



United Nations Environment
World Conservation Monitoring Centre

PROTEUS ANNUAL MEETING

27th – 28th June 2017, David Attenborough Building, Cambridge, UK



ExxonMobil



RioTinto

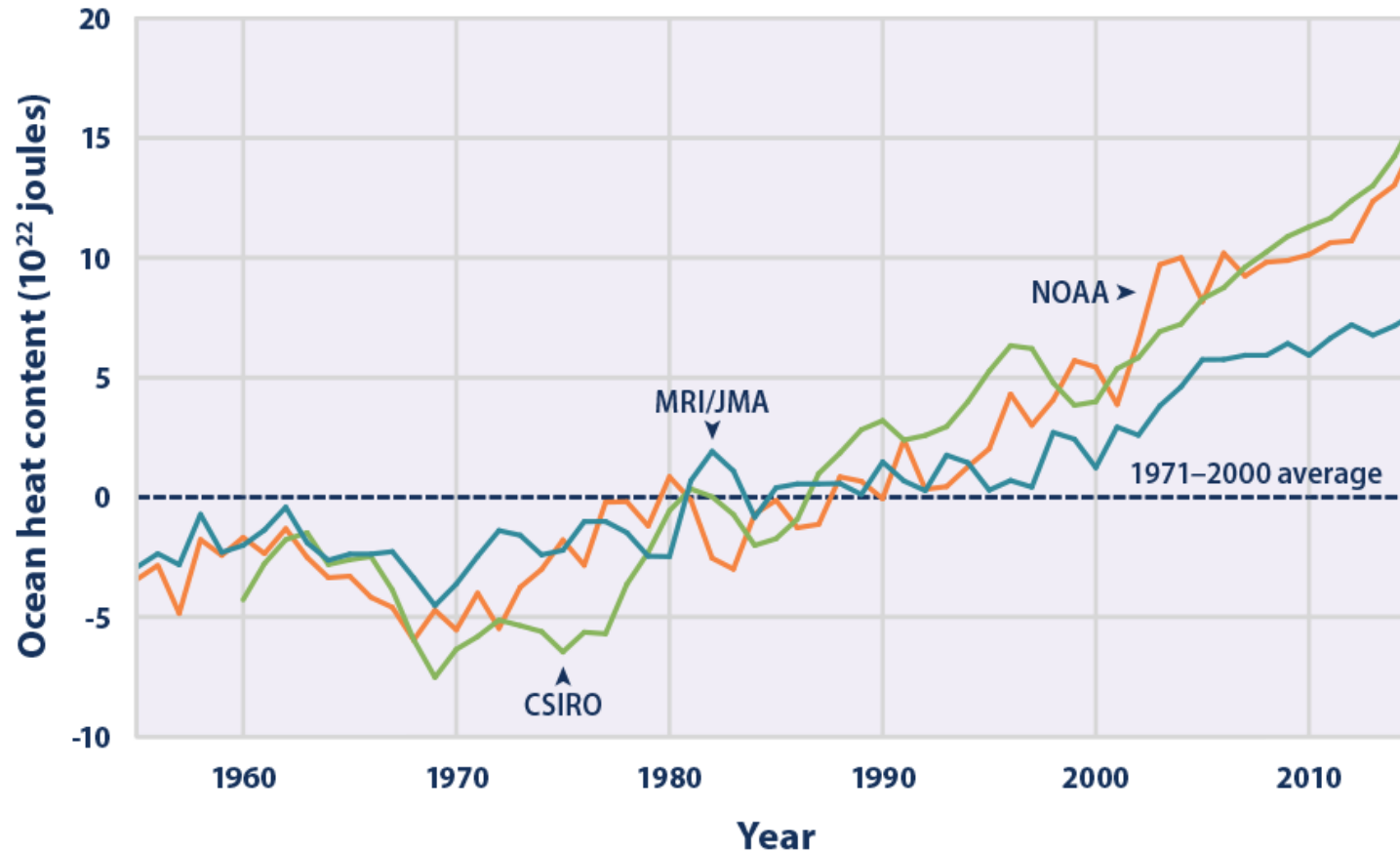




OCEAN SPRAWL: PLANNING MARINE INFRASTRUCTURE IN A CHANGING CLIMATE

Steve Fletcher

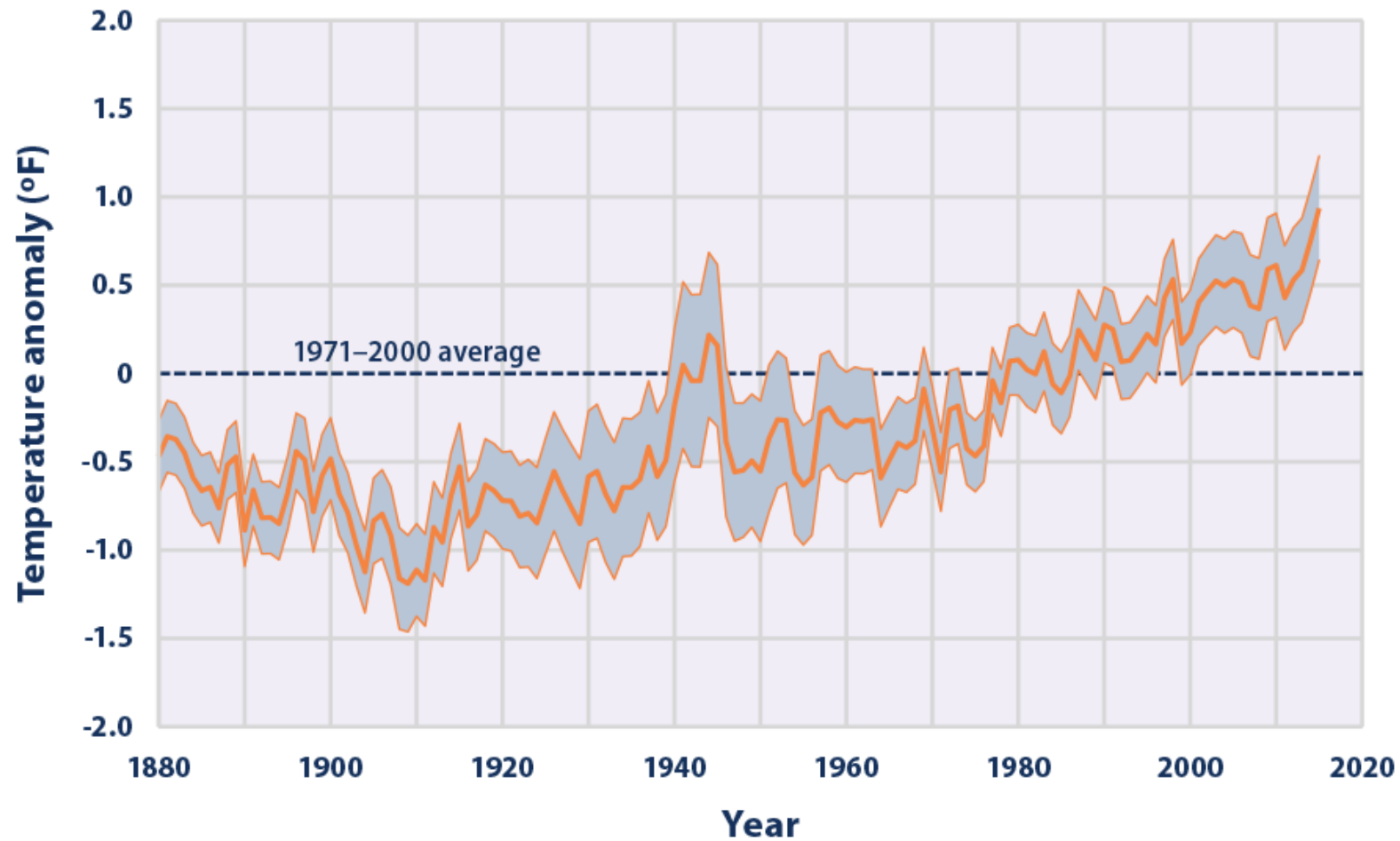
Ocean Heat Content, 1955–2015



Data sources:

