Supplementary Material

Appendix 1

Friedman, W. R., Halpern, B. S., McLeod, E., Beck, M. W., Duarte, C. M., Kappel, C. V., Levine, A., Sluka, R. D., Adler, S., O'Hara, C. C., Sterling, E. J., Tapia-Lewin, S., Losada, I. J., McClanahan, T. R., Pendleton, L., Spring, M., Toomey, J. P., Weiss, K. R., Possingham, H. P., and Montambault, J. R. (2019). Research priorities for achieving healthy marine ecosystems and human communities in a changing climate. *Frontiers in Marine Science.* DOI: 10.3389/fmars.2020.00005.

Appendix 1: Figure S1. Four alternative futures, modified from Merrie et al. (2018) to include popular culture analogs. Scenarios correspond to the shared socio-economic pathways (SSPs) developed for climate change research (O'Neill et al. 2017). Axes are socially fragmented to connected (y-axis), and environmentally collapsed to sustained (x-axis). This figure was useful for our group in thinking about possible future scenarios, and we include it here to provide others with tangible and provocative context for the types of scenarios being discussed.

Appendix 1: Table S1. A retrospective timeline of the major events over the last 60 years that have shaped today's marine social-ecological systems. Descriptions of each event and its relevance toward oceans are provided.

Decade	Year(s)	Category	Event	Brief Summary and Significance for Oceans	Key Resources
1950s	1956	Environment	Minamata disaster	Minamata disease (methylmercury poisoning) outbreak in 1956 led to the diagnosis of over 2200 individuals, shaped national and international policy on mercury pollution in marine systems, and led to widespread research and public health messaging on mercury poisoning.	Harada 1995, Selin and Selin 2006.
1950s		Environment	CO2 Acceleration	Charles David Keeling started the long-term systematic measurement of atmospheric CO2 known as the Mauna Loa record in the 1950s. This important historic record was among the first evidence of human caused climate change. It was later combined with CO2 data from ice cores and shows that increases in atmospheric CO2 correlate with increased use of fossil fuels, and the exponential rate of CO2 increase begins around 1950.	Keeling 1976, Keeling 2008, IPCC 2014
1950s	1955	Politics	Maximum Sustainable Yield (MSY)	* MSY (Maximum sustainable yeild) grows in popularity as a management tool. * 1955 - International MSY treaty was eventually adopted; gave foreign fleets the right to fish off any coast. Nations that wanted to exclude foreign boats had to first prove that its fish were overfished. * 1982 - MSY incorporated into the United Nations Convention for the Law of the Sea, ensuring its integration into national and international fisheries acts and laws. * Widely contested for appropriateness and effectiveness as a management goal, especially when stock size is not well known. * Presently used as a harvest limit rather than target.	Larkin 1977, Smith & Punt 2001
1950s	1959	Politics	Antarctic Treaty	The treaty provides that Antarctica shall be used for peaceful purposes only. It specifically prohibits "any measures of a military nature, such as the establishment of military bases and fortifications, the carrying out of military maneuvers, as well as the testing of any type of weapons." The Treaty also provides inspections by member countries in all areas of Antarctica, including all stations, installations and equipment, and ships and aircraft at discharge or embarkation points. It was originally signed into law by 12 countries with vested interest in 1959, currently includes 50 countries.	
1950s	1947 - 1991	Politics	Cold wars	First Cold Wars from 1947-1953; extend until 1991. Cold wars locked Arctic Ocean away from research during that period, but also lead to the development of technologies that would later be prevelant in marine research, including satellites, GPS, and digital cameras	

