

# Being Prepared for Climate Change

## Checklists of Potential Climate Change Risks



Cover photograph: Waquoit Bay National Estuarine Research Reserve. From: National Oceanic and Atmospheric Administration/Department of Commerce, photographer Rick Crawford

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Risk identification checklists help environmental professionals think about how climate change might affect their organization or place. Checklist items are potential risks that could be inferred by crossing climate change stressors with the given goals. The EPA publication, *Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans* (EPA 842-K-14-002, August 2014) has more information about risks, risk identification and risk analysis. Tables 3-1a through 3-1d and Table 3-2 were originally published in that workbook.

In the electronic pdf version of this document, the checklist checkboxes are selectable. If checkboxes are selected, then that information can be retained by saving the document or printing checklist pages.

The *Being Prepared for Climate Change* workbook and this document are available via the Climate Ready Estuaries website, [www.epa.gov/cre](http://www.epa.gov/cre).

**TABLE 3-1A. POTENTIAL CLIMATE CHANGE RISKS FOR POLLUTION CONTROL**

Clean Water Act goals	Warmer summers	Warmer winters	Warmer water	Increasing drought	Increasing storminess	Sea level rise	Ocean acidification
<p><b>Controlling point sources of pollution and cleaning up pollution</b></p>	<p><input type="checkbox"/> Loss of melting winter snows may reduce spring or summer flow volume, and raise pollutant concentration in receiving waters</p>	<p><input type="checkbox"/> Temperature criteria for discharges may be exceeded (thermal pollution) <input type="checkbox"/> Warmer temperatures may increase toxicity of pollutants</p>	<p><input type="checkbox"/> Critical-low-flow criteria for discharging may not be met <input type="checkbox"/> Pollutant concentrations may increase if sources stay the same and flow diminishes</p>	<p><input type="checkbox"/> Combined sewer overflows may increase <input type="checkbox"/> Treatment plants may go offline during intense floods</p>	<p><input type="checkbox"/> Treatment plants may not be able to discharge via gravity at higher water levels <input type="checkbox"/> Treatment infrastructure may be susceptible to flooding <input type="checkbox"/> Sewage may mix with seawater in combined sewer systems <input type="checkbox"/> Contaminated sites may flood or have shoreline erosion <input type="checkbox"/> Sewer pipes may have more inflow (floods) or infiltration (higher water table)</p>		
<p><b>Controlling nonpoint sources of pollution</b></p>	<p><input type="checkbox"/> Wildfires may lead to soil erosion</p>	<p><input type="checkbox"/> Longer growing season can lead to more lawn maintenance with fertilizers and pesticides</p>	<p><input type="checkbox"/> Higher solubility may lead to higher concentration of pollutants <input type="checkbox"/> Water may hold less dissolved oxygen <input type="checkbox"/> Higher surface temperatures may lead to stratification <input type="checkbox"/> Greater algae growth may occur <input type="checkbox"/> Parasites, bacteria may have greater survival or transmission</p>	<p><input type="checkbox"/> Pollution sources may build up on land, followed by high-intensity flushes</p>	<p><input type="checkbox"/> Streams may see greater erosion and scour <input type="checkbox"/> Urban areas may be subject to more floods <input type="checkbox"/> Flood control facilities (e.g., detention basins, manure management) may be inadequate <input type="checkbox"/> High rainfall may cause septic systems to fail</p>	<p><input type="checkbox"/> Tidal flooding may extend to new areas, leading to additional sources of pollution</p>	<p><input type="checkbox"/> Decomposing organic matter releases carbon dioxide, which may exacerbate the ocean acidification problem in coastal waters</p>