- CSIRO (Commonwealth Scientific and Industrial Research Organisation). 2016 update to data originally published in: Domingues, C.M., J.A. Church, N.J. White, P.J. Gleckler, S.E. Wijffels, P.M. Barker, and J.R. Dunn. 2008. Improved estimates of upper-ocean warming and multi-decadal sea-level rise. *Nature* 453:1090–1094. www.cmar.csiro.au/sealevel/thermal_expansion_ocean_heat_timeseries.html.
- MRI/JMA (Meteorological Research Institute/Japan Meteorological Agency). 2016 update to data originally published in: Ishii, M., and M. Kimoto. 2009. Reevaluation of historical ocean heat content variations with time-varying XBT and MBT depth bias corrections. *J. Oceanogr.* 65:287–299.
- NOAA (National Oceanic and Atmospheric Administration). 2016. Global ocean heat and salt content. Accessed May 2016. www.nodc.noaa.gov/OC5/3M_HEAT_CONTENT.

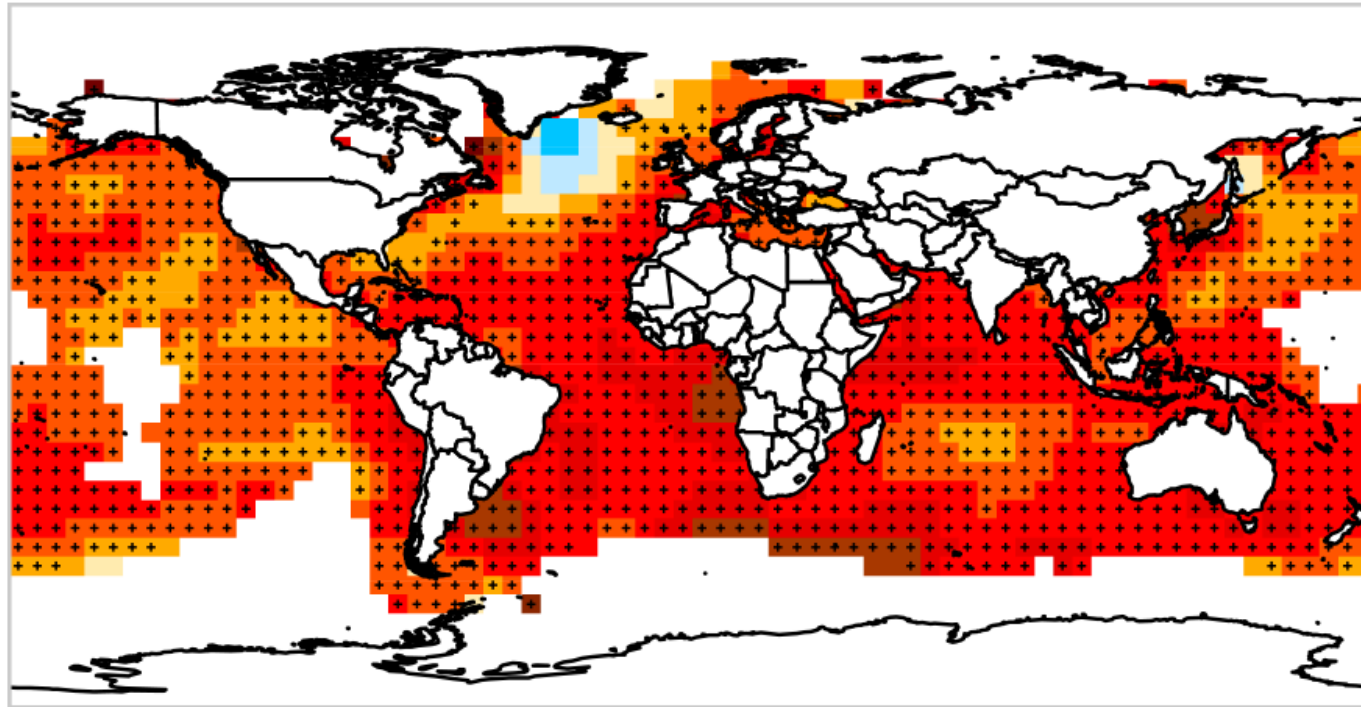
Average Global Sea Surface Temperature, 1880–2015