Decade	Year(s)	Category	Event	Brief Summary and Significance for Oceans	Key Resources
1950s		Politics	Food & Agriculture Organization (FAO) is formed	Established in 1945 with significant growth through the 1950s. Present stated goals of the organization are to: help eliminate hunger, food insecurity and malnutrition; make agriculture, forestry and fisheries more productive and sustainable; reduce rural poverty; enable inclusive and efficient agricultural and food systems; increase the resilience of livelihoods to threads and crises. They do this in part by conducting global surveys and analysis of food systems, including mariculture and fisheries.	http://www.fao.org/
1950s		Politics	Decolonization	Decolonization during the second half of the 20th century, supported by the 1960 UN Declaration on the Granting of Independence to Colonial Countries and Peoples, "affirmed the right of all people to self-determination and proclaimed that colonialism should be brought to a speedy and unconditional end." Decolonization affected how ocean resources were used and managed by local communities and exploited by foreign parties. In some cases decolonization supported traditional management of resources, in others traditional values did not align with globalized relationships (e.g. trade) established during the colonial era.	Graham and Idechong 1998, Rakotoson and Tanner 2006, www.un.org:: decolonization
1950s	1952	Society	Atomic bomb testing	Multiple tests were conducted in Pacific coral reefs with ecological impacts. Also provided an unintended experiment on the capacity of recovery from the most acute impact one can imagine	
1950s	1956	Society	Jacques Cousteau Documentaries	Cousteau was an early pioneer of scuba equipment & beloved public icon. His 1956 film 'The Silent World' was the first underwater film to use color; brought images of the ocean, marine wildlife, and areas of the ocean never seen before to widespread public viewership. He helped drive support for marine conservation including the international moratorium on commercial whaling in 1982	
1950s		Society	Surfing	* Originally by ancient Hawaiians, possibly earlier * Spread to N. America, Australia, and UK in the early 1900s * Gained widespread popularity in the 1950s and 1960s, popularized by the film ‘Gidget’ and bands like the Beach Boys * First professional contests started in 1975	
1950s		Society	Garbage dumping	Unregulated dumping of trash & toxins into oceans; including 'waste disposal, including the disposal of chemical and industrial wastes, radioactive wastes, trash, munitions, sewage sludge, and contaminated dredged material' (EPA). Not regulated until 1972	
1950s		Technology	Industrial fishing	Technological innovations in fishing gear and ships, including that of commercial trawlers and purse seiners increases catch efficiency and distance travelled by foreign fleets. Leads to rapid increase in exploitation of global fisheries.	

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1950s		Technology	Plastics	Plastics increased in production during WWII and continued as a major consumer good therafter. There was little awareness that this would reach the ocean and impact on marine life until at least the 1960s, by which point plastics had become ubiquitous.	
1950s		Technology	Pesticides, Fertilizers	The development of industrial fertilizer, originally developed for warfare explosives (ammonium chloride) led to widespread use in farmlands, and to coastal eutrophication and hypoxia	
1950s		Technology	SCUBA (Jacques Cousteau)	Provided access to the submarine environment to tens of millions of people	
1950s		Technology	1st deep sea dive	Opening opportunity for research and exploration of previously unexplored regions of the marine environment.	
1950s		Technology	Secondary sewage treatment	Regulations and mechanisms for the the disposal and treatment of sewage were implemented throughout the 20th century. The processes of industrialization, war, and reconstruction in the mid 1900s increased the number of biological compounds as well as the implementation of secondary sewage treatment (a process which increases water quality before it is released into the environment). This was further regulated by governments in the US and Europe from the 1970s to 1990 as information and awareness of environmental effects grew.	UNEP 2000; Metcalf et al. 2003
1960s	1968	Economics	Hardin's Tradegy of the Commons	Influenced decades of thinking and policy on the governance of 'common-pool resources', including centralizing resource control in order to avoid the assumed depletion of common pool resources by selfish actors. Undermines the many successful forms of community-based resource use including use and management by indigenous communities. Countered by Elinor Ostrom and others.	Hardin 1968, Ostrom 1990
1960s		Economics	Global shipping and transport	Increased use of offshore marine environment increases pollution, ship strikes, invasive species, also increases technology used for scientific surveys and fishing.	
1960s	1969	Environment	Santa Barbara oil spill (Platform Blowout)	Largest oil spill in US at that time. Public outrage resulted in numerous pieces of environmental legislation within the next several years, contributing largely to the legal and regulatory framework for the modern environmental movement in the U.S.	
1960s		Politics	First Marine Protected Area (MPA)	Sets stage for one of the mostly widely used tools in current marine conservation.	

