Extreme and compound climate events and their implications for fisheries

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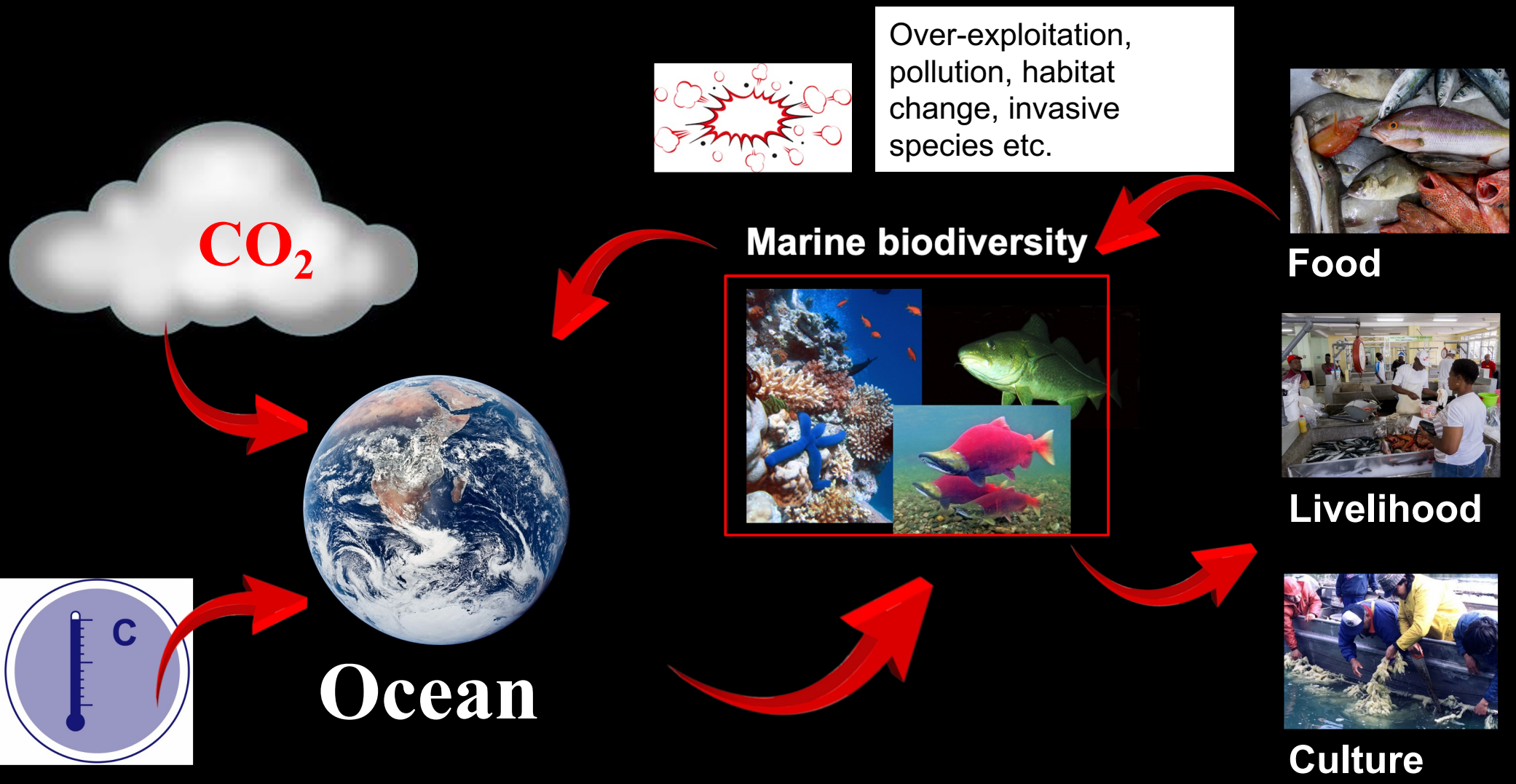
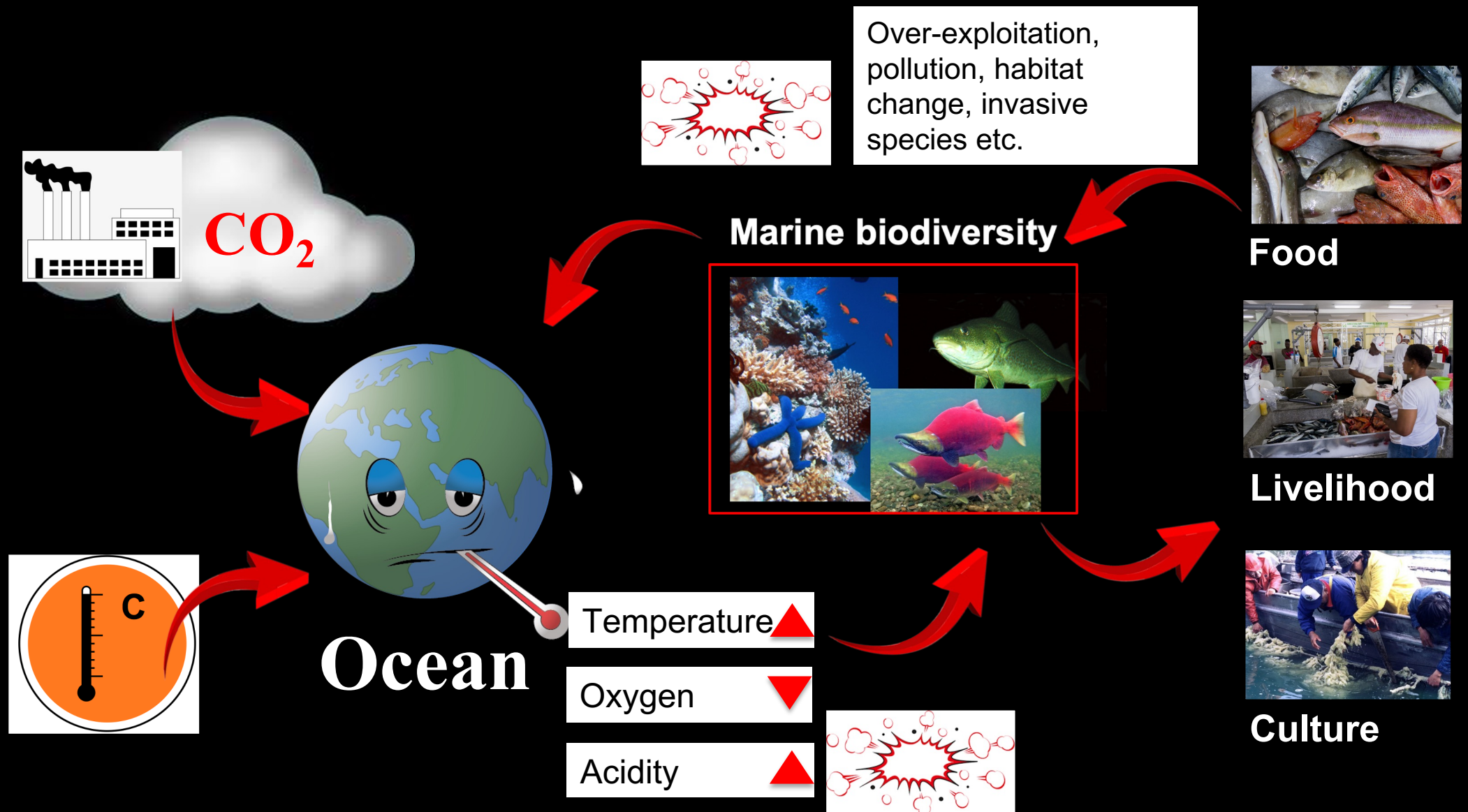
