition (see Comp Plan page 112 for benchmarks).
- **CTUIR Hazard Mitigation Plan (2021) Section 3:** Hazard Identification and Risk Assessment Results (page 68-190).
- **CTUIR Hazard Mitigation Plan (2021) Section 4:** Hazard Mitigation Strategy (page 192-212)
- **Good Health and Wellness in Indian Country (GWIC) Grant Objective 1:** Improve Tribal food and beverage programs/systems
- **GWIC Grant Objective 3:** Expand and enhance awareness of high blood pressure and high blood cholesterol within the CTUIR community.
- Channels of feedback on services and community needs for Tribal Members, patients, and families.

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

- Unique exposure pathways for Tribal people
- Ozone effects on vegetation and consumption of potentially contaminated Foods;
- Changing land management practices that affect chemical exposure;
- Effects on disease vectors and disease potential;
- Anticipated changes in food-, water-, and air-borne illness, testing, and monitoring;
- Community observation and reporting capabilities and knowledge.

Climate Impacts for Emotional Wellbeing

“Hundreds of generations of ancestors have known this land intimately from living on it for thousands of years. Every creek, spring, pond, swale, saddle, box canyon, draw, and peak witnessed people’s long history here, and our people knew all the features of this land. Our children also must know this land if they are going to take care of it when they inherit this responsibility (Morning Owl et al 2015).”

Disconnection from the seasonal and cultural indicators is already creating anxiety and sense of loss when First Foods are inaccessible. Community connections are also negatively impacted, as extreme events require emergency preparedness, and shelter-in-place recommendations reduce access to social engagement for those with chronic illness and other health and mobility considerations.

7. Potential Disconnection from First Foods, Indigenous Culture, and Spiritual Connection

First Foods historic migration routes and timing are likely to shift and increasing frequency of natural disasters can trigger existing emotional health issues and potentially create new ones. Indigenous health is integrally tied to land, First Foods, community, and culture.

Environmental climate impacts create challenges to traditional foods access, which in turn affect the Indigenous Health Indicators: **Natural Resources Security, Self Determination, Cultural Use, Community Connection, Well-Being, and Education.** These are used to inform needs, health policy, and resource planning (Donatuto et al 2016) as seen in Figure 3D.7a (page 163).

8. Exacerbated Climate Grief, Eco-anxiety, and Solastalgia

Indigenous communities’ concept of health is woven with land management practices and religious ceremony. Health outcomes are greatly improved for Tribal people who are able to continue access to subsistence foods and cultural practice.

Vicarious distress for those experiencing intense weather or environmental hardship; access to, and time spent on, the land linked to fulfilling psychological needs; altered or loss of place results in negative consequences for livelihoods, cultural practices, and social networks, as well as to alterations in personal and collective identities (Middleton et al 2020) as seen in Figure 3D.8 (page 165).



Climate Impacts for Emotional Wellbeing

7. Potential Disconnection from First Foods, Indigenous Culture, and Spiritual Connection

“This loss of traditional food resources exacerbates Tribal health issues (e.g., poor fitness, diabetes). Studies have shown that food resource loss is associated with lifestyle changes (e.g., increasing sedentary lifestyle while decreasing cultural-specific activities and food diversity) and health concerns (e.g., increased diabetes, obesity, heart disease). Thus, restoring Tribal food resources is apt to benefit the health and culture of Umatilla Tribe by providing traditional food choices and promoting activities (e.g., hunting, gathering, and fishing) that draw on Tribal knowledge and skills (Umatilla River Vision, 2011).”

Connection to culture and First Foods is essential for the health of Tribal people, physically, emotionally, and spiritually. “Health” then, has its own unique definition to Tribal communities, and safeguarding these connections are required in climate adaptation.

In **Figure 3D.7a**, a concept map illustrates one Tribal community’s specific and intimate connection of health with traditional foods.

- This mapping exercise was conducted by the Swinomish Nation on the Washington state coast. They developed their “Indigenous Health Indicators” to map all the ways traditional foods dictate what components of “health” are for that unique community.
- Within the red box are the community-identified indicators that make up “health” to the Swinomish people. The flow chart maps the ways in which this interconnected concept of health is impacted by climate change.

- Climate impacts create challenges to traditional foods access, which in turn affects these **Indigenous Health Indicators: Natural Resources Security, Self Determination, Cultural Use, Community Connection, Well-Being, and Education.** These are used to inform needs, health policy, and coastal planning (Donatuto et al 2016).

In **Fig. 3D.7b** on the following page, importance of each Indicator was weighed by Tribal community. Validation ranking for each Indicator quantifies the extent to which the community member felt these concepts reflected their values. Most of these Indicators were valued evenly among participant, with the greatest variability being how the Education indicator was viewed (Donatuto et al, 2016).

- Without clear methodologies of how to equitably incorporate Indigenous health values and concerns into non-Indigenous health assessment frameworks, the Indigenous values are at risk of

Figure 3D.7a : Swinomish Indigenous Health Indicators and Climate Impacts (2016)

