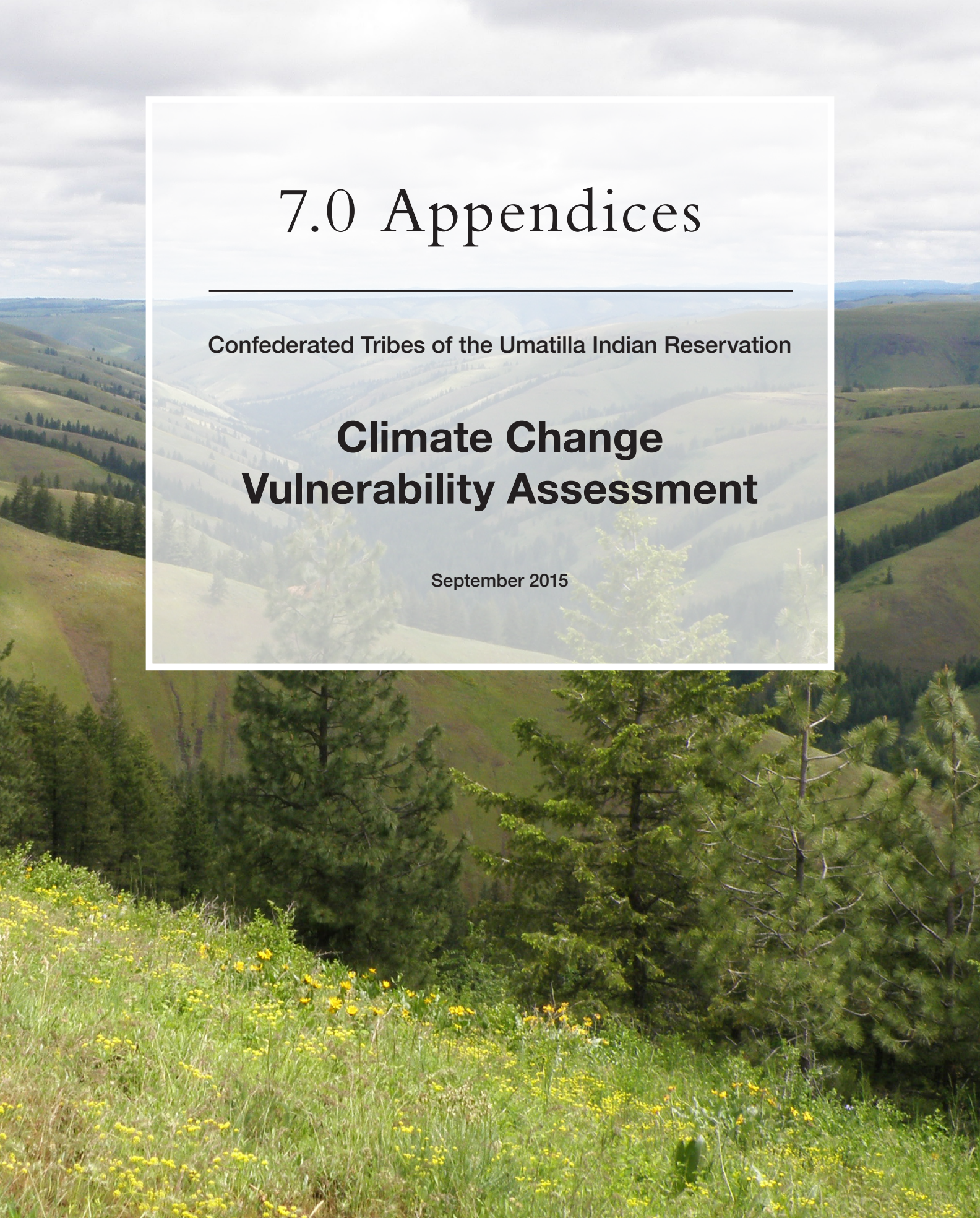

7.0 Appendices

Confederated Tribes of the Umatilla Indian Reservation

Climate Change Vulnerability Assessment

September 2015

This report is a collaboration between the CTUIR, Adaptation International, and the Oregon Climate Change Research Institute (OCCRI).

For information about the CTUIR and its Vulnerability Assessment work, contact CTUIR Department of Science and Engineering at:

CTUIR-DOSE
46330 Timine Way, Pendleton, OR 97801
Phone: 541-429-7040
Fax: 541-429-7040
Email: DOSEFS@ctuir.org

Cover Image Credit
CTUIR Department of Natural Resources

Funding
Project funding was provided by a grant from the Bureau of Indian Affairs for the November 2013 Category 2 (adaptation planning) grant proposal titled Climate Adaptation: CTUIR Vulnerability and Resiliency Assessment and in-kind assistance by the Confederated Tribes of the Umatilla Indian Reservation.

Recommended Citation
Confederated Tribes of the Umatilla Indian Reservation, 2015. Climate Change Vulnerability Assessment. Nasser, E., Petersen, S., Mills, P. (eds). Available online: www.ctuir.org

7.0 Appendices

Appendix 1: CTUIR January 8, 2015 Participant Worksheet

Climate Change and the CTUIR

Participant Worksheet

Instructions

1. ***Indicate tribal enrollment status by checking the appropriate box:***

   ➔ Are you a CTUIR Tribal Member? Yes □ No □

2. ***Write your name below (optional):***

   ➔ Your Name:_____

3. ***Answer the following 5 questions (denoted with Q) pertaining to each presentation.***

Your input supports the first ever CTUIR Climate Change Vulnerability Assessment. Thank you!

Presentation 1: Weather

Stephen Bieda, National Oceanic and Atmospheric Administration

Q-1) What are your concerns related to climate change impacts to weather? Please be as specific as possible

Presentation 2: Water

Kyle Dittmer, Columbia River Inter-Tribal Fish Commission

Q-2) What are your concerns related to climate change impacts to water? Please be as specific as possible.

Presentation 3: Human Health
Emily York, Oregon Health Authority

Q-3) What are your concerns related to climate change impacts to human health? Please be as specific as possible.

Presentation 4: Food
Darrin Sharp, Oregon State University/Oregon Climate Change Research Institute

Q-4) What are your concerns related to climate change impacts to food? Please be as specific as possible.

Q-5) What are your other climate change concerns not relating to the topics presented above? Examples include roadways and other infrastructure, the economy (yes, even the economy will be impacted by climate change), etc. Please be as specific as possible. Refer to the table of potential vulnerabilities for more examples.

