Commissioned by

HIGH LEVEL PANEL *for*
A SUSTAINABLE
OCEAN ECONOMY

BLUE PAPER

Summary for Decision-Makers

The Expected Impacts of Climate Change on the Ocean Economy

The ocean is critically important to our global economy. Collectively, it is estimated that ocean-based industries and activities contribute hundreds of millions of jobs and approximately US$2.5 trillion to the global economy each year, making it the world's seventh-largest economy when compared with national gross domestic products.[1] In addition, the nonmarket services and benefits provided by the global ocean are significant and may in fact far exceed the value added by market-based goods and services.[2]

Anthropogenic climate change, driven by the exponential increase in emissions of greenhouse gasses (GHGs) since the industrial revolution, will have wide-ranging and severe impacts on the ocean and ocean-based economy. Swift efforts to reduce anthropogenic GHGs are needed to maintain a robust ocean economy. The recent Intergovernmental Panel on Climate Change report estimates that climate-induced declines in ocean health will cost the global economy $428 billion per year by 2050 and $1.979 trillion per year by 2100.[3]

New analysis[4] commissioned by the High Level Panel for a Sustainable Ocean Economy examines the impacts of climate change across three of the largest ocean-based industries—wild capture fisheries, marine aquaculture (mariculture) and coral reef tourism—and offers a set of solutions for decision-makers to follow to secure their continued viability.

Wild Capture Fisheries

IMPACTS

- Wild capture fisheries produce approximately 79.3 million metric tons (mmt) of landings annually, representing 46.4% of global seafood production (170.9 mmt) and US$130 billion in first sale value.[5]
- Approximately 30.6 million people participate —either full time, part time, or occasionally—in capture fisheries globally.
- Climate change is changing the distribution and reducing the productivity of marine fisheries globally, with drastic regional variation (Figure 1).
- Marine animal biomass is forecast to decline by 15–30% in the North/South Atlantic, North/South Pacific and Indian Ocean basins by 2100 while increasing by 20–80% in the polar Arctic and Southern Ocean basins.[6]

OPPORTUNITIES FOR ACTION

- Implement best practices in fisheries management to improve the current system and build ecological resilience.
- Be dynamic, flexible and forward-looking.
- Establish and strengthen international institutions and agreements to better manage stocks shifting in and out of jurisdictions.
- Develop fisheries permits that are tradeable across political boundaries, which would give future resource users access to fisheries not yet in their waters and incentivise good management.
- Build socioeconomic resilience.
- Use principles of fairness and equity to drive policy decisions.

Mariculture

IMPACTS

- Mariculture produces over 38.6 mmt of seafood worth $67.4 billion every year.[7]
- Like wild marine species, cultivated marine species are impacted by changing environmental conditions, but unlike wild species, humans can induce accelerated adaptation in cultivated species through selective breeding.

OPPORTUNITIES FOR ACTION

- Continue developing mariculture as an alternative to traditional capture fisheries.
- Prevent, reduce and accept the environmental trade-offs associated with mariculture.
- Advance feed technology to enable the sustainable expansion of mariculture.
- Adjust portfolios of mariculture species and pursue selective breeding for fast growth and robustness to climate change.
- Increase farmers' access to finance.
- Site mariculture farms in low-risk areas and actively monitor and respond to changing conditions.

Coral Reef Tourism

IMPACTS

- Coral reef tourism is worth $35.8 billion globally every year.[8]
- Coral reef tourism directly supports the livelihoods of millions of people and the economies of the developing tropics and many small island developing states.
- Climate change will reduce global coral cover by 72–87% (relative to present) by 2100 under a high emissions scenario (RCP 8.5 [a]), substantially affecting the coral reef tourism industry, and associated socioeconomic impacts, of many countries.

