Statement of World Aquatic Scientific Societies on the Need to Take Urgent Action against Human-Caused Climate Change, Based on Scientific Evidence

*American Fisheries Society (AFS) • American Institute of Fishery Research Biologists
American Society of Ichthyologists and Herpetologists • American Water Resources Association
Asian Fisheries Society • Asociación de Oceanólogos de México, A.C.
Asociación Internacional de Hidrogeologos - Mexico Chapter
Asociatia Romana de Limnogeografei (Romanian Limnogeographical Association)
Association Française de Limnologie / French Limnological Association [EFFS member*]
Associazione Italiana di Oceanologia e Limnologia [EFFS member*] • Australian Coral Reef Society
The Australian Freshwater Sciences Society • Australian Marine Sciences Association
Australian Meteorological and Oceanographic Society • Australian Society for Fish Biology • BirdLife Australia
Blue Ventures • The Brazilian Society of Ichthyology • British Phycological Society
Canadian Aquatic Resources Section (CARS) of AFS • Canadian Centre for Evidence-based Conservation
Canadian Conference for Fisheries Research • Canadian Society of Zoologists
Coastal & Estuarine Research Federation • Coastal Research and Education Society of Long Island (CRESLI)
The Coastal Society • Community of Arran Seabed Trust • Conchological Society of Great Britain and Ireland
Croatian Association of Freshwater Ecologists (CAFÉ, HUSEK) [EFFS member]
Czech Limnological Society [EFFS member*] • Deep Ocean Stewardship Initiative (Climate and Fisheries WG)
Desert Fishes Council • EFYR European Fresh and Young Scientists [EFFS member]
European Federation for Freshwater Sciences (EFFS) • Finnish Limnological Society [EFFS member]
Fisheries Society of the British Isles • The Freshwater Biological Association [EFFS member*]
Freshwater Fisheries Society of BC • Freshwater Mollusk Conservation Society • German Ichthyological Society
German Limnological Society (DGL) [EFFS member*] • Gilbert Ichthyological Society
Hungarian Hydrological Society [EFFS member] • Hydroecological Society of Ukraine
The Hydrographic Society of America • The Hydrozoan Society • Iberian Association of Limnology [EFFS member]
Ichthyological Society of Japan • Ichthyological Society of Ukraine • The Institute of Fisheries Management
International Association for Danube Research • International Association for Great Lakes Research (IAGLR)
International Association of Aquatic and Marine Science Libraries and Information Centers (IAMSLIC)
International Coral Reef Society • International Federation of Hydrographic Societies • International Peatland Society
International Phycological Society • International Seaweed Association • International Society of Limnology
International Water History Association • Irish Freshwater Sciences Association [EFFS member]
The Japanese Society of Fisheries Science • Lake Victoria Fisheries Organization
The Limnological Society of Turkey [EFFS member] • Living Oceans Society • Macrolatinos@ Network
Malacological Society of London • Marine and Oceanographic Technology Network
The Marine Biological Association of India • Marine Biological Association of the United Kingdom
Marine Stewardship Council • National Association of Marine Laboratories (NAML)
Netherlands Malacological Society (Nederlandse Malacologische Vereniging)
The New Zealand Freshwater Sciences Society (NZFSS) • North American Lake Management Society
Oceania Chondrichthyan Society • Ocean Conservation Society • Philippine Association of Marine Science
Phycological Society of America • Polish Hydrobiological Society [EFFS member*] • Polish Limnological Society
Romanian Ecological Society [EFFS member] • Scientific Committee on Antarctic Research
Serbian Water Pollution Control Society SWPCS [EFFS member] • SIL Austria [EFFS member*]
Slovak Ichthyological Society • Slovak Limnological Society (SLS) [EFFS member*] • Sociedad Chilena de Limnología
Sociedad Científica Mexicana de Ecología, A.C. • Sociedad Iberica de Ictiologia • Sociedad Ictiológica Mexicana
Sociedad Mexicana de Planctologia A.C.
Sociedad Mexicana para el Estudio de los Florecimientos Algales Nocivos (SOMEFAN; Mexican Society for the Study of Harmful Algal Blooms • Sociedade Brasileira de Carcinologia • Société Française d'Ichtyologie
Society for Conservation Biology Marine Policy Section • Society for Freshwater Science
The Society for Marine Mammalogy • Society for the Study of Amphibians and Reptiles
Society of Canadian Limnologists/Société canadienne de Limnologie (SC) • Society of Wetland Scientists
Southern African Soc. Aquatic Scientists • Spanish Malacological Society (Sociedad Española de Malacología)
Swiss Hydrological and Limnological Society [EFFS member*] • Vietnam Fisheries Society (VINAFIS)
Western Indian Ocean Marine Science Association • Wild Oceans • World Aquaculture Society
The World Council of Fisheries Societies • World Sturgeon Conservation Society • Zoological Society of Pakistan*

[*] Denotes both part of EFFS, which signed, and a society that signed individually.

Water is the most important natural resource on Earth as it is vital for life. Aquatic ecosystems, freshwater or marine, provide multiple benefits to human society, such as provisioning of oxygen, food, drinking water, and genetic resources; regulation of atmospheric composition and climate; water purification; storm buffering; mitigation of floods/droughts; recreation areas; and other purposes. Our existence and well-being depend on the health and well-functioning of aquatic ecosystems. People naturally distribute around water—approximately 40% of the world's population lives within 100 km (62 mi) of a coast.[1]

The world's aquatic resources are now under their greatest threat in human history. Human-caused climate change is accelerating the degradation of aquatic ecosystems and the services they provide. Aquatic ecosystems are among the most affected worldwide (e.g., in case of freshwater ecosystems, one measure of biodiversity, the freshwater living planet index for species populations, declined 83% from 1970 to 2014, while up to 90% of coral reefs will disappear by mid-century if the current trends continue).[2]

We, the world's aquatic scientists, spend our lives studying these systems. We see exceptional and disturbing changes in the world's aquatic ecosystems due to climate change and believe that we must continue to share peer-reviewed scientific findings with the public and policymakers to emphasize the seriousness of this threat and the need for immediate action. For the first time, the assessment of global risks conducted by the World Economic Forum ranked the impact of "climate action failure," "biodiversity loss," and "water crisis" among the top five risks over the next decade.[3] In recent years, migration has increased and geopolitical tensions have been exacerbated: between 2008 and 2016, more than 20 million people per year have been forced to move due to extreme weather events, while according to the United Nations, in 2017, water was a major conflict factor in 45 countries.[3] These negative effects are expected to increase under current climatic trends. For example, in the United States, the climate-related economic damage is estimated to reach 10% of the gross domestic product by the end of the century.[3] In Europe, the minimum cost of not adapting to climate change is estimated at €100 billion per year in 2020 and €250 billion in 2050.[4]

Experts in environmental, social, and economic fields collectively point towards a severe environmental and humanitarian crisis, with repercussions at a global level, unless worldwide concerted climate actions are implemented urgently.

This document summarizes key scientific findings highlighting the effect of climate changes on aquatic ecosystems. These findings provide evidence of what effects are currently happening and why world policymakers and all of humankind need to act jointly and launch concerted actions now if they wish to mitigate these impacts.

The Challenge

- Thousands of peer-reviewed studies by scientists from authoritative institutions worldwide have documented evidence for climate effects on aquatic systems that are already occurring and are extensive.[5]
- Many globally respected sources, including the American Geophysical Union,[6] National Academies of Science from dozens of countries,[7] the Intergovernmental Panel on Climate Change,[8] and the Fourth U.S. National Climate Assessment[9] support findings that increased atmospheric concentrations of greenhouse gases from fossil fuels (i.e., emissions) and land use changes such as deforestation are driving current climate change.
- Many of these changes are and will be irreversible. They will continue to worsen if we persist on our current trajectory.[10]

- Impacts already occurring range from increased frequency, intensification, and severity of droughts, heat waves, floods, wildfires, and storms; melting glaciers; destabilization of major ice sheets; shifting ocean currents, rising sea level; ocean acidification and deoxygenation; shifts in species ranges, including expansion of alien-invasive species; aquatic plant and wildlife disease outbreaks; mass coral bleaching events; and more, with a mounting toll on vulnerable ecosystems, human societies, and local and global economies.[11]
- These events are precursors of even more damages to fisheries, biodiversity, and human society at large.[12]
- Delaying action to stop underlying causes of climate change will increase the economic, environmental, and societal consequences.[13]
- If humanity wishes to avoid calamitous consequences for our aquatic ecosystems and humans that depend on them, the time to curb greenhouse gas emissions, sequester greenhouse gasses, and adapt to an already changing climate is now.[14] Intelligent, rapid movement toward such goals will provide great benefits to aquatic ecosystems and the humans that depend on them.
- Rapid global response and large-scale actions are possible if public and government commitment exists.[15]

The Evidence: Effects on Marine Resources

- Shifts in species composition, behavior, abundance, and biomass production are now occurring.[16]
- Lobster,[17] cod,[18] mackerel,[19] coral reef fishes,[20] and other species important to fisheries[21] are either moving poleward to deeper waters or declining.[22]
- Coastal ecosystems are being transformed, degraded, or lost, either largely[23] or in part due to climate change, including sea grass meadows,[24] mangroves,[25] coral reefs,[26] and kelp forests.[27]
- Effects of altered species compositions are affecting entire ecosystems.[28]
- Carbon emissions cause global ocean acidification, which is affecting the survival of organisms, especially shellfish, and accelerating coral reef erosion.[29]
- Rising frequency and intensity of marine heatwaves has been documented and is projected to continue.[30]
- Reductions in global ocean dissolved oxygen concentrations have occurred over the past five decades.[31]
- Climate change is interacting with other stressors such as excess nutrient input,[32] overharvesting,[33] and novel species interactions[34] to further suppress marine ecosystems.
- Climate change is linked to emerging and re-emerging disease outbreaks in marine wildlife and plant species.[35]
- Global production of marine animals continues to decrease and shifts in species composition will increase unless greenhouse gas emissions are reduced.[36]
- Seabirds are recognized as indicators of long-term environmental change: nearly three out of four of the world's seabirds have disappeared since 1950, and more than half the remaining species face substantial threats.[37] In North America alone, two-thirds (389/604) of bird species, which includes waterbirds, are moderately or highly vulnerable to climate change under a 3°C scenario.[38]

The Evidence: Effects on Freshwater Resources

- Freshwater ecosystems are among the most threatened on Earth.[39]

- Freshwater ecosystems cover less than 1% of the planet's surface but support one-third of vertebrate species and 10% of all species.[40]
- The capacity of all freshwater ecosystems to adapt is relatively low given the nature of freshwater systems and the scale of impacts of climate change.[41]
- Climate change is altering abundance, predator–prey dynamics, expansion of invasive species, growth, recruitment of species, and novel species interactions, leading to declines in the number and diversity of freshwater aquatic organisms.[42]
- Increased frequency, intensity, and length of drought are affecting the amount and quality of freshwater available for both aquatic ecosystems and humans.[43]
- Climate change impacts on flow regimes, including both increased droughts and low-flow periods, and increased flooding impact native species with narrow ranges of flow requirements and allow expansion of alien-invasive species that affect recreational and commercial harvest of fishes and clog waterways.[44]
- Geographic ranges of many plants and animals have moved poleward and to higher altitudes while alien-invasive species expand with the increasingly warm conditions.[45] Unlike marine systems, pathways to other habitats are often blocked, leading to localized extinctions.[46]
- Temporal shifts in seasonal cues, such as spring runoff or monsoon seasons, affect spawning success of fish, resulting in poor survival.[47]
- Higher incidence of wildfires is affecting aquatic systems by making watersheds more susceptible to flooding and by reducing water quality, especially with post-fire ash and sediment deposition.[48]
- Wetlands capacity for carbon storage and mitigation of climate change are being damaged by changes linked to climate shifts and other components of global change, such as increased land development and fires.[49]
- Higher temperatures and precipitation runoff have increased harmful algae blooms, which can hurt fish, mammals, birds, and even humans.[50]
- Climate change may act synergistically with nutrients to magnify eutrophication and further degrade water quality and ecosystem services, including affecting drinking water.[51]
- Organisms dependent on snow melt and glacial streams are declining or shifting their distribution.[52]
- Release of heavy metals such as mercury, currently stored in glaciers and the permafrost, is projected to further affect freshwater organisms.[53]
- Climate change is linked to emerging and re-emerging disease outbreaks in freshwater wildlife and plant species.[54]
- These seemingly diverse and small-scale changes combine to create multiple, cumulatively stressful challenges to aquatic species.[55]

The Evidence: Effects on World Society Dependent on Aquatic Resources.