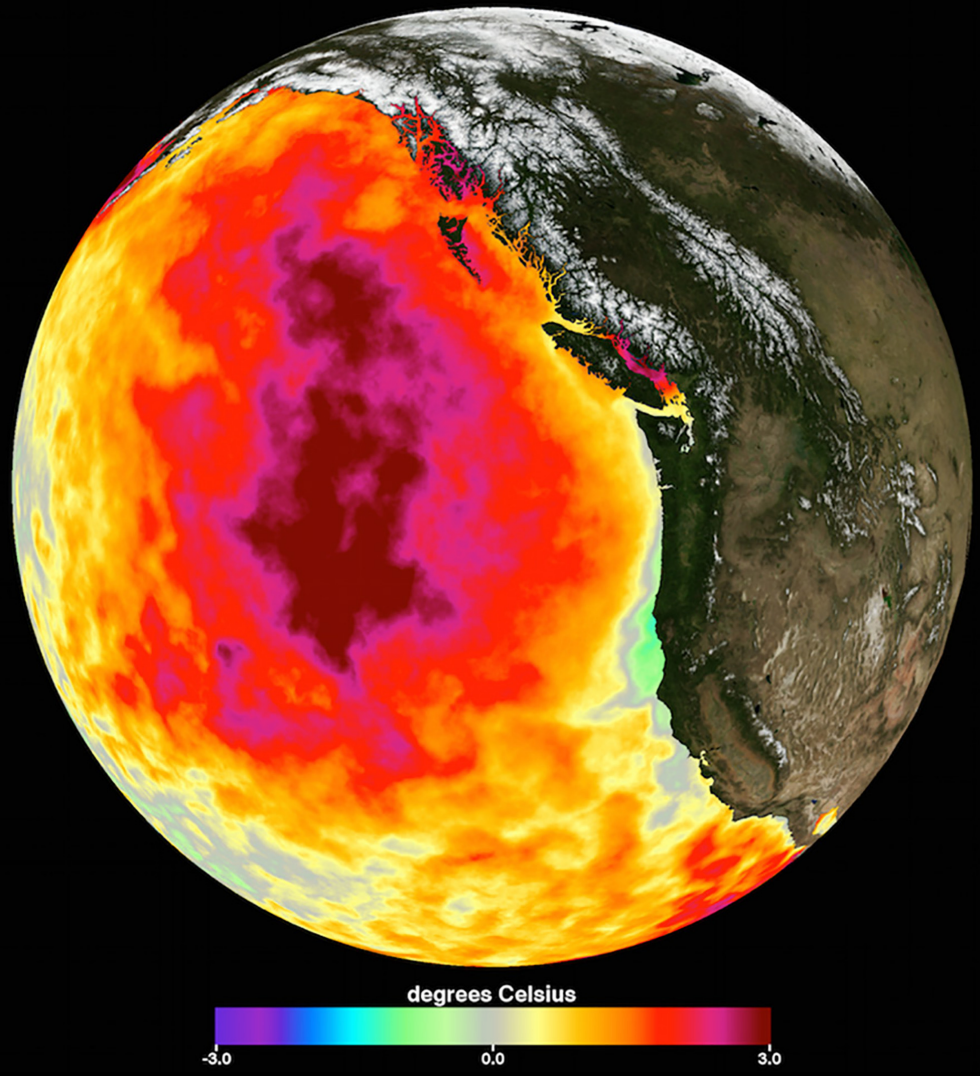
Ocean is crucial for biodiversity and human systems