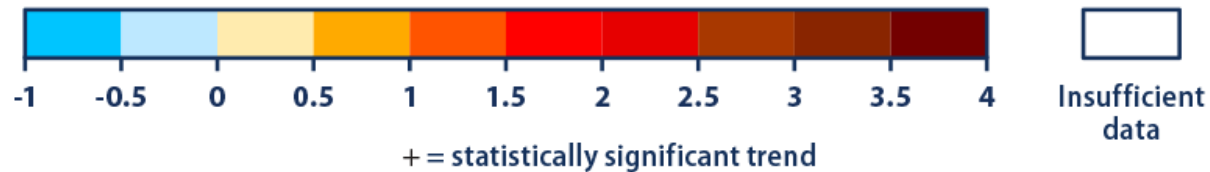
Data source: NOAA (National Oceanic and Atmospheric Administration). 2016. Extended reconstructed sea surface temperature (ERSST.v4). National Centers for Environmental Information. Accessed March 2016.
www.ncdc.noaa.gov/data-access/marineocean-data/extended-reconstructed-sea-surface-temperature-ersst.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

Change in Sea Surface Temperature, 1901–2015



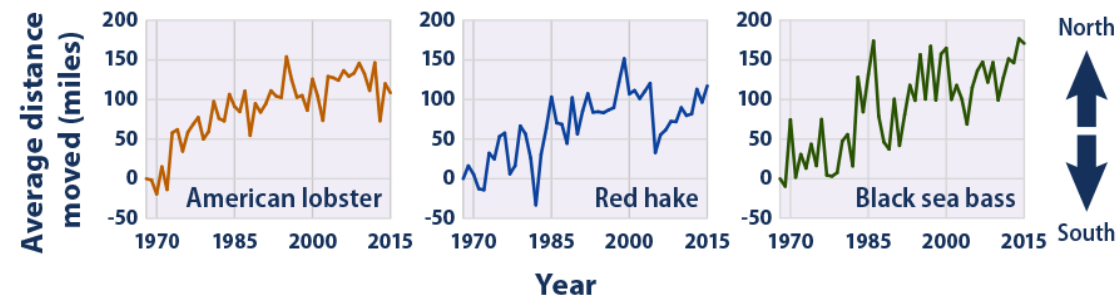
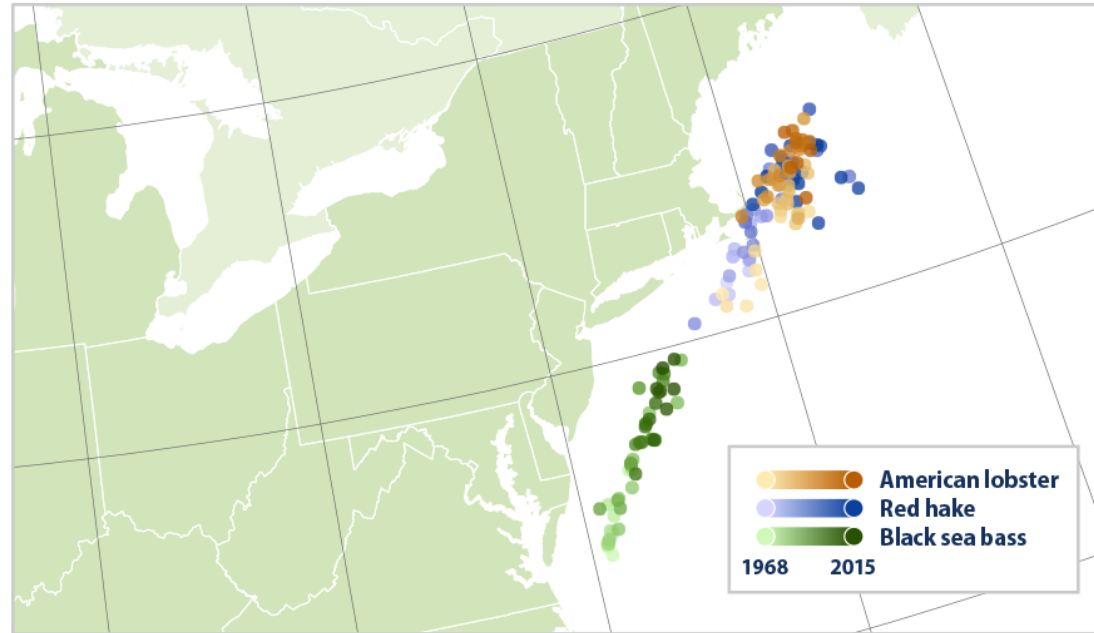
Change in sea surface temperature (°F):