- Clean and sufficient water is needed by all life forms.
- Fisheries provide quality protein sources not easily replaced by terrestrial sources. According to the Food and Agriculture Organization of the United Nations, fish accounts for 17% of animal protein consumed globally, fishing and aquaculture directly employ almost 60 million people, and global trade in fish products has reached US$152 billion per year, with 54% originating in developing countries.[56]
- In the short term, new fisheries are appearing in some newly formed ice-free areas[57]; however, overall fisheries catch is projected to decline related to increasing declines in water quality and

primary production as a result of climate change, with corresponding effects on food security.[58] Ocean warming and changes in primary productivity are related to changes in many fish stocks. Fish population reestablishment has declined 3% per decade, and maximum catch potential declined 4.1% over the 20th century.[59] Water temperature increases due to climate change are projected to exceed the tolerance limits of 10–60% of freshwater and marine species by 2100, depending on the amount of greenhouse gas emissions allowed.[60]

- Climate change impacts on aquatic ecosystems are affecting incomes, food security, key cultural dimensions, and livelihoods of resource-dependent communities.[61]
- Species shifts are affecting traditional fisheries from the tropics to the polar regions through reduced access to fish stocks, fishing areas, and loss of local knowledge.[62]
- Climate change compounds the impact of other practices such as pollution, overfishing, and unsustainable coastal development. These combined impacts are projected to drive many small-scale fisheries and economies out of existence.[63]
- Warming of waters affects seafood safety through elevated bioaccumulation of heavy metals and pollutants and an increased prevalence of waterborne pathogens affecting both human and animal health.[64]
- Tourism and tourist sites are being affected in many areas that are dependent on local ecosystems. Sustainable diving, snorkeling, angling, marine mammal and bird watching, and other recreational activities and businesses depend on maintenance of healthy aquatic resources.[65]
- Climate change degrades coastal ecosystems such as mangroves, sea grasses, marshes, peatlands, and coral reefs that provide services to humans such as protecting coasts from erosion, storms, and flooding, providing key wildlife habitat and sequestering carbon.[66]
- Climate change damages riparian ecosystems that provide services to humans, such as protecting streams from flooding, intercepting pollutants, reducing erosion, providing shade and wildlife habitat, sequestering carbon, and storing water during high-flow events.[67]
- Climate change contributes to harming wetlands, which provide many of the same services to humans, as stated above. Wetlands play a critical role in carbon storage and sequestration. In particular, peatlands, despite occupying on 3% of the land surface, store twice as much carbon as the world's forests.[68]
- The level of impacts will be governed by the level of protective limits our nations place on future emissions combined with riparian and coastal zoning, and changes in fisheries management practices.[69]

The Needed Responses

- We assert that rapid action is necessary to drastically curb release of greenhouse gas emissions and to remove and store CO_2 from the atmosphere to prevent the most calamitous consequences of human-caused climate change to marine and freshwater ecosystems on which all humankind depends.
- Global and national targets are necessary to protect and restore carbon dense ecosystems, such as peat, sea grasses, and other wetlands to sequester carbon, prevent greenhouse gas emissions, and reduce the impacts of climate change.
- Governments, the public, industry, academia, and all other sectors of society must prioritize actions and act in a concerted way to halt human-caused climate change if they are to prevent dire consequences.

- A rapid transition towards energy sources and other products and services that do not release greenhouse gases, and research and policies that favor an efficient transition to a low carbon world is required to slow the degradation of aquatic systems, as above. Such a transition could be accomplished by all governments by immediately acting on the advice of specialists in green energy technology, carbon sequestration, marketing, education, socioeconomic principles, and related disciplines.
- Robust adaptation measures; identification and easing of other environmental stressors that act synergistically with climate change; and additional resources for data collection, mapping, and research to better understand potential impacts and to arm natural resources agencies with the tools to mitigate these impacts are essential to better understand and plan for changes in aquatic ecosystems.
- Done intelligently, movement to curtail human-caused climate change can result in advanced, novel technologies; strong economies; healthier aquatic ecosystems; greater food security; and human well-being.

It is time to acknowledge the urgent need to act to address climate change. Delaying action to control greenhouse gas emissions is not an option if humankind wishes to conserve the aquatic resources and environmental safety of the world.

Notes

1. Center for International Earth Science Information Network. No date. Percentage of total population “living in coastal areas. Center for International Earth Science Information Network, Earth Institute, Columbia University, New York. Available: https://sedac.ciesin.columbia.edu/es/papers/Coastal_Zone_Pop_Method.pdf. (July 2020).
2. Finlayson C. M., G. T. Davies, W. R. Moomaw, G. L. Chmura, S. M. Natali, J. E. Perry, N. Roulet, and A. E. Sutton-Grier. 2019. The second warning to humanity—providing a context for wetland management and policy. Wetlands 39:1–5.

   Finlayson C. M., R. D’Cruz, and N. C. Davidson. 2005. Ecosystems and human well-being: wetlands and water, synthesis. World Resources Institute, Washington, D.C. Available: www.millenniumassessment.org/documents/document.358.aspx.pdf. (July 2020).

   Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. 2018. Summary for policymakers. Pages 1–24 *in* Global warming of 1.5°C: an IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available: www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf. (July 2020).

   Ramsar Convention on Wetlands 2018. Global wetland outlook: state of the world’s wetlands and their ecosystem services. Ramsar Convention, Gland, Switzerland. Available: www.global-wetland-outlook.ramsar.org. (July 2020).

   World Wildlife Fund. 2018. Living planet report 2018: aiming higher. World Wildlife Fund, Gland, Switzerland [pages 75 and 54]. Available: https://wwf.panda.org/knowledge_hub/all_publications/living_planet_report_2018/. (July 2020).
3. World Economic Forum. 2020. The global risks report 2020 [Figure II and page 31]. World Economic Fund, Geneva, Switzerland. Available: www.weforum.org/reports/the-global-risks-report-2020. (July 2020).

4. European Commission. 2020. The EU strategy on adaptation to climate change [fact sheet]. Available: https://ec.europa.eu/clima/sites/clima/files/docs/eu_strategy_en.pdf. (July 2020).

5. The number of studies that have investigated effects of human-caused climate change on aquatic systems is vast. Most literature compilations combine already observed effects with those projected. In three reports, we counted a total of more than 2,000 studies that reported observed effects on aquatic systems. We did not count projected effects. These reports are as follows:

Barros, V. R., C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. 2014. Climate change 2014—impacts, adaptation, and vulnerability: part B: regional aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York.

Field, C. B., V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. 2014. Climate change 2014—impacts, adaptation, and vulnerability: part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York.

Krabbenhoft, T. J., B. J. E. Myers, J. P. Wong, C. Chu, R. W. Tingley, J. Falke, T. J. Kwak, C. P. Paukert, and A. J. Lynch. 2020. FiCli, the Fish and Climate Change Database, informs climate adaptation and management for freshwater fishes. Scientific Data 7:124.

Pörtner, H.-O., D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. 2019. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/srocc/home/. (July 2020).

These are just the beginning of peer-reviewed studies and peer-reviewed compilations of studies that discuss human-caused climate change and the effects of climate change on aquatic ecosystems. Other reports that include both projections and already observed effects on aquatic systems are as follows:

Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel, and J. C. Minx, editors. 2014. Climate change 2014: mitigation of climate change. Contribution of Working Group III to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York. [This report gives methods to control greenhouse gas emissions and other ways to "mitigate" or control the factors affecting climate change itself. Cites close to 10,000 studies.]

Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. 2018. Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available: www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf. (September 2020). [Cites effects on a variety of systems, including both aquatic and terrestrial. The press release accompanying this document states report cites more than 6,000 scientific references and resulted from contribution of thousands of expert and government reviewers worldwide.]

Paukert, G. P., A. J. Lynch, and J. E. Whitney, editors. 2016. Effects of climate change on North American inland fishes. Fisheries 41(7). [Full issue concerning effects of climate change on inland fishes containing more than 90 authors and more than 600 cited references.]

Reidmiller, D. R., C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. 2018. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C. [Cites effects on a variety of systems, including both aquatic and terrestrial. More than 5,600 references cited, mostly peer-reviewed, and data sets.]

Stocker, T. F., D. Qin, G.-K Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P. M. Midgley, editors. 2013. Climate change 2013: the physical science basis. Contribution of Working Group I to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York. [Discusses the physical scientific evidence for change to both terrestrial and aquatic systems, citing more than 9,200 scientific publications according to the Working Group 1 fact sheet.]

Wuebbles, D. J., D. W. Fahey, K. A. Hibbard, D. J. Dokken, B. C. Stewart, and T. K. Maycock, editors. 2017. Climate science special report: fourth national climate assessment, volume I. U.S. Global Change Research Program, Washington, D.C. [Cites effects on a variety of systems, including both aquatic and terrestrial. Number of references not provided, but likely similar to U.S. Global Change Research Program 2018.]

6. American Geophysical Union (AGU). 2019. Society must address the growing climate crisis now. Position statement. AGU, Washington, D.C.

7. Statements from various academies of sciences include the following:

European Academy of Sciences. 2015. Statement. Facing critical decisions on climate change in 2015. Available: https://easac.eu/publications/details/facing-critical-decisions-on-climate-change-in-2015/. (September 2020).

The Royal Society and the U.S. National Academy of Sciences. 2020. Climate change evidence & causes: update 2020. An overview from the Royal Society and the US National Academy of Sciences. Available: https://royalsociety.org/-/media/Royal_Society_Content/policy/projects/climate-evidence-causes/climate-change-evidence-causes.pdf. (September 2020).

Academies of Science for the G8+5 Countries. 2008. Joint science academies' statement: climate change: adaptation and the transition to a low carbon society. Available: http://insaindia.res.in/pdf/Climate_05.08_W.pdf. (September 2020).

Academies of Science for the G8+5 Countries. 2007. Joint science academies' statement on growth and responsibility: sustainability, energy efficiency and climate protection. Available: www.scj.go.jp/ja/info/kohyo/pdf/kohyo-20-s4.pdf (September 2020).

Network of African Science Academies (NASAC). 2007. Joint statement by the Network of African Science Academies (NASAC) to the G8 on sustainability, energy efficiency and climate change. Available: www.interacademies.org/sites/default/files/publication/nasac_g8_statement_07_-_low_res.pdf. (September 2020).

Interacademy Medical Panel (IAMP). 2010. Statement on the health co-benefits of policies to tackle climate change. Available: www.interacademies.org/statement/iamp-statement-health-co-benefits-policies-tackle-climate-change. (September 2020).

8. See references in 5. References that cite the causes of climate change, including thorough discussions that show overwhelming evidence that emissions are the chief factor, are found in Collins et al. (2013), Edenhofer et al. (2014), and Masson-Delmotte et al. (2018).