Climate change is exacerbating human impacts on biodiversity and ecosystem services

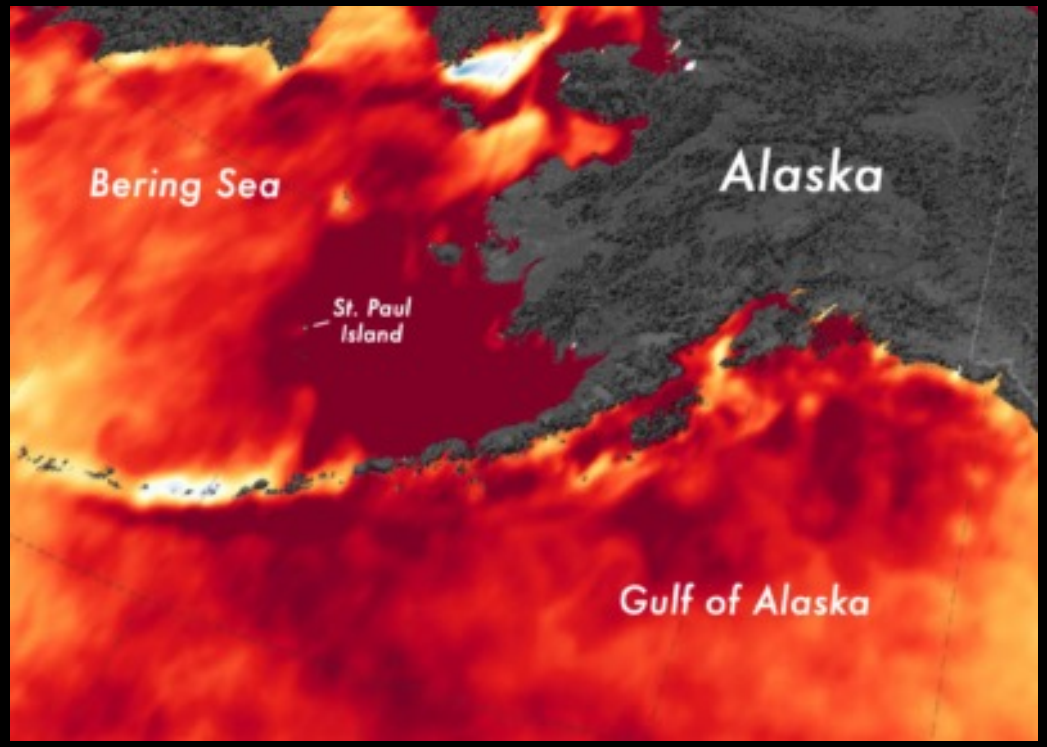


Increasing intensity and frequency of marine extreme and compound events in the ocean are impacting marine life and people