Appendix 2: Homeland Security and Climate Vulnerability and Resiliency Elements Incorporated into the KICs

Element	***Homeland Security application***	***Climate Change application***
Land Base	A secure land base with jurisdiction and ownership	Ability to implement priorities effectively through ownership and jurisdiction.
Governance	Stable, balanced government with self-determination of the tribal nation	Stable government, thoughtful priorities, with community participation.
Resources	Natural, cultural, legal, technical, organizational, and human resources adequate to define and meet threats to stability, self-determination, resources, culture, mental and physical health, religion, economy and security. Technical and legal staff. Health and human services adequately funded.	Same resources, along with relevant data needed for climate predictions, stressor identification, signal identification, and adaptation planning. Health stressors, species migration, and other foci.
Capital Resources	Infrastructure, cyber, and domestic resources designed to respond to threats and protect tribal values and resources with strength and understanding in a traditional manner. Adequate housing, and other built environment.	Same resources, focused on emergency response and communications, smart grid, backup power, other.
Security	Confidence in natural resource adequacy and quality, confidence in a leadership that looks out for the members and the resources, confidence in adequate economic well-being; confidence that the culture, language, values, and people will survive; freedom from legal battles brought by the federal and other governments.	Same resources, with a focus on community cohesion and system redundancy.
Culture	Appreciation of individuals, creativity, support of the needy, devotion to the people, justice, and the shared history and blood ties to the land and to each other, according teachings of our elders.	Use of TEK in climate signal detection and adaptation.
Religion	Freedom to choose and practice any religion.	Same
Economy	Adequate food, clothing, shelter for individual and tribal needs, both in dollars and barter, but also including riches of the landscape, heritage, and knowledge.	Individual resiliency, good investments, community support of everyone, other traditional values.

Appendix 3: CTUIR Climate Change Comprehensive Key Items of Concern

1st Level Elements	*2nd Level Elements*	*3rd Level Elements*	*4th Level Elements*
Water	Hydrology	Stream flow in the Umatilla River and impacts to agriculture, cattle and First Foods.	Temperature
			Timing
			Volumetric flow
			Aquifer status
			DO levels
		Snowpack	
		Flooding *and impacts to infrastructure*	
		Drought	
		Groundwater recharge and evapotranspiration	
Weather	Precipitation		
	UV radiation intensity		
	Photo synthetically active radiation intensity		
	Air	Quality *due to wildfires in the Umatilla National Forest.*	PM 10
			PM 2.5 *and impacts to human health (valley fever)*
			SO_X
			NO_X
			Ozone
		Greenhouse gases	CO_2
			Water Vapor
			Methane
		Temperature	Average
			Extremes *heat waves, tornados*
Food	Commercial		
	Commodity		
	Homegrown		
	Wild (with emphasis on First Foods)	Water (as a traditional food source) availability and quality	
		Fish	*Chinook* salmon *impacts due to increased stream temperature, decreases in stream flows, increased pollutants due to decreases in stream flows and possible myriad of other impacts.*
			Lamprey

			Mussels
			Steelhead/Trout
			Whitefish
			Suckers
			Sturgeon
		Game	Elk
			Deer
			Bighorn sheep
			Mtn. goat
			Bison
		Roots *impacts due to drought, increased water temperature resulting in decreased abundance, plants being overrun by non-native species and impacts to/shortening of the gathering window.*	Cous
			Camas
			Bitterroot
		Berries *impacts due to drought, increased water temperature resulting in decreased abundance, plants being overrun by non-native species and impacts to/shortening of the gathering window.*	Huckleberry
			Chokecherry
People	Societal relationships		
	Tribal governance	Policy	
	Emergency services	Fire Department *increased crime with increased temperatures.*	
		Ambulance *increased crime with increased temperatures.*	
		Police *increased crime with increased temperatures.*	
	Health	Heatstroke *due to increased temperatures, in particular with vulnerable populations.*	
		Respiratory and asthma related conditions	
		Medical supplies	
		Vector Borne Illness (increases in)	
	Speech		
	Traditional Ecological Knowledge (TEK)		
	Population dynamics	*Impacts on natural resources/public safety to movement of more people to the area due to drought conditions elsewhere.*	
Built Environment	Transportation	Roads	Paved
			Unpaved
		Bridges	
		Rail	
	Dwelling	Housing	Styles

			Security
		Buildings	
		Wellness center and elder housing	
		Child poverty	
		Climate control	
	Waste water treatment		
	Power lines/substations		
Economy	Agriculture	Bumper crops (over production: harvesting/storage complications	
		Crop failure	
		Forest resources	Species change
			Forest fires
			Disease and insect outbreak
		Water availability and quality	
	Fuel	Gasoline/Diesel	
	Renewables	Hydroelectric	*How to increase energy independence for the CTUIR?*
		Wind	
		Solar	
		Biodiesel	
		Ethanol	
	Dress	Household product cost	
		Durability	
		Effectiveness	
	Employment		
	Tribal revenue sources	Wildhorse Resort and Casino	
		Mission Market	
		Arrowhead Travel Plaza	
Land	Forestry Resources		
	Agriculture		

During the process of refining this comprehensive KICs list to a subset of prioritized KICs to focus on for the vulnerability assessment, three additional priority items, emerged for the CTUIR—tornadoes, mental health of tribal citizens, and energy independence. These were not included in the vulnerability assessment process intentionally. Tornados cannot be analyzed within the scope of this project given the limited ability for climate models to make meaningful future projections of this type of mid-scale extreme weather phenomena. Further, after initial review of internal CTUIR policy documents, it was clear that tornados are of limited importance or risk to the CTUIR. Mental health was included as an area of concern connected to lack of access to First Foods and the Tribes experiencing a loss of culture if these First Foods were to disappear. This concern was incorporated into the overall analysis of First Foods. Finally, the issue of energy independence is not one that can be directly analyzed with climate data. For example, climate change and extreme weather events do not directly impact the ability of the Tribes to become energy

independent. Although energy independence is connected to the ability of the Tribes to decrease their contribution to greenhouse gases, an analysis of climate data does not contribute to a deeper understanding of whether or not the CTUIR can or should move towards the goal of energy independence, nor is energy independence an issue of "vulnerability" for the Tribes.

Appendix 4: Breakout Session Sensitivity and Adaptive Capacity Worksheet Detail.