9. See references in 5. Wuebbles et al. (2017) is the primary U.S. report that discusses the physical basis of climate change.

10. "As a result of the large ocean inertia and the long lifetime of many greenhouse gases, primarily carbon dioxide, much of the warming would persist for centuries after greenhouse gas emissions have stopped." [From Collins, M., R. Knutti, J. Arblaster, J.-L. Dufresne, T. Fichefet, P. Friedlingstein, X. Gao, W. J. Gutowski, T. Johns, G. Krinner, M. Shongwe, C. Tebaldi, A. J. Weaver, and M. Wehner. 2013. Long-term climate change: projections, commitments and irreversibility. Pages 1029–1136 *in* T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P. M. Midgley, editors. Climate change 2013: the physical science basis. Contribution of Working Group I to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York.]

See also the following:

Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. 2018. Summary for policymakers. Pages 1–24 *in* Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available: www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_HR.pdf. (September 2020).

Pörtner, H.-O., D. C. Roberts, V. Masson-Delmotte, P. Zhai, E. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. 2019. Technical summary. Pages 37–69 *in* IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/04_SROCC_TS_FINAL.pdf (September 2020).

11. See citations included in references in 5. Impacts are documented in vast numbers of studies in these citations.
12. For increasing impacts on the world's oceans, freshwaters, and societies, start with the following:

Bindoff, N. L., W. W. L. Cheung, J. G. Kairo, J. Arístegui, V. A. Guinder, R. Hallberg, N. Hilmi, N. Jiao, M. S. Karim, L. Levin, S. O'Donoghue, S. R. Purca Cuicapusa, B. Rinkevich, T. Suga, A. Tagliabue, and P. Williamson. 2019. Changing ocean, marine ecosystems, and dependent communities. Pages 447–587 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/09_SROCC_Ch05_FINAL-1.pdf. (September 2020).

Brugere C., D. M. Onuigbo, and K. L. Morgan. 2017. People matter in animal disease surveillance: challenges and opportunities for the aquaculture sector. Aquaculture 467:158–169.

Fleming, E., J. Payne, W. Sweet, M. Craghan, J. Haines, J. F. Hart, H. Stiller, and A. Sutton-Grier. 2018. Coastal effects. Pages 322–352 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C.

Hoegh-Guldberg, O., D. Jacob, M. Taylor, M. Bindi, S. Brown, I. Camilloni, A. Diedhiou, R. Djalante, K. L. Ebi, F. Engelbrecht, J. Guiot, Y. Hijioka, S. Mehrotra, A. Payne, S.I. Seneviratne, A. Thomas, R. Warren, and G. Zhou. 2018. Impacts of 1.5°C global warming on natural and human systems. Pages 175–311 *in* V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. Global warming of 1.5°C: an IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available: www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter3_Low_Res.pdf. (July 2020).

Lipton, D., M. A. Rubenstein, S. R. Weiskopf, S. Carter, J. Peterson, L. Crozier, M. Fogarty, S. Gaichas, K. J. W. Hyde, T. L. Morelli, J. Morisette, H. Moustahfid, R. Muñoz, R. Poudel, M. D. Staudinger, C. Stock, L. Thompson, R. Waples, and J. F. Weltzin. 2018. Ecosystems, ecosystem services, and biodiversity. Pages 268–321 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C.

Pershing, A. J., R. B. Griffis, E. B. Jewett, C. T. Armstrong, J. F. Bruno, D. S. Busch, A. C. Haynie, S. A. Siedlecki, and D. Tommasi. 2018. Oceans and marine resources. Pages 353–390 *in* D. R. Reidmiller,

C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C.

Pörtner, H.-O., D. M. Karl, P. W. Boyd, W. W. L. Cheung, S. E. Lluch-Cota, Y. Nojiri, D. N. Schmidt, and P. O. Zavialov. 2014. Ocean systems. Pages 411–484 in C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York.

Settele, J., R. Scholes, R. Betts, S. Bunn, P. Leadley, D. Nepstad, J. T. Overpeck, and M. A. Taboada. 2014. Terrestrial and inland water systems. Pages 271–359 *in* C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York.

Wong, P. P., I. J. Losada, J.-P. Gattuso, J. Hinkel, A. Khattabi, K. L. McInnes, Y. Saito, and A. Sallenger. 2014. Coastal systems and low-lying areas. Pages 361–409 in C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York.

13. Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufou-ma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. 2018. Summary for policymakers. Pages 1–24 *in* Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Avail-able: www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf. (July 2020). [Pages 7–11.]

World Bank. 2019. Climate change and marine fisheries in Africa: assessing vulnerability and strengthening adaptation capacity. World Bank, Washington, D.C.

14. Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufou-ma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. 2018. Summary for policymakers. Pages 1–24 *in* Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the con text of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate pov-erty. Available: www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf. (July 2020). [Page 4.]

15. Some examples of large-scale, rapid action in response to disease epidemics reported in the following:

Cheng, V. C. C., S. C. Wong, J. H. K. Chen, C. C. Y. Yip, V. W. M. Chuang, O. T. Y. Tsang, S. Sridhar, J. F. W. Chan, P. L. Ho, and K. Y. Yuen. 2020. Escalating infection control response to the rapidly evolving epidemiology of the coronavirus disease 2019 (COVID-19) due to SARS-CoV-2 in Hong Kong. Infection Control and Hospital Epidemiology 41:493–498.

Smith, N., and M. Fraser. 2020. Straining the system: novel coronavirus (COVID-19) and preparedness for concomitant disasters. American Journal of Public Health 110:648–649.

Sohrabi, C., Z. Alsafi, N. O'Neill, M. Khan, A. Kerwan, A. Al-Jabir, C. Iosifidis, and R. Agha. 2020. World Health Organization declares global emergency: a review of the 2019 novel coronavirus (COVID-19), International Journal of Surgery 76:71–76.

16. Bindoff, N. L., W. W. L. Cheung, J. G. Kairo, J. Arístegui, V. A. Guinder, R. Hallberg, N. Hilmi, N. Jiao, M. S. Karim, L. Levin, S. O'Donoghue, S. R. Purca Cuicapusa, B. Rinkevich, T. Suga, A. Tagliabue, and P. Williamson. 2019. Changing ocean, marine ecosystems, and dependent communities. Pages 447–587 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/09_SROCC_Ch05_FINAL-1.pdf. (September 2020). [Pages 450–451, 478–481.]

Burrows, M. T., D. S. Schoeman, A. J. Richardson, J. G. Molinos, A. Hoffmann, L. B. Buckley, P. J. Moore, C. J. Brown, J. F. Bruno, C. M. Duarte, B. S. Halpern, O. Hoegh-Guldberg, C. V. Kappel, W. Kiessling, M. I. O'Connor, J. M. Pandolfi, C. Parmesan, W. J. Sydeman, S. Ferrier, K. J. Williams, and E. S. Poloczanska. 2014. Geographical limits to species-range shifts are suggested by climate velocity. Nature 507:492–495.

Chambers, L. E., P. Dann, B. Cannell, and E. J. Woehler. 2014. Climate as a driver of phenological change in southern seabirds. International Journal of Biometeorology 58:603–612.

Chambers, L. E., C. A. Devney, B. C. Congdon, N. Dunlop, E. J. Woehler, and P. Dann. 2011. Observed and predicted impacts of climate on Australian seabirds. Emu 111:235–251.

Hoegh-Guldberg, O., D. Jacob, M. Taylor, M. Bindi, S. Brown, I. Camilloni, A. Diedhiou, R. Djalante, K. L. Ebi, F. Engelbrecht, J. Guiot, Y. Hijioka, S. Mehrotra, A. Payne, S.I. Seneviratne, A. Thomas, R. Warren, and G. Zhou. 2018. Impacts of 1.5°C global warming on natural and human systems. Pages 175–311 *in* V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available: www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter3_Low_Res.pdf. (July 2020). [Pages 218, 222.]

Nagelkerken, I., and S. D. Connell, 2015: Global alteration of ocean ecosystem functioning due to increasing human CO_2 emissions. Proceedings of the National Academy of Sciences of the United States of America 112:13272–13277.

Poloczanska, E. S., C. J. Brown, W. J. Sydeman, W. Kiessling, D. S. Schoeman, P. J. Moore, K. Brander, J. F. Bruno, L. B. Buckley, M. T. Burrows, C. M. Duarte, B. S. Halpern, J. Holding, C. V. Kappel, M. I. O'Connor, J. M. Pandolfi, C. Parmesan, F. Schwing, S. A. Thompson, and A. J. Richardson. 2013. Global imprint of climate change on marine life. Nature Climate Change 3:919–925.

Price C. A., K. Hartmann, T. J. Emery, E. J. Woehler, C. R. McMahon, M. A. Hindell. 2020. Climate variability and breeding parameters of a trans-hemispheric migratory seabird over seven decades. Marine Ecology Progress Series 642:191–205.

Vergés, A., P. D. Steinberg, M. E. Hay, A. G. B. Poore, A. H. Campbell, E. Ballesteros, K. L. Heck, D. J. Booth, M. A. Coleman, D. A. Feary, W. Figueira, T. Langlois, E. M. Marzinelli, T. Mizerek, P. J. Mumby, Y. Nakamura, M. Roughan, E. van Sebille, A. S. Gupta, D. A. Smale, F. Tomas, T. Wernberg, and S. K. Wilson, 2014. The tropicalization of temperate marine ecosystems: climate-mediated changes in herbivory and community phase shifts. Proceedings of the Royal Society B 281(1789):20140846.

17. Caputi, N., R. Melville-Smith, S. de Lestang, A. Pearce, and M. Feng. 2010. The effect of climate change on the western rock lobster (*Panulirus cygnus*) fishery of Western Australia. Canadian Journal of Fisheries and Aquatic Sciences 67:85–96.

Gould, W. A., E. L. Díaz, (co-leads), N. L. Álvarez-Berríos, F. Aponte-González, W. Archibald, J. H.

Bowden, L. Carrubba, W. Crespo, S. J. Fain, G. González, A. Goulbourne, E. Harmsen, E. Holupchinski, A. H. Khalyani, J. Kossin, A. J. Leinberger, V. I. Marrero-Santiago, O. Martínez-Sánchez, K. McGinley, P. Méndez-Lázaro, J. Morell, M. M. Oyola, I. K. Parés-Ramos, R. Pulwarty, W. V. Sweet, A. Terando, and S. Torres-González, 2018: U.S. Caribbean. Pages 809–871 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C.

Le Bris, A., K. E. Mills, R. A. Wahle, Y. Chen, M. A. Alexander, A. J. Allyn, J. G. Schuetz, J. D. Scott, and A. J. Pershing. 2018. Climate vulnerability and resilience in the most valuable North American fishery. Proceedings of the National Academy of Sciences of the United States of America. 115:1831–1836.

18. Barbeaux, S., K. Aydin, B. Fissel, K. Holsman, W. Palsson, K. Shotwell, Q. Yang, and S. Zador. 2017. Assessment of the Pacific Cod stock in the Gulf of Alaska. Pages 189–332 *in* North Pacific Fisheries Management Council Gulf of Alaska SAFE (Stock Assessment and Fishery Evaluation) [council draft]. Available: www.city.kodiak.ak.us/sites/default/files/fileattachments/fisheries_workgroup/meeting/10388/2017_goa_pcod_stock_assessment.pdf. (July 2020).