Carey 2022. PNAS

E.g., North Pacific heatwaves 2019-2021 and the Alaska crab fishery collapse



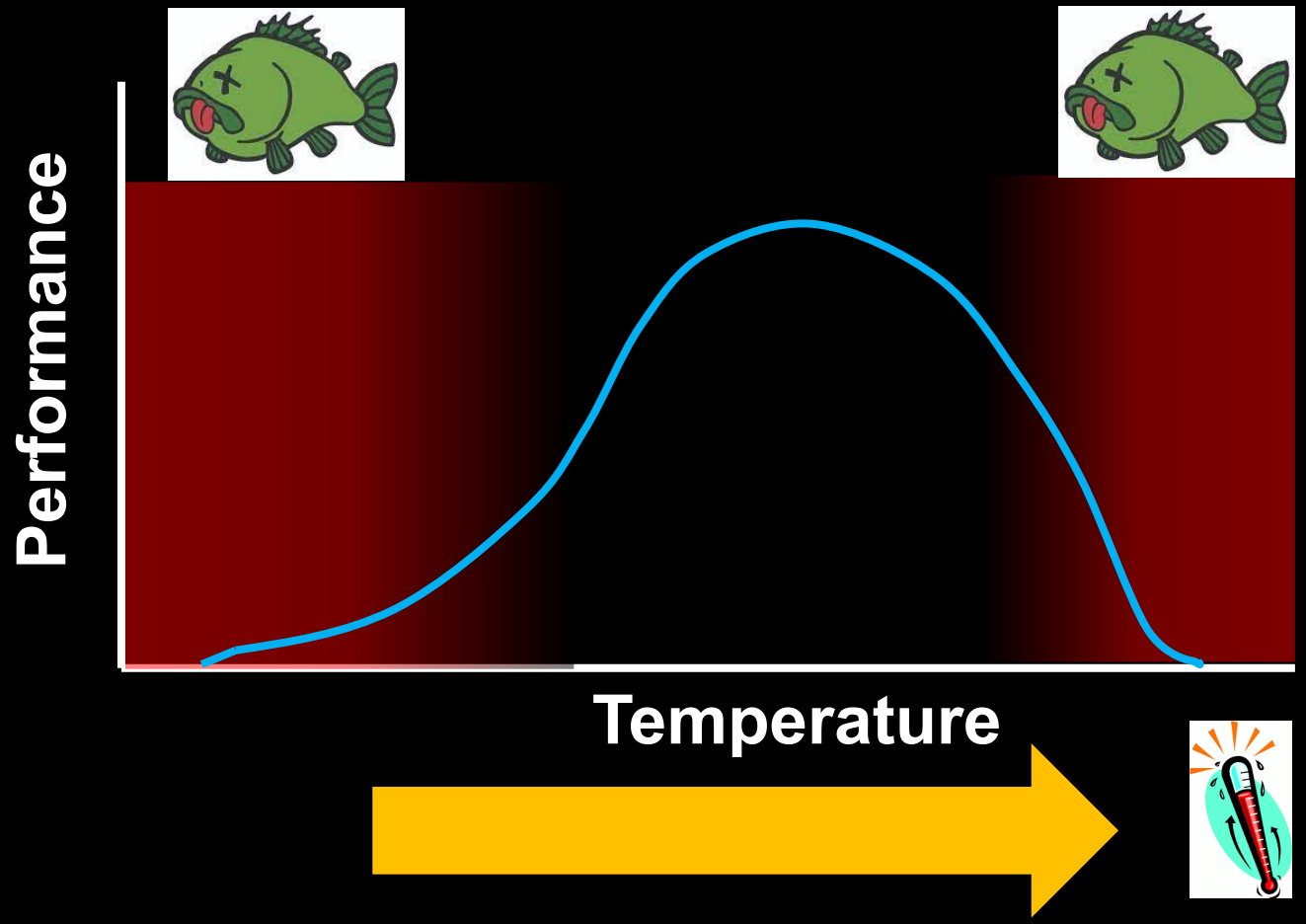
Source: A marine heat wave in August 2019. In deep red areas, the ocean surface was more than 5 degrees F warmer than normal. NASA / Yale Environment 360

Alaska crab fishery collapse seen as warning about Bering Sea transformation

Loss of snow crab and Bristol Bay red king crab harvests pose immediate hardships and raise worries about future seafood prospects

BY: **YERETH ROSEN** - DECEMBER 19, 2022 5:00 AM

Marine fishes and invertebrates suffer when temperature goes beyond their biological tolerance limits