Exercise One: Exposure, Sensitivity, and Adaptive Capacity					
Column 1 **What things, systems, or groups of people could be affected by this change (Key Item of Concern)?**	**Column 2** **Changing Climate Condition(s)**	**Column 3** **How has weather or climate historically affected this system?**	**Column 4** **How might this system be affected by the projected change in climate listed in Column 2?**	**Column 5** **What additional non-climate factors currently affect this system?**	**Column 6** **Sensitivity Ranking**
Chinook Salmon	Increased winter and summer temperatures affecting winter and summer stream temperatures.	Changes in timing of snow melt affecting timing and volume of stream flows in turn affecting life cycle (spawning, rearing, migrational emergence); changes in water quality; increases in stream temperatures.	Increased fish kills; decreased diversity; decreased fish population; increases in toxic exposures for fish; increases in invasive species and predation.	Increases in toxics from Ag runoff, dam operations; decreases in stream flow from irrigation withdrawals; habitat loss.	S4
Cous	Increases in temperatures (winter/summer); seasonal precipitation.	Less snow pack/more sun= better roots. Less spring precipitation=less growth.	High stems with no seeds; April-June is the harvest window.	Invasive species; decreases in collection for use; fire activity; development (roads, wind turbines, etc.).	S3

Huckleberry	Increases in temperatures (winter/summer); seasonal precipitation.	Less snowpack=less berries. Summer crop, so flowering issues occur when there is over/under abundance in precipitation.	Move up in altitude; less flowering.	Forest management practices; dense thickets impacting sunlight for huckleberry plants.	S3
Elk	Late summer water impacts.	Late summer/early fall water impacts; need habitat and fire decreases habitat; wet spring.	They migrate based on food availability, so would migrate north; move off of ceded territory and thus off the harvest list.	Road development; habitat connectivity/fragmentation; habitat degradation.	S3
Agriculture (Non-Irrigated Crops: Winter Wheat, Dry land Peas, Canola)	Precipitation (except during summer); higher temperatures.	Drought is bad for all crops.	First season may be better (more winter-spring precipitation), but the second season might be worse.	Farming practices manage the crops (i.e.: irrigation). (CTUIR=mostly winter wheat which is harvested in July.)	S3
Agriculture (Irrigated Crops: (Hay, Alfalfa)	Less water availability in the summer due to drought.	Drought.	Less water to produce the crops.	More mold and other pests.	S4

Water	Increases in temperatures; less freezing days.	Uncertain. Replenishment mechanisms are uncertain.	Reach a threshold of development with replenishment lowering pressure heads. Decreased snowmelt=decreased opportunity for recharge. Increased temperatures=decreased water to infiltrate.	Increased pumping with increased development.	S0 *Short term* S4 *Long term*
Flooding	Increases in flooding frequency due to warming winter temperatures (less snowpack).	Historically rarely in the wintertime do you see floods, now they occur annually. Peak flows are higher.	Increase in the 100-year floods. Increase in fall peak flows and disturbances.	Increased erosion rates; increased development rates; decreased capacity of existing infrastructure.	S4
Vector Borne Diseases	Warmer winters; hotter summers; increased precipitation.	Hotter conditions=more disease carrying insects.	Increases in vector borne disease due to no die off of vectors; change in distribution of vectors.	Movement of people and animals.	S1
Increased crime	Increases in temperatures.	None observed (look to Ray Denny for data supporting this).	Increased crime.	Poverty; crime at isolated homes; others? (Ask Ray Denny)	S2
Population Dynamics	Drought conditions elsewhere.	Extreme weather events and drought would displace	Some influx might occur.	Job availability due to increased relocation to the area.	S1

		people.			
Heat waves	Higher temperatures.	More extreme heat events.	More temperature-related illness.	Not everyone has air conditioning or ability to use it (fixed income).	S2
Wildfires	Precipitation; temperature (heat); weather (storms).	Hotter, drier conditions give rise to more intense fires; wetter springs result in more fuel for summer wildfires.	Increased fire activity; more fires during storms.	Human-related agricultural practices or arson starting fires; more people=more fires (85% of the fires are human-caused); fewer burn days.	S3

Exercise One: Exposure, Sensitivity, and Adaptive Capacity					
Column 1 **What things, systems, or groups of people could be affected by this change (Key Item of Concern)?**	**Column 7** **What does the system currently have that will help it to adapt?**	**Column 8** **What does this system need in order to adapt?**	**Column 9** **Of these needs, which is the highest priority?**	**Column 10** **Can what the system needs to adapt be easily provided?**	**Column 11** **Adaptive Capacity Ranking**
Chinook Salmon	Reservoirs; land use protections; USFS lands; Floodplain restoration and connectivity; Interagency cooperation and collaboration to take action.	Floodplain zoning; Protection laws to support stream volume; cold water; manage dams for ecosystem restoration; expand river sinuosity.	Implement *River Vision.*	Not easy. Policy challenges—water rights, private lands, limited funding, water quality degradation.	AC1-species adaptive capacity. AC3-humans ability to respond to the adaptive needs.

Cous	Changing distribution (new locations)/move to higher altitudes.	Replanting activities; Management policies; habitat continuity.	Proper land management.	Yes, easily but it depends on staff, funding and cooperation with the forest service since plans are already in place.	AC2
Huckleberry	More to higher altitudes; public lands can move up; lots of space. Leverage First Foods Working Group.	Assisted irrigation; sensitivity to infrastructure but land management practices can preserve areas.	Preserve habitat/connectivity; decommission roads.	Easier habitat to restore. Tension for development but have relationships with the forest service and landowners to do so.	AC3
Elk	Wide range to move about, forest, tribal lands. Leverage First Foods Working Group.	Protection of rangeland, limit human development, enhance existing land preserves.	Protect habitat and connectivity of landscape.	Yes, through cooperation and collaboration and decommissioning of roads.	AC2
Agriculture (Non-Irrigated Crops: Winter Wheat, Dry land Peas, Canola)	Lots of land is needed for wheat production.	Water and legal water rights.	Water availability. (Umatilla River Basin is 20% over allocated.)	No, need to make water available. For example, additional water storage.	AC2
Agriculture (Irrigated Crops: (Hay, Alfalfa)	Water is available, just need more of it.	Resources for deep wells, reliable water sources.	Building reservoirs.	Already have the infrastructure.	AC3

Water	Large reservoir underground to support current use.	Maintain pressure head to protect flow. Riparian and floodplain restoration.	Keeping the system full.	No without investment. Yes with money, and engineering solutions, conservation, monitoring, conjunctive use, and water trusts.	AC4 *Short term* AC3 *Long term*
Flooding	Levee system; riparian zone alternation routes; land use zoning for the 500-year flood zone.	Floodplain restoration; education; easements (?); update and upgrade infrastructure; remove levees.	Implement *River Vision*; Floodplain restoration.	No.	AC3
Vector Borne Diseases	Education; communication of outbreak; response plans.	Maintain health and disease support services and monitoring.	Monitoring of cases.	Yes.	AC4
Increased crime	Enhanced emergency response.	Spread people out; more police protection; enhanced emergency response; cooling stations.		Unsure.	AC4
Population Dynamics	Zoning; additional housing; more jobs.	More housing; water resources.	Code/Zoning.	Unsure.	AC4

Heat waves	Better buildings; more availability of air conditioning; cooling stations; shade generation; emergency generators.	More generators; more air conditioning; address these potential impacts in the *Hazard Mitigation Plan.*	More air conditioning; enhanced emergency response.	Unsure.	AC4
Wildfires	Forest management practices.	Coordinated responses on all levels.		Easily. Plans are already in place.	AC3

Appendix 5: Breakout Session Prioritizing Vulnerabilities Instructions.