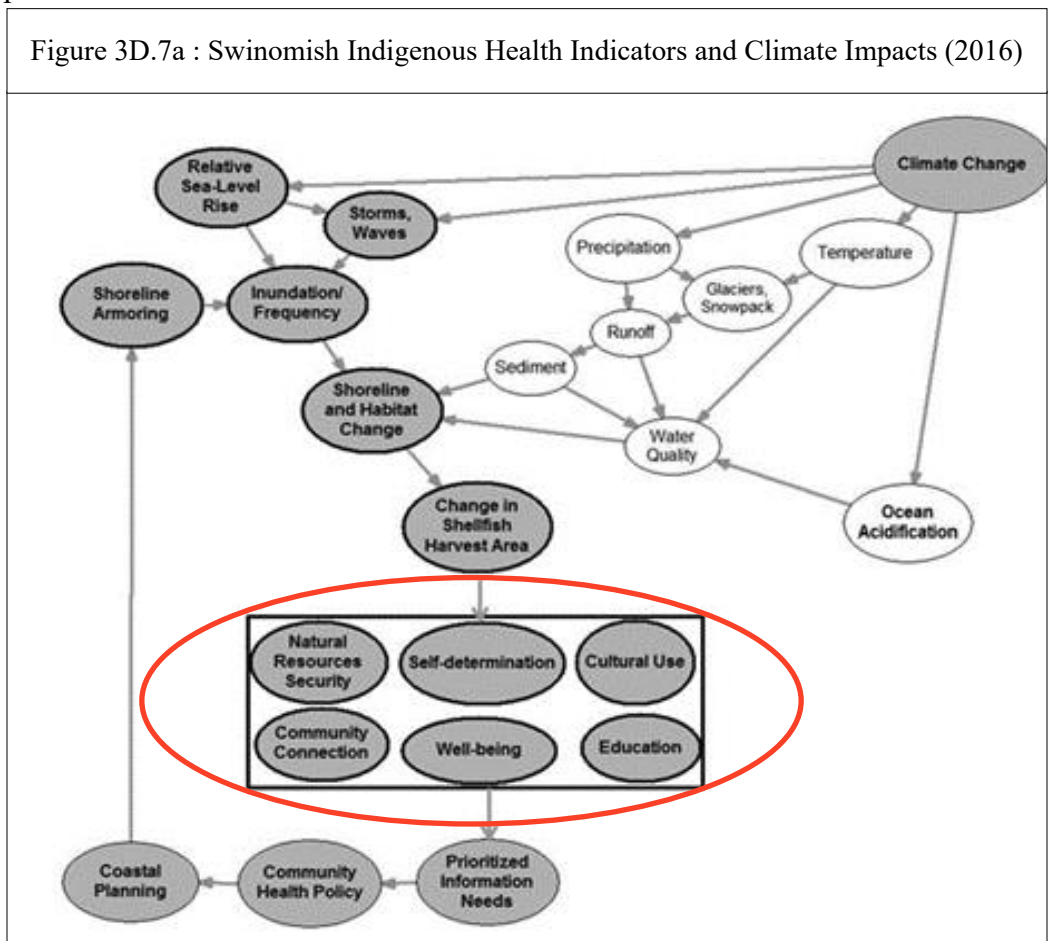
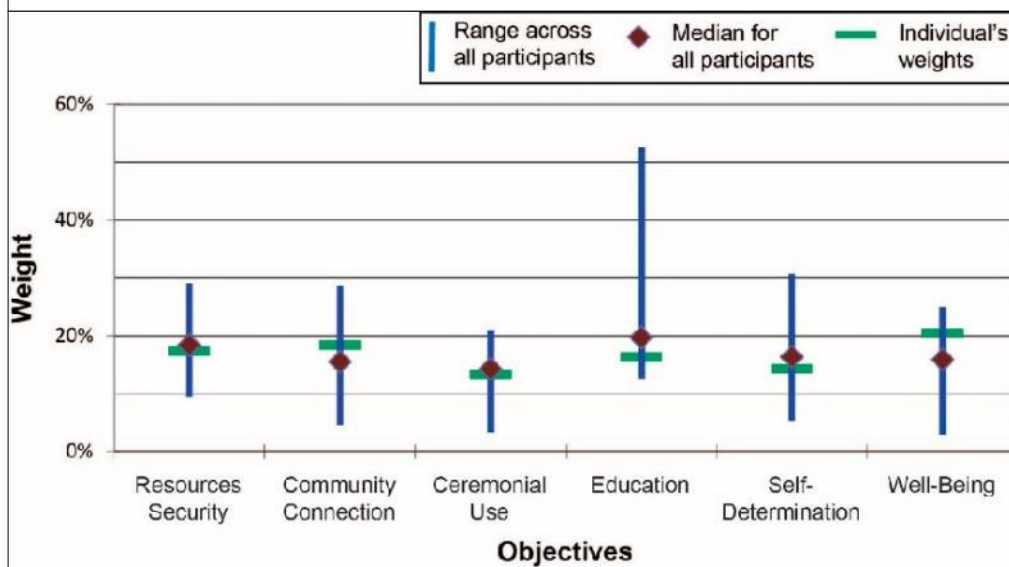


Figure 3D.7b : Swinomish Community Evaluation of IHIs for Relevance, Accuracy



being were identified, including strength of people’s connections to land and culture, and that remote living can help Indigenous people better cope with stressful circumstances at an individual, family and community level (Green and Minchin 2014).

(Credit: Donatuto et al 2016)

Gaps in Knowledge/Data/Policy:

- Mapping of specific health and culture connections for the CTUIR Tribal community;
- Updating the current

co-optation, or of becoming irrelevant or inaccurate to the community.

- Current public health assessment indicators often disregard key cultural values, beliefs and practices, and don’t account for explicit exposure pathways that exist uniquely for Indigenous communities.
- Examples include: harvest and use of culturally important resources such as salmon, wild rice, reeds for basket weaving, or the use of water for sweatlodges, among others (Donatuto et al, 2016).

Other studies have attempted to quantify the impact cultural connection has on health for Indigenous peoples globally. In studies of Indigenous Australians, Aboriginal spirituality is land-centered, and considers not just physical well-being but social, emotional and cultural well-being of the whole community (Green and Minchin, 2014). Studies of these communities report that health of Aboriginal people with diabetes improved dramatically when they returned to traditional subsistence activities (Green and Minchin, 2014).

Similar studies have also found Indigenous people involved with environmental and cultural activities are more physically active, have better diets, and suffered lower rates of obesity, diabetes, renal disease, cardiovascular disease and psychological stress. All this indicates self-determination is an important driver of health and well-being (Green and Minchin, 2014).