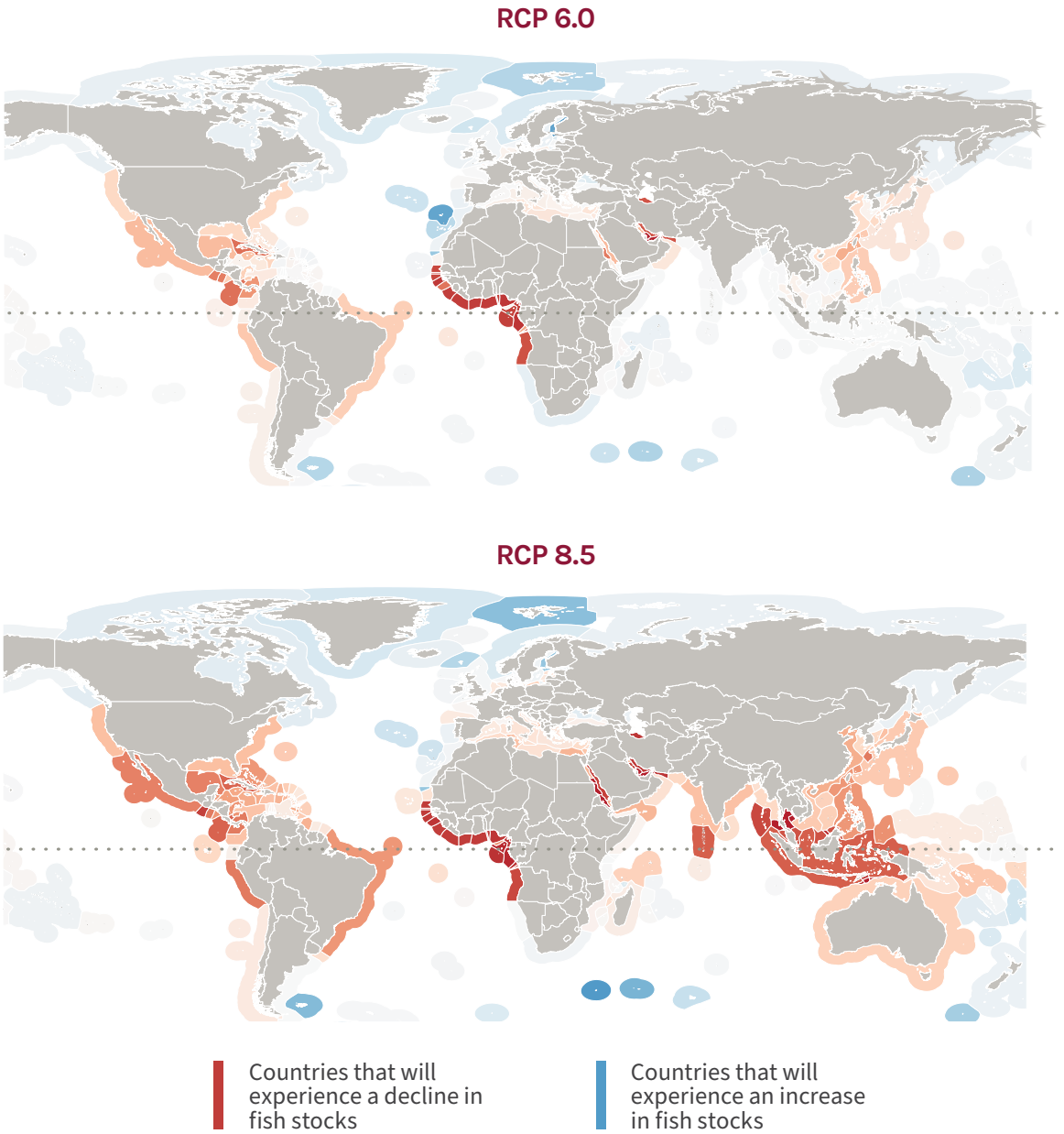
OPPORTUNITIES FOR ACTION

- Enhance the resilience of natural ecosystems through conservation and restoration.
- Use 'blue coastal infrastructure' instead of traditional hard infrastructure.
- Diversify tourism activities and development portfolios.
- Invest in proper waste disposal and treatment facilities.
- Reduce the greenhouse gas footprint of tourism.

Notes: [a] The Representative Concentration Pathway (RCP) scenarios are named according to the projected radiative forcing experienced in 2100 (2.6, 4.5, 6.0 and 8.5 Watts per square metre, respectively). They roughly correspond to projected increases in planetary surface temperatures relative to 1850–1900 of 1.6, 2.5, 2.9 and 4.3°C, respectively, by the end of this century.

Source: IPCC 2019.

Figure 1: Changes in Global Distribution and Productivity of Fish Stocks Under Different Climate Scenarios through 2100



Note: Fig 1. shows that maximum sustainable yield (MSY) is forecast to decrease in equatorial exclusive economic zones (EEZs) and increase in poleward EEZs through 2100. The impacts of climate change on fisheries and the opportunities and benefits of climate-adaptive fisheries management reforms can be explored for specific countries in an interactive web application created by the Sustainable Fisheries Group at the University of California, Santa Barbara.[9]