Prioritizing Vulnerabilities: Afternoon Breakout Session

Instructions

Step 1 **Appoint at least one recorder** - Someone who will be responsible for filling out this sheet and submitting at the end of the exercise. This can be the same person as in Exercise One and Two or someone new.

Step 2 **Appoint a reporter -** Someone who will be responsible for sharing the results of your team's work verbally with the rest of the workshop participants. This can be the same person as in Exercise One and Two or someone new.

Step 3 **Magnitude of impact -** Identify the magnitude of the impact on the CTUIR from the vulnerability listed in column one. More guidance on assessing magnitude can be found on page 2. Input your answer (scale from 1-5) in column two.

Step 4 **Impact timing -** Identify the timing of the impact on the CTUIR community from the vulnerability in column one (on a scale of 1-5). More guidance for assessing timing of impact can be found on page 2. Input your answer into column three.

Step 5 **Persistence -** Identify how persistent and/or reversible the impacts of the vulnerability listed in column one could be on the CTUIR (on a scale of 1-5). More guidance on assessing persistence and reversibility can be found on page 2. Input your answers in column four.

Step 6 **Likelihood -** Identify how likely impacts are to manifest from the vulnerability listed in column one (on a scale of 1-5). More guidance on assessing the likelihood of impacts can be found on page 2. Input your answer in column five.

Step 7 **Importance -** Identify how important the systems are that could be impacted by the vulnerability listed in column one (on a scale of 1-5). More guidance on assessing the importance of systems can be found on page 2. Input your answers in column six.

Step 8 **Impact Distribution -** Identify the distributional nature of the impacts associated with the vulnerability listed in column one (on a scale of 1-5). More guidance on assessing the distributional nature of impacts and vulnerabilities can be found on page 2. Input your answer in column seven.

Step 9 **Adaptation potential -** Identify the potential for adaptation actions to address the vulnerability listed in column one. Input your response (based on a scale of 1-5) in the eighth column.

Step 10 **Score -** Add the total for all scores and input the total into column nine.

Step 11 Repeat steps 3-10 for each of the vulnerabilities, which received vulnerability rankings of *Medium Vulnerability, Medium-High Vulnerability* or *High Vulnerability* from Exercises 1 and 2 of the morning breakout sessions.

Summary of Criteria to Rank Vulnerabilities*

Magnitude of Impact: The magnitude of a climate impact is determined by its scale (e.g., the area or number of people affected) and its intensity (e.g., the degree of damage caused). For this exercise, use a 1-5 scale to rank magnitude. 1 correlates to low magnitude, 3 to moderate magnitude, and 5 to large magnitude of impact. Note: this assessment does not look at the likelihood of the impact, just the magnitude of its effects.

Timing of Impact: A reflection of when in time the impact is likely to occur as well as the rate at which impacts are likely to happen. Generally, impacts likely to occur sooner or happen suddenly are perceived as "key" vulnerabilities. For this exercise, use a 1-5 scale to rank the timing of impact. 1 correlates to a distance and gradual impact, 3 to an impact likely to manifest in the medium term, and 5 signifies an impact that could happen in the near-term and/or could suddenly occur causing significant disruption.

Persistence and Reversibility of Impact: An indication of whether or not an impact is a one-time occurrence or is likely to happen more often and/or be irreversible. For this exercise, use a 1-5 scale to rank the persistence and reversibility of an impact. A score of 1 indicates an impact that is not persistent and is highly reversible, a score of 3 indicates an impact that is likely to be persistent or irreversible, but not both, and a score of 5 indicates an impact that is both persistent and irreversible.

Likelihood of Impacts and Vulnerabilities: Likelihood is the probably of an impact or vulnerability having occurred or occurring in the future. For this exercise, use a 1-5 scale to rank the likelihood of an impact. A score of 1 indicates an extremely unlikely impact, a score of 3 indicates an impact that is as likely as not to occur, and a score of 5 indicates an impact that is extremely likely (or already occurring).

Importance of the System at Risk: This measure evaluates the importance of the system that is impacted. While subjective, this is an important chance to acknowledge the non-monetary values that different systems contribute. For this exercise, use a 1-5 scale to rank the importance of the system at risk. A score of 1 indicates a system that is not particularly significant, a score of 3 indicates a system that is moderately significant, and a score of 5 indicates a system that is critically important.

Distributional Nature of Impacts and Vulnerabilities: The distributional nature of impacts is an assessment of how widespread and equitably distributed impacts are across the community. For this exercise, use a 1-5 scale to rank the distribution nature of the impact and/or vulnerability. A score of 1 indicates an impact is equally distributed amongst the population, a score of 3 indicates an impact is generally distributed amongst a population but a certain group may feel the impacts more acutely, and a score of 5 indicates

an impact will disproportionately impact an important and vulnerable segment of the population.

Potential for Adaptation: The potential for adaptation is a measure of the ability to do anything to reduce or eliminate the adverse impacts (including the financial, technical, and human capacity). For this exercise, use a 1-5 scale to rank the potential for adapting to a given impact. A score of 1 indicates that you have a strong potential to adapt, a score of 3 that you have a moderate ability to adapt, and a score of 5 indicates that you have little to no potential to adapt.

*Key vulnerability criteria and their definitions are adapted from the Intergovernmental Panel on Climate Change's 2007 Report: Climate Change 2007: Working Group II: Impacts, Adaptation, and Vulnerability.

