

## Potential Climate Change Vulnerabilities and Adaptation Strategies for Tribal Communities

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### Potential Climate Change Vulnerabilities

Drivers									
	Higher Temperatures	Earlier Snowmelt	More rain, less snow	More extreme flood events	Longer, more frequent droughts	Sea Level Rise/ Ocean Acidification	More Erosion	More frequent & intense wildfires	Cumulative Impacts
<b>Subsistence Activities</b>	Shift or loss of traditional fish, plant and animal species	Barriers to fish species migration/ movement; shift or loss of traditional fish, plant, and animal species	Greater stress on cold-water species from warmer runoff; shift or loss of traditional fish, plant, and animal species	Reduced water quality for traditional aquatic species; habitat disturbance/loss	Reduced productivity/ greater stress on traditional fish, plant, and animal species	Loss of coastal/tidal wetland habitats and species; ocean and estuarine food web changes; loss of shellfish	Reduced water quality for traditional aquatic species; stream channel changes; habitat disturbance/loss	Reduced water quality for traditional aquatic species; increased sedimentation in streams; habitat and species disturbance/ loss	Dietary changes; loss of local food resources; change in hunting/ gathering practices; loss of income
<b>Traditional Practices</b>									Loss of traditional medicinal plants and materials for jewelry, sculptures, ceremonial pieces, basketry, nets, and lodgings.
<b>Sacred Sites and Practices</b>	Shift or loss of traditional fish, plant and animal species	Reduced streamflows in summer/fall	Reduced streamflows in summer/fall	Damage to sacred sites; temporary inaccessibility to sacred sites	Reduction in streamflows; reduced productivity/ greater stress on traditional fish, plant, and animal species	Inundation of/ damage to sacred sites; loss of access to sacred sites; shift or loss of traditional coastal species	Damage to sacred sites; loss of access to sacred sites; exposure of cultural resources	Damage to sacred sites; species disturbance/loss	Loss of traditional materials and other components for ceremonies; loss of sacred sites; changes in traditional timing of spiritual practices
<b>Water Supply</b>	Changes in runoff timing reducing seasonal availability; higher water demands	Reduced reliability; less groundwater recharge; decrease in summer/ fall runoff	Changes in runoff timing reducing seasonal availability; less groundwater recharge; reduced reliability	Damage to conveyance infrastructure; increased treatment; service interruptions	Reduced availability and reliability of surface water; less groundwater recharge; increased treatment; increased potential for overdrafting groundwater	Damage to coastal conveyance infrastructure; reduced supplies; increased treatment; degradation of coastal aquifers	Damage to conveyance infrastructure; increased treatment	Damage to conveyance infrastructure; increased treatment; service interruptions; sedimentation	Reduction in water availability; reduced quality or increased contamination of local surface and groundwater supplies; increase in water-related illnesses; potential conflicts over water rights; higher human water demands reduce water needed to support ecosystems/ species
<b>Water Quality</b>	Increase in water-borne illnesses; taste and odor issues; decrease in dissolved oxygen increase in algal blooms; impacts to aquatic species	Seasonal changes in quality due to decreased summer/fall runoff	Seasonal changes in quality (such as reduced dissolved oxygen) due to decreased summer/fall runoff	Wastewater spills; contaminated stormwater runoff; turbidity	Increase in water-borne illnesses; taste and odor issues; higher contaminant loading; increase in algal blooms; decrease in dissolved oxygen; impacts to aquatic species	Increased by-products from treating brackish water; inundation of wastewater treatment facilities or discharge impacts; salinity intrusion into aquifers	Damage to conveyance and wastewater infrastructure; increased turbidity	Damage to infrastructure, increased turbidity/ sedimentation	Reduction in water availability; reduced quality or increased contamination of local surface and groundwater supplies; increase in water-related illnesses; potential conflicts over water rights; higher human water demands reduce water needed to support ecosystems/ species
<b>Health</b>	Increased mortality rates (especially for children and elderly); poor air quality; allergens increase; illnesses <sup>1</sup> exacerbated; increased health care costs	Reduced water supply reliability and quality	Change in prevalence & spread of disease; reduced water supply reliability and quality	Change in prevalence & spread of diseases; mortality; displacement <sup>2</sup>	Change in prevalence & spread of diseases; mortality; reduced water supply reliability; increased malnutrition; increased health care costs	Displacement; illness due to poor water quality; reduced coastal water supply reliability	Displacement; poor water quality; mudslides	Poor air and water quality; displacement; illnesses exacerbated, esp. respiratory illnesses; mortality; mudslides	Overall reduction in community health; increase in chronic and infectious diseases; increased health care costs; impacts associated with displacement

<sup>1</sup>Illnesses - includes chronic, infectious, and vector borne diseases

<sup>2</sup>Displacement - encompasses associated health consequences, including mortality, due to economic disruption, loss of personal income, and disruption of social networks

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### Potential Climate Change Adaptation Strategies