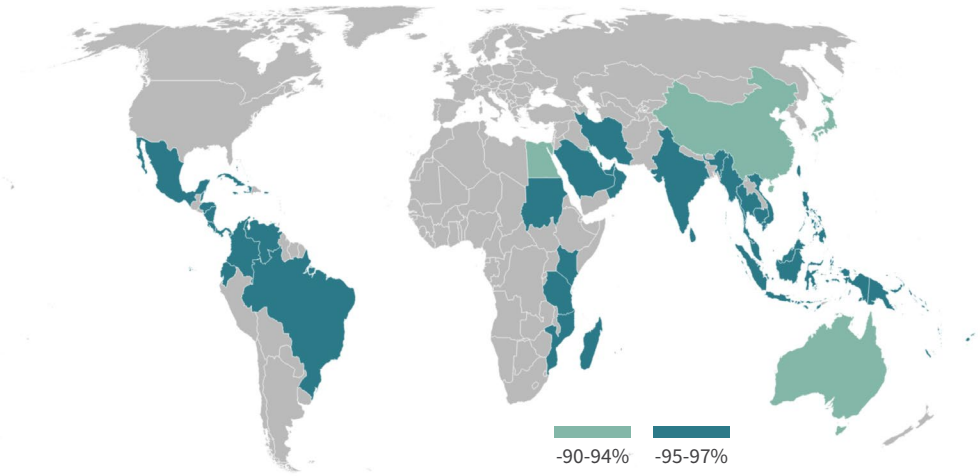
Source: Adapted from Free et al. 2019b.

Countries stand to gain significant benefits by implementing climate-adaptive fisheries management reforms that address both changes in species distributions and productivities due to climate change. Analysis finds climate-adaptive fisheries management results in greater cumulative profits than business-as-usual management for 99 percent of countries under RCPs 6.0 and 8.5.

Mariculture potential is likely to remain high under climate change and could offset losses in food and income from capture fisheries. Expanding the potential for mariculture will require enhancing capacity, defining best practices and easing regulatory burdens, increasing farmers' access to credit and insurance, breeding stocks for fast growth and improving feed technology.

Climate change impacts (ocean warming plus acidification) could reduce the economic potential of the coral reef tourism industry by over 90 percent in 2100 if climate change continues under a high emissions scenario (RCP 8.5).

Figure 2: Percent Change in Coral Reef Tourism Values in 2100 if Climate Change Continues Under a High Emissions Scenario (RCP 8.5)



The loss in revenue to the five countries with the largest coral reef tourism industries in 2100 (US dollars/year)

Egypt	Indonesia	Australia	Mexico	Thailand
$5.6b	**$1.9b**	**$1.6b**	**$1.2b**	**$1b**

Notes: Climate change effect based on RCP 8.5. Values in 2100 are relative to those in 2019. See Table A2 in Gaines, S., R. Cabral, C. Free, Y. Golbuu, et al. 2019. for country values. The top five countries with the highest coral reef tourism values are Egypt (~$7 billion/year), Indonesia (~$3.1 billion/year), Mexico (~$3 billion/year), Thailand (~$2.4 billion/year) and Australia (~$2.2 billion/year). These five countries have 45–86 percent of their coral reef tourism values based on on-reef activities (e.g. snorkelling and diving). Dollar figures are round to the nearest hundred million.

Source: Country-level tourism values data provided by M. Spalding. Model for change in coral cover adapted from Chen et al. 2015.

The paper proposes three high-level mandates to build socioecological resilience to climate change and ensure the continued, or improved, provision of functions and services from the ocean:

1. **Focus on equity.** It will be profoundly important to examine the equity implications of all new and existing management decisions across these three sectors. Climate change will exacerbate global inequities, reducing resilience and thereby likely worsening outcomes under all climate change scenarios. Truly inclusive, representative, participatory decision-making processes are needed in all sectors to ensure procedural equity in all policy and management decisions.

2. **Be forward looking.** It will no longer be possible to rely on historical benchmarks to guide management decisions. As the climate changes, the fishery, mariculture and tourism sectors will need to work to understand risks and anticipate changes, and make decisions aimed at improving ecosystem health. In many cases, the risks and changes will become increasingly uncertain, which means that all management decisions need to factor in adaptive and precautionary strategies, such as the following:

    - *Wild capture fisheries:* Undertake scenario planning and management strategy evaluations that incorporate flexible, adaptive and precautionary stock assessments, harvest controls, allocation systems and marine protected area designs.

    - *Mariculture:* Invest in selective breeding and improvements to feed conversion ratios to increase robustness to temperature changes, as well as technologies that reduce risks derived from increasingly frequent and stronger storms.

    - *Coral Reef Tourism:* Engage in practices aimed at building ecosystem resilience and health, diversify portfolios of activities and shift to activities that provide high economic returns with lower ecological footprints (i.e. ecotourism).