A number of protective factors for Indigenous well-

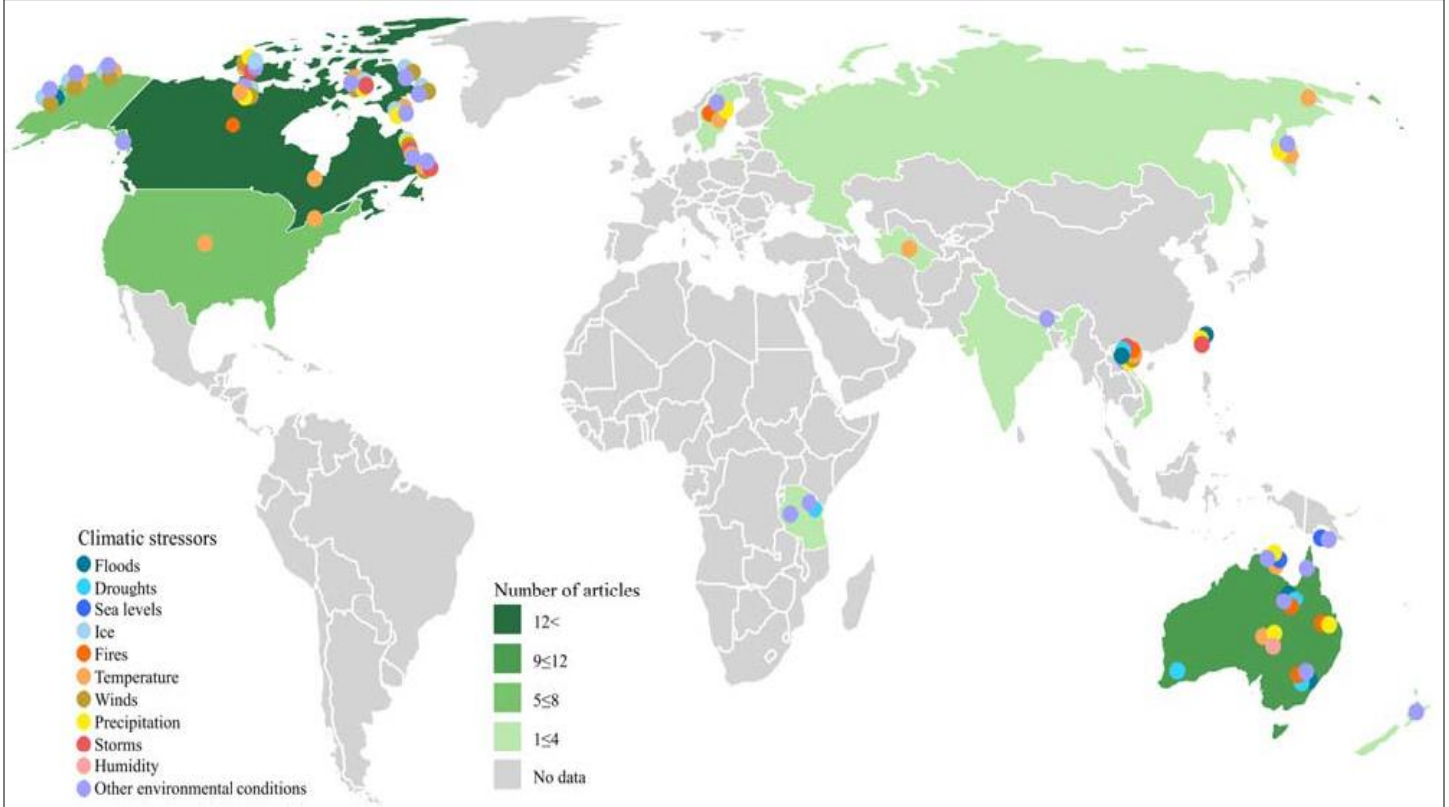
- Community Health Assessment by incorporating climate impacts;
- How connections to culture are impacted by changing climates and access issues for the CTUIR community specifically.

8. Exacerbated Climate Grief, Eco-anxiety, and Solastalgia

“In Tribal creation belief, in the time before people, the Creator gathered all the plants and animals and explained that there were going to be people and that they would be like infants and would need to learn about their new world. The Creator asked the plants and animals ‘who will take care of the Indian people?’ Salmon was the first to promise his knowledge and body, then other fish lined up behind salmon. Next came Deer and the other game animals, then Cous and other roots, then Huckleberry and all the other berries.”

“In return, Indian people promised to respectfully harvest and care for the First Foods. The First Food serving ritual in the Longhouse is based on the order of the First Food promised themselves and serves as a reminder of the promise and people’s reciprocal responsibility to respectfully use and take care of the foods. Embedded within this promise is that people need to harvest First Foods in order to fulfill their responsibility to the First Foods. Many in the CTUIR, therefore, regard plants, like animals and other natural objects, to have a spirit and morality (First Foods

Figure 3D.8: Global Research Into Mental Health Impacts Associated with Climate Change for Indigenous Communities



Upland Vision, 2019).”

Stress and mental health issues have tangible effects on a person’s wellbeing, and impacts from the climate crisis will create more risk for communities to experience chronic stress. Mental health refers not just to mental illness, but states of mental wellness, emotional resilience, and psychosocial wellbeing.

‘Psychosocial wellbeing’ is the interaction between social and psychological conditions that shape human welfare. Impacts to mental health can be categorized as direct impacts (like stress around extreme weather events), community and environmental disruption, and increasing emotional distress, depression, and anxiety, that create conditions for post-traumatic stress disorder (PTSD) (Hayes et al 2018).

Long-term changes create a disconnection between landscapes, water, animals, and people that can exacerbate mental health issues, especially for Indigenous people. This can also ripple out to built and social environments, as climate weaken critical infrastructure, intensifies financial and relationship stress, increases risks of violence and aggression, and threatens to displace entire communities (Middleton et al 2020).

Figure 3D.8 displays a map of existing research that has been conducted on mental health impacts to Indigenous communities specifically, and notes the primary climate impact being examined in each case.

- Mental health research on climate effects of Indigenous people are shown on the map in green-scale based on the number of articles published within these countries: light greens indicate between 1 and 8 articles available; darker colors show countries with significant investment in Indigenous-specific mental health, with 9 or more published articles. Countries in gray had no published studies (Middleton et al 2020).
- Many of these studies examined a specific category of climate change impact. These specific focuses are identified with a range of colors: water impacts like flood, drought, sea level rise and ice change are indicated in blue shades; fires and extreme heat are shaded in oranges; wind and precipitation impacts are shown in yellow, while storms and humidity are colored pink. Other impacts are colored gray.
- The majority of primary research was conducted in Canada (39.6%), Australia (25%), or the United

States (10%), with most occurred at a local/ community level and predominantly set in remote or rural contexts. Within the map, the United States is indicated to have published 5-8 articles specifically documenting Indigenous people’s connection with mental health, with the only climate factor addressed within these studies being extreme heat.

- This shows that Indigenous mental health is impacted by multiple interconnected pathways, as several studies reported **vicarious distress among Indigenous participants who feared or empathized for those experiencing intense weather or environmental hardship**, particularly within their social networks, family, and friends.
- Others cited **deep ancestral connection to place and land, showing that access to, and time spent on, the land was not only important for subsistence and livelihoods, but was also linked to fulfilling psychological needs**. These included a strong sense of identity and self-worth as well as strengthening interpersonal relationships and cultural practices (Middleton et al, 2020).
- Changes linked to an **altered or loss of place resulted in negative consequences for livelihoods, cultural practices, and social networks, as well as to alterations in personal and collective identities** intimately tied to the health of the environment, generating negative mental health outcomes.

However, psychosocial resilience is often a complex thing, and early evidence suggests that these desperate conditions can also inspire communities to altruism, compassion, optimism, and a sense of meaning and post-traumatic growth. Awareness of changes is another avenue for mental health concerns, especially for Indigenous people who are in constant communication with the non-human world. Psychoterratic syndromes include phenomena such as ‘ecoanxiety’, ‘ecoparalysis’, and ‘solastalgia’ are being recognized.

- ‘Ecoanxiety’ refers to the anxiety people face from constantly being surrounded by the ‘wicked’ and threatening problems associated with a changing climate.
- ‘Ecoparalysis’ refers to the complex feelings of not being able to take effective

action to significantly mitigate climate change risks.