**TABLE 3-1B. POTENTIAL CLIMATE CHANGE RISKS FOR HABITAT**

Clean Water Act goals	Warmer summers	Warmer winters	Warmer water	Increasing drought	Increasing storminess	Sea level rise	Ocean acidification
<p><b>Restoring and protecting physical and hydrologic features</b></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Higher temperatures may lead to greater evaporation and lower groundwater tables</li> <li><input type="checkbox"/> Switching between surface and groundwater sources for public water supplies may affect the integrity of water bodies</li> <li><input type="checkbox"/> Greater electricity demand may affect operation decisions at hydropower dams</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Less snow, more rain may change the runoff/infiltration balance; base flow in streams may change</li> <li><input type="checkbox"/> A spring runoff pulse may disappear along with the snow</li> <li><input type="checkbox"/> Rivers may no longer freeze; a spring thaw would be obsolete</li> <li><input type="checkbox"/> Marshes and beaches may erode from loss of protecting ice</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Warmer water may lead to greater likelihood of stratification</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Groundwater tables may drop</li> <li><input type="checkbox"/> Base flow in streams may decrease</li> <li><input type="checkbox"/> Stream water may become warmer</li> <li><input type="checkbox"/> Increased human use of groundwater during drought may reduce stream baseflow</li> <li><input type="checkbox"/> New water supply reservoirs may affect the integrity of freshwater streams</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> The number of storms reaching an intensity that causes problems may increase</li> <li><input type="checkbox"/> Stronger storms may cause more intense flooding and runoff</li> <li><input type="checkbox"/> Coastal overwash or island breaching may occur</li> <li><input type="checkbox"/> Turbidity of surface waters may increase</li> <li><input type="checkbox"/> Increased intensity of precipitation may yield less infiltration</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Shoreline erosion may lead to loss of beaches, wetlands and salt marshes</li> <li><input type="checkbox"/> Saline water may move farther upstream and freshwater habitat may become brackish</li> <li><input type="checkbox"/> Tidal influence may move farther upstream</li> <li><input type="checkbox"/> Bulkheads, sea walls and revetments may become more widespread</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Long-term shellfish sustainability may be an open question</li> <li><input type="checkbox"/> Fish may be adversely affected during development stages</li> </ul>
<p><b>Constructing reefs to promote fish and shellfish</b></p>			<ul style="list-style-type: none"> <li><input type="checkbox"/> Desired fish may no longer be present</li> <li><input type="checkbox"/> Warmer water may promote invasive species or disease</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Stream erosion may lead to high turbidity and greater sedimentation</li> <li><input type="checkbox"/> Lower pH from NPS pollution may affect target species</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Stream erosion may lead to high turbidity and greater sedimentation</li> <li><input type="checkbox"/> Lower pH from NPS pollution may affect target species</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Light may not penetrate through deeper water</li> <li><input type="checkbox"/> Higher salinity may kill targeted species</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Long-term shellfish sustainability may be an open question</li> <li><input type="checkbox"/> Fish may be adversely affected during development stages</li> </ul>

**TABLE 3-1c. POTENTIAL CLIMATE CHANGE RISKS FOR FISH, WILDLIFE AND PLANTS**

Clean Water Act goals	Warmer summers	Warmer winters	Warmer water	Increasing drought	Increasing storminess	Sea level rise	Ocean acidification
<b>Protecting and propagating fish, shellfish and wildlife</b>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Species that won't tolerate warmer summers may die/migrate; biota at the southern limit of their range may disappear from ecosystems</li> <li><input type="checkbox"/> Species may be weakened by heat and become out-competed</li> <li><input type="checkbox"/> Essential food sources may die off or disappear, affecting the food web</li> <li><input type="checkbox"/> Species may need to consume more water as temperature rises</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Species that used to migrate away may stay all winter</li> <li><input type="checkbox"/> Species that once migrated through may stop and stay</li> <li><input type="checkbox"/> Pests may survive winters that used to kill them</li> <li><input type="checkbox"/> Invasive species may move into places that used to be too cold</li> <li><input type="checkbox"/> Some plants may need a "setting" cold temperature</li> <li><input type="checkbox"/> A longer growing season may lead to an extra reproductive cycle</li> <li><input type="checkbox"/> Food supplies and bird migrations may be mis-timed</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Newly invasive species may appear</li> <li><input type="checkbox"/> Habitat may become unsuitably warm, for a species or its food</li> <li><input type="checkbox"/> Heat may stress immobile biota</li> <li><input type="checkbox"/> Dissolved oxygen capacity of water may drop</li> <li><input type="checkbox"/> Some fish reproduction may require cold temperatures; other reproductive cycles are tied to water temperature</li> <li><input type="checkbox"/> Coral bleaching episodes may increase</li> <li><input type="checkbox"/> Parasites and diseases are enhanced by warmer water</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Species may not tolerate a new drought regime</li> <li><input type="checkbox"/> Native habitat may be affected if freshwater flow in streams is diminished or eliminated</li> <li><input type="checkbox"/> Changing freshwater inputs may affect salinity distribution in estuaries (especially of interest with shellfish habitat)</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Greater soil erosion may increase turbidity and decrease water clarity</li> <li><input type="checkbox"/> Greater soil erosion may increase sediment deposition in estuaries, with consequences for benthic species</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Sea level may push saltier water farther upstream (especially of interest with regard to shellfish habitat)</li> <li><input type="checkbox"/> Light may not penetrate through the full depth of deeper water</li> <li><input type="checkbox"/> Greater coastal wetland losses may occur</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Corrosive waters may impact shellfish development</li> <li><input type="checkbox"/> Shellfish predators may not survive the disappearance of shellfish</li> <li><input type="checkbox"/> Fish may be adversely affected during development stages by changes to water chemistry</li> <li><input type="checkbox"/> The effect of ocean acidification on calcifying plankton may lead to cascading effects in the food chain</li> </ul>
<b>Controlling nonnative and invasive species</b>							
<b>Maintaining biological integrity and reintroducing native species</b>							