Exacerbated by ocean deoxygenation and acidification

Latitude

Climate-shifted distribution

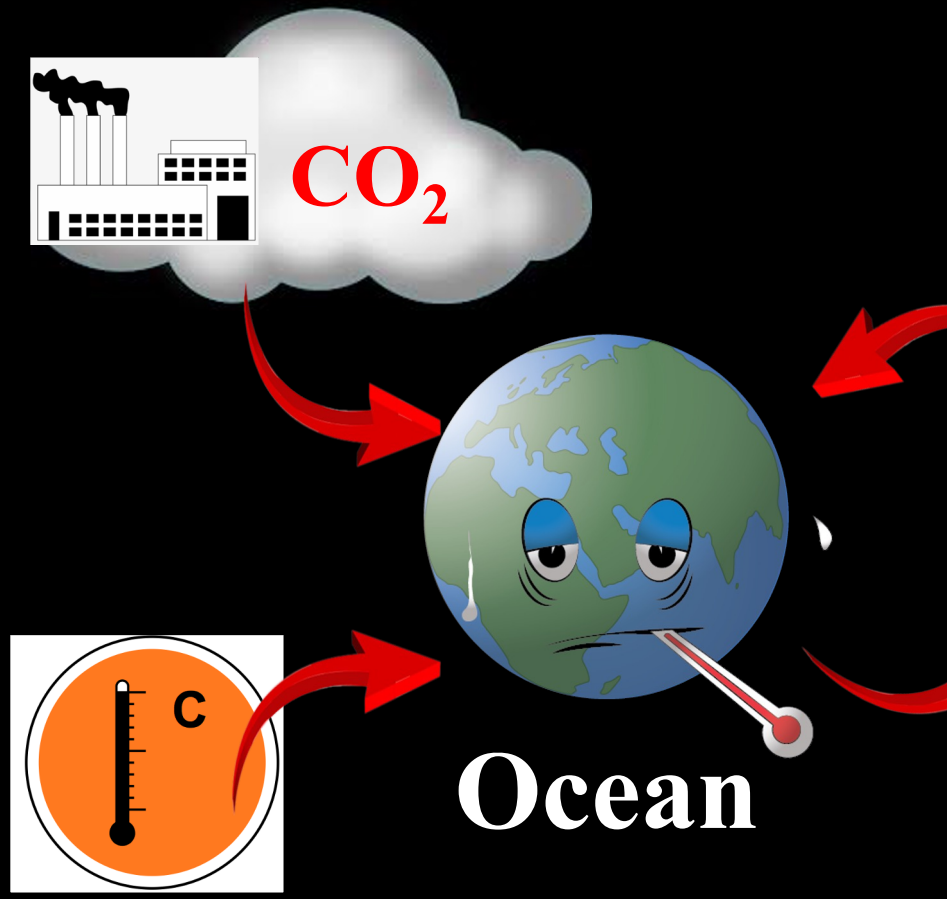
Species interactions

Warming

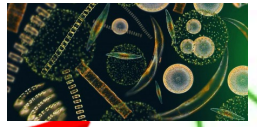
deoxygenation

Original distribution

Warming and shifts in nutrient cycling are altering ocean primary production, impacting energy flow through the food web