- ‘Solastalgia’ refers to “the distress and isolation caused by the gradual removal of solace from the present state of one’s home environment,” and is commonly associated with displacement following a climate change-related extreme weather event (Middleton et al 2020).

Mental health impacts can be felt differently across various age groups, genders, and livelihoods. In global studies of Indigenous communities, **female respondents reported higher levels of frustration, sadness, fear, anger, helplessness, and distress** in response to observed and lived climatic change and the odds of reporting symptoms of solastalgia (Middleton et al 2020).

For Indigenous men, anxiety, suicide, and substance abuse were more of a challenge as an emotional response, particularly for those who depend on seasonal and climate-dependent employment (e.g. farming, hunting), and those who highly value their land-based identity (Middleton et al, 2020).

For Tribal youth, mental health experiences can differ from other generations: they are experience changing climate conditions unprecedented for previous generations, and child and adolescent experiences are formative for wellbeing later in life. Elders also face mental health challenges related to identities, livelihoods, and



Cultural knowledge keeper David Wolf demonstrates net-repair techniques to a youth group participant. Connection and sharing of culture will be essential to climate adaptations for mental health.

wellbeing that is deeply rooted in time spent on the land, especially as conditions for shelter-in-place responses to climate impacts are prioritized.

Food security (or knowing where one’s next meal will come from) will also be affected. Many studies show the practice of harvesting and sharing traditional food is tied to fulfilling psychological needs at both individual and community levels. The ability to provide food for one’s family was reported as a source of positive identity, and the process of harvesting and food-sharing contributed to stronger social networks.

Both planned and unplanned relocation creates negative impacts to Indigenous communities, studies report **individuals who were able to stay in their community following a natural disaster showed higher resilience compared to those who relocated to urban centers**. Poor planning and policy can have more severe psychological consequences than the disaster itself, demonstrating that governments should set aside more space, hold longer discussions,

and provide different alternatives’ for relocation. Some negative health outcomes were linked to feelings of abandonment by governments and the broader global community.

Repeated exposure to multiple climatic stressors and subsequent environmental adversities can compound emotional and behavioral distress over time, and become precursors to mental illness, suicidality, substance abuse, and limited psychological resilience (Middleton et al 2020). Preserving connection to place has been highlighted as an important mental health adaptation for Indigenous communities, particularly those with land-based livelihoods and identities.

(Middleton et al 2020)

Gaps in Knowledge/Data/Policy:

- Community health assessments insufficiently measure sources of mental health issues for Indigenous people, thus knowledge of how these are changing is lacking.

Adaptation Goals for Emotional Wellbeing

D. Create Opportunities to Gather, Learn, and Share Stories Together

“Through the ages, these stories connected individuals to this land. Our stories explain the nature of behavior or the encapsulated events and worldviews of our Tribal people.” (Phillip E. Cash Cash, 2015)

i. Support and Normalize Asking for Help with Physical and Emotional Pain

Starting within each individual, and within each family, and reaching out to communities and governance; being comfortable asking for help is essential in building resilience.

Short Term:

- **Facilitate gathering opportunities for those with marginalized identities**

including disabled, chronically ill, and Two-Spirit community members to support each other and to listen to one another, and to be heard by health care staff and administrators. Solidarity from others affected by similar circumstances can reduce feelings of isolation, improve services to meet distinct needs, and empower families to embrace adaptation that suits their needs.

- **Expand opportunities for Tribal Members to access informal mental health and counselling services;** regularly available informal opportunities reduce administrative hurdles to receiving care that can be a barrier for those who are struggling.

Long Term:

- **Create policies to encourage medical and mental health practitioners to earnestly listen to complaints of pain**



and suffering, and proactively address them. Often medical staff disbelieve patients about pain, particularly in communities affected by opioid crises.

found on page 171.

Long Term:

ii. Facilitate a Community-led Climate Shifted Revision of Seasonal Round

Disconnection between First Foods and traditional timing has been documented by cultural practitioners. Hunters, fishermen, and gatherers who are closely connected with seasonal change indicators have noted the shift in First Foods timing they are experiencing, but it has been difficult to apply this knowledge to cultural timing due to lack of modeling and data around native species.

Short Term:

- **Organize and facilitate a community-led initiative to document a seasonal hazards round**, to identify where health and emergency needs may overlap with various harvesting windows. This could help families anticipate seasonal hazards and incorporate mitigation into their own planning. A version of this seasonal hazard rounds has been attempted for air quality impacts, and could be expanded and verified by the Tribal community. A version of this round is

- **Organize and facilitate a community-led initiative to document CTUIR’s climate-shifted First Foods seasonal round**, based in observations of Tribal Members’ experiences, noting any gaps in information or planning.

iii. Support opportunities for Healing Connections with First Foods, Land, Community, and Culture

Tribal people are emotionally and spiritually connected to place-based culture, but few studies have specifically examined emotional health and connection to land that Indigenous communities experience. Health outcomes are improved for tribal communities when they have access to their traditional lands and cultural practices.

Short Term:

- **Support and expand DNR’s Cultural Resources Protection Program (CRPP) First Foods Excursions**; these are being organized and facilitated by CRPP and Yellowhawk Community Wellness staff, and aim to provide opportunities for Tribal Members and community to reconnect with First Foods guided by cultural knowledge keepers.

- **Support and expand cultural revival activities that center Tribal language learning**, like the Tamycet (earth oven) revival facilitated by the Language Program within the Education Department. Reconnection to language is integral to Indigenous knowledge and Tamanwit that creates climate resilience. See Ch 3G pages 288-290 for additional detail.

- **Collaborate with regional organizations hosting youth and adult First Foods Camps**, such as Salmon Camp with Columbia River Intertribal Fish Commission (CRITFC), and with cultural revival camps held by Naknuwithlama Tiichamna (Caretakers of the



Bringing community together for intergenerational learning creates families that are resilient and prepared for emergencies mentally and physically.

Land) in Cove, OR, and develop new extended cultural and First Foods learning opportunities.

- **Expand K12 and family-based learning opportunities for learning through play engagement;** both structured learning opportunities like Outdoor School and Watershed Field Days, as well as unstructured learning like the Indian Lake Campground Fish Derby can build positive connection with First Foods.