Data sources:

- IPCC (Intergovernmental Panel on Climate Change). 2013. Climate change 2013: The physical science basis. Working Group I contribution to the IPCC Fifth Assessment Report. Cambridge, United Kingdom: Cambridge University Press. www.ipcc.ch/report/ar5/wg1.
- NOAA (National Oceanic and Atmospheric Administration). 2016. NOAA Merged Land Ocean Global Surface Temperature Analysis (NOAAGlobalTemp): Global gridded 5° x 5° data. National Centers for Environmental Information. Accessed June 2016. www.ncdc.noaa.gov/data-access/marineocean-data/noaa-global-surface-temperature-noaaglobaltemp.

Average Location of Three Fish and Shellfish Species in the Northeast, 1968–2015



Data source: NOAA (National Oceanic and Atmospheric Administration) and Rutgers University. 2016. OceanAdapt. <http://oceanadapt.rutgers.edu>.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

What is 'Ocean Sprawl'

The spread of **artificial structures** in the ocean, including for:

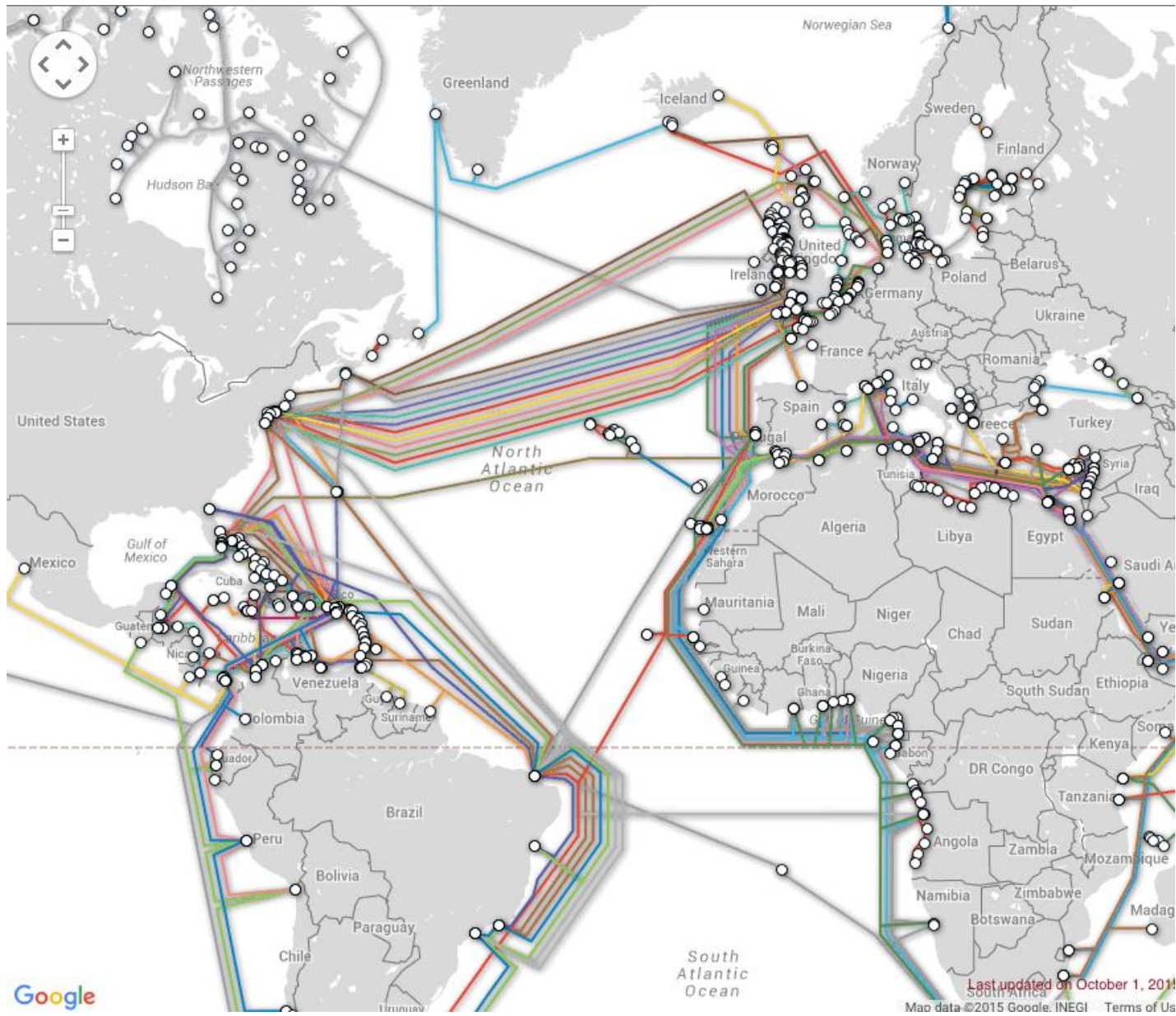
- Shoreline protection
- Aquaculture
- Renewable energy generation
- Natural resource extraction
- Recreational and commercial activities
- Power and communication transmission
- Urban waterfront development



Doha



Hong Kong







Implications of artificial structures (Firth, et.al. 2016)

Negative:

- Usually less species diversity (biotic homogenization)
- Non-indigenous species are more common on artificial structures.

Positive:

- Provide bridges between 'natural' habitat.
- Offset weak species dispersal potential.