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1960s	1962	Society	Rachel Carson's Silent Spring	Documented the adverse effects on the environment of the indiscriminate use of pesticides. Carson accused the chemical industry of spreading disinformation and public officials of accepting the industry's marketing claimsunquestioningly.Spurred a reversal in national pesticide policy, led to a nationwide ban on DDT for agricultural uses, and inspired an environmental movement that led to the creation of the U.S. Environmental Protection Agency	
1960s		Society	The Pill	On the one helped contained human population, thereby reducing pressures on envrionmental resources, but on the other, discharged chemicals linked to disrupted hormonal balance of fish populations proximal to sewage effluent discharges. Empowered women's choice of when in their careers to have children and likely lead to more females in professions like the marine sciences.	
1960s		Society	Tourism	Increased use of marine environment along with increased awareness	
1960s	1964	Technology	Alvin	The HOV Alvin is among the world's first deep-ocean submersibles, and has been operating from 1964 until present. Carrying a crew of 3, it has made more than 4,400 dives and contributed to research in thousands of scientific papers on the biology, geology, and chemistry of the deep sea. Its current rating of 4,500 m depth allows for observation of about 2/3 of the ocean floor.	www.whoi.edu:: hov-alvin
1970s	1971-1972	Environment	Peruvian Anchoveta Collapse	The first fishery collapse with global reprecussions. The collapse was initially attributed to enviornmental conditions, and not until later associated with overfishing. Overfishing of global stocks continued; though recent decades have seen increasing awareness of overexploitation.	Pauly et al 2002
1970s		Environment	Amoco Cadiz Oil Spill	Largest oil spill to date at the time.	Conan 1982
1970s	1972	Politics	London Convention	International regulations for the prevention of marine pollution by dumping of wastes and other matter. Entered into force 1975. MPRSA by USA adopted in 1972	
1970s	1972	Politics	Marine Mammal Protection Act (MMPA)	Prohibits the hunting, killing, capture, and/or harassment of marine mammals, and enacts a moratorium on the import, export, and sale of any marine mammal, along with any marine mammal part or product within the United States	https://www.fisheries.noaa.gov/topic/laws-policies#marine-mammal-protection-act
1970s	1972	Politics	Clean Water Act (CWA)	Regulates of pollutants into the waters of the US and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 under the Federal Water Pollution Control Act, but the Act was reorganized and expanded in 1972.	https://www.epa.gov/laws-regulations/summary-clean-water-act

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1970s	1973	Politics	MARPOL	International convention for the prevention of pollution from ships caused by operational or accidental causes. Adopted at the International Maritime Organization (IMO) in 1973. Includes provisions for pollution by oil, bulk noxious liquid substances, packaged harmful substances, sewage from ships, garbage from ships, and air pollution from ships.	
1970s	1973	Politics	Endangered Species Act (ESA)	Established to protect critically imperiled species from extinction, as well as the ecosystems upon which they depend.	https://www.fisheries.noaa.gov/topic/laws-policies#endangered-species-act
1970s	1973	Politics	Oil Crisis	The oil crisis of 1973 and 1978 was a major disruption to Post WWII and Cold War politics. Prior to the 1970s the U.S. had been the world's leading oil producer, shaping its relationships within the Western Alliance. Consumption and reliance on oil to fuel economies and war increased throughout and after WWII. The peaking of U.S. reserves in 1968 and trade embargoes in 1973 during the Arab-Israli war severely limited access to oil, shifting international politics and economics. In addition to effects on global relationships, environmental and political dynamics radically increased price of oil and affected exploitation of marine environments in productive regions.	Painter 2014
1970s	1976	Politics	Magnuson–Stevens Fishery Conservation and Management Act (MSA)	Guides fisheries management in US and is used as a model worldwide. Established the first 200-mile EEZ off the coast of the US, continued to evolve over 3 decades. In 2006, the MSA established accountability for exceeding catch limits. In the U.S. the National Marine Fisheries Service (NMFS), is the federal agency responsible for implementing this law and ensuring that U.S. fisheries comply with conservation and management requirements.	https://www.fisheries.noaa.gov/topic/laws-policies#magnuson-stevens-act
1970s		Politics	Increased industrial aquaculture	One one hand, aquaculture has the ability to provide a global and sustainable source of protein, however the history of the industry has been riddled with both success and failure. Sustainable solutions must reduce or eliminate impacts to natural systems such as the spread of disease and introgression with wild populations, and the effect of feed on local ecosystems and wild harvest operations.	Froehlich et al. 2018
1970s	1970	Society	Earth Day	Originally proposed an a UNESCO meeting and sanctioned by the UN. First Earth Day was in the US in 1970 as an environmental teach-in; first global Earth Day occurred in 141 countries in 1990. The first March for Science occurred on Earth Day 2017	
1970s	1972	Society	Blue Marble	Image of earth from space, taken by the crew of Apollo 17. One of the most reproduced images in human history	
1970s		Society	Jaws	Traumatized generations of humans, leading to irrational fear of sharks and a willingness to cull sharks in many regions of the world	