**TABLE 3-1D. POTENTIAL CLIMATE CHANGE RISKS FOR RECREATION AND PUBLIC WATER SUPPLIES**

Clean Water Act resource goals	Warmer summers	Warmer winters	Warmer water	Increasing drought	Increasing storminess	Sea level rise	Ocean acidification
<p><b>Restoring and maintaining recreational activities, in and on the water</b></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> More people using water for recreation may raise the potential for pathogen exposure</li> </ul>		<ul style="list-style-type: none"> <li><input type="checkbox"/> Harmful algal blooms may be more likely</li> <li><input type="checkbox"/> Jellyfish may be more common</li> <li><input type="checkbox"/> Fishing seasons and fish may become misaligned</li> <li><input type="checkbox"/> Desired recreational fish may no longer be present</li> <li><input type="checkbox"/> Invasive plants may clog creeks and waterways</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Freshwater flows in streams may not support recreational uses</li> <li><input type="checkbox"/> Increased estuary salinity may drive away targeted recreational fish</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> More frequent or more intense storms may decrease recreational opportunities</li> <li><input type="checkbox"/> Greater NPS pollution may impair recreation</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Beaches or public access sites may be lost to coastal erosion or inundation</li> <li><input type="checkbox"/> Clearance under bridges may decrease</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Eco-tourism resources or attractions (e.g., birding, diving, fishing) may be degraded</li> <li><input type="checkbox"/> Recreational shellfish harvesting may be lost</li> </ul>
<p><b>Protecting public water supplies</b></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Warmer temperatures may drive greater water demand</li> <li><input type="checkbox"/> Evaporation losses from reservoirs and groundwater may increase</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Summer water supplies that depend on winter snow pack may disappear</li> <li><input type="checkbox"/> Cold places may see more freeze/thaw cycles that can affect infrastructure</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Changes in treatment processes may be required</li> <li><input type="checkbox"/> Increased growth of algae and microbes may affect drinking water quality</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Lower freshwater flows may not keep saltwater downstream of intakes</li> <li><input type="checkbox"/> Groundwater tables may drop</li> <li><input type="checkbox"/> Coastal aquifers may be salinized from insufficient freshwater input</li> <li><input type="checkbox"/> Coastal aquifers may be salinized from higher demand on groundwater</li> <li><input type="checkbox"/> Maintaining passing flows at diversions may be difficult</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Water infrastructure may be vulnerable to flooding</li> <li><input type="checkbox"/> Flood waters may raise downstream turbidity and affect water quality</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Sea level may push salt fronts upstream past water diversions</li> <li><input type="checkbox"/> Water infrastructure may be vulnerable to inundation or erosion</li> <li><input type="checkbox"/> Saltwater intrusion into groundwater may be more likely</li> </ul>	

