

**Table 18-8** | Observed impacts of climate change reported since AR4 on coastal and marine ecosystems, over the past several decades, across major world regions, with descriptors for (1) the confidence in detection of a climate change impact; (2) the relative contribution of climate change to the observed change, compared to that of non-climatic drivers; (3) the main climatic driver(s) causing the impacts; (4) the reference behavior of the system in the absence of climate change; and (5) the confidence in attribution of the impacts to climate change. References to related chapters in this report are given as well as key references to other IPCC reports and the scientific literature. Absence of climate change impacts from this table does not imply that such impacts have not occurred.

	Coastal and marine ecosystems	References	Confidence in detection	Role of climate	Climate driver	Reference behavior	Confidence in attribution
Africa	Decline in coral reefs in tropical African waters	Sections 30.5.3.1.2 and 30.5.4.1.5; Baker et al. (2008); Carpenter et al. (2008); Ateweberhan et al. (2011)	High	Major	Ocean warming	Decline due to human impacts	High
Europe	Northward shifts in the distributions of zooplankton, fish, seabirds, and benthic invertebrates in the northeast Atlantic	Box 6-1; Table 6-2; Sections 6.3.1, 23.6.5, and 30.5.1.1; Beaugrand et al. (2009); Philippart et al. (2011)	High	Major	Ocean warming	No change	High
	Northward and depth shift in distribution of many fish species across European seas	Sections 6.3.1, 23.6.4, 23.6.5, and 30.5.3.1; Table 6-2; Perry et al. (2005); Pörtner et al. (2008); Beaugrand et al. (2009, 2010); Beaugrand and Kirby (2010); Hermant et al. (2010); Philippart et al. (2011)	High	Major	Ocean warming	No change	Medium
	Phenology changes in plankton in the northeast Atlantic	Box 6-1; Sections 6.3.1, 23.6.5, and 30.5.1.1; Beaugrand et al. (2002, 2009); Edwards and Richardson (2004); Philippart et al. (2011)	Medium	Major	Ocean warming	No change	Medium
	Spread of warm water species into the Mediterranean	Sections 23.6.5 and 30.5.3.1.5; Boero et al. (2008); Lasram and Mouillot (2009); Raitsos et al. (2010)	High	Major	Ocean warming	Changes due to invasive species and human impacts	Medium
Asia	Decline in coral reefs in tropical Asian waters	Sections 24.4.3.2 and 30.5.1.4.3; McLeod et al. (2010); Krishnan et al. (2011); Coles and Riegl (2012)	High	Major	Ocean warming	Decline due to human impacts	High
	Northward range extension of coral in the East China Sea and western Pacific, and a predatory fish in the Sea of Japan	Section 24.4.3.2; Yamano et al. (2011); Tian et al. (2012); Ogawa-Onishi and Berry (2013)	Medium	Major	Ocean warming	No change	Medium
	Shift from sardines to anchovies in the western North Pacific	Sections 6.3.1 and 6.3.6; Table 6-2; Takasuka et al. (2007, 2008)	Medium	Major	Ocean warming	Fluctuations due to fisheries	Low
	Increased coastal erosion in Arctic Asia	Section 24.4.3.2; Razumov (2010); Forbes (2011); Lantuit et al. (2011)	Medium	Major	Permafrost degradation, ocean warming, change in sea ice	No change	Low
Australasia	Southward shifts in the distribution of marine species near Australia	Table 25-3; Ling et al. (2009b); Pitt et al. (2010); Neuheimer et al. (2011); Wernberg et al. (2011b)	High	Major	Ocean warming	Changes due to short-term environmental fluctuations; fishing and pollution	Medium
	Change in timing of migration of seabirds in Australia	Section 25.6.2.1; Chambers et al. (2011, 2013a)	Medium	Major	Air and ocean warming	No change	Low
	Increase in coral bleaching in the Great Barrier Reef and Western Australian Reefs	Sections 6.3.1.4, 6.3.1.5, and 25.6.2.1; Table 25-3; Cooper et al. (2008); De'ath et al. (2009, 2012); Moore et al. (2012)	High	Major	Ocean warming	Pollution; physical disturbance	High
	Changes in coral disease patterns at Great Barrier Reef	Section 25.6.2.1; Table 25-3; Bruno et al. (2007); Sato et al. (2009); Dalton et al. (2010)	Medium	Major	Ocean warming	Pollution	Medium
North America	Northward shifts in the distributions of northwest Atlantic fish species	Section 30.5.1.1; Nye et al. (2009, 2011); Lucey and Nye (2010)	High	Major	Ocean warming	No change	High
	Changes in mussel beds along the west coast of the USA	Smith et al. (2006); Menge et al. (2008); Harley (2011)	High	Major	Ocean warming	No change	High
	Changes in migration and survival of salmon in the northeast Pacific	Table 6-2; Eliason et al. (2011); Kovach et al. (2012)	High	Major	Ocean warming	No change	High
	Increased coastal erosion in Alaska and Canada	Sections 18.3.1.1 and 18.3.3.1; Mars and Houseknecht (2007); Forbes (2011); Lantuit et al. (2011)	High	Major	Permafrost degradation; ocean warming, change in sea ice	No change	Medium