Appendix 6: Prioritizing Vulnerabilities Results

Exercise 2: Prioritizing Key Vulnerabilities *=Individual voting post workshop								
Vulnerability Identified	**Magnitude of Impact**	**Timing of Impact**	**Persistence and Reversibility of Impacts**	**Likelihood of Impacts and Vulnerabilities**	**Importance of the System at Risk**	**Distributional Nature of Impacts and Vulnerabilities**	**Potential for Adaptation**	**Total Score**
High Priority Vulnerabilities								
Chinook salmon	5	4	5	5	5	3	3	**30**
Medium Priority Vulnerabilities								
Wildfires*	4	4	4	5	4	2	3	**26**
Huckleberry*	4	3	4	4	4	3	3	**25**
Cous*	3	3	4	4	4	3	3	**24**
Agriculture (Non-Irrigated Crops: Winter Wheat, Dry land Peas, Canola)	3	4	4	3	4	1	5	**24**
Heat waves*	4	3	3	4	4	3	3	**24**
Elk*	4	3	3	4	4	3	3	**24**
Flooding	2	4	1	5	3	4	4	**23**
Low Priority Vulnerabilities								
Agriculture (Irrigated Crops: Hay, Alfalfa)*	3	3	3	4	3	2	3	**21**
Water (Short-term)*	3	3	3	3	4	2	3	**21**
Water (Long-term)	3	2	4	3	5	1	2	**20**
Population dynamics*	3	2	3	3	3	2.5	2.5	**19**
Vector Borne Diseases*	2	2	2	3	3	3	3	**18**
Increased crime*	3	3	2	3	3	2	2	**18**

Appendix 7: Answers to a few MACA-related questions

1. How believable are the MACA Relative Humidity #'s?

RH is suspect coming from the Global Models, although it does get distributed as part of MACA. The general consensus is that Specific Humidity is more reliable.

2. What is the "statistical significance" of the MACA projections?

Given that MACA is a *projection*, one can't really assess the statistical significance in the typical sense. We have to remember these are projections, not observations. Maybe a better way to think about them is to note the "spread" of the projections between the different models. It's also important to remember that MACA, at its core, relies on projections from the global climate models. So, any issues present in the global climate models may percolate through to MACA.

3. Are those huge error bars in the daily precipitation=0 projections expected?

There is considerable variation in how global models simulate fundamental precipitation processes. These differences are magnified when you look at daily results. Also, the threshold for "zero" precipitation can be different between the models. So, given all of this, the huge error bars aren't totally unexpected.

Appendix 8: Additional Downscaled Climate Projections Results

<u>Change in</u> seasonal average monthly precipitation

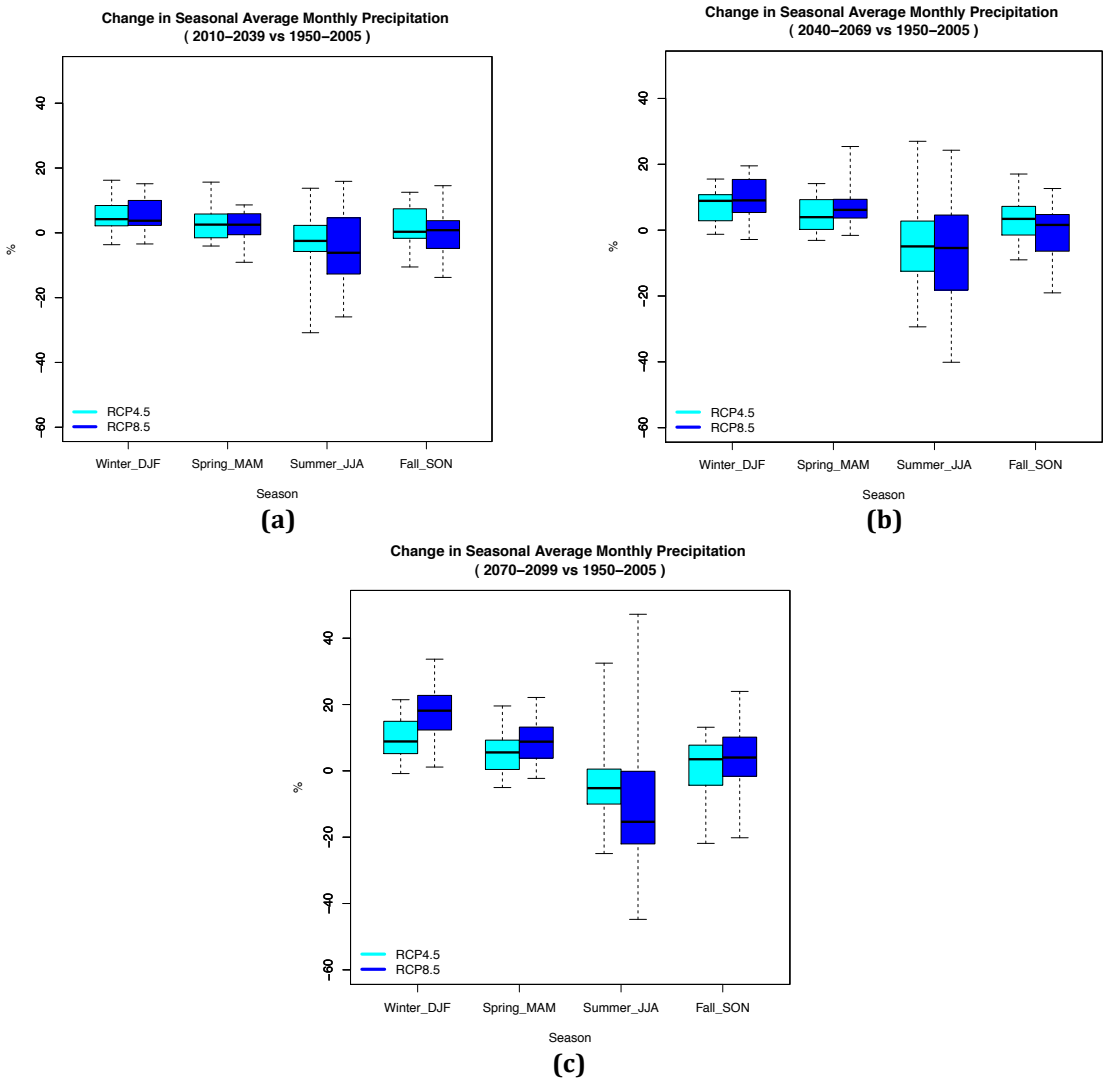

Figure 1: Change in seasonal average monthly precipitation for the years **(a)** <u>2010-2039</u>, **(b)** <u>2040-2069</u>, and **(c)** <u>2070-2099</u> relative to the historical (1950-2005) period. A positive precipitation change projects a wetter future. The "box" represents the 25th and 75th percentile projections for the 20-model ensemble. The heavy line is the median projection, and the whiskers define the most extreme projections. The seasons are defined as: Winter=Dec-Feb; Spring=Mar-May; Summer=Jun-Aug; and Fall=Sep-Nov. The light blue boxes are projections under the RCP 4.5 scenario while the dark blue boxes are projections under the RCP 8.5 scenario.