Long Term:

- **Expand First Foods mutual aid frameworks** for Tribal community to provide cultural and nutritional assistance to each other. These could include seed banks, kitchen equipment cooperatives, canning classes and gatherings, ingredient sourcing and sharing, CTUIR salmon and bison distribution, and building connection with local and Tribal seed producers. nutritional assistance to each other; these could include seed banks, kitchen equipment cooperatives, canning classes and gatherings, ingredient sourcing and sharing, CTUIR salmon and bison distribution, and building connection with local and Tribal seed producers. See Ch 3F page 255 for additional detail.
- **Identify land development and living standards that support Treaty Rights exercise and community participation.** These might include diversified land development that facilitates community, intergenerational connection, living and working in reasonable proximity, and carbon-free (biking, walking, horse trails etc) commutable neighborhoods. New Nixyaawii Community Neighborhood (formerly known as the “Bowman Property”) is an example of this kind of diversified land development and planning. See Ch 3F pages 231-233 for

additional detail.

iv. Continue to Work with Seniors Center, Elders, and Education Opportunities

Elders are precious keepers of knowledge, and have seen much change over their lives. Cross-generational learning and sharing creates opportunities for knowledge to be passed between individuals and generations, and keep strategies for resilience alive.

Short Term:

- **Conduct and compile knowledge keeper interviews** to identify ecological and First Foods changing trends that have occurred within living memory. A number of interviews with knowledge keepers include information about changes these Elders have seen within the archives of CRPP; a coordinated project to collect and expand on this existing information could inform seasonal round activities, and other Indigenous knowledge and adaptation implementation projects.
- **Develop community participation projects that encourage youth to engage their family and Elders** in questions of change and shifting cultural connection; organize gathering opportunities to share those expressions with the community, such as talking circles, art displays, theme pow wows, film festivals, painting murals, and other collaborative creative expressions.

Long Term:

- **Partner with Nicht-Yow-Way Seniors Center and other Elder care services** to provide listening and education opportunities with a cross-generational learning focus.



E. Continue to Revitalize Cultural First Foods Harvest, Processing, and Connection

“The CTUIR traditionally harvest about 135 species of plants as sources of food. Other plants and plant products are used for a variety of other purposes. For example, over 125 plants were used for dyes, cordage, containers, glues, weaving materials and other uses. Plateau cultures, including the Tribes of the CTUIR also used over 125 plant species for medicinal and spiritual purposes. While not First Foods, these culturally important resources are also a fundamental part of the health, cultural identity and sovereignty of the CTUIR (Hunn et al. 1998, First Foods Up-lands Vision 2019).”

i. Develop Employment Frameworks for First Foods Procurement by Tribal Harvesters

Tribal subsistence harvesters are keepers of knowledge from their time in connection with land, and are critical to preserving First Foods ecological knowledge. Some examples of frameworks that could currently assist in developing First Foods procurement employment are (but not limited to):

Short Term:

- **Policy advances like 638 contracting for Tribal food assistance programs (FDIPR, SNAP etc)** which could create opportunities for harvesters to become USDA “vendors” to programs that serve low income Tribal families. See Ch 3G pages 278-279 for additional detail.



Cultural teachings revitalization, like the Huckleberry Cedar Basket workshop series pictured, connects Tribal Members with harvest opportunities on Traditional Use Area lands, and with processing knowledge previously dormant.

- **Tribal grant support to Tribal enterprises and startups aimed at providing fresh, local, and culturally appropriate foods** and plant medicines within the community; this could include assistance with enterprise operator health and business insurance, and other operations costs. See Ch 3F pages 231-233 for additional detail.
- **Nixyaawii Community Financial Services (NCFS) Food Sovereignty loans** will provide financial assistance to home food producers to start or expand small business operations for Tribal Members and UIR residents. See Ch 3F pages 231-234 for additional detail.

Long Term:

- **Develop and implement frameworks for flexible employment arrangements** that allow for Tribal Members to participate more fully with First Foods harvests and activities.
- **Advocate for cultural leave implementation** at schools and other institutions that employ or educate tribal members around the region.
- **Investigate potential for cultural foods harvest and processing of First Foods to account for social contract payments**, such as child support, minor infractions, and other outstanding debt that would be eligible for this framework.

ii. Plan for Extreme Heat, Toxic Algal Bloom, and Wildfire Hazards

Seasonal hazards are set to become more frequent and severe, and many hazards create multiple pathways for harm to human health. Risk is highest for subsistence harvesters who are out on the land for extended periods of time in hazardous conditions.

Short Term:

- **Facilitate opportunities for education around personal risk mitigation** for climate impacts to cultural activities and practitioners. This could include workshops that stress recognition of hazards present, signs and symptoms of associated illnesses, mitigation strategies, and opportunities for practitioners to share their observations and strategies.
- **Assess community needs for risk mitigation equipment** and provide assistance with procurement, maintenance, and skills around proper use and safety. Much of the equipment that would help mitigate for harm is costly, which can be a barrier to families. Assessing these needs and barriers will provide more information for services and funding requests.

Long Term:

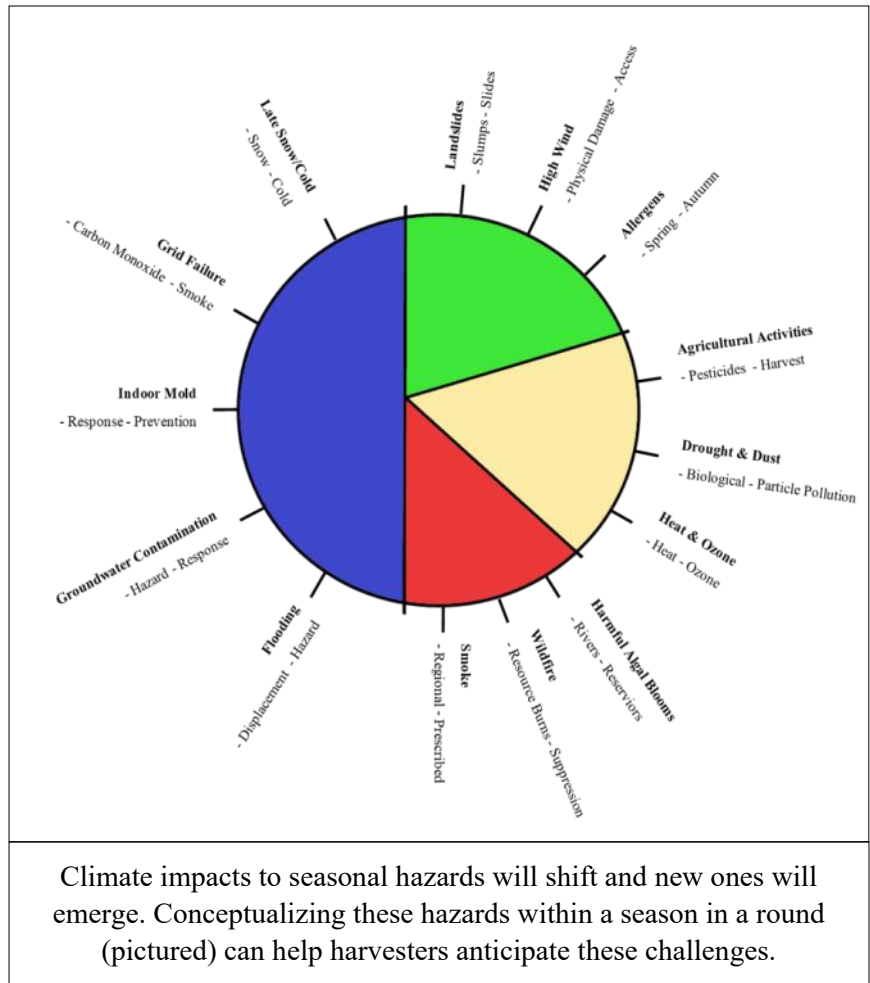
- **Planned excursions and gatherings must account for seasonal hazards and have protocols in place** for assessing threat levels to health, with contingency action triggers established. With action triggers set by leaders and community, decision making about safe conditions to hold individual events will be standardized to relieve pressure on organizers and staff.