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1970s		Society	Recycling	Salvage campaigns in WWII initiate start of recycling. Recycling programs pick up steam again in the 1970s after Earth day	
1980s		Economics	Fall of communism	Greatly reduced fertilizer application in soviet block nations, allowing coastal areas to recover, along with the Black Sea	
1980s		Economics	Neoliberalism	Resurgance of classic liberalism in the 1970s, endorsed by politicians including Reagan & Thatcher administrations through 1980s. Ideals of free market economics and reduced government regulations leave little room for integrated social-environmental policy.	
1980s	1987	Environment	Coral bleaching recognized a major threat linked to warming events / ENSO	First evidence of coral bleaching reported in scientific literature after El Niño 1983. A second large-scale event in 1987 led to increased discussion among scientists and governments worldwide.	Williams & Bunkley-Williams 1990; Glynn 1993; McClanahan 2018
1980s	1989	Environment	*Exxon Valdez* oil spill	Considered one of the worst human-caused environmental disasters. The rupture of the tanker released 42 million liters of crude oil and affected 1900 km of remote and pristine coastline in Prince William Sound, Alaska. The spill severely affected the local ecosystem both in the short and long term, including populations of sea otters, seabirds, harbor seals, Pacific herring and pink salmon. The local economy was similarly affected. It resulted in the US Oil Pollution Act of 1990, which among other things required a phase-out of single-hulled oil tankers in US waters. This legislation was extended by the International Maritime Organization after two subsequent spills (Erika, 1999 and Prestige, 2002). Further unanticipated affects of the oil spill included effects of high-pressure hoses used on beaches, which destroyed interlocking layers of gravel and sediment that protect clams and mussels, and affected otter populations that feed on them.	Peterson et al. 2003
1980s	1982	Politics	United Nations Convention on the Law of the Sea (UNCLOS)	The Law of the Sea Convention defines the rights and responsibilities of nations with respect to their use of the world's oceans, establishing guidelines for businesses, the environment, and the management of marine natural resources, as well as exclusive economic zones (EEZs). It also states that if a country cannot fully utilize the fisheries resource within its EEZ, it must make this surplus available to the fleet of other countries, increasing fishing pressure globally. Opened for signature in 1982, entered into force in 1994.	
1980s	1982	Politics	IWC whaling moratorium	International agreement to cease commercial whaling. Norway and Iceland still participate in commercial whaling. Whaling for aboriginal-subsistence provision is regulated by the IWC and practiced in several countries including the US. Whaling for scientific-research is permitted by 1946 IWC regulations and currently practiced by Japan.	https://iwc.int/whaling

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1980s		Politics	Increased awareness of community-based management	Increased awareness of community-based management accelerated through the 1980s and 1990s as researchers including E. Ostrom and F. Berkes exposed the false dichotomy offered by Hardin's Tragedy of the Commons (1968) and similar models of thinking, and institutions such as UNESCO and FAO increased interest in traditional knowledge and local management of resources. Research identified many examples of community-based management, as well as patterns associated with successful community-based management. Following this shift in thinking, thousands of local initiatives were established and supported through various mechanisms.	Ostrom 1988, Berkes and Farvar 1989, Ostrom 1990, Pretty 2003, Armitage 2005
1980s		Politics	Increased number of ENGOs	The 1980s saw a rapid increase in the formation of environmental non-governmental organizations. ENGOs have become major players in national and international environmental politics, as well as key actors in moving societies away from enviornmental degredation and towards sustainable economies through social and political change.	Princen and Finger 1994
1980s		Politics	Increased corporate power	(see neoliberalism)	
1980s		Society	Increased sushi demand	Increased rates of exploitation and demand for seafood, as well as for live capture and trade.	
1980s		Society	Increased fish demand	Global fish consumption is on the rise and is associated with increases in population size, production, global trade, rising incomes, and urbanization, as well as increased public awareness of health benefits. This growing demand has taxed wild fisheries, which leveled off in production in the 1980s, and has been largely met by an increase in aquaculture. In 2016, aquaculture outpaced capture fisheries in the provision of fish for human consumption.	FAO 2018
1980s		Society	Ocean acidification awareness	Long-term data collection on ocean pH began at various stations around the world in the 1980s. Ocean acidification, caused by increased uptake of atmospheric carbon dioxide in the oceans, alters the carbonate chemistry that governs many processes in marine ecosystems including the formation of shells in organisms from plankton to corals. Further, while oceans currently serve as an important sink for anthropogenic carbon dioxide, this capacity is limited.	Sabine et al. 2004, Doney et al. 2009, Kroeker et al. 2013
1980s		Technology	Internet	Enables sharing of information and is a major platform for ocean conservation awareness	
1980s		Technology	GPS Satellite	Developed for military purposes, it enables technologies, such as AIS as well as tracking of marine animals, with an important role in marine research	
1980s		Technology	IBM, AT, Apple, Commodore 64	Growth of computing technology and the 'digital revolution' allowed for advances in data collection (e.g. by remote sensors), storage, analysis, as well as the transmission of and access to information globally. However, there are social and ecological consequences to the current technological revolution driven by a reliance on rare minerals.	