Change in maximum monthly temperatures

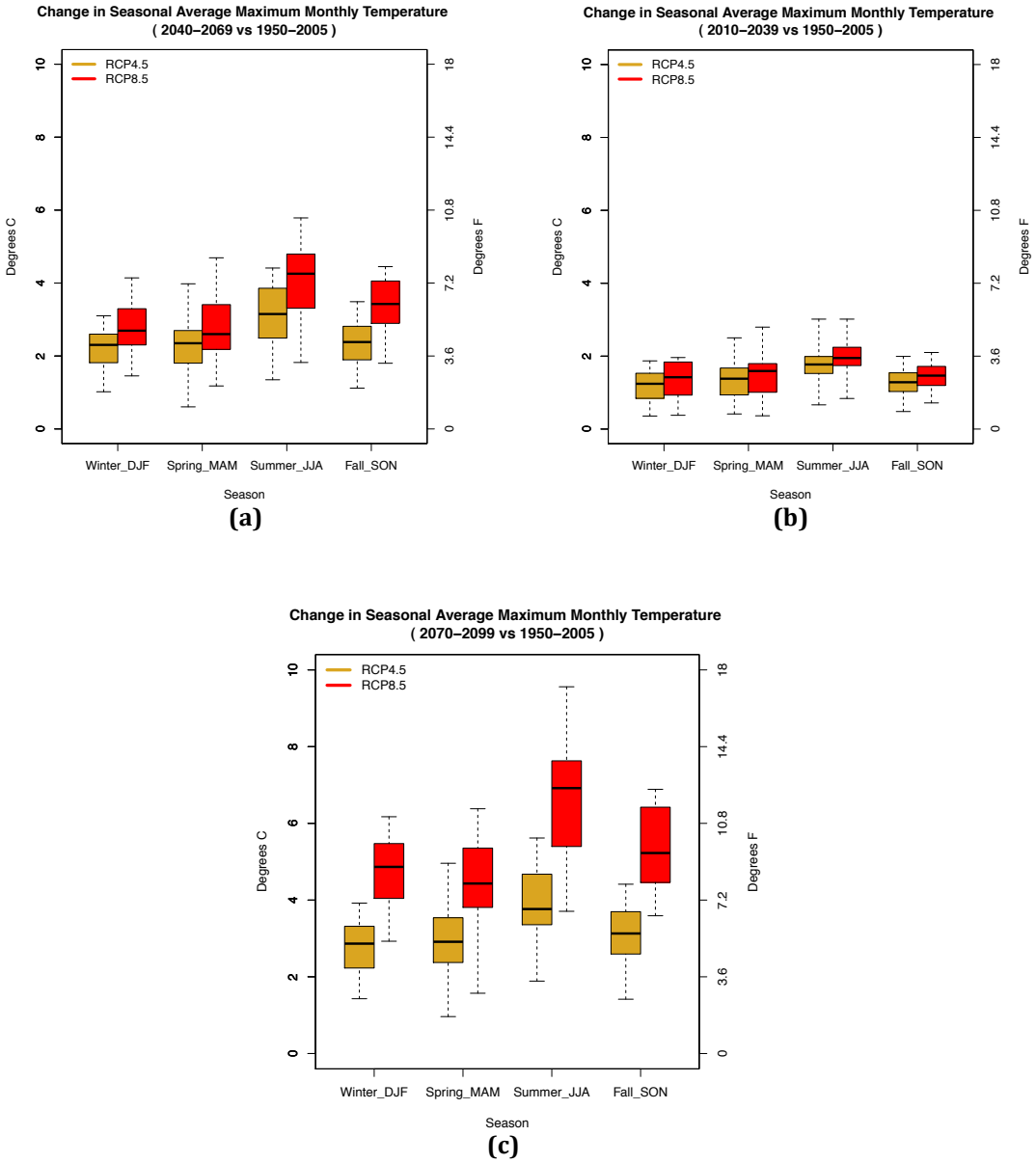

Figure 2: Change in seasonal average maximum monthly temperature for the years **(a)** 2010-2039, **(b)** 2040-2069, and **(c)** 2070-2099 relative to the historical (1950-2005) period. A positive temperature change projects a warmer future. The "box" represents the 25th and 75th percentile projections for the 20-model ensemble. The heavy line is the median projection, and the whiskers define the most extreme projections. The seasons are defined as: Winter=Dec-Feb; Spring=Mar-May; Summer=Jun-Aug; and Fall=Sep-Nov. The yellow boxes are projections under the RCP 4.5 scenario while the red boxes are projections under the RCP 8.5 scenario.