3. **Cooperate across boundaries.** Marine species will move across jurisdictional boundaries and regional, national and international cooperative agreements will be necessary to ensure that these species are well-managed, and that the benefits are fairly distributed during and after the transitions.

Climate change impacts will differ by country and sector and solutions must be context-specific and developed on a case-by-case basis. By exploring climate change impacts at the country level for fisheries, mariculture and coral reef tourism, countries can assess what they stand to gain or lose due to climate change and understand how they might capitalise on these predictions to inform their investments and actions.

Endnotes

1 Hoegh-Guldberg, O. 2015. *Reviving the Ocean Economy: The Case for Action*. Gland, Switzerland: WWF International; IPCC (Intergovernmental Panel on Climate Change). 2019. *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC)*. Edited by H.O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, et al. Geneva: Intergovernmental Panel on Climate Change.

2 Costanza, R., R. de Groot, P. Sutton, S. van der Ploeg, S.J. Anderson, I. Kubiszewski, S. Farber, et al. 2014. "Changes in the Global Value of Ecosystem Services." *Global Environmental Change* 26 (May): 152–58. https://doi.org/10.1016/j.gloenvcha.2014.04.002.

3 IPCC (Intergovernmental Panel on Climate Change). 2019. *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC)*. Edited by H.O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, et al. Geneva: Intergovernmental Panel on Climate Change.

4 Gaines, S., R. Cabral, C. Free, Y. Golbuu, et al. 2019. *The Expected Impacts of Climate Change on the Ocean Economy*. Washington, DC: World Resources Institute. https://oceanpanel.org/blue-papers/expected-impacts-climate-change-ocean-economy

5 FAO (Food and Agriculture Organization of the United Nations). 2018. *The State of World Fisheries and Aquaculture: Meeting the Sustainable Development Goals*. CC BY-NC-SA 3.0 IGO. Rome: FAO. http://www.fao.org/fishery/sofia/en.

6 Bryndum-Buchholz, A., D.P. Tittensor, J.L. Blanchard, W.W.L. Cheung, M. Coll, E.D. Galbraith, S. Jennings, et al. 2019. "Twenty-First-Century Climate Change Impacts on Marine Animal Biomass and Ecosystem Structure across Ocean Basins." *Global Change Biology* 25 (2): 459–72. https://doi.org/10.1111/gcb.14512.

7 FAO (Food and Agriculture Organization of the United Nations). 2018. *The State of World Fisheries and Aquaculture: Meeting the Sustainable Development Goals*. CC BY-NC-SA 3.0 IGO. Rome: FAO. http://www.fao.org/fishery/sofia/en.

8 Spalding, M., L. Burke, S.A. Wood, J. Ashpole, J. Hutchison and P. zu Ermgassen. 2017. "Mapping the Global Value and Distribution of Coral Reef Tourism." *Marine Policy* 82 (August): 104–13. https://doi.org/10.1016/j.marpol.2017.05.014.

9 UCSB (University of California, Santa Barbara). 2019. *Interactive web interface developed by the Sustainable Fisheries Group*. https://sfg-ucsb.shinyapps.io/fishcast2/.>

10 Defined by the United Nations Food and Agriculture Organization as fish, crustaceans, molluscs and other aquatic animals, excluding mammals and reptiles as well as seaweeds and other aquatic plants.

11 FAO (United Nations Food and Agriculture Organization). 2018. *The State of World Fisheries and Aquaculture: Meeting the Sustainable Development Goals*. Rome: FAO.

12 Costello, C., L. Cao, S. Gelcich et al. 2019. *The Future of Food from the Sea*. Washington, DC: World Resources Institute. Available online at www.oceanpanel.org/blue-papers/future-food-sea.

The High Level Panel for a Sustainable Ocean Economy (Ocean Panel) is a unique initiative by 14 world leaders who are building momentum for a sustainable ocean economy in which effective protection, sustainable production and equitable prosperity go hand in hand.

Co-chaired by Norway and Palau, the Ocean Panel comprises members from Australia, Canada, Chile, Fiji, Ghana, Indonesia, Jamaica, Japan, Kenya, Mexico, Namibia, Norway, Palau and Portugal and is supported by the UN Secretary-General's Special Envoy for the Ocean.

The Ocean Panel gathers input from a wide array of stakeholders, including an Expert Group and an Advisory Network. The Secretariat, based at World Resources Institute, assists with analytical work, communications and stakeholder engagement.

The Blue Paper that this brief summarises is an independent input to the Ocean Panel process and does not necessarily represent the thinking of the Ocean Panel, Sherpas or Secretariat.

For more information, including the full report, visit **www.oceanpanel.org**