iii. Expand First Foods Revitalization Efforts that Embrace Uncertainty

Uncertainty is the biggest impact the climate crisis creates, and seasonal weather patterns will become less reliable into the future. Accurately assessing risks from climate and non-climate related impacts to human health is necessary for protecting Tribal communities while building cultural connection.

Short Term:

- **Retain virtual options for gathering and meeting attendance**, even as additional attendance



options for in-person events, to maximize the ability for people with different circumstances to participate. Retaining a diversity of communication and gathering options allows greater access for those with mobility and transportation barriers, though improving internet access for those who lack it will improve equity of this adaptation.

- **Create contingency plans for cultural and First Foods education** activities that assesses risk and likelihood of modification to seasonal plans, and proactively plan for sudden changes that may need to be made. Assuming seasonal hazards are likely to complicate plans encourages organizers to plan secondary activities, should hazards actually occur, without disrupting continuity of these efforts.

Long Term:

- **Implement flexible work frameworks to allow for smooth services** in natural and public health disaster situations; in surveys to the Tribal community, “time” is consistently identified as a

barrier to engaging in cultural practices. While CTUIR as an employer provides some amount of “cultural leave” for participation, flexible and condensed employment schedules would create additional opportunities for Tribal Members to practice cultural connections and First Foods harvest. See Ch 3F pages 231-233 for additional detail.

- **Conduct periodic First Foods knowledge and access assessments** similar to the 2020 First Foods Assessment, with a greater emphasis on identifying non-education barriers to access. Understanding where barriers exist and how they are changing helps staff, knowledge keepers, and services remain relevant and supportive as needed.

iv. **Expand knowledge of First Foods Harvest Opportunities through Data and Reporting**
Information about how First Foods are changing is necessary for maintaining connections with these species, and updating knowledge about their locations and timing.

Short Term:

- **Develop reporting protocols for First Foods issues, as well as community education on these protocols,** and raise awareness of key indicators for Tribal Members to observe; these could include timings of First Foods harvests, obstacles to harvest that were encountered, invasive species that have increased or are newly present, and behaviors of symbiotic and indicator species, among others. See Ch 3B pages 88-90 for additional detail.

Long Term:

- **Expand DNR capacity to collect population monitoring data for First Foods** in their known locations, and implement scouting efforts to identify new and potential locations. CRPP has begun this cataloging work through staff surveys conducted ad-hoc, using Survey 123 software and GIS mapping. Expanding this work would provide greater information on existing and changing First Foods harvest opportunities. See Ch 3B pages 83-84 for additional detail.

v. **Support Tribal Community in Documenting First Foods Knowledge**

Conventional medical science is lagging behind Indigenous knowledge in terms of understanding the holistic nature of health, but supporting Tribal scientists and practitioners conducting this work is the best strategy for addressing gaps.

Short Term:

- **Pursue funding opportunities that build scientific knowledge of First Foods relationships to land and people.** These could include testing capacity to document contamination issues with certain species, documenting access barriers experienced, and changing education needs.

Long Term:

- **Participate and organize Tribal-led research projects into First Foods nutrition** and properties, as guided by knowledge keepers, Tribal youth and Elders, and the Tribal community, and supported by outside partners.



Measuring Success and Gaps in Emotional Wellbeing Adaptation

How Do We Measure the Success of These Adaptations?

“When we do not visit the places that our ancestors knew or when we do not tend to the rituals of honoring those places in prayer, do we deprive ourselves of the insight and wisdom the land provides? If knowledge of the land is a reflection of knowledge of ourselves, do we become separated from our history when we are separated from our land, the place of our history? The answers depend on how well we keep the stories alive and whether we can maintain our inextricable relationship with the land. After over two hundred years of cultural disruption, we are doing the best we can (Morning Owl et al 2015).”

- Yellowhawk Community Health Assessment Benchmarks.
- Yellowhawk Annual Plan Goals and Objectives
- **Comprehensive Plan Objective 5.4.8:** Support Tribal members to pursue and excel in education to become self-reliant and to contribute to the Tribal community (see Comp Plan page 74 for benchmarks);
- **Comprehensive Plan Objective 5.5.10:** Encourage Tribal community participation in Long House practices and promote freedom of religion on the UIR (see Comp Plan page 76 for benchmarks);
- **Comprehensive Plan Objective 5.7.4:** Provide training and education to CTUIR employees, Tribal community and outside entities on the importance of the First Foods and the federal, state and Tribal laws which protect them. Coordinate with CTUIR Education and other programs on culturally related ceremonies, activities, foods and heritage (see Comp Plan page 90 for benchmarks);
- **Comprehensive Plan Objective 5.11.8:** Actively participate in State, Federal and area Indian Health Board health care related policy and legislative activities to the best interest of all CTUIR members (see Comp Plan page 108 for benchmarks);
- **Comprehensive Plan Objective 5.11.9:** Promote the well-being of all Tribal Members (see Comp Plan page 108 for benchmarks).
- Access to mental health services and group sharing opportunities for community.
- **CTUIR Hazard Mitigation Plan (2021) Section 3:** Hazard Identification and Risk Assessment Results (page 68-190).
- **CTUIR Hazard Mitigation Plan (2021) Section 5:** Mitigation Strategy Implementation and Integration (page 214-225)
- Reduced displacement of Tribal Members and families from homelands and property.
- Family connection in learning and knowledge-sharing.
- Flexibility in self, family, community, and governance.
- Continued reciprocity with First Foods.