Mean seasonal total precipitation

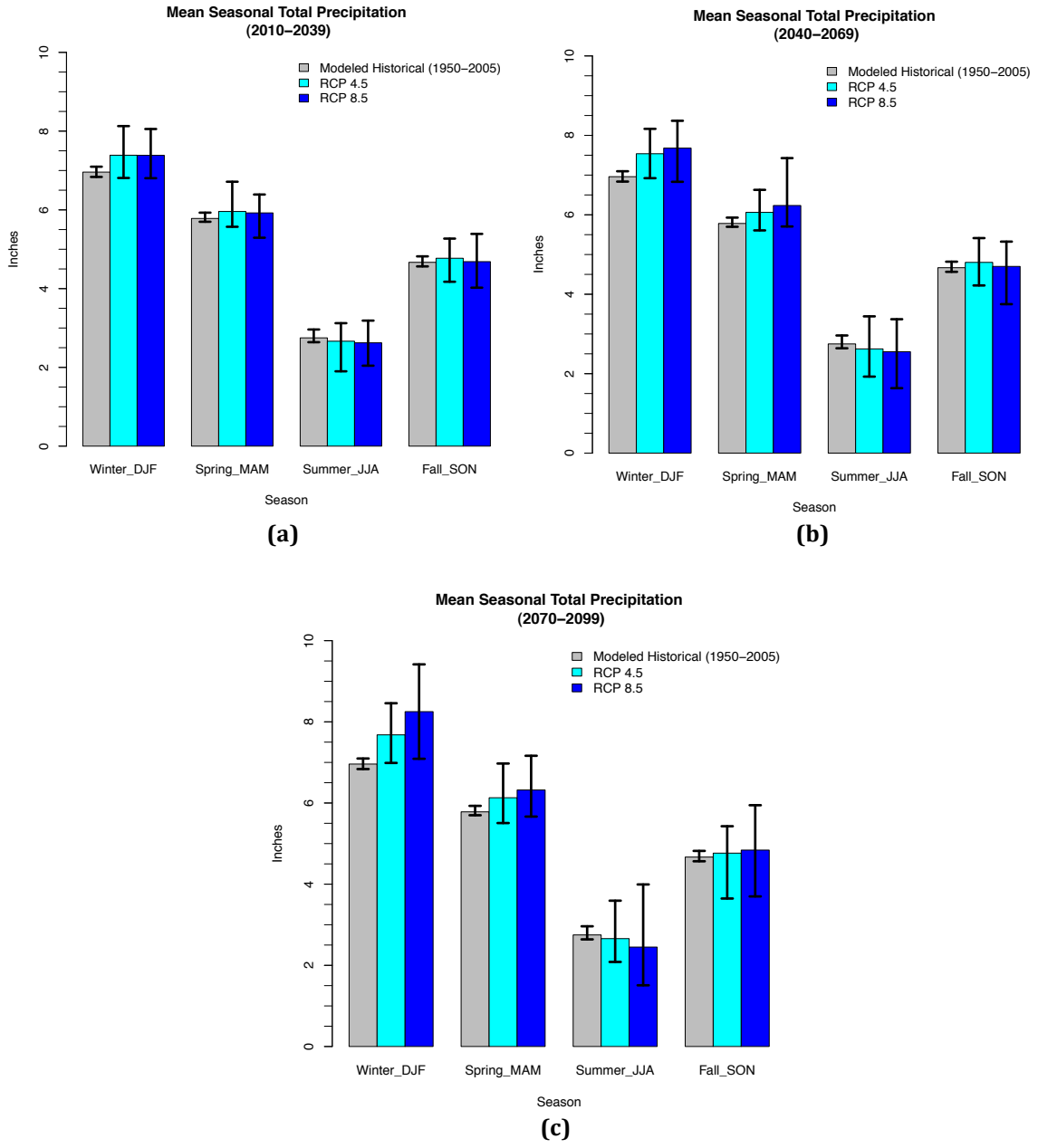

Figure 3: Mean total precipitation for each season for the years **(a)** 2010-2039, **(b)** 2040-2069, and **(c)** 2070-2099. A comparison to the historical modeled period (1950-2005) is included for reference, shown as the bar in grey. The light blue bars are projections under the RCP 4.5 scenario while the dark blue bars are projections under the RCP 8.5 scenario. The bar represents the 20-model mean, while the error bars extend to the most extreme model projections.

Mean seasonal daily maximum temperature

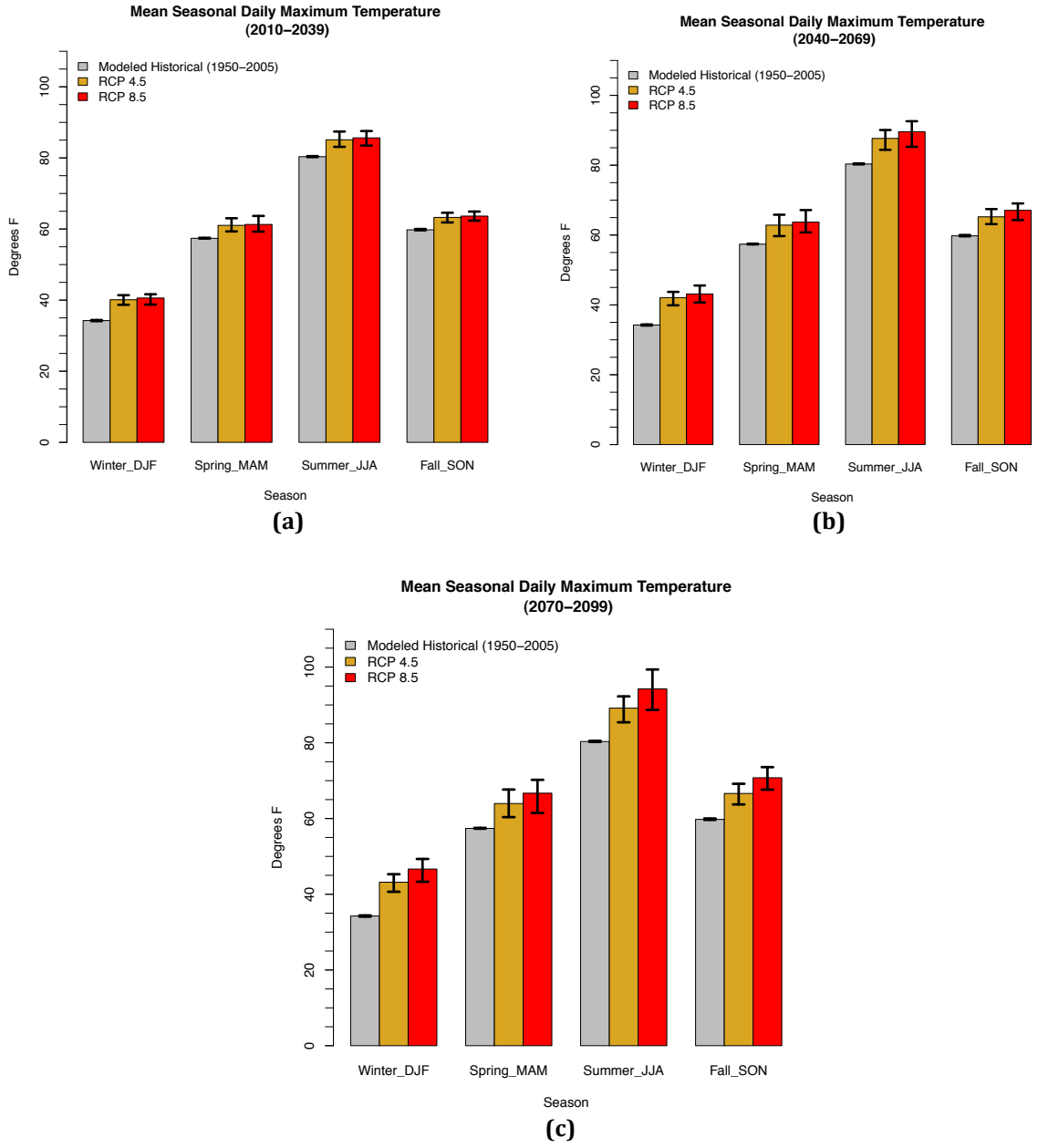

Figure 4: Mean seasonal daily maximum temperature for the years **(a)** 2010-2039, **(b)** 2040-2069, and **(c)** 2070-2099. A comparison to the historical modeled period (1950-2005) is included for reference, shown as the bar in grey. The yellow bars are projections under the RCP 4.5 scenario while the red bars are projections under the RCP 8.5 scenario. The bar represents the 20-model mean, while the error bars extend to the most extreme model projections.