19. Meredith, M., M. Sommerkorn, S. Cassotta, C. Derksen, A. Ekaykin, A. Hollowed, G. Kofinas, A. Mackintosh, J. Melbourne-Thomas, M. M. C. Muelbert, G. Ottersen, H. Pritchard, and E. A. G. Schuur. 2019. Polar regions. Pages 203–320 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/07_SROCC_Ch03_FINAL.pdf. (July 2020).

20. Nicholas A. J. Graham, N. A. J., S. K. Wilson, S. Jennings, N. V. C. Polunin, J. P. Bijoux, J. Robinson. 2006. Dynamic fragility of oceanic coral reef ecosystems. Proceedings of the National Academy of Sciences 103:8425–8429.

21. Poloczanska, E. S., C. J. Brown, W. J. Sydeman, W. Kiessling, D. S. Schoeman, P. J. Moore, K. Brander, J. F. Bruno, L. B. Buckley, M. T. Burrows, C. M. Duarte, B. S. Halpern, J. Holding, C. V. Kappel, M. I. O'Connor, J. M. Pandolfi, C. Parmesan, F. Schwing, S. A. Thompson, and A. J. Richardson. 2013. Global imprint of climate change on marine life. Nature Climate Change 3:919–925.

22. Dulvy, N. K., S. I. Rogers, S. Jennings, V. Stelzenmüller, S. R. Dye, and H. R. Skjoldal. 2008. Climate change and deepening of the North Sea fish assemblage: a biotic indicator of warming seas. Journal of Applied Ecology 45:1029–1039.

Hastings, R. A., L. A. Rutterford, J. J. Freer, R. A. Collins, S. D. Simpson, and M. J. Genner. 2020. Climate change drives poleward increases and equatorward declines in marine species. Current Biology 30:1572–1577.

Pershing, A. J., R. B. Griffis, E. B. Jewett, C. T. Armstrong, J. F. Bruno, D. S. Busch, A. C. Haynie, S. A. Siedlecki, and D. Tommasi. 2018. Oceans and marine resources. Pages 353–390 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C. [Pages 358, 362.]

23. Babcock, R. C., R. H. Bustamante, E. A. Fulton, D. J. Fulton, M. D. E. Haywood, A. J. Hobday, R. Kenyon, R. J. Matear, E. Plaganyi, A. J. Richardson, and M. Vanderklift. 2019. Severe continental-scale impacts of climate change are happening now: extreme climate events impact marine habitat forming communities along 45% of the Australian coast. Frontiers in Marine Science 6:411.

24. Fleming, E., J. Payne, W. Sweet, M. Craghan, J. Haines, J. F. Hart, H. Stiller, and A. Sutton-Grier. 2018. Coastal effects. Pages 322–352 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C. [Page 331.]

Kaladharan, P., and A. Koya. 2019. Shrinking seagrass meadows observations from four lagoons of Lakshadweep archipelago. Journal of the Marine Biological Association of India 61:47–51.

Wong, P. P., I. J. Losada, J.-P. Gattuso, J. Hinkel, A. Khattabi, K. L. McInnes, Y. Saito, and A. Sallenger. 2014. Coastal systems and low-lying areas. Pages 361–409 *in* C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York. [Page 377.]

25. Fleming, E., J. Payne, W. Sweet, M. Craghan, J. Haines, J. F. Hart, H. Stiller, and A. Sutton-Grier. 2018. Coastal effects. Pages 322–352 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C. [Page 331.]

Friess, D. A., K. Rogers, C. E. Lovelock, K. W. Krauss, S. E. Hamilton, S. Y. Lee, R. Lucas, J. Primavera, A. Rajkaran, and S. Shi. 2019. The state of the world's mangrove forests: past, present and future. Annual Review of Environment and Resources 44:16.1–16.27.

Jennerjahn, T. C., E. Gillman, K. W. Krauss, L. D. Lacerda, I. Nordhaus, and E. Wolanski. 2017. Mangrove ecosystems under climate change. Pages 211–244 *in* V. H. Rivera-Monroy, S. Y. Lee, E. Kristensen, and R. R. Twilley, editors. Mangrove ecosystems: a global biogeographic perspective.Springer International Publishing, New York.

Oppenheimer, M., B. C. Glavovic , J. Hinkel, R. van de Wal, A. K. Magnan, A. Abd-Elgawad, R. Cai, M. Cifuentes-Jara, R. M. DeConto, T. Ghosh, J. Hay, F. Isla, B. Marzeion, B. Meyssignac, and Z. Sebesvari. 2019. Sea level rise and implications for low-lying islands, coasts and communities. Pages 321–445 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/08_SROCC_Ch04_FINAL.pdf. (July 2020).

Saintilan, N., N. S. Khan, E. Ashe, J. J. Kelleway, K. Rogers, C. D. Woodroffe, and B. P. Horton. 2020. Thresholds of mangrove survival under rapid sea level rise. Science 368:1118–1121.

26. Hoegh-Guldberg, O., D. Jacob, M. Taylor, M. Bindi, S. Brown, I. Camilloni, A. Diedhiou, R. Djalante, K. L. Ebi, F. Engelbrecht, J. Guiot, Y. Hijioka, S. Mehrotra, A. Payne, S.I. Seneviratne, A. Thomas, R. Warren, and G. Zhou. 2018. Impacts of 1.5°C global warming on natural and human systems. Pages 175–311 *in* V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available: www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter3_Low_Res.pdf. (July 2020). [Pages 229–230.]

Gattuso, J.-P., A. Magnan, R. Billé, W. W. L. Cheung, E. L. Howes, F. Joos, D. Allemand, L. Bopp, S. R. Cooley, C. M. Eakin, O. Hoegh-Guldberg, R. P. Kelly, H.-O. Pörtner, A. D. Rogers, J. M. Baxter, D. Laffoley, D. Osborn, A. Rankovic, J. Rochette, U. R. Sumaila, S. Treyer, and C. Turley. 2015. Contrasting futures for ocean and society from different anthropogenic CO_2 emissions scenarios. Science 349(6243):aac4722.

Gould, W. A., E. L. Díaz, (co-leads), N. L. Álvarez-Berríos, F. Aponte-González, W. Archibald, J. H. Bowden, L. Carrubba, W. Crespo, S. J. Fain, G. González, A. Goulbourne, E. Harmsen, E. Holupchinski, A. H. Khalyani, J. Kossin, A. J. Leinberger, V. I. Marrero-Santiago, O. Martínez-Sánchez, K.

McGinley, P. Méndez-Lázaro, J. Morell, M. M. Oyola, I. K. Parés-Ramos, R. Pulwarty, W. V. Sweet, A. Terando, and S. Torres-González. 2018. U.S. Caribbean. Pages 809–871 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C. [Pages 827–831.]

Hughes, T. P., K. D. Anderson, S. R. Connolly, S. F. Heron, J. T. Kerry, J. M. Lough, A. H. Baird, J. K. Baum, M. L. Berumen, T. C. Bridge, D. C. Claar, C. M. Eakin, J. P. Gilmour, N. A. J. Graham, H. Harrison, J. P. A. Hobbs, A. S. Hoey, M. Hoogenboom, R. J. Lowe, M. T. McCulloch, J. M. Pandolfi, M. Pratchett, V. Schoepf, G. Torda, and S. K. Wilson. 2018. Spatial and temporal patterns of mass bleaching of corals in the Anthropocene. Science 359:80–83.

Pershing, A. J., R. B. Griffis, E. B. Jewett, C. T. Armstrong, J. F. Bruno, D. S. Busch, A. C. Haynie, S. A. Siedlecki, and D. Tommasi. 2018. Oceans and marine resources. Pages 353–390 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C. [Page 359.]

Wong, P. P., I. J. Losada, J.-P. Gattuso, J. Hinkel, A. Khattabi, K. L. McInnes, Y. Saito, and A. Sallenger. 2014. Coastal systems and low-lying areas. Pages 361–409 *in* C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York. [Pages 378–379.]

27. Bindoff, N. L., W. W. L. Cheung, J. G. Kairo, J. Arístegui, V. A. Guinder, R. Hallberg, N. Hilmi, N. Jiao, M. S. Karim, L. Levin, S. O'Donoghue, S. R. Purca Cuicapusa, B. Rinkevich, T. Suga, A. Tagliabue, and P. Williamson. 2019. Changing ocean, marine ecosystems, and dependent communities. Pages 447–587 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/09_SROCC_Ch05_FINAL-1.pdf. (September 2020). [Pages 499–500.]

Krumhansl, K. A., D. K. Okamoto, A. Rassweiler, M. Novak, J. J. Bolton, K. C. Cavanaugh, S. D. Connell, C. R. Johnson, B. Konar, S. D. Ling, F. Micheli, K. M. Norderhaug, A. Pérez-Matus, I. Sousa-Pinto, D. C. Reed, A. K. Salomon, N. T. Shears, T. Wernberg, R. J. Anderson, N. S. Barrett, A. H. Buschmann, M. H. Carr, J. E. Caselle, S. Derrien-Courtel, G. J. Edgar, M. Edwards, J. A. Estes, C. Goodwin, M. C. Kenner, D. J. Kushner, F. E. Moy, J. Nunn, R. S. Steneck, J. Vásquez, J. Watson, J. D. Witman, and J. E. K. Byrnes. 2016. Global patterns of kelp forest change over the past half-century. Proceedings of the National Academy of Science of the United States of America 113:13785–13790.

Voerman, S. E., E. Llera, and J. M. Rico. 2013. Climate driven changes in subtidal kelp forest communities in NW Spain. Marine Environmental Research 90:119–127.

Wernberg, T., K. Krumhansl, K. Filbee-Dexter, and M. F. Pedersen. 2019. Status and trends for the world's kelp forests. Pages 57–78 *in* C. Sheppard, editor. World seas: an environmental evaluation. Elsevier, New York.

Wong, P. P., I. J. Losada, J.-P. Gattuso, J. Hinkel, A. Khattabi, K. L. McInnes, Y. Saito, and A. Sallenger. 2014. Coastal systems and low-lying areas. Pages 361–409 *in* C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York. [Pages 377–378.]

28. Babcock, R. C., R. H. Bustamante, E. A. Fulton, D. J. Fulton, M. D. E. Haywood, A. J. Hobday, R. Kenyon,

R. J. Matear, E. Plaganyi, A. J. Richardson, and M. Vanderklift. 2019. Severe continental-scale impacts of climate change are happening now: extreme climate events impact marine habitat forming communities along 45% of the Australian coast. Frontiers in Marine Science 6:411.

Gattuso, J.-P., A. Magnan, R. Billé, W. W. L. Cheung, E. L. Howes, F. Joos, D. Allemand, L. Bopp, S. R. Cooley, C. M. Eakin, O. Hoegh-Guldberg, R. P. Kelly, H.-O. Pörtner, A. D. Rogers, J. M. Baxter, D. Laffoley, D. Osborn, A. Rankovic, J. Rochette, U. R. Sumaila, S. Treyer, and C. Turley. 2015. Contrasting futures for ocean and society from different anthropogenic CO_2 emissions scenarios. Science 349(6243):aac4722.

Gould, W. A., E. L. Díaz, (co-leads), N. L. Álvarez-Berríos, F. Aponte-González, W. Archibald, J. H. Bowden, L. Carrubba, W. Crespo, S. J. Fain, G. González, A. Goulbourne, E. Harmsen, E. Holupchinski, A. H. Khalyani, J. Kossin, A. J. Leinberger, V. I. Marrero-Santiago, O. Martínez-Sánchez, K. McGinley, P. Méndez-Lázaro, J. Morell, M. M. Oyola, I. K. Parés-Ramos, R. Pulwarty, W. V. Sweet, A. Terando, and S. Torres-González. 2018. U.S. Caribbean. Pages 809–871 *in* D. R. Reidmiller, W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C.