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

- Changing population dynamics and projections of climate migration;
- Community emergency displacement needs that may change as disasters intensify;
- Mental health and wellness check measurements in health assessments;
- Pathways for feedback and ways to reach out for help;
- Stress testing of health services in anticipation of emergencies;
- How climate disasters will compound and exacerbate one another.

Health Adaptation Summary

Physical Health Adaptations

- A. Support and Expand Community Health Capacity and Education**
- B. Approach Public Health Holistically with Cultural Connection**
- C. Expand Organizational Cooperation on Health Needs of Tribal Community**

Health for Indigenous communities is much more complex than conventional public health frameworks understand, and increasing capacity for Tribal Members and community to direct their own research and wellness creates climate resilience in public health.

Measures of Success:

- Yellowhawk Tribal Health Center Annual Work Plans, and Community Health Assessments
- Comprehensive Plan Objectives 5.4.3, 5.5.7, 5.7.9, 5.11.3, 5.11.6, 5.11.11, 5.13.1, and 5.12.3
- CTUIR Hazard Mitigation Plan (2021) Sections 3 and 4
- Good Health and Wellness in Indian Country (GWIC) Grant Objectives 1,2, and 3 and sub-objectives and benchmarks.
- Chronic health prevalence in communities

Emotional Wellbeing Adaptations

- D. Create Opportunities to Gather, Learn, and Share Stories Together**
- E. Continue to Revitalize Cultural First Foods Harvest, Processing, and Connection**

Emotional wellbeing is closely tied with land and cultural wellbeing, and the two must be treated simultaneously in climate adaptation. Opportunities to connect with land, community, culture, and inter-generational knowledge create psychosocial wellbeing for Indigenous people.

Measures of Success:

- Yellowhawk Tribal Health Center Annual Work Plans, and Community Health Assessments (2016 and 2022)
- Comprehensive Plan Objectives 5.4.8, 5.5.10, 5.7.4, 5.11.8, and 5.11.9
- CTUIR Hazard Mitigation Plan (2021) Sections 3 and 5
- Family connection in learning and knowledge-sharing.
- Flexibility in self, family, community, and governance.
- Continued reciprocity with First Foods.



Chapter 3D References and Credits

Literature References

Boxall, Alistair B.A.; Hardy, Anthony; Beulke, Sabine; Boucard, Tatiana; Burgin, Laura; Falloon, Peter D.; Haygarth, Philip M.; Hutchinson, Thomas; Kovats, R. Sari; Leonardi, Giovanni; Levy, Leonard S.; Nichols, Gordon; Parsons, Simon A.; Potts, Laura; Stone, David; Topp, Edward; Turley, David B.; Walsh, Kerry; Wellington, Elizabeth M.H.; and Williams, Richard J. 2009. "Impacts of Climate Change on Indirect Human Exposure to Pathogens and Chemicals from Agriculture." *Environmental Health Perspectives* volume 117 | number 4 | April 2009

Dalton, Meghan. 2020. "Future Climate Projections: Umatilla County." Oregon Climate Change Research Institute for Oregon Department of Land Conservation and Development.

Donatuto, Jamie; Grossman, Eric E.; Konovsky, John; Grossman, Sarah; and Campbell, Larry W. 2014. "Indigenous Community Health and Change: Integrating Biophysical and Social Science Indicators" *Coastal Management*, 42:355–373.

Donatuto, Jamie; Campbell, Larry; and Gregory, Robin. 2016. "Developing Responsive Indicators of Indigenous Community Health." *Int. J. Environ. Res. Public Health* 2016, 13, 899; doi:10.3390/ijerph13090899

Doubleday, Annie; Schulte, Jill; Sheppard, Lianne; Kadlec, Matt; Dhammapala, Ranil; Fox, Julie; and Isaksen, Tania Busch. 2020. "Mortality associated with wildfire smoke exposure in Washington state, 2006–2017: a case-crossover study." *Environmental Health* (2020) 19:4 <https://doi.org/10.1186/s12940-020-0559-2>

Environmental Law Institute (ELI). 2016.

"Indoor Air Quality in Homes: State Policies for Improving Health Now and Addressing Future Risks in a Changing Climate." Washington, D.C. All rights reserved.

Fann, Neal; Nolte, Christopher, G.; Dolwick, Patrick; Spero, Tanya L.; Brown, Amanda Curry; Phillips, Sharon; and Anenberg, Susan. 2015. "The geographic distribution and economic value of climate change-related ozone health impacts in the United States in 2030." *Journal of the Air & Waste Management Association*, 65:5, 570-580, DOI: 10.1080/10962247.2014.996270

Fritze, Jessica G; Blashki, Grant A; Burke, Susie; and Wiseman, John. 2008. "Hope, despair and transformation: Climate change and the promotion of mental health and wellbeing." *International Journal of Mental Health Systems* 2008, 2:13 doi:10.1186/1752-4458-2-13

Griffith, Andrew W.; Gobler Christopher J. 2020. "Harmful algal blooms: A climate change co-stressor in marine and freshwater ecosystems." *Harmful Algae* 91 (2020) 1015902

Gorris, M. E., Treseder, K. K., Zender, C. S., & Randerson, J. T. (2019). Expansion of coccidioidomycosis endemic regions in the United States in response to climate change. *GeoHealth*, 3, 308–327. <https://doi.org/10.1029/2019GH000209>

Hayes, Katie, Blashki, G.; Wiseman, J., Burke, S.; and Reifels, L. 2018. "Climate change and mental health: risks, impacts and priority actions." *Int. Journal of Mental Health Systems*(2018) 12:28

Jaffe, Daniel; Price, Heather; Parrish, David; Goldstein, Allen; and Harris, Joyce. 2003.