- Support species range increases.
- Can support species responses to climate change.



Collateral benefits

Making the unintentional intentional

Artificial structures may provide opportunities for **assisted migration** of species at risk from climate change (Hoegh-Guldberg et.al. 2008).

How?

- **Species manipulation** (e.g. transplantation)
- **Eco-engineering** (e.g. engineered complexity / habitat construction)
- **Strategic location of structures** (e.g. marine spatial planning)

Conclusion:

Marine planning, artificial structures and climate change

Options:

- View artificial structures as a **global network** with the potential to support ocean climate change adaptation..
- **Plan the network** of structures to pre-empt climate change as business need emerges.
- Identify artificial structures as '**Artificial Marine Micro Reserves**' (already proposed in the Western Mediterranean Sea).
- Emergence of **marine spatial planning provides a pathway.**

A fisherman wearing a white jacket, orange pants, and a straw hat with red and green floral patterns is sitting in a traditional wooden boat on a body of blue water. The boat is equipped with a large, intricate fishing net structure. The water is calm, reflecting the boat and the fisherman. The scene is set during the day, with clear blue skies and water.

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www.unep-wcmc.org
[@unepwcmc](https://twitter.com/unepwcmc)

Steve Fletcher

Head of Marine Programme

Steve.fletcher@unep-wcmc.org

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