Hughes, T. P., K. D. Anderson, S. R. Connolly, S. F. Heron, J. T. Kerry, J. M. Lough, A. H. Baird, J. K. Baum, M. L. Berumen, T. C. Bridge, D. C. Claar, C. M. Eakin, J. P. Gilmour, N. A. J. Graham, H. Harrison, J. P. A. Hobbs, A. S. Hoey, M. Hoogenboom, R. J. Lowe, M. T. McCulloch, J. M. Pandolfi, M. Pratchett, V. Schoepf, G. Torda, and S. K. Wilson. 2018. Spatial and temporal patterns of mass bleaching of corals in the Anthropocene. Science 359:80–83.

Levin, L., M. Baker and A. Thompson, editors. 2019. Deep-ocean climate change impacts on habitat, fish and fisheries. FAO Fisheries and Aquaculture Technical Paper No. 638, Rome.

Pörtner, H.-O., D. C. Roberts, V. Masson-Delmotte, P. Zhai, E. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. 2019. Technical summary. Pages 37–69 *in* IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/04_SROCC_TS_FINAL.pdf (July 2020). [Page 61.]

29. Bednaršek, N., R. A. Feely, M. W. Beck, S. R. Alin, S. A. Siedlecki, P. Calosi, E. L. Norton, C. Saenger, J. Štrus, D. Greeley, N. P. Nezlin, M. Roethler, and J. I. Spicer. 2020. Exoskeleton dissolution with mechano-receptor damage in larval Dungeness crab related to severity of present-day ocean acidification vertical gradients. Science of The Total Environment 716:136610.

Pershing, A. J., R. B. Griffis, E. B. Jewett, C. T. Armstrong, J. F. Bruno, D. S. Busch, A. C. Haynie, S. A. Siedlecki, and D. Tommasi. 2018. Oceans and marine resources. Pages 353–390 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C. [Page 357.]

Rhein, M., S. R. Rintoul, S. Aoki, E. Campos, D. Chambers, R. A. Feely, S. Gulev, G. C. Johnson, S. A. Josey, A. Kostianoy, C. Mauritzen, D. Roemmich, L. D. Talley, and F. Wang. 2013. Observations: ocean. Pages 255–267 *in* T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P. M. Midgley, editors. Climate change 2013: the physical science basis. Contribution of Working Group I to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York.

Wisshak M., C. H. L. Schönberg, A. Form, and A. Freiwald. 2012. Ocean acidification accelerates reef bioerosion. PLOS (Public Library of Science) ONE 7(9):e45124.

30. Hobday, A. J., E. C. J. Oliver, A. S. Gupta, J. A. Benthuysen, M. T. Burrows, M. G. Donat, N. J. Holbrook, P. J. Moore, M. S. Thomsen, T. Wernberg, and D. A. Smale. 2018. Categorizing and naming marine heatwaves. Oceanography 31:162–173.

Holbrook, N. J., H. A. Scannell, A. S. Gupta, J. A. Benthuysen, M. Feng, E. C. J. Oliver, L. V. Alexander,

M. T. Burrows, M. G. Donat, A. J. Hobday, P. J. Moore, S. E. Perkins-Kirkpatrick, D. A. Smale, S. C. Straub, and T. Wernberg. 2019. A global assessment of marine heatwaves and their drivers. Nature Communications 10:2624.

Oliver, E. C. J., M. T. Burrows, M. G. Donat, A. S. Gupta, L. V. Alexander, S. E. Perkins-Kirkpatrick, J. A. Benthuysen, A. J. Hobday, N. J. Holbrook, P. J. Moore, M. S. Thomsen, and T. W. D. A. Smale. 2019. Projected marine heatwaves in the 21st century and the potential for ecological impact. Frontiers in Marine Science 6:734.

Oliver, E. C. J., M. G. Donat, M. T. Burrows, P. J. Moore, D. A. Smale, L. V. Alexander, J. A. Benthuysen, M. Feng, A. Sen Gupta, A. J. Hobday, N. J. Holbrook, S. E. Perkins-Kirkpatrick, H. A. Scannell, S. C. Straub, and T. Wernberg. 2018. Ocean warming brings longer and more frequent marine heatwaves. Nature Communications 9:1324.

31. Pershing, A. J., R. B. Griffis, E. B. Jewett, C. T. Armstrong, J. F. Bruno, D. S. Busch, A. C. Haynie, S. A. Siedlecki, and D. Tommasi. 2018. Oceans and marine resources. Pages 353–390 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C. [Pages 355, 357.]

Rhein, M., S. R. Rintoul, S. Aoki, E. Campos, D. Chambers, R. A. Feely, S. Gulev, G. C. Johnson, S. A. Josey, A. Kostianoy, C. Mauritzen, D. Roemmich, L. D. Talley, and F. Wang. 2013. Observations: ocean. Pages 255–267 *in* T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P. M. Midgley, editors. Climate change 2013: the physical science basis. Contribution of Working Group I to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York. [Pages 294–296.]

Schmidtko, S., L. Stramma, and M. Visbeck. 2017. Decline in global oceanic oxygen content during the past five decades. Nature 542:336–339.

32. Bindoff, N. L., W. W. L. Cheung, J. G. Kairo, J. Arístegui, V. A. Guinder, R. Hallberg, N. Hilmi, N. Jiao, M. S. Karim, L. Levin, S. O'Donoghue, S. R. Purca Cuicapusa, B. Rinkevich, T. Suga, A. Tagliabue, and P. Williamson. 2019. Changing ocean, marine ecosystems, and dependent communities. Pages 447–587 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/09_SROCC_Ch05_FINAL-1.pdf. (September 2020). [Pages 451, 494–498.]

Wiedenmann, J., C. D'Angelo, E. G. Smith, A. N. Hunt, F. E. Legiret, A. D. Postle and E. P. Achterberg. 2013. Nutrient enrichment can increase the susceptibility of reef corals to bleaching. Nature Climate Change 3:160–164.

33. Bindoff, N. L., W. W. L. Cheung, J. G. Kairo, J. Arístegui, V. A. Guinder, R. Hallberg, N. Hilmi, N. Jiao, M. S. Karim, L. Levin, S. O'Donoghue, S. R. Purca Cuicapusa, B. Rinkevich, T. Suga, A. Tagliabue, and P. Williamson. 2019. Changing ocean, marine ecosystems, and dependent communities. Pages 447–587 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/09_SROCC_Ch05_FINAL-1.pdf. (September 2020). [Pages 512–513.]

Free, C. M., J. T. Thorson, M. L. Pinsky, K. L. Oken, J. Widenmann, and O. P. Jensen. 2019. Impacts of historical warming on marine fisheries production. Science 363:979–983.

34. Bindoff, N. L., W. W. L. Cheung, J. G. Kairo, J. Arístegui, V. A. Guinder, R. Hallberg, N. Hilmi, N. Jiao, M. S. Karim, L. Levin, S. O'Donoghue, S. R. Purca Cuicapusa, B. Rinkevich, T. Suga, A. Tagliabue, and P. Williamson. 2019. Changing ocean, marine ecosystems, and dependent communities. Pages 447–587 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC

special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/09_SROCC_Ch05_FINAL-1.pdf. (September 2020). [Pages 450–451,478–502.]

Lurgi, M., B. C. Lopez, and J. M. Montoya. 2012. Novel communities from climate change. Philosophical Transactions of the Royal Society B 367:2913–2922.

35. Burge, C. A., and P. K. Hershberger. 2020. Climate change can drive marine diseases. Pages 83–94 *in* D. C. Behringer, B. R. Silliman, and K. D. Lafferty, editors. Marine disease ecology. Oxford University Press, Oxford, UK.

Harvell, C. D., and J. B. Lamb. 2020. Disease outbreaks can threaten marine biodiversity. Pages 141–158 *in* D. C. Behringer, B. R. Silliman, and K. D. Lafferty, editors. Marine disease ecology. Oxford University Press, Oxford, UK.

Lamb, J. B., J. A. J. M. Van de Water, D. G. Bourne, C. Altier, M. Y. Hein, E. A. Fiorenza, N. Abu, J. Jomba, and C. D. Harvell. 2017. Seagrass ecosystems reduce exposure to bacterial pathogens of humans, fishes, and invertebrates. Science 355:731–733.

Sokolow, S. 2009. Effects of a changing climate on the dynamics of coral infectious disease: a review of the evidence. Diseases of Aquatic Organisms 87:5–18.

36. Bindoff, N. L., W. W. L. Cheung, J. G. Kairo, J. Arístegui, V. A. Guinder, R. Hallberg, N. Hilmi, N. Jiao, M. S. Karim, L. Levin, S. O'Donoghue, S. R. Purca Cuicapusa, B. Rinkevich, T. Suga, A. Tagliabue, and P. Williamson. 2019. Changing ocean, marine ecosystems, and dependent communities. Pages 447–587 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/09_SROCC_Ch05_FINAL-1.pdf. (September 2020). [Pages 450–454, 478–502.]

Hoegh-Guldberg, O., D. Jacob, M. Taylor, M. Bindi, S. Brown, I. Camilloni, A. Diedhiou, R. Djalante, K. L. Ebi, F. Engelbrecht, J. Guiot, Y. Hijioka, S. Mehrotra, A. Payne, S.I. Seneviratne, A. Thomas, R. Warren, and G. Zhou. 2018. Impacts of 1.5°C global warming on natural and human systems. Pages 175–311 *in* V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available: www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter3_Low_Res.pdf. (July 2020). [Pages 226–230.]

Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. 2018. Summary for policymakers. Pages 1–24 *in* Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available: www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf. (September 2020). [Pages 12, 22.]

Pershing, A. J., R. B. Griffis, E. B. Jewett, C. T. Armstrong, J. F. Bruno, D. S. Busch, A. C. Haynie, S. A. Siedlecki, and D. Tommasi. 2018. Oceans and marine resources. Pages 353–390 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C. [Pages 358–361.]

Porter, J. R., L. Xie, A. J. Challinor, K. Cochrane, S. M. Howden, M. M. Iqbal, D. B. Lobell, and M. I.

Travasso. 2014. Food security and food production systems. Pages 485–533 *in* C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York.

Pörtner, H.-O., D. M. Karl, P. W. Boyd, W. W. L. Cheung, S. E. Lluch-Cota, Y. Nojiri, D. N. Schmidt, and P. O. Zavialov. 2014. Ocean systems. Pages 411–484 *in* C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York. [Pages 456–459.]

Pörtner, H.-O., D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. 2019. Summary for policymakers. Pages 1–35 *in* IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/03_SROCC_SPM_FINAL.pdf. (July 2020).

37. North American Bird Conservation Initiative. 2016. The state of North America's birds 2016. Environment and Climate Change Canada, Ottawa.

Paleczny, M., E. Hammill, V. Karpouzi, and D. Pauly. 2015. Population trend of the world's monitored seabirds, 1950–2010. PLOS (Public Library of Science) ONE 10(6):e0129342.

38. Bateman, B. L., C. Wilsey, L. Taylor, J. Wu, G. S. LeBaron, and G. Langham. 2020. North American birds require mitigation and adaptation to reduce vulnerability to climate change. Conservation Science and Practice, https://doi.org/10.1111/csp2.242.

39. Of the 29,500 freshwater dependent species so far assessed for the IUCN Red List, 27% are threatened with extinction. See the following:

Dudgeon, D., A. H. Arthington, M. O. Gessner, Z. I. Kawabata, D. J. Knowler, C. Leveque, R. J. Naiman, A. H. Prieur-Richard, D. Soto, M. L. J. Stiassny, and C. A. Sullivan. 2006. Freshwater biodiversity: importance, threats, status and conservation challenges. Biological Reviews 81:163–182.