**TABLE 3-1E(i). POTENTIAL CLIMATE CHANGE RISKS FOR HUMAN HEALTH**

Public Health Goals	Warmer summers	Warmer winters	Warmer water	Increasing drought	Increasing storminess	Sea level rise	Ocean acidification
<p><b>Protecting people from vector or pathogenic diseases</b></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Increasingly favorable conditions for bacteria like <i>Salmonella</i> may increase food poisoning</li> <li><input type="checkbox"/> Expansion of the geographic range of pests and parasites, such as mosquitoes and ticks, may increase disease exposure</li> <li><input type="checkbox"/> A wider distribution of pests, parasites and pathogens may increase pesticide use and human exposure to chemical contaminants</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Extended seasons for disease vectors, such as ticks and mosquitoes, may lead to more human infections</li> <li><input type="checkbox"/> Disease vectors that survive through winter without dying off may infect more humans</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Harmful algal blooms, bacteria, and protozoa that flourish in warmer water may cause sickness in people engaged in water-related activities</li> <li><input type="checkbox"/> HABs and waterborne diseases may spread to new areas that used to be too cold for these pathogens to survive</li> <li><input type="checkbox"/> Warmer waters affect the growth and distributions of pathogens that accumulate in fish and shellfish, increasing both the geographic and seasonal ranges where people are at risk of shellfish poisoning</li> </ul>	<p>Drought may lead to warmer water temperatures if depths gets shallower or if cold water inputs diminish. See the <b>Warmer Water</b> column for associated risks</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Turning to unsafe water sources for irrigation may spread <i>E. Coli</i> and <i>Salmonella</i></li> <li><input type="checkbox"/> Evaporation may lead to higher concentrations of pathogens in streams and rivers</li> <li><input type="checkbox"/> Drought may increase dust storms and airborne transmission of fungal pathogens</li> <li><input type="checkbox"/> Increased dust deposits into aquatic systems may increase harmful algal blooms</li> <li><input type="checkbox"/> Rodents that carry pathogens may enter dwellings when searching for water</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Increased stormwater runoff and combined sewer overflows (CSOs) may increase the spread of pathogens to humans</li> <li><input type="checkbox"/> Floods or higher groundwater levels may lead to water intrusion into buildings that can cause mold and reduce indoor air quality</li> <li><input type="checkbox"/> Flooded areas may serve as breeding pools for mosquitoes carrying diseases</li> <li><input type="checkbox"/> Abandoned storm-damaged properties may attract rodent populations that carry pathogens</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Tidal flow into combined sewer systems may lead to overflows that increase the spread of pathogens</li> <li><input type="checkbox"/> Higher water tables may cause water intrusion into buildings leading to mold and reduced indoor air quality</li> </ul>	

**TABLE 3-1E(ii). POTENTIAL CLIMATE CHANGE RISKS FOR HUMAN HEALTH**

Public Health Goals	Warmer summers	Warmer winters	Warmer water	Increasing drought	Increasing storminess	Sea level rise	Ocean acidification
<p><b>Protecting people from environmental effects on health and well-being</b></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Higher rates of evaporation may worsen droughts and wildfires</li> <li><input type="checkbox"/> Higher temperatures may cause occupational health hazards, especially for those working outdoors</li> <li><input type="checkbox"/> Higher temperatures may cause more heat stroke, dehydration</li> <li><input type="checkbox"/> Hot stagnant air with higher particulate matter and ozone (smog) levels may exacerbate asthma &amp; cardiovascular disease</li> <li><input type="checkbox"/> Higher temperatures may increase air conditioning usage and produce more emissions that impair air quality</li> <li><input type="checkbox"/> Higher CO<sub>2</sub> levels and expansion of the geographic range for allergy-inducing species may worsen asthma and other allergic illnesses</li> <li><input type="checkbox"/> Greater rates of violent crime may occur on hotter days</li> <li><input type="checkbox"/> Greater demand for electricity may lead to blackouts and brownouts that affect people who rely on electricity for health maintenance</li> <li><input type="checkbox"/> Higher temperatures may exacerbate cases where medication is impairing the body's ability to regulate heat</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> A longer pollen season may worsen allergies and asthma episodes</li> <li><input type="checkbox"/> Greater time spent outside may increase hazards associated with outdoor activity</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Higher evaporation rates may reduce drinking water supplies</li> <li><input type="checkbox"/> More water-related recreation can lead to increases in swimming or boating accidents</li> <li><input type="checkbox"/> Warmer temperature of cooling water sources may affect power generation and endanger those who depend on electricity for health maintenance</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Fine particulates from wildfires may aggravate cardiovascular and respiratory diseases</li> <li><input type="checkbox"/> Water shortages may cause crop failures and rising prices that affect the food choices people make</li> <li><input type="checkbox"/> Financial-related stress or forced migration from drought and wild-fires may impact mental health</li> <li><input type="checkbox"/> In areas without fire hydrants, surface water sources may dry up making it harder to put out dangerous fires</li> <li><input type="checkbox"/> Drought may cause water scarcity</li> <li><input type="checkbox"/> Lower water levels in hydropower reservoirs may impact electricity production and endanger those who rely on heating, ventilating and air conditioning (HVAC), or electrical equipment</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> During extreme events, rain, wind or waves may produce more injuries or deaths</li> <li><input type="checkbox"/> Storms that lead to homelessness, relocation or separation may increase anxiety and Posttraumatic Stress Disorder</li> <li><input type="checkbox"/> Storms may increase economic strain from damage or loss of income</li> <li><input type="checkbox"/> Public health services may be disrupted by damaged health care facilities, interrupted communication, offline utilities, or emergency responders being exposed to dangers</li> <li><input type="checkbox"/> After extreme events, personal health efforts may be disrupted if prescriptions are unfillable, devices are lost, or mobility is limited</li> <li><input type="checkbox"/> Floodwaters may spread hazardous materials to areas where clean up workers may come in contact with them</li> <li><input type="checkbox"/> The use of portable electric generators after a storm may cause carbon monoxide poisoning</li> <li><input type="checkbox"/> Flooding at drinking or wastewater facilities may increase exposure to untreated sewage or limit availability of drinking water</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Saltwater intrusion into aquifers may salinize potable freshwater sources</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Subsistence communities may face shortages of key shellfish resources</li> </ul>