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1980s		Technology	Unleaded fuel	Public health concerns over leaded gasoline prompted the introduction of unleaded fuel in the 1970s. The introduction of catalytic converters to reduce pollution further compelled use of unleaded fuel. In the US, leaded fuel was phased out by 1996. Further changes to fuel standards in the 2000s includes the use of renewable fuels such as ethanol. Oil and gas exploration continue to have major political and ecological consequences. In the marine environment, this includes ecological disturbance, the risk of oil spills (and associated ecological effects), and the effects of noise pollution on behavior of marine organisms.	
1990s		Economics	Ecocertification	Allows for consumer choice to drive sustainable practices in businesses. Several advances in the 90s include an international consensus at the UN Earth Summit to orient consumption towards sustainable practices, as well as the emergence of certification organizations including the EU Ecolabel and the Marine Stewardship Council (MSC). Additional ecocertifications for marine products include the Global Aquaculture Alliance's Best Aquaculture Practice, Friend of the Sea, and 'dolphin safe'.	
1990s	1991	Environment	Gulf War Oil Spill	One of the largest oil spills in history, resulting from the Gulf War in 1991. No environmental cleanup, little science conducted on effects.	
1990s	1997-98	Environment	El Niño & worldwide bleaching of corals	The number of coral reef bleaching events, driven principally by episodic increases in sea temperature, increased dramatically since the early 1980s. The mass coral bleaching event of 1998 was the most severe on record, with bleaching affecting every geographic coral-reef realm in the world. It coicided with the strongest ENSO on record. It was the sixth major episode of coral bleaching since 1979 to affect coral reefs across a significant portion of the worldís oceans.	Glynn 1993; Hoegh-Guldberg 1999; Baker et al 2008; Hughes et al 2017
1990s	1998, 2002	Environment	*Erika* Oil Spill, *Prestige* Oil Spill	Affected French (*Erika*) and Spanish (*Prestige*) coastlines and ecosystems. Resulted in several maritime laws by the European Union that improve certification and safety standards for shipping. Also lead to legislation by the International Maritime Organization phasing out single-hulled oil tankers by 2015.	
1990s		Environment	Publicity around the Pacific Garbage Patch	Charles J. Moore, returning home through the North Pacific Gyre after competing in the Transpacific Yacht Race in 1997, claimed to have come upon an enormous stretch of floating debris. Moore alerted the oceanographer Curtis Ebbesmeyer, who subsequently dubbed the region the "Eastern Garbage Patch" (EGP). The area is frequently featured in media reports as an exceptional example of marine pollution.	