Appendix 9: Specific Areas Vulnerable to Flooding from the CTUIR Hazard Mitigation Plan

- Cayuse, *ʔIšqúulktpe* Creek, McKay Creek, Section Line Road, South Market Road, Short Mile Road and Confederated Way continued to be impacted by flooding.
- Mission has been affected by flooding from the Umatilla River, Spring Creek (from a rising water table), and Mission Creek (off Short Mile Road).
- Flooding in Mission in the recent past can be characterized as *limited.*
- There are three sites upstream of the Upper McKay Creek where the creek eroded the county road, closing it.
- Mission: flooded homes located close to the Umatilla River
- Cayuse: flooded homes, possibly as many as 4 homes, water had broken through sandbags.
- Thornhollow and Gibbon areas: flooded homes possibly as many as 8 homes, the area roads were closed to traffic for several days, stranded families needed rescuing.
- Upper McKay Creek: 15 homes cut-off from road access by floodwaters. Stranded families needed rescuing, eroded roadways forced closures.
- *ʔIšqúulktpe* Creek: road closures occur as the railroad and highway bridges are too low to allow floodwaters to pass.
- Buckaroo Creek**:** water over road.
- There are three sites upstream of the Upper McKay Creek where the creek eroded the county road, closing it.
- Thornhollow and Gibbon areas: flooded homes possibly as many as 8 homes, the area roads were closed to traffic for several days, stranded families needed rescuing.
- Upper McKay Creek: 15 homes cut-off from road access by floodwaters. Stranded families needed rescuing, eroded roadways forced closures.
- *ʔIšqúulktpe* Creek: road closures occur as the railroad and highway bridges are too low to allow flood waters to pass
- Buckaroo Creek: water over road
- Mission: flooded homes located close to the Umatilla River
- Cayuse: flooded homes, possibly as many as 4 homes, water had broken through sandbags [56].

Appendix 10: Overview of Carbon Tax Initiatives in Oregon

*At Oregon Climate, we love every flavor of carbon pricing, but a **dividend** - where the money is distributed evenly into an annual check to every citizen - is our favorite because we believe it truly addresses carbon pollution. If there were a way to price carbon that is self-sustaining, ensured a financial return, and even rewarded taxpayers equally...**wouldn't you want to know more**?*

- We can't afford to pass a scientifically grounded policy only to lose the electorate's support just when this essential program starts to work, as it should. A **dividend provides a self-sustaining motor** by encouraging conservation, rewarding innovation, and stimulating a holistic energy transition.

- We can learn from jurisdictions that have gone before us without the dividend, like Australia, where the carbon tax was successful in reducing emissions … but was repealed last summer. This is what happens when not everyone feels like they're **sharing the benefits**.

- British Columbia passed a revenue-neutral carbon tax, but instead of cutting everyone a check, it cut income taxes. This made the tax popular, but support for making prices *higher* (which is needed to achieve the tax's goal) has decreased because the benefit isn't tangible. If every resident of British Columbia were **getting a check in the mail**, political will to keep raising carbon prices would be stronger.

- Carbon pricing advocates often point to California's cap-and-trade as a success, which is true. The problem is that prices have not risen past $12 per ton, one-sixth of the absolute $60 per ton minimum required to even begin to address real change… and already money supposedly targeted to low-income people and communities of color has been raided for other state programs that are in need of funding -- not protecting lower income households from the burden of increased energy costs. If every Californian were receiving a dividend, those with the least political capital would be **ensured a financial return**.

- A policy so fundamental to our future should be modeled after the **most popular programs in the country**: at the national level, Social Security; at the state level, the Alaska Permanent Fund. Both policies mail people money. Both are politically untouchable. Economic modeling by NERC found that the dividend would not only reduce emissions but would also have a negligible impact on our state's economy. We have nothing to lose in trying cap and dividend, but we have everything to lose if we do not implement strong climate policy. We're writing the most important law of our generation. Every citizen needs to be a stakeholder.

Our vision is a price and dividend that would send every Oregonian a check for $500 once a year -- more than enough to offset the average Oregonian's cost if we tax pollution. As carbon prices rise, annual checks would grow too, to $1500.
We're building a movement to make Oregon the national model for this winning policy. Join us.

Millennial Leadership for a Real Solution

Climate change is a real problem that deserves a real solution. Scientists sounded the alarm on air pollution decades ago, and yet the world burns fossil fuels faster every year. We need to get practical and get serious. **It is time to address the roots of the crisis with a holistic solution to free ourselves of dirty energy.** The *price and dividend* is Oregon's opportunity to lead the way.

A price on carbon--through a fee or a cap--has the power to cut pollution fast enough for our children to inherit a livable planet. Our future hinges on a national carbon price, and the states are the laboratories of democracy. **Oregon is the perfect place to start:** we don't extract fossil fuels, we're rich in renewable energy, and we are bold leaders of social change.

Oregon Climate is a grassroots campaign to hold polluters accountable for the climate crisis. Our organization grew out of a community climate art project two years ago in which 1,500 people in the Rogue Valley created a giant mosaic of a salmon. **We educate and organize advocates in support of a carbon *price and dividend*,** which would require that polluters pay a fee for each ton of carbon dioxide emitted, and then return 100% of the revenue back to Oregonians.

A "revenue-neutral" price on carbon can win bipartisan support by disproving the myth that climate change is some elaborate trick to grow the size of government. By returning the revenue to every Oregonian, we can also achieve climate stability without burdening low-income families. In fact, the bottom two-thirds of earners would come out ahead!

Oregon Climate empowers volunteers to fight for a clear solution with effective tools: creative projects, digital campaigns, advocacy training, city resolutions and more. **This year, we introduced three price-and-dividend bills and two are still alive.** In the House, HB 3470 (Cap-and-Allocate) has made it through two committees and is almost to the floor. In the Senate, SB 965 (Cap-and-Dividend) has eleven co-sponsors and a recently successful hearing.

The *price and dividend* is scientifically sound, equitable, and built to last. It is Oregon's chance to hold fossil fuels companies accountable, bringing emissions 85% below 1990 levels by 2050, matching the reduction rate we need to avoid a 2°C rise in global temperature. It would create our very own Alaska Permanent Fund: loathed by polluters, adored by the electorate. Alaska holds polluters accountable for the extraction of fossil fuels. As intern Sydney Scout testified, "I know the power of the dividend because I grew up in Alaska. Big Petroleum makes a lot of money from our natural resources, so we hold them accountable–with an annual dividend that goes to every Alaskan. I'm a college student in Bend now, and I'll graduate debt-free because of those dividends." This is a solution for everybody. **Join the movement!**

This report is a collaboration between the CTUIR, Adaptation International, and the Oregon Climate Change Research Institute (OCCRI).

For information about the CTUIR and its Vulnerability Assessment work, contact CTUIR Department of Science and Engineering at:

CTUIR-DOSE
46330 Timine Way, Pendleton, OR 97801
Phone: 541-429-7040
Fax: 541-429-7040
Email: DOSEFS@ctuir.org