Primary production



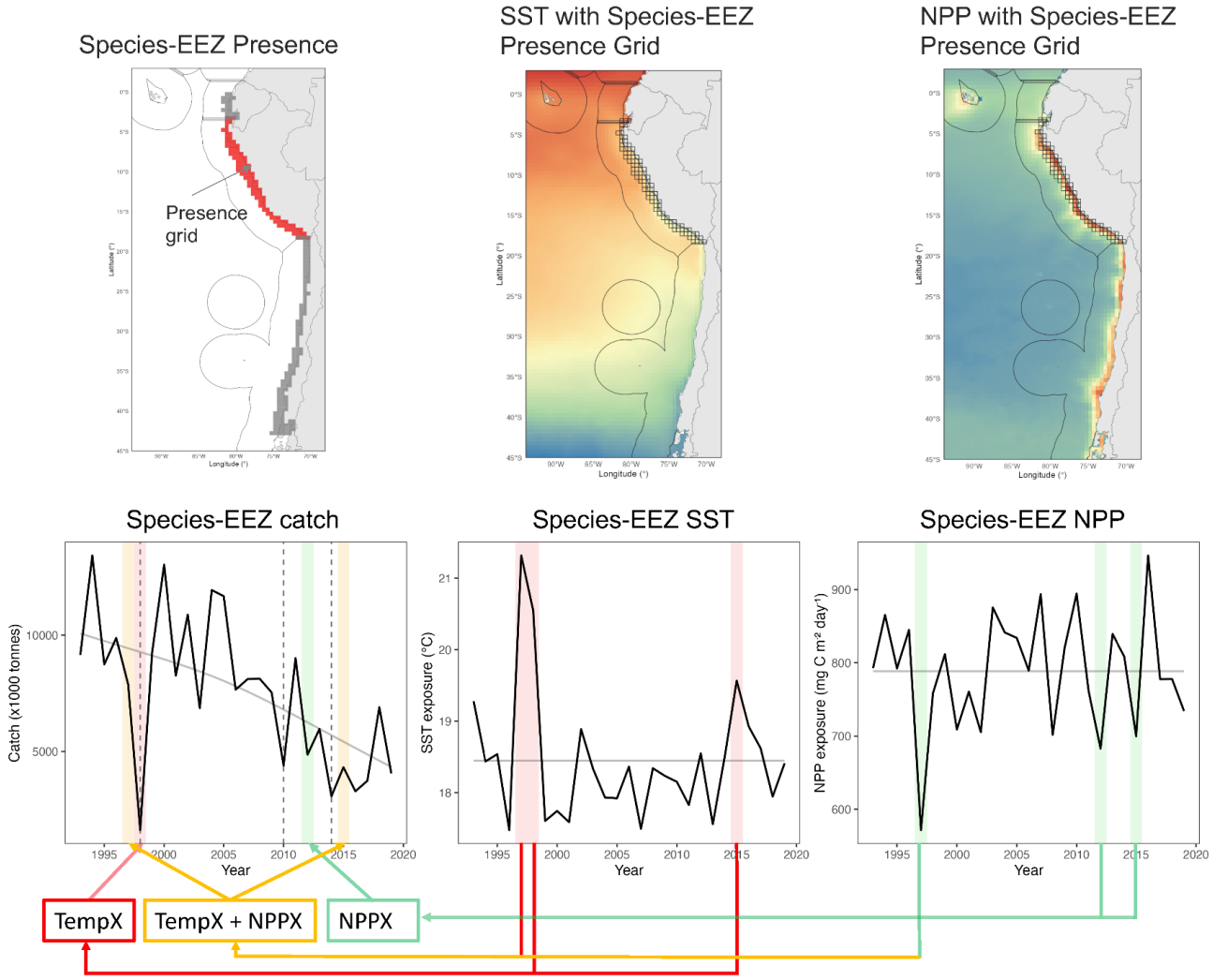
Source: Planque & Mullon (2020) ICES JMS.

Source: flickr

A risk-based framework applied to 6,659 fisheries and environmental time-series data to quantify how temperature and NPP extremes alter the likelihood of extreme low fisheries catches