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1990s		Environment	Increased oceanic dead zones	The number of oceanic dead zones (areas of extreme oxygen depletion), fueled by increased runoff of fertilizers and burning fossil fuels, have been doubling since the 1960s. In the 1990s the number of systems reporting dead zones increased to over 300 globally. Environmental effects of oxygen depletion in these zones include mass mortality of benthic animals, boom-bust cycles, habitat compression, trophic cascades, and expansion of hypoxic regions.	Diaz and Rosenberg 2008
1990s		Environment	Overfishing identified as a global problem	Long-term ecological datasets such as those collected by FAO and long term research stations, as well as historic, archaelogical, and paleoecological records used to identify global trends in overfishing including massive declines in abundance, and transition in landings from high to low tropic species as food webs are fished down, resulting in cascading effects.	Pauly et al. 1998, Jackson et al. 2001
1990s	1992	Politics	Integrated Coastal Zone Management (ICZM)	* Establishes a set of principles for sustainable use of coastal zones, balancing environmental, economic, social, cultural and recreational objectives. * Concept emerged at the 1992 Earth Summit (Rio) * ICZM Protocol was signed in 2008 by 14 Mediterranean countries	
1990s	1992	Politics	UN Earth Summit, Rio de Janeiro	United Nations Conference on Environment and Development (UNCED) aka "Rio de Janeiro Earth Summit" 1992 --> Convention on Biological Diversity (CBD), UN Framework convention on Climate change (UNFCCC)	
1990s	1995	Politics	FAO Code of Conduct for Responsible Fisheries	A voluntary code of conduct to promote sustainable management of fisheries. Used as reference for national and international frameworks.	http://www.fao.org/fishery/code/en
1990s	1997	Politics	Kyoto Protocol	* Extends 1992 UNFCC based on the scientific consensus that (1) global warming is occurring and (2) it is extremely likely that human-made CO2 emissions have predominantly caused it. The Kyoto Protocol was adopted in Kyoto, Japan on 11 December 1997 and entered into force on 16 February 2005. There are currently 192 parties (Canada withdrew effective December 2012) to the Protocol. * First commitment period started in 2008 and ended in 2012 * Doho amendment - second commitment period; 37 countries have binding targets.	
1990s		Politics	Devolution of government	Shifting perspectives on the effectiveness of centralized governance through the 1980s lead to the promotion of community-based management, co-management, and other 'bottom-up' mechanisms for "bringing government closer to the governed" in the 1990s, including in Agenda 21 of the Rio Earth Summit (Berkes 2010). The growth of community based management of marine areas has been significant. Social and ecological responses have been generally positive, but not without challenges.	Berkes 2010, d'Armengol et al. 2018, Gelcich et al. 2019

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1990s		Politics	Fishery catch limits	Stock collapses due to overfishing occuring around the world lead to national and international moves to refine regulations and impose fishery catch limits to promote sustainable fisheries, including 1995 FAO Code of Conduct.	
1990s	1995	Society	WTO established	International organization regulating trade between nations. Plays a role in regulating fisheries subsidies and is therefore currently recognized as a key player in achieving SDG 14.6	
1990s	1995, 2001, 2005	Society	James Cameron Titanic dives	James Cameron made 12 dives to the Titanic in making of the movie (released in 1999), in addition to two subsequent dives (2001, 2005). 12 dives in 2001 include state of the art mini ROVs and result in the documentary 'Ghosts of the Abyss'. 2005 dives accomplish furthest dive into wreck; footage used in 'Last Mysteries of the Titanic'. Movies & dives increases public interest in oceans	
1990s		Society	Increased remote work	May decrease carbon-based pollution contributing to global climate change.	
1990s		Technology	Technology for Oil and Gas Exploration	Improvements in technology such as geological modeling and seismic surveying increase rate of successful wells. Improvements in drilling and pumping technology improve efficiency and reduce costs.	
2000s		Environment	Observed recovery of bleached corals	Some types of coral were observed to recover quicker than others from bleaching events. These include "broadcast spawning taxa with a potential for asexual growth, relatively long distance dispersal, successful settlement, rapid growth and a capacity for framework construction" (Baker et al 2008).	Baker et al 2008
2000s	2004	Politics	Regional conservation challenges -> CBD, MPA targets	In 2004 the Convention on Biological Diversity (CBD) established a target to conserve at least 10% of the world's ecological regions by 2010. This target was updated and reinforced by the Aichi Biodiversity Targets (2010), which specifically establishes a 10% goal for seas by 2020. These targets have contributed to the worldwide increase in Marine Protected Areas (MPAs), but areas set aside primarily for conservation are not realistic for many regions where communities rely heavily on marine resources for livelihood and where 'sustainable use' better reflects cultural practices. In these communities, other effective area based conservation measures ('OECMs', e.g. ICCAs, LMMAs, TURFs) often make more sense.	Govan and Jupiter 2013, Jonas et al. 2014
2000s	2007	Politics	IPCC 4	IPCC Fourth Assessment Report (AR4) was published in 2007; states warming is unequivocal, and anthropogenic cause is 'very likely' (90% probability based on expert judgement); (updated to 'extremely likely, 95-100% probabilty in AR5 in 2014)	IPCC 2007