Settele, J., R. Scholes, R. Betts, S. Bunn, P. Leadley, D. Nepstad, J. T. Overpeck, and M. A. Taboada. 2014. Terrestrial and inland water systems. Pages 271–359 *in* C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York. [Page 312.]

Tickner, D., J. J. Opperman, R. Abell, M. Acreman, A. H. Arthington, S. E. Bunn, S. J. Cooke, J. Dalton, W. Darwall, G. Edwards, I. Harrison, K. Hughes, T. Jones, D. Leclére, A. J. Lynch, P. Leonard, M. E. McClaine, D. Muruven, J. D. Olden, S. J. Ormerod, J. Robinson, R. E. Tharme, M. Thieme, K. Tockner, M. Wright, and L. Young. 2020. Bending the curve of global freshwater biodiversity loss: an emergency recovery plan. BioScience 70:330–342.S

Vörösmarty, C. J., P. B. McIntyre, M. O. Gessner, D. Dudgeon, A. Prusevich, P. Green, S. Glidden, S. E. Bunn, C. A. Sullivan, C. R. Liermann, and P. M. Davies, 2010. Global threats to human water security and river biodiversity. Nature 467:555–561.

40. Strayer, D. L., and D. Dudgeon. 2010. Freshwater biodiversity conservation: recent progress and future challenges. Journal of the North American Benthological Society 29:344–358.

41. Bloesch, J., C. Sandu, and J. Janning. 2012. Challenges of an integrative water protection and river basin management policy: the Danube case. River Systems 20:129–144.

Harrod, C., A. Ramírez, J. Valbo-Jørgensen and S. Funge-Smith. 2018. How climate change impacts inland fisheries. Pages 375–391 *in* M. Barange, T. Bahri, M. C. M. Beveridge, K. L. Cochrane, S. Funge-Smith, and F. Poulain, editors. Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigation options. Food and Agricultural Organization of the United Nations, Fisheries and Aquaculture Technical Paper 627, Rome.

42. Alexander, J. E., Jr., and K. C. Wagoner. 2016. Respiratory response to temperature variability in the river snail *Lithasia obovata* and its relevance to the potential impacts of climate change on freshwater gastro0-pods. American Malacological Bulletin 34:1–14.

Bănăduc D., M. Joy, H. Olosutean, S. Afanasyev, and A. Curtean-Bănăduc. 2020. Natural and anthropogenic driving forces as key elements in the Lower Danube basin—south-eastern Carpathians−north-western Black Sea coast area lakes: a broken stepping stones for fish in a climatic change scenario? Environmental Science Europe 32: article 7.

Ferreira-Rodrıguez, N. 2019. Spatial aggregation of native with non-native freshwater bivalves and activity depletion under summer heat waves: 'dangerous liaisons' in a climate change context. Hydrobiologia 834:75–85.

Ganser, A. M., T. J. Newton, and R. J. Haro. 2013. The effects of elevated water temperature on native juvenile mussels: implications for climate change. Freshwater Science 32:1168–1177.

Lipton, D., M. A. Rubenstein, S. R. Weiskopf, S. Carter, J. Peterson, L. Crozier, M. Fogarty, S. Gaichas, K. J. W. Hyde, T. L. Morelli, J. Morisette, H. Moustahfid, R. Muñoz, R. Poudel, M. D. Staudinger, C. Stock, L. Thompson, R. Waples, and J. F. Weltzin. 2018. Ecosystems, ecosystem services, and biodiversity. Pages 268–321 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C. [Pages 273–279.]

Lynch, A. J., B. J. E. Myers, C. Chu, L. A. Eby, J. A. Falke, R. P. Kovach, T. J. Krabbenhoft, T. J. Kwak, J. Lyons, C. P. Paukert, and J. E. Whitney. 2016. Climate change effects on North American inland fish populations and assemblages. Fisheries 41:346–361.

Markovic, D., S. Carrizo, J. Freyhof, N. Cid, S. Lengyel, M. Scholz, H. Kasperdius, and W. Darwall. 2014. Europe's freshwater biodiversity under climate change: distribution shifts and conservation needs. Diversity and Distributions 20:1097–1107.

Settele, J., R. Scholes, R. Betts, S. Bunn, P. Leadley, D. Nepstad, J. T. Overpeck, and M. A. Taboada. 2014. Terrestrial and inland water systems. Pages 271–359 *in* C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York. [Pages 312–314.]

43. Dai, A. 2013. Increasing drought under global warming in observations and models. Nature Climate Change 3:52–58.

Gonzalez, P., G. M. Garfin, D. D. Breshears, K. M. Brooks, H. E. Brown, E. H. Elias, A. Gunasekara, N. Huntly, J. K. Maldonado, N. J. Mantua, H. G. Margolis, S. McAfee, B. R. Middleton, and B. H. Udall. 2018. Southwest. Pages 1101–1184 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C.

Jiménez Cisneros, B. E., T. Oki, N. W. Arnell, G. Benito, J. G. Cogley, P. Döll, T. Jiang, and S. S. Mwakalila. 2014. Freshwater resources. Pages 229–269 *in* C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York.

Vertessy, R., D. Barma, L. Baumgartner, S. Mitrovic, F. Sheldon, and N. Bond. 2019. Independent assessment of the 2018–19 fish deaths in the lower Darling. Final Report. Available: www.mdba.gov.au/sites/default/files/pubs/Final-Report-Independent-Panel-fish-deaths-lower%20Darling_4.pdf. (July 2020).

44. Center, T. D., and N. R. Spencer. 1981. The phenology and growth of water hyacinth (*Eichhornia crassipes* (Mart.) Solms) in a eutrophic north-central Florida lake. Aquatic Botany 10:1–32.

Döll, P., and S. E. Bunn. 2014. Cross-chapter box on the impact of climate change on freshwater ecosystems due to altered river flow regimes. Pages 143–146 *in* C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York.

Rahel, F. J., and J. D. Olden. 2008. Assessing the effects of climate change on aquatic invasive species. Conservation Biology 22:521–533.

Rehage, J. S., and J. R. Blanchard. 2016. What can we expect from climate change for species invasions? Fisheries 405–407.

Oliver, J. D. 1993. A review of the biology of giant salvinia (Salvinia molesta Mitchell). Journal of Aquatic Plant Mangement 31:227–231.

Pimentel, D., R. Zuniga, and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. Ecological Economics 52:273–288.

45. Alahuhta, J., J. Heino, and M. Luoto, 2011: Climate change and the future distributions of aquatic macrophytes across boreal catchments. Journal of Biogeography 38:383–393.

Comte, L., and G. Grenouillet, 2013. Do stream fish track climate change? Assessing distribution shifts in recent decades. Ecography 36:1236–1246.

Galego de Oliveira, A., D. Bailly, F. A. S. Cassemiro, E. V. d. Couto, N. Bond, D. Gilligan, T. F. Rangel, A. A. Agostinho, and M. J. Kennard. 2019. Coupling environment and physiology to predict effects of climate change on the taxonomic and functional diversity of fish assemblages in the Murray–Darling basin, Australia. PLOS (Public Library of Science) ONE 14(11):e0225128.

Lipton, D., M. A. Rubenstein, S. R. Weiskopf, S. Carter, J. Peterson, L. Crozier, M. Fogarty, S. Gaichas, K. J. W. Hyde, T. L. Morelli, J. Morisette, H. Moustahfid, R. Muñoz, R. Poudel, M. D. Staudinger, C. Stock, L. Thompson, R. Waples, and J. F. Weltzin. 2018. Ecosystems, ecosystem services, and biodiversity. Pages 268–321 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C. [Pages 275, 276–277, 281.]

Rahel, F. J., and J. D. Olden. 2008. Assessing the effects of climate change on aquatic invasive species. Conservation Biology 22:521–533.

Rehage, J. S., and J. R. Blanchard. 2016. What can we expect from climate change for species invasions? Fisheries 405–407.

Settele, J., R. Scholes, R. Betts, S. Bunn, P. Leadley, D. Nepstad, J. T. Overpeck, and M. A. Taboada. 2014. Terrestrial and inland water systems. Pages 271–359 *in* C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York. [Pages 295, 312–314, 295.]

Sorte, C. J. B., I. Ibáñez, D. M. Blumenthal, N. A. Molinari, L. P. Miller, E. D. Grosholz, J. M. Diez, C. M. D'Antoniao, J. D. Olden, S. J. Jones, and J. S. Dukes. 2013. Poised to prosper? A cross-system comparison of climate change effects on native and non-native species performance. Ecology Letters 16:261–270.

46. Settele, J., R. Scholes, R. Betts, S. Bunn, P. Leadley, D. Nepstad, J. T. Overpeck, and M. A. Taboada. 2014. Terrestrial and inland water systems. Pages 271–359 *in* C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York. [Pages 295, 312–314.]

47. Lipton, D., M. A. Rubenstein, S. R. Weiskopf, S. Carter, J. Peterson, L. Crozier, M. Fogarty, S. Gaichas, K. J. W. Hyde, T. L. Morelli, J. Morisette, H. Moustahfid, R. Muñoz, R. Poudel, M. D. Staudinger, C. Stock, L. Thompson, R. Waples, and J. F. Weltzin. 2018. Ecosystems, ecosystem services, and biodiversity. Pages 268–321 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C. [Page 285.]

Lynch, A. J., B. J. E. Myers, C. Chu, L. A. Eby, J. A. Falke, R. P. Kovach, T. J. Krabbenhoft, T. J. Kwak, J. Lyons, C. P. Paukert, and J. E. Whitney. 2016. Climate change effects on North American inland fish populations and assemblages. Fisheries 41:346–361.

Whitney, J. E., R. Al-Chokhachy, D. B. Bunnell, C. A. Caldwell, S. J. Cooke, E. J. Ellason, M. Rogers, A. J. Lynch, and C. P. Paukert. 2016. Physiological basis of climate change impacts on North American inland fishes. Fisheries 41:332–345.

48. Goode, J. R., C. H. Luce, and J. M. Buffington. 2012. Enhanced sediment delivery in a changing climate in semi-arid mountain basins: implications for water resource management and aquatic habitat in the northern Rocky Mountains. Geomorphology 139–140:1–15.

Lall, U., T. Johnson, P. Colohan, A. Aghakouchak, C. Brown, G. McCabe, R. Pulwarty, and A. Sankarasubramanian. 2018. Water. Pages 145–173 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C.

Lyon, J. P., and J. P. O'Connor. 2008. Smoke on the water: can riverine fish populations recover following a catastrophic fire-related sediment slug? Austral Ecology 33:794–806.

Vose, J. M., D. L. Peterson, G. M. Domke, C. J. Fettig, L. A. Joyce, R. E. Keane, C. H. Luce, J. P. Prestemon, L. E. Band, J. S. Clark, N. E. Cooley, A. D'Amato, and J. E. Halofsky. 2018. Forests. Pages 232–267 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C.

49. Morant, D., A. Picazo, C. Rochera, A. C. Santamans, J. Miralles-Lorenzo, A. Camacho-Santamans, C. Ibañez, M. Martınez-Eixarch, and A. Camacho. 2020. The role of ecological features and conservation status on the carbon cycle and methane emissions in the Ebro Delta wetlands. PLOS (Public Library of Science) ONE 15(4):e0231713.

Hooijer, A., S. Page, J. Jauhiainen, W. A. Lee, X. X. Lu, A. Idris, and G. Anshari. 2011. Subsidence and carbon loss in drained tropical peatland: reducing uncertainty and implications for CO_2 emission reduction options. Biogeosciences Discussions 8:931–935.