Table 18-8 (continued)

	Coastal and marine ecosystems	References	Confidence in detection	Role of climate	Climate driver	Reference behavior	Confidence in attribution
South and Central America	Increase in coral bleaching in the western Caribbean	Section 27.3.3.1; Guzman et al. (2008); Manzello et al. (2008); Carilli et al. (2009); Eakin et al. (2010)	<i>High</i>	Major	Ocean warming	Pollution; physical disturbance	<i>High</i>
	Mangrove degradation on north coast of South America	Section 27.3.3.1; Alongi (2008); Lampis (2010); Polidoro et al. (2010); Giri et al. (2011)	<i>Low</i>	Minor	Ocean warming	Degradation due to pollution and land use	<i>Low</i>
Polar regions	Increased coastal erosion across the Arctic	Sections 18.3.1.1, 18.3.3.1, 28.2.4.2, and 28.3.4; Mars and Houseknecht (2007); Razumov (2010); Forbes (2011); Lantuit et al. (2011)	<i>Medium</i>	Major	Permafrost degradation; ocean warming, change in sea ice	No change	<i>Medium</i>
	Negative effects on non-migratory Arctic species	Section 28.2.2.1; Laidre et al. (2008); Amstrup et al. (2010); McIntyre et al. (2011)	<i>High</i>	Major	Atmospheric and ocean warming; circulation change; change in sea ice	No change	<i>High</i>
	Decreased reproductive success in Arctic seabirds	Section 28.2.2.1.2; Gaston et al. (2009); Grémillet and Boulinier (2009)	<i>Medium</i>	Major	Air and ocean warming; change in ocean circulation; change in sea ice	No change	<i>Medium</i>
	Decline in Southern Ocean seals and seabirds	Section 28.2.2.2; Croxall et al. (2002); Patterson et al. (2003); Jenouvrier et al. (2005); Véran et al. (2007); Forcada et al. (2008); Trathan et al. (2011); Chambers et al. (2013a)	<i>High</i>	Major	Ocean warming	No change	<i>Medium</i>
	Reduced thickness of foraminiferal shells in the Southern Ocean	Sections 6.3.2 and 28.2.2.2; Moy et al. (2009)	<i>Medium</i>	Major	Ocean acidification	No change	<i>Medium</i>
	Reduced density of krill in the Scotia Sea	Atkinson et al. (2004); Trivelpiece et al. (2011)	<i>Medium</i>	Major	Ocean warming; change in ocean circulation; change in sea ice	No change	<i>Medium</i>
Small islands	Increased coral bleaching near many tropical small islands	Section 29.3.1.2; Alling et al. (2007); Bruno and Selig (2007); Oxenford et al. (2008); Sandin et al. (2008)	<i>High</i>	Major	Ocean warming	Degradation due to fishing and pollution	<i>High</i>
	Degradation of mangroves, wetlands, and seagrass around small islands	Section 29.3.1.2; McKee et al. (2007); Gilman et al. (2008); Schlepner (2008); Krauss et al. (2010); Marbà and Duarte (2010); Rankey (2011)	<i>Low</i>	Minor	Sea level rise; atmospheric and ocean warming	Degradation due to other disturbances	<i>Very low</i>
	Increasing flooding and erosion	Section 29.3.1.1; Webb (2006); Webb (2007); Yamano et al. (2007); Cambers (2009); Novelo-Casanova and Suarez (2010); Storey and Hunter (2010); Ballu et al. (2011); Rankey (2011); Ford (2012); Romine et al. (2013)	<i>Low</i>	Minor	Sea level rise	Erosion due to human activities, natural erosion, and accretion	<i>Low</i>
	Degradation of groundwater and freshwater ecosystems due to saline intrusion	Section 29.3.2; White et al. (2007a,b); Ross et al. (2009); Carreira et al. (2010); Terry and Falkland (2010); White and Falkland (2010); Goodman et al. (2012)	<i>Low</i>	Minor	Sea level rise	Degradation due to pollution and groundwater pumping	<i>Low</i>