		Drivers							
	Cumulative Impacts	Higher Temperatures	Earlier Snowmelt	More rain, less snow	More extreme flood events	Longer, more frequent droughts	Sea Level Rise/ Ocean Acidification	More Erosion	Longer wildfire season/ More frequent & intense wildfires
<b>Subsistence Activities</b>	Dietary changes; loss of local food resources; change in hunting/ gathering practices; loss of income; changes in fire management (fewer burning windows)	Restore habitat to provide thermal refugia (i.e. riparian corridors); manage ecosystems to promote native species; promote traditional practices to restore traditional landscapes; promote policies that ensure tribal rights for subsistence practices	Restore habitat to remove barriers to fish migration; restore meadows restoration and implement forestry practices that help retain water in upper watersheds	Restore habitat to provide thermal refugia for cold water species; manage ecosystems to promote native species; promote traditional practices to restore traditional landscapes; promote policies that ensure tribal rights for subsistence practices	Restore and enhance existing floodplain and wetland habitat; restore and manage watersheds to reduce erosion	Restore and manage habitat to promote native species; implement land use practices that promote water retention on-site; remove or minimize invasive species	Restore wetlands; manage sediment to maintain/ enhance wetland elevations; restore subtidal habitat to attenuate storm surge; promote traditional practices to restore traditional landscapes; protect upland habitat and transition zones to allow for wetland migration	Restore and enhance riparian corridors; promote ranch land and forest management practices that reduce erosion	Reduce forest density where needed via mechanical or hand thinning and/or prescribed burning; restore soil mantle; construct and maintain fuel breaks; restore meadows to help retain water; remove or minimize invasive species
<b>Traditional Practices</b>	Loss of traditional medicinal plants and materials for jewelry, sculptures, ceremonial pieces, basketry, nets, and lodgings.								
<b>Sacred Sites and Practices</b>	Loss of traditional materials and other components for ceremonies; loss of sacred sites; changes in traditional timing of spiritual practices	Restore and manage ecosystems to promote traditional materials/ native species; promote traditional practices to restore traditional landscapes	Restore forests and implement practices that help retain water in upper watersheds; promote traditional practices to restore traditional landscapes	Restore and manage ecosystems to promote traditional materials/ native species; promote traditional practices to restore traditional landscapes	Restore habitat to buffer sacred sites; build infrastructure (i.e., levees, sea walls) to protect sacred sites	Restore and manage habitat to promote native species; impement land use practices that promote water retention; remove or minimize invasive species	Restore habitat to buffer sacred sites; build infrastructure to protect sacred sites; promote traditional practices to restore traditional landscapes	Restore habitat to buffer sacred sites; build infrastructure to protect sacred sites	Manage fuel loads to reduce fire severity; create fire breaks to protect sacred sites; remove or minimize invasive species; restore habitat
<b>Water Supply</b>	Reduction in water availability; reduced quality or increased contamination of local surface and/or groundwater supplies; increase in water-related illnesses; potential conflicts over water rights; higher human water demands reduce water needed to support ecosystems/ species	Increase storage capacity; improve conjunctive mgmt; conserve water; restore habitat	Increase storage capacity; facilitate groundwater recharge basins; conserve water and energy; restore habitat in upper watersheds	Increase storage capacity; facilitate groundwater recharge basins; conserve water and energy; restore habitat in upper watersheds	Reinforce or relocate vulnerable conveyance infrastructure; improve treatment capacity	Increase storage capacity; improve conjunctive management; conserve water and energy	Reinforce or relocate vulnerable conveyance infrastructure; improve treatment capacity; diversify supply portfolio; consider desalination	Protect vulnerable conveyance infrastructure with habitat buffers; improve treatment capacity	Create fire breaks to protect infrastructure; improve treatment capacity; manage fuel and restore habitat to reduce risk
<b>Water Quality</b>		Improve treatment capacity; promote use of wetlands in wastewater treatment	Habitat restoration that help retain water in upper watershed to support summer/fall baseflows	Habitat restoration to support summer/fall baseflows; groundwater recharge/ conjunctive use	Improve wastewater systems to avoid spills; use green infrastructure to filter stormwater runoff	Improve treatment capacity; promote use of wetlands in wastewater treatment	Reinforce or relocate of wastewater facilities; brackish water desalination; wetland restoration	Protect vulnerable conveyance and wastewater infrastructure; improve treatment capacity	Fire breaks to protect infrastructure; improve treatment capacity; fuel mgmt and habitat restoration to reduce risk
<b>Health</b>	Overall reduction in community health; increase in chronic and infectious diseases; increased health care costs; impacts associated with displacement <sup>1</sup>	Establish community cooling centers; develop renewable energy sources; provide education and outreach on heat-related illnesses	Improve water supply reliability and water quality (see strategies above)	Provide education and outreach on disease prevention; improve water supply reliability and water quality (see strategies above)	Provide education and outreach on disease prevention; establish emergency shelters; establish funding for recovery assistance	Education and outreach on disease prevention; establish emergency water supplies; establish funding for assistance programs	Improve infrastructure to protect communities; improve water supply reliability and water quality (see strategies above)	Establish emergency shelters and water supplies; establish funding for recovery assistance	Establish emergency shelters and water supplies; establish funding for recovery assistance

<sup>1</sup>Displacement - encompasses associated health consequences, including mortality, due to economic disruption, loss of personal income, and disruption of social networks