Page, S. E., and A. Hooijer. 2016. In the line of fire: the peatlands of Southeast Asia. Philosophical Transactions of the Royal Society B 371:20150176.

Turetsky, M. R., B. Benscoter, S. Page, G. Rein, G. R. van dr Werf, and A. Watts. 2014. Global vulnerability of peatlands to fire and carbon loss. Nature Geoscience 8:11–14.

50. Chapra, S. C., B. Boehlert, C. Fant, V. J. Bierman, J. Henderson, D. Mills, D. M. L. Mas, L. Rennels, L. Jantarasami, J. Martinich, K. M. Strzepek, and H. W. Paerl. 2017. Climate change impacts on harmful algal blooms in U.S. freshwaters: a screening-level assessment. Environmental Science and Technology 51:8933–8943.

Jöhnk, K. D., J. Huisman, J. Sharples, B. Sommeijer, P. M. Visser, and J. M. Stroom, 2008. Summer heatwaves promote blooms of harmful cyanobacteria. Global Change Biology 14:495–512.

Michalak, A. M., E. J. Anderson, D. Beletsky, S. Boland, N. S. Bosch, T. B. Bridgeman, J. D. Chaffin, K. Cho, R. Confesor, I. Daloğlu, J. V. DePinto, M. A. Evans, G. L. Fahnenstiel, L. He, J. C. Ho, L. Jenkins, T. H. Johengen, K. C. Kuo, E. LaPorte, X. Liu, M. R. McWilliams, M. R. Moore, D. J. Posselt, R. P. Richards, D. Scavia, A. L. Steiner, E. Verhamme, D. M. Wright, and M. A. Zagorski. 2013. Record-setting algal bloom in Lake Erie caused by agricultural and meteorological trends consistent with expected future conditions. Proceedings of the National Academy of Sciences of the United States of America 110:6448–6452.

Settele, J., R. Scholes, R. Betts, S. Bunn, P. Leadley, D. Nepstad, J. T. Overpeck, and M. A. Taboada. 2014. Terrestrial and inland water systems. Pages 271–359 *in* C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York. [Page 291.]

51. Gordon, L., C. M. Finlayson, and M. Falkenmark. 2010. Managing water in agriculture to deal with trade-offs and find synergies among food production and other ecosystem services. Agricultural Water Management 97:512–519.

Jenny, J.-P., O. Anneville, F. Arnaud, Y. Baulaz, D. Bouffard, I. Domaizon, S. A. Bocaniov, N. Chèvre, M. Dittrich, J.-M. Dorioz, E. S. Dunlop, G. Dur, J. Guillard, T. Guinaldo, S. Jacquet, A. Jamoneau, Z. Jawed, E. Jeppesen, G. Krantzberg, J. Lenters, B. Leoni, M. Meybeck, V. Nava, T. Nõges, P. Nõges, M. Patelli, V. Pebbles, M.-E. Perga, S. Rasconi, C. R. Ruetz III, L. Rudstam, N. Salmaso, S. Sapna, D. Straile, O. Tam-meorg, M. R. Twiss, D. G. Uzarski, A.-M. Ventelä, W. F. Vincent, S. W. Wilhelm, S.-Å. Wängberg, and G. A. Weyhenmeyer. 2020. Scientists' warning to humanity: rapid degradation of the world's large lakes. Journal of Great Lakes Research 46:686–702.

52. Heim, K. C., M. S. Wipfli, M. S. Whitman, C. D. Arp, J. Adams, and J. A. Falke. 2016. Seasonal cues of Arctic Grayling movement in a small Arctic stream: the importance of surface water connectivity. Environmental Biology of Fishes 99:49–65.

Meredith, M., M. Sommerkorn, S. Cassotta, C. Derksen, A. Ekaykin, A. Hollowed, G. Kofinas, A. Mackintosh, J. Melbourne-Thomas, M. M. C. Muelbert, G. Ottersen, H. Pritchard, and E. A. G. Schuur. 2019. Polar regions. Pages 203–320 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/07_SROCC_Ch03_FINAL.pdf. (July 2020). [Page 256.]

Poesch, M. S., L. Chavarie, C. Chu, S. N. Pandit, and W. Tonn. 2016. Climate change impacts on freshwater fishes: a Canadian perspective. Fisheries 41:385–391.

53. Hock, R., G. Rasul, C. Adler, B. Cáceres, S. Gruber, Y. Hirabayashi, M. Jackson, A. Kääb, S. Kang, S. Kutuzov, A. Milner, U. Molau, S. Morin, B. Orlove, and H. Steltzer. 2019. High mountain areas. Pages 131–202 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/06_SROCC_Ch02_FINAL.pdf. (July 2020).

Zhang, Q., J. Huang, F. Wang, L. Mark, J. Xu, D. Armstrong, C. Li, Y. Zhang, and S. Kang. 2012. Mercury distribution and deposition in glacier snow over western China. Environmental Science and Technology 46:5404–5413.

54. Marcos-Lopéz, M., P. Gale, B. C. Oidtmann, and E. J. Peeler. 2010. Assessing the impact of climate change on disease emergence in freshwater fish in the United Kingdom. Transboundary and Emerging Diseases 57:293–304.

Olusanya, H. O., and M. van Zyll de Jong. 2018. Assessing the vulnerability of freshwater fishes to climate change in Newfoundland and Labrador. PLOS (Public Library of Science) ONE 13(12):e0208182.

Viana, D. S. 2017. Can aquatic plants keep pace with climate change? Frontiers in Plant Science 8:1906.

55. Lipton, D., M. A. Rubenstein, S. R. Weiskopf, S. Carter, J. Peterson, L. Crozier, M. Fogarty, S. Gaichas, K. J. W. Hyde, T. L. Morelli, J. Morisette, H. Moustahfid, R. Muñoz, R. Poudel, M. D. Staudinger, C. Stock, L. Thompson, R. Waples, and J. F. Weltzin. 2018. Ecosystems, ecosystem services, and biodiversity. Pages 268–321 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C. [Pages 282–283.]

Ormerod, S. J., M. Dobson, A. G. Hildrew, and C. R. Townsend. 2010. Multiple stressors in freshwater ecosystems. Freshwater Biology 55(s1).

Tockner, K., M. Pusch, D. Borchardt, and M. S. Lorang. 2010. Multiple stressors in coupled river–floodplain ecosystems. Freshwater Biology 55(s1):135–151.

56. Food and Agriculture Organization of the United Nations (FAO). 2018. The state of world fisheries and aquaculture 2018: meeting the sustainable development goals. FAO, Rome.

57. Meredith, M., M. Sommerkorn, S. Cassotta, C. Derksen, A. Ekaykin, A. Hollowed, G. Kofinas, A. Mackintosh, J. Melbourne-Thomas, M. M. C. Muelbert, G. Ottersen, H. Pritchard, and E. A. G. Schuur. 2019. Polar regions. Pages 203–320 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/07_SROCC_Ch03_FINAL.pdf. (July 2020). [Pages 256–257, 261–262.]

Hoegh-Guldberg, O., D. Jacob, M. Taylor, M. Bindi, S. Brown, I. Camilloni, A. Diedhiou, R. Djalante, K. L. Ebi, F. Engelbrecht, J. Guiot, Y. Hijioka, S. Mehrotra, A. Payne, S.I. Seneviratne, A. Thomas, R. Warren, and G. Zhou. 2018. Impacts of 1.5°C global warming on natural and human systems. Pages 175–311 *in* V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available: www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter3_Low_Res.pdf. (July 2020). [Pages 222, 239.]

58. Pörtner, H.-O., D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. 2019. Technical summary. Pages 37–69 *in* IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/04_SROCC_TS_FINAL.pdf. (July 2020). [Pages 61, 65.]

59. Magnan, A. K., M. Garschagen, J.-P. Gattuso, J. E. Hay, N. Hilmi, E. Holland, F. Isla, G. Kofinas, I. J. Losada, J. Petzold, B. Ratter, T. Schuur, T. Tabe, and R. van de Wal. 2019. Cross-chapter box 9: integrative cross-chapter box on low-lying islands and coasts. Pages 657–674 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean

and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/11_SROCC_CCB9-LLIC_FINAL.pdf. (2020).

Pörtner, H.-O., D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. 2019. Technical summary. Pages 37–69 *in* IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/04_SROCC_TS_FINAL.pdf. (September 2020). [Page 61.]

60. Dahlke, F. T., S. Wohlrab, M. Butzin, and H.-O. Pörtner. 2020. Thermal bottlenecks in the life cycle define climate vulnerability of fish. Science 369:65–70.

61. Bindoff, N. L., W. W. L. Cheung, J. G. Kairo, J. Arístegui, V. A. Guinder, R. Hallberg, N. Hilmi, N. Jiao, M. S. Karim, L. Levin, S. O'Donoghue, S. R. Purca Cuicapusa, B. Rinkevich, T. Suga, A. Tagliabue, and P. Williamson. 2019. Changing ocean, marine ecosystems, and dependent communities. Pages 447–587 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/09_SROCC_Ch05_FINAL-1.pdf. (September 2020). [Pages 451, 502–503.]

Hoegh-Guldberg, O., D. Jacob, M. Taylor, M. Bindi, S. Brown, I. Camilloni, A. Diedhiou, R. Djalante, K. L. Ebi, F. Engelbrecht, J. Guiot, Y. Hijioka, S. Mehrotra, A. Payne, S.I. Seneviratne, A. Thomas, R. Warren, and G. Zhou. 2018. Impacts of 1.5ºC global warming on natural and human systems. Pages 175–311 *in* V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available: www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter3_Low_Res.pdf. (July 2020). [Pages 180, 212, 230, 237–238.]

Junk, W. J., S. An, C. M. Finlayson, B. Gopal, J. Květ, S. A. Mitchell, W. J. Mitsch, and R. D. Robarts. 2013. Current state of knowledge regarding the world's wetlands and their future under global climate change: a synthesis. Aquatic Sciences 75:151–167.

Magnan, A. K., M. Garschagen, J.-P. Gattuso, J. E. Hay, N. Hilmi, E. Holland, F. Isla, G. Kofinas, I. J. Losada, J. Petzold, B. Ratter, T. Schuur, T. Tabe, and R. van de Wal. 2019. Cross-chapter box 9: integrative cross-chapter box on low-lying islands and coasts. Pages 657–674 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/11_SROCC_CCB9-LLIC_FINAL.pdf. (2020). [Page 664.]

Markon, C., S. Gray, M. Berman, L. Eerkes-Medrano, T. Hennessy, H. Huntington, J. Littell, M. Mc Cammon, R. Thoman, and S. Trainor. 2018. Alaska. Pages 1185–1241 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C.

Meredith, M., M. Sommerkorn, S. Cassotta, C. Derksen, A. Ekaykin, A. Hollowed, G. Kofinas, A. Mackintosh, J. Melbourne-Thomas, M. M. C. Muelbert, G. Ottersen, H. Pritchard, and E. A. G. Schuur. 2019. Polar regions. Pages 203–320 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/07_SROCC_Ch03_FINAL.pdf. (July 2020). [Pages 260, 262–263.]

Pendleton, L., A. Comte, C. Langdon, J. A. Ekstrom, S. R. Cooley, L. Suatoni, M. W. Beck, L. M. Brander, L. Burke, J. E. Cinner, C. Doherty, P. E. T. Edwards, D. Gledhill, L.-Q. Jiang, R. J. van Hooidonk, L. The, G. G. Waldbusser, and J. Ritter. 2016. Coral reefs and people in a high-CO2 world: where can science make a difference to people? PLOS (Public Library of Science) ONE 11(11):e0164699.