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2000s		Politics	Increased large MPAs	* Several very large MPAs were established in the 2000s, and more have been since. * Very large MPAs have several benefits, including the ability to protect whole ecosystems, and include large portions of migratory species range. * They may also be more cost effective to implement and maintain. * Challenges include the ability to enforce over large scales, and spatial planning to maximize benefits to nature and human communities.	Wilhelm et al. 2014
2000s		Politics	Increased EBFM	The results of several advisory boards around the world led to the push towards increased ecosystem-based fisheries management (EBFM), and away from single-species management, which ignored habitat, predators, and prey of target species with both ecological, social, and economic costs.	Pikitch et al. 2004
2000s		Politics	Increased focus on community-based management	Community-based approaches to management have continued to see attention and growth throughout the world, including increasing use and support of co-managment institutions, locally managed marine areas (LMMAs) and territoral user rights for fisheries (TURFs). These arrangements have recieved significant study and have been general beneficial, although not without challenges, and are not yet broadly recognized for their conservation benefits at national and international levels. (Also see "Devolution of Government").	Govan and Jupiter 2013, d'Armengol et al. 2018, Gelcich et al. 2019
2000s		Politics	Global recognition that climate change is human caused	Along with IPCC 4 (2007), which states warming is unequivocal, and anthropogenic cause is 'very likely' (see "IPCC 4"), there is a growing global recognition, both in public and scientific communities, that climate change is caused by human activities, with global increases in carbon dioxide (CO2) and methane (CH4) strongly linked to fossil fuel and land use (agriculture).	IPCC 2007
2000s	2003	Society	Finding Nemo	While intended to enhance ocean conservation, it hugely raised the demand for clown fish and anemonae kits, causing a widespred decline of this fish species	
2000s	2009	Society	Elinor Ostrom wins Nobel Prize	Recognition of common pool resource management as viable in many contexts; rejection of Hardin's 'tragedy of the commons' as a foregone conclusion. (See "Increased awareness of community-based conservation").	
2000s	1990s-2010s	Society	The Mediterrian Diet	Medical researchers consistently find positive beneifts to those adhering to a 'mediterrian diet'; including decreased risk of heart disease, cancer, Parkinson's and Alzhiemer's	https://www.bmj.com/content/337/bmj.a1344.long
2000s	2001, 2017	Society	Blue Planet	BBC Documentary. Described as "the first ever comprehensive series on the natural history of the world's oceans". Sequel Blue Planet II released in 2017. Associated with the global movement to reduce plastic pollution	
2000s	2000	Technology	Argo network	* Allows, for the first time, continuous monitoring of the temperature, salinity, and velocity of the upper ocean, with all data being relayed and made publicly available within hours after collection. * Argo deployments began in 2000, and by November 2007, the millionth profile was collected.	http://www.argo.ucsd.edu/