- McNally, Bryan; Hoshiko, Sumi; with the CARES Surveillance Group. 2020. "Out-of-Hospital Cardiac Arrests and Wildfire-Related Particulate Matter During 2015–2017 California Wildfires." *J. Am. Heart Assoc.* 2020; 9:e014125. DOI:10.1161/JAHA.119.014125.)
- Korsiak, Jill; Pinault, Lauren; Christidis, Tanya; Burnett, Richard T.; Abrahamowicz, Michal; Weichen-
thal, Scott. 2022. "Long-term exposure to wildfires and cancer incidence in Canada: a population-based observational cohort study." *Lancet Planet Health*, 6: e400-09.
- 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>
- Middleton, Jacqueline; Cunsolo, Ashlee; Jones-Bitton, Andria; Wright, Carlee J; and Harper, Sherilee L. 2020. "Indigenous mental health in a changing climate: a systematic scoping review of the global literature." *Environmental Research Letters* 15, 053001 <https://doi.org/10.1088/1748-9326/ab68a9>
- Moore, Stephanie K; Trainer, Vera L; Mantua, Nathan J; Parker, Micaela S; Laws, Edward A; Backer, Lorraine C; and Fleming, Lora E. 2008. "Impacts of climate variability and future climate change on harmful algal blooms and human health." *Environmental Health* 2008, 7(Suppl 2):S4 doi:10.1186/1476-069X-7-S2-S4
- Mora, Camilo PhD; Counsell, Chelsie W.W, MSc.; Bielecki, Coral R. BS; Louis, Leo V BS. 2017. "Twenty-Seven Ways a Heat Wave Can Kill You: Deadly Heat in the Era of Climate Change." *Circ Cardiovasc Qual Outcomes*. 2017;10:e004233. DOI: 10.1161/CIRCOUTCOMES.117.004233.
- Reid, Colleen E.; Brauer, Michael; Johnston, Fay H.; Jerrett, Michael; Balmes, John R.; and Elliott, Catherine T. 2016. "Critical Review of Health Impacts of Wildfire Smoke Exposure." *Environmental Health Perspectives* volume 124 | number 9
- Rigby, C.; Rosen, A.; Berry, H.; and Hart, C. 2011. "If the land's sick, we're sick': The impact of prolonged drought on the social and emotional well-being of Aboriginal communities in rural New South Wales." *Australian Journal of Rural Health* 19:249–254
- Rogers, Christine A.; Wayne, Peter M.; Macklin, Eric A.; Muilenberg, Michael L.; Wagner, Christopher J.; Epstein, Paul R.; and Bazzaz, Fakhri A. 2006. "Interaction of the Onset of Spring and Elevated Atmospheric CO₂ on Ragweed (*Ambrosia artemisiifolia* L.) Pollen Production." *Environmental Health Perspectives* • VOLUME 114 | NUMBER 6 | June 2006
- Rogge, WF; Medeiros, PM; Simoneit, BRT. 2007. "Organic marker compounds in surface soils of crop fields from the San Joaquin Valley fugitive dust characterization study." *Atmos. Environ* 41:8183–8204.
- Shea KM, Truckner RT, Weber RW, Peden DB. 2008. "Climate change and allergic disease." *Journal of Allergy Clin Immunol.* 122(3):443–453.
- Singer, Ben D., Ziska, Lewis H., Frenz, David A., Gebhard Dennis E., Straka James G. 2005. "Increasing Amb a 1 content in common ragweed (*Ambrosia artemisiifolia*) pollen as a function of rising atmospheric CO₂ Concentration." *Functional Plant Biology*, 32, 667-670.
- Smith JL, Lee K. 2003. "Soil as a source of dust and implications for human health." *Adv Agron* 80:1–32.
- Turner N, Clifton H (2009) It's so different today: climate change and indigenous lifeways in British Columbia, Canada. *Global Environmental Change* 19:180–190
- Ziska, L.H., and F.A. Caulfield. 2000. "Rising CO₂ and pollen production of common ragweed (*Ambrosia artemisiifolia* L.), a known allergy-inducing species: implications for public health." *Australian Journal of Plant Physiology*, 27(10): 893-898.
- Zubrick S, Dudgeon P, Gee G, Glaskin B, Kelly K, Paradies Y, et al. 2010. "Social Determinants of Aboriginal and Torres Strait Islander Social and Emotional

Wellbeing.” In: Working Together: Aboriginal and Torres Strait Islander Mental Health and Wellbeing Principles and Practice, Purdie N, Dudgeon P, Walker R (editors), Canberra: Office of Aboriginal and Torres Strait Islander Health, pp 75–90.

Photo Credits

- Part D Cover photo; “First Foods Excursion Family Outing.” CTUIR DNR FFPP Aug 2018.
- Background photo; “Smoky summer skies.” CTUIR DNR FFPP Aug 2018.
- Background photo; “Tribal Youth Assembles Tipi.” Althea Huesties Wolf.
- Inset Photo, “CTUIR wildland fire crews use drip torches in prescribed burn,” BIA Umatilla Agency Fire Operations, Oct 2021.
- Inset Photo, “Algae grows along the shore of the Umatilla River,” CTUIR DNR FFPP Sept 2022.
- Inset Photo, “UIR resident Judy Beers surveys Feb 2020 Flood damage,” CTUIR DNR 2020.
- Inset Photo, “Community identified allergens as significant climate impact,” CTUIR DNR FFPP Aug 2022.
- Inset Photo, “Tribal fishermen scientists/practitioners teach youth on Columbia,” CTUIR FWC Bud Herrera.
- Panel Photo, “Salmon bake in traditional cooking methods over fire,” CTUIR DNR CRPP.
- Inset Photo, “Participants visit Yellowhawk Fun Run outreach booths,” CTUIR CUJ 2022.
- Panel Photo, “Winter landscape in the Wallowa Range,” CTUIR DNR CRPP.
- Inset Photo, “CTUIR DECD staff pass out shirts and PPE at Earth Day Clean Up,” CTUIR CUJ 2021.
- Panel Photo, “Umatilla River North Fork in summer,” CTUIR FFPP Aug 2022.
- Inset Photo, “Tribal Knowledge Keepers teach and learn with food classes,” Oregon State Extension Service, 2018.
- Panel Photo, “Raised beds in home gardens help with food production,” Althea Huesties-Wolf.
- Inset Photo, “Yellowhawk Bread and Butter Pickles workshop,” Oregon State Extension Service, 2017.
- Background Photo, “Outreach staff and volunteers smile during CTUIR Community Picnic,” CTUIR CUJ Aug 2022.
- Inset Photo, “Tribal Knowledge Keeper David Wolf teaches youth to repair fishing nets,” CTUIR DNR CRPP.
- Panel Photo, “Tipi on the July Grounds for Community Picnic,” CTUIR DNR FFPP 2022.
- Inset Photo, “Tribal Member and toddler smile at Community Picnic,” CTUIR CUJ Aug 2022.
- Panel Photo, “Tribal youth learn home meat processing lessons,” Althea Huesties-Wolf.
- Inset Photo, “Tribal Members learn from cedar basket weaver Ramona Kiona,” CTUIR DNR CRPP Wenix Red Elk, 2019.
- Inset Photo, “Draft concept of seasonal hazard round,” CTUIR DNR FFPP 2021.
- Panel Photo, “BIA Umatilla Agency fire crews light prescribed burns,” BIA Umatilla Agency Fire Operations, Oct 2021.
- Summary Inset Photo, “Cultural excursions for youth and community expand knowledge of First Foods and practices,” CTUIR DNR CRPP.
- Panel Photo, “Native plan Prairie Smoke (*Geum triflorum*) before bloom,” CTUIR DNR FFPP 2019.