**TABLE 3-1F. POTENTIAL CLIMATE CHANGE RISKS FOR FLOODPLAIN MANAGEMENT**

Higher magnitude flood events or more frequent occurrences of flooding, will amplify the numerous and well known social, economic and environmental impacts of flooding that are the very reason for floodplain management. This checklist focuses on natural infrastructure and changes to the probability of flooding. Many of the risks stemming from places becoming flooded are in other checklists in this series: they are particularly associated with the “increasing storminess” and “sea level rise” stressors; see the public health checklist for potential human impacts.

Floodplain Management Goals	Warmer summers	Warmer winters	Warmer water	Increasing drought	Increasing storminess	Sea level rise	Ocean acidification
<p><b>Understanding the probability of flooding</b></p>	<p><input type="checkbox"/> Increased demand for summertime water may change how reservoirs are managed in the winter and spring</p>	<p><input type="checkbox"/> Warmer winters may lead to earlier snowmelt and result in higher springtime flows and lower summer flows</p>	<p><input type="checkbox"/> Stratification may affect flood hydrodynamics</p> <p><input type="checkbox"/> Temperature driven changes to viscosity may affect sediment transport and bed roughness</p> <p><input type="checkbox"/> Changes in temperature may affect aquatic vegetative productivity affecting flood storage, water quality, and habitat</p>	<p><input type="checkbox"/> As drought years are added to the historical record they may alter statistics of the probability of flooding</p> <p><input type="checkbox"/> Long periods of drought may increase the relative proportion of rainfall runoff and contribute to flooding</p>	<p><input type="checkbox"/> The past will be less useful for understanding future risk</p> <p><input type="checkbox"/> Increased precipitation may stress stormwater infrastructure leading to more nuisance flooding</p> <p><input type="checkbox"/> Flood control facilities (e.g., detention basins, dams, dikes and levees) may fail</p>	<p><input type="checkbox"/> A rising sea level will continuously increase the likelihood of coastal flooding</p> <p><input type="checkbox"/> Higher sea level may change the floodplains of coastal streams</p> <p><input type="checkbox"/> Regular nuisance flooding from high tides will increase in low lying coastal areas</p> <p><input type="checkbox"/> Higher water may decrease protection from breakwaters, sea walls, bulkheads, revetments, dikes or levees</p> <p><input type="checkbox"/> Seawater inflow to storm sewers may reduce their capacity to handle stormwater runoff</p> <p><input type="checkbox"/> Stormwater outfalls may become submerged, affecting how the service area drains</p>	
<p><b>Protecting hydrologic features and beneficial functions of floodplains</b></p>	<p><input type="checkbox"/> Changes in temperature may affect terrestrial vegetative productivity, which in turn may impact flood storage and water quality</p>	<p><input type="checkbox"/> Warmer temperatures may lead to more vegetation through the winter, which may impact flood storage and water quality</p>		<p><input type="checkbox"/> Increasing drought may affect floodplain vegetation, which could impact the protection benefits of floodplains as well as biological productivity, and wildlife habitat</p>	<p><input type="checkbox"/> Increased precipitation can lead to bank erosion and stream channel changes</p> <p><input type="checkbox"/> Flood protection structures may become more prevalent and impact overall floodplain function</p> <p><input type="checkbox"/> Natural features, engineered nature-based features or green infrastructure that provides beneficial functions could be damaged</p>	<p><input type="checkbox"/> Bulkheads, seawalls, and revetments may become more widespread with detrimental effects on tidal wetlands and intertidal habitat</p> <p><input type="checkbox"/> Higher water tables may affect floodplain storage</p> <p><input type="checkbox"/> Low elevation uplands will transition to wetlands, wetlands will transition to open water</p>	<p><input type="checkbox"/> Degradation of oyster reefs or coral reefs may increase damages from storm waves</p>