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2000s	2001	Technology	Wikipedia founded	Widespread access to information about oceans as well as policies, movements, science, etc.	
2000s	2004	Technology	Social media platforms take off	Rapid dissemination of information and phenomena across global networks. Unites disparate citizens in common causes (e.g. environmentalism; social movements); also creates echo chambers leading to social division (2016 US elections)	
2000s	2007	Technology	Smartphone	Allows citizens to participate in the observation of the ocean and collection and reporting of data of ocean conservation value. Radically increases acess to information and communication. Also increases the demand for minerals used in smart phones leading to increased pollution, and dredging of marine ecosystems.	
2010s	2010	Environment	BP Deepwatwer Horizon Oil Spill	One of the largest marine oil spills in the history of the petroleum industry. Affected over 650 miles of Gulf coast habitats in a highly productive ecosystem and resulted in major environmental, economic, and health damages. Unanticipated consequences include the collapse of the Gulf oyster populations due to post-spill management and demand decisions.	National Commission 2011, Beck et al 2011
2010s	2015-2017	Environment	Global-scale mass coral bleaching, including extreme bleaching of Great Barrier Reef	From 2015-16 record warm temperatures lead to a third global-scale mass coral bleaching event. The Great Barrier Reef experienced extreme thermal stress 2 years in a row (2016, 2017). 2016 was the largest heat stress event on record; 31% of reefs experienced multiple weeks of high heat stress and 2/3 of corals along a 700km stretch of the Northern Great Barrier Reef were killed (Hughes et al 2017). 2016 was coincident with an El Niño event that was among the most severe ever recorded. However, climate change has been consistently identified as the main factor in the extreme temperatures recorded in the Coral Sea.	Hughes et al 2017; Stuart-Smith et al 2018
2010s	2010	Politics	Aichi Biodiversity Targets	In 2010, in Nagoya, Japan, 193 countries meeting for the U.N. Convention on Biological Diversity (CBD) agreed on 20 targets to reduce global pressures on our natural world. Known as the Aichi Biodiversity Targets, these goals cover everything from avoiding extinctions of threatened species, to reducing subsidies that are harmful to the environment, to protecting 17% of the Earth's land and 10% of its seas by 2020. Although countries have begun planning ways to meet these targets, much more rapid progress is needed. Only about 13% of land and 1.6% of our oceans currently lie within protected areas, and half of nature's most important sites remain unprotected.	
2010s	2015	Politics	United Nations Sustainable Development Goals (SDGs)	Established 17 interlinked international targets for achieving social and environmental well-being, including to "conserve and sustainably use the oceans, seas and marine resources for sustainable development" (SDG 14). SDG 14 is strongly linked to many other goals including global food security, economic growth, sustainable communities, and climate solutions.	United Nations 2015, ICSU 2017

Decade	Year(s)	Category	Event	Brief Summary and Significance for Oceans	Key Resources
2010s	2015	Politics	Paris Agreement	Agreement with the UN Framework Convention on Climate Change dealing with greenhouse-gas-emissions mitigation, adaptation, and finance, starting in the year 2020. * Language negotiated by 196 state parties; 12 Dec 2015. (All the countries in the WORLD). * As of July 2018, 195 UNFCCC members have signed, and 180 have become party to it. * Goal is to keep the increase in global average temperature to well below 2’C above pre-industrial levels, and to limit the increase to 1.5’C, as this would substantially reduce the risks and effects of climate change. * Each country must determine, plan, and regularly report on the contribution that it undertakes to mitigate global warming. * US plans to withdraw (Trump); earliest date is Nov 2020, shortly before the end of the current term. In practice, changes to US policy contrary to the Paris Agreement have already been put in place.	
2010s		Politics	First cross-arctic shipping	Opens otherwise untouched ecosystem to global shipping and various forms of pollution. Increased oil drilling in remote areas mean risk of spills occurring and being contained is increased for vulnerable ecosystems. Pursued for oil and gas exploration as well as for reduced costs of global trade.	
2010s		Politics	Commitment to green coastal	Led by Norway, this is a large scale effort to convert coastal shipping fleets to run on batteries and sustainable fuels. Especially with widespread adoption, would reduce ocean pollution and reliance on oil and gas.	
2010s	2015	Society	Pope Francis' encyclical Laudato Si	Pope Francis produced a document outlining the current environmental crisis and outlines a religious framework for responding. While most Christians are not Catholic, this was widely hailed as an open door for deepening conversation between people of faith and the environmental/conservation community. Much more "religious" participation followed in major conservation meetings, including the UN Oceans meeting in 2016. Many conferences, books, etc building off this document utilizing faith-based terminology to engage people in ocean conservation.	http://w2.vatican.va/content/francesco/en/encyclicals/documents/papa-francesco_20150524_enciclica-laudato-si.html
2010s	2017	Society	March for Science, People's Climate March	Global demonstrations in support of science and action on climate change	

Decade	Year(s)	Category	Event	Brief Summary and Significance for Oceans	Key Resources
2010s	2019	Society	Youth Strike 4 Climate	On March 15, 2019 students in over 2000 countries participated in a "Global Climate Strike for the Future" or "Youth Strike 4 Climate", following months of widespread “School Strike for Climate” started by youth activist Greta Thurnberg. These events have captured global media and public attention, and youth, including Thurberg, have spoken at national and international political meetings to communicate concern over the future and the immediate need for action on climate change.	
2010s		Society	Octonauts TV series	Octonauts created by BBC, became top pre-school TV show in the UK, distributed internationally. Increased public awareness of marine life and threats to the oceans.	

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