Pershing, A. J., M. A. Alexander, C. M. Hernandez, L. A. Kerr, A. Le Bris, K. E. Mills, J. A. Nye, N. R. Record, H. A. Scannell, J. D. Scott, G. D. Sherwood, and A. C. Thomas. 2015. Slow adaptation in the face of rapid warming leads to collapse of the Gulf of Maine cod fishery. Science 350:809–812.

Pershing, A. J., R. B. Griffis, E. B. Jewett, C. T. Armstrong, J. F. Bruno, D. S. Busch, A. C. Haynie, S. A. Siedlecki, and D. Tommasi. 2018. Oceans and marine resources. Pages 353–390 in D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C. [Pages 361–362, 365–366.]

62. Barange, M., T. Bahri, M. C. M. Beveridge, K. L. Cochrane, S. Funge-Smith, and F. Poulain, editors. 2018. Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigation options. Food and Agriculture Organization of the United Nations, Fisheries and Aquaculture Technical Paper 627, Rome.

Markon, C., S. Gray, M. Berman, L. Eerkes-Medrano, T. Hennessy, H. Huntington, J. Littell, M. McCammon, R. Thoman, and S. Trainor. 2018. Alaska. Pages 1185–1241 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C [Pages 1204–1206.]

Pörtner, H.-O., D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. 2019. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/srocc/home/. (July 2020). [Pages 15–16.]

63. Cheung, W. W. L., V. W. Y. Lam, J. L. Sarmiento, K. Kearney, R. Watson, Z. Zeller, and D. Pauly. 2010. Large-scale redistribution of maximum fisheries catch potential in the global ocean under climate change. Global Change Biology 16:24–35.

Hoegh-Guldberg, O., D. Jacob, M. Taylor, M. Bindi, S. Brown, I. Camilloni, A. Diedhiou, R. Djalante, K. L. Ebi, F. Engelbrecht, J. Guiot, Y. Hijioka, S. Mehrotra, A. Payne, S.I. Seneviratne, A. Thomas, R. Warren, and G. Zhou. 2018. Impacts of 1.5°C global warming on natural and human systems. Pages 175–311 *in* V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available: www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter3_Low_Res.pdf. (July 2020). [Pages 230, 237.]

McClanahan, T. R., E. H. Allison, and J. E. Cinner. 2015. Managing fisheries for human and food security. Fish and Fisheries 16:78–103.

64. Alava, J. J., W. W. L. Cheung, P. S. Ross, and U. Rashid Sumaila. 2017. Climate change–contaminant inter actions in marine food webs: toward a conceptual framework. Global Change Biology 23:3984–4001.

Bindoff, N. L., W. W. L. Cheung, J. G. Kairo, J. Arístegui, V. A. Guinder, R. Hallberg, N. Hilmi, N. Jiao, M. S. Karim, L. Levin, S. O'Donoghue, S. R. Purca Cuicapusa, B. Rinkevich, T. Suga, A. Tagliabue, and P. Williamson. 2019. Changing ocean, marine ecosystems, and dependent communities. Pages 447–587 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/

uploads/sites/3/2019/11/09_SROCC_Ch05_FINAL-1.pdf. (September 2020). [Pages 509–512.]

Vezzulli, L., C. Grande, P. C. Reid, P. Hélaouët, M. Edwards, M. G. Höfle, I. Brettar, R. R. Colwell, and C. Pruzzo. 2016. Climate influence on Vibrio and associated human diseases during the past half-century in the coastal North Atlantic. Proceedings of the National Academy of Sciences of the United States of America 113:E5062–E5071.

65. Bindoff, N. L., W. W. L. Cheung, J. G. Kairo, J. Arístegui, V. A. Guinder, R. Hallberg, N. Hilmi, N. Jiao, M. S. Karim, L. Levin, S. O'Donoghue, S. R. Purca Cuicapusa, B. Rinkevich, T. Suga, A. Tagliabue, and P. Williamson. 2019. Changing ocean, marine ecosystems, and dependent communities. Pages 447–587 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/site/assets/uploads/sites/3/2019/11/09_SROCC_Ch05_FINAL-1.pdf. (September 2020). [Pages 516–517.]

Chen, P.-Y., C.-C. Chen, L. Chu, and B. McCarl. 2015. Evaluating the economic damage of climate change on global coral reefs. Global Environmental Change 30:12–20.

Cisneros-Montemayor, A. M., and U. R. Sumaila, 2010: A global estimate of benefits from ecosystem-based marine recreation: potential impacts and implications for management. Journal of Bioeconomics 12:245–268.

Gattuso, J.-P., O. Hoegh-Guldberg, and H.-O. Pörtner. 2014. Cross-chapter box on coral reefs. Pages 97–100 *in* C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York.

Markham, A., E. Osipova, K. Lafrenz Samuels, and A. Caldas. 2016. World heritage and tourism in a changing climate. United Nations Environment Programme, Nairobi, Kenya and United Nations Educational, Scientific and Cultural Organization, Paris, France.

66. Alexandrov, G. A., V. A. Brovkin, T. Kleinen, and Z. Yu. 2020. The capacity of northern peatlands for long-term carbon sequestration. Biogeosciences 17:47–54.

Alongi, D. M. 2008. Mangrove forests: resilience, protection from tsunamis, and responses to global climate hange. Estuarine, Coastal and Shelf Science 76:1–13.

Kaladharan, P., A. M. Amalu, and S. Revathy, 2019. Role of seaweeds in neutralizing the impact of seawater acidification: a laboratory study with beached shells of certain bivalves and spines of a sea urchin. Journal of the Marine Biological Association of India 61:94–99.

Nahlik A. M., and M. S. Fennessy. 2016. Carbon storage in US wetlands. Nature Communications. 7:1–9. Oppenheimer, M., B. C. Glavovic , J. Hinkel, R. van de Wal, A. K. Magnan, A. Abd-Elgawad, R. Cai, M. Cifuentes-Jara, R. M. DeConto, T. Ghosh, J. Hay, F. Isla, B. Marzeion, B. Meyssignac, and Z. Sebesvari. 2019. Sea level rise and implications for low-lying islands, coasts and communities. Pages 321–445 *in* H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/srocc/chapter/chapter-4-sea-level-rise-and-implications-for-low-lying-islands-coasts-and-communities/ (September 2020). [Pages 380, 411.]

Orth, R. J., T. J. B. Carruthers, W. C. Dennison, C. M. Duarte, J. W. Fourqurean, K. L. Heck, Jr., A. R. Hughes, G. A. Kendrick, W. J. Kenworthy, S. Olyarnik, F. T. Short, M. Waycott, and S. L. Williams. 2006. A global crisis for seagrass ecosystems. BioScience 56:987–996.

Pendleton, L., D. C. Donato, B. C. Murray, S. Crooks, W. A. Jenkins, S. Sifleet, C. Craft, J. W. Fourqurean, J. B. Kauffman, N. Marbá, P. Megonigal, E. Pidgeon, D. Herr, D. Gordon, and A. Baldera. 2012. Estimating global "blue carbon" emissions from conversion and degradation of vegetated coastal ecosystems. PLOS (Public Library of Science) ONE 7(9):e43542.

Reguero, B. G., M. W. Beck, V. N. Agostini, P. Kramer, and B. Hancock. 2018. Coral reefs for coastal protection: a new methodological approach and engineering case study in Grenada. Journal of Environmental Management 210:146–161.

Waycotta M., C. M. Duarte, T. J. B. Carruthers, R. J. Orth, W. C. Dennison, S. Olyarnike, A. Calladinea, J. W. Fourqurean, K. L. Heck, Jr., A. R. Hughese, G. A. Kendrick, W. J. Kenworthy, F. T. Short, and S. L. Williams. 2009. Accelerating loss of seagrasses across the globe threatens coastal ecosystems. Proceedings of the National Academy of Sciences of the United States of America 106:12377–12381.

Wong, P. P., I. J. Losada, J.-P. Gattuso, J. Hinkel, A. Khattabi, K. L. McInnes, Y. Saito, and A. Sallenger. 2014. Coastal systems and low-lying areas. Pages 361–409 *in* C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York. [Pages 386–388.]

67. Dargie, G. C. 2017. Age, extent and carbon storage of the central Congo Basin peatland complex. Nature 542:86–90.

Davies, P. M. 2010. Climate change implications for river restoration in global biodiversity hotspots. Restoration Ecology 18:261–268.

Feld, C. K., M. R. Fernandes, M. T. Ferreira, D. Hering, S. J. Ormerod, M. Venohr, and C. Gutiérrez-Cánovas. 2018. Evaluating riparian solutions to multiple stressor problems in river ecosystems—a conceptual study. Water Research 139:381–394.

Gundersen, P., A. Laurén, L. Finér, E. Ring, H. Koivusalo, M. Sætersdal, J. O. Weslien, B. D. Sigurdsson, L. Högbom, J. Laine, and K. Hansen. 2010. Environmental services provided from riparian forests in the Nordic countries. Ambio 39:555–566.

Baker, J. P., and S. A. Bonar. 2019. Using a mechanistic model to develop management strategies to cool Apache Trout streams under the threat of climate change. North American Journal of Fisheries Management 39:849–867.

Vose, J. M., D. L. Peterson, G. M. Domke, C. J. Fettig, L. A. Joyce, R. E. Keane, C. H. Luce, J. P. Prestemon, L. E. Band, J. S. Clark, N. E. Cooley, A. D'Amato, and J. E. Halofsky. 2018. Forests. Pages 232–267 *in* D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C. [Page 246.]

68. Alexandrov, G. A., V. A. Brovkin, T. Kleinen, and Z. Yu. 2020. The capacity of northern peatlands for long-term carbon sequestration. Biogeosciences 17:47–54.

Camacho, A., A. Picazo, C. Rochera, A. C. Santamans, D. Morant, J. Miralles-Lorenzo, and A. Castillo-Escriva. 2017. Methane emissions in Spanish saline lakes: current rates, temperature and salinity responses, and evolution under different climate change scenarios. Water 9:659.

Crump, J., editor. 2017. Smoke on water: countering global threats from peatland loss and degradation—a rapid response assessment. United Nations Environment Programme, Nairobi, Kenya and GRID-Arendal, Arendal, Norway.

Leifeld, J., and L. Menichetti. 2018. The underappreciated potential of peatlands in global climate change mitigation strategies. Nature Communications 9:article 1071.

Ramsar Convention on Wetlands. 2018. Global wetland outlook: state of the world's wetlands and their services to people. Ramsar Convention Secretariat, Gland, Switzerland.

69. Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield, editors. 2018. Summary for policymakers. Pages 1–24 *in* Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of

strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available: www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf. (September 2020). [Pages 7–11.]

Pershing, A. J., R. B. Griffis, E. B. Jewett, C. T. Armstrong, J. F. Bruno, D. S. Busch, A. C. Haynie, S. A. Siedlecki, and D. Tommasi. 2018. Oceans and marine resources. Pages 353–390 in D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, and B. C. Stewart, editors. Impacts, risks, and adaptation in the United States: fourth national climate assessment, volume II. U.S. Global Change Research Program, Washington, D.C. [Pages 362, 364.]

Porter, J. R., L. Xie, A. J. Challinor, K. Cochrane, S. M. Howden, M. M. Iqbal, D. B. Lobell, and M. I. Travasso. 2014. Food security and food production systems. Pages 485–533 in C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate change 2014—impacts, adaptation, and vulnerability: Part A: global and sectoral aspects. Contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York. [Pages 516–517.]

Pörtner, H.-O., D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N. M. Weyer, editors. 2019. IPCC special report on the ocean and cryosphere in a changing climate. Available: www.ipcc.ch/srocc/home/. (July 2020). [Pages 17–28, 31–33.]