**TABLE 3-1G. POTENTIAL CLIMATE CHANGE RISKS FOR WETLAND HABITATS**

This checklist focuses on the wetland habitat type specifically, and it should be used in conjunction with the habitats checklist in this series which has other general habitat risks that are also relevant to wetlands. ♦ Drought may lead to warmer water if depth becomes shallower or if cold water inputs diminish. See the **Warmer Water** column for associated risks.

Wetlands Goals	Warmer summers	Warmer winters	Warmer water	Increasing drought	Increasing storminess	Sea level rise	Ocean acidification
<p><b>Maintaining hydrology</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Higher temperatures may lead to greater evaporation and lower groundwater tables</li> <li><input type="checkbox"/> Greater upstream water usage may impact downstream freshwater supply or estuarine salinity</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Winter ice may not form, or may melt quicker</li> <li><input type="checkbox"/> Less snow, more rain may change the runoff/infiltration balance; base flow in streams may change, impacting freshwater availability</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Warmer water may lead to greater likelihood of water column stratification</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Water levels in streams and lakes may drop and groundwater may be reduced</li> <li><input type="checkbox"/> Wetlands may become disconnected from bays, lakes or streams</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Greater amounts of rainfall may cause more intense flooding and runoff</li> <li><input type="checkbox"/> Increased intensity of precipitation may yield more runoff and less infiltration</li> <li><input type="checkbox"/> Turbidity of surface waters may increase</li> <li><input type="checkbox"/> Wind-driven currents may alter customary flow patterns</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Tidal influence may move farther upstream</li> <li><input type="checkbox"/> Tidal restrictions (e.g., undersized culverts, road crossings) may exacerbate flooding</li> </ul>		
<p><b>Protecting and restoring wetland species</b></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Higher evaporation may worsen drought and wildfire</li> <li><input type="checkbox"/> Species may be weakened and become out-competed by native or invasive species</li> <li><input type="checkbox"/> Biota at the limit of their ranges or with temperature-dependent life stages may disappear from ecosystems</li> <li><input type="checkbox"/> Essential food sources may die off or disappear</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Organisms that have narrow aquatic temperature ranges may be further constrained or stressed</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Water scarcity may adversely affect wetland-dependent plants and animals</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Floodwaters may spread hazardous materials to soils and throughout watersheds</li> <li><input type="checkbox"/> Flooding at drinking or wastewater facilities may increase risk of spills or overflows into sensitive habitat</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Sea level may push saltwater farther upstream, impacting sensitive species</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Shellfish mortality may increase due to increased acidity of aquatic habitat</li> </ul>	
<p><b>Protecting and restoring wetland habitat</b></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Marshes and beaches may erode due to loss of protecting ice</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Higher rate of evaporation may raise salinity in coastal waters</li> <li><input type="checkbox"/> Temperature changes affect rates of nutrient and chemical reactions</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Wetland plants may shift their habitat ranges—into, away from, or to larger/smaller proportions of a place</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Shoreline erosion may lead to loss of beaches, wetlands, and salt marshes</li> <li><input type="checkbox"/> Damage to mangrove stands may affect feeding, mating, nesting, and resting areas for birds and reptiles</li> <li><input type="checkbox"/> Damage or loss of seagrass beds may affect critical habitat and food sources</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Salt water may move farther upstream and habitats may become more brackish</li> <li><input type="checkbox"/> Changing salinity may have a large effect on methane release from soils</li> <li><input type="checkbox"/> Mudflat changes may make it more difficult for birds to access food</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Higher concentration of hydrogen ions in water column could have consequences for sensitive organisms</li> </ul>	

**TABLE 3-2. ORGANIZATIONAL GOALS**

Organizational Goals	Warmer summers	Warmer winters	Warmer water	Increasing drought	Increasing storminess	Sea level rise	Ocean acidification
<b>Goal:</b>							
<b>Goal:</b>							
<b>Goal:</b>							