High temperature extreme: **TempX**

Low net primary production extreme: **NPPX**



Cheung et al. (under review) **Please do not cite without permission.**

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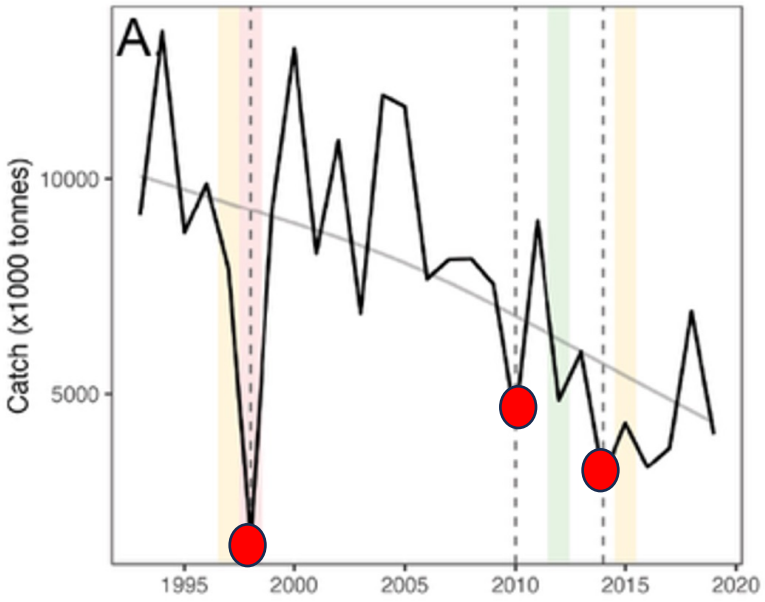
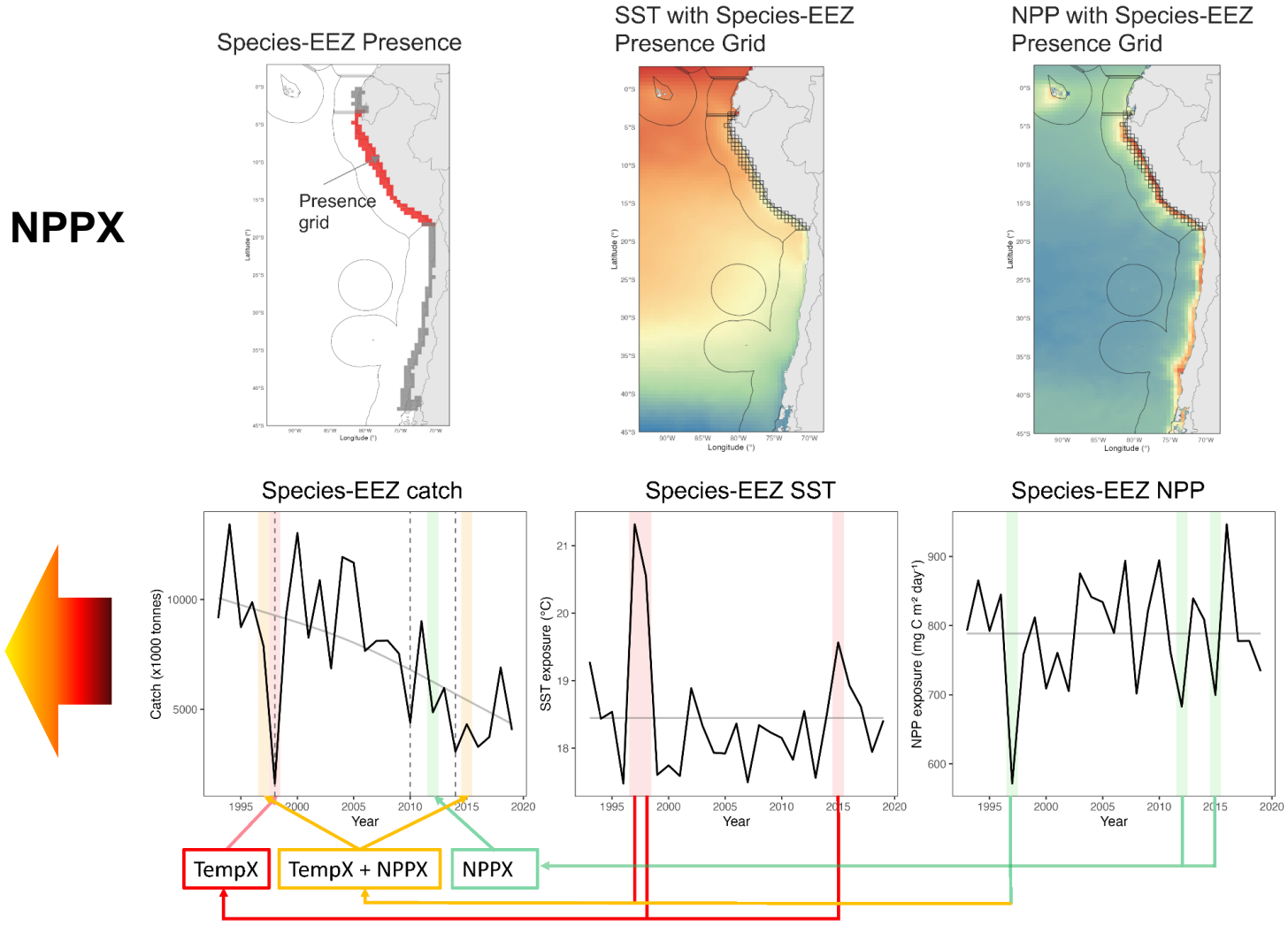
Odds of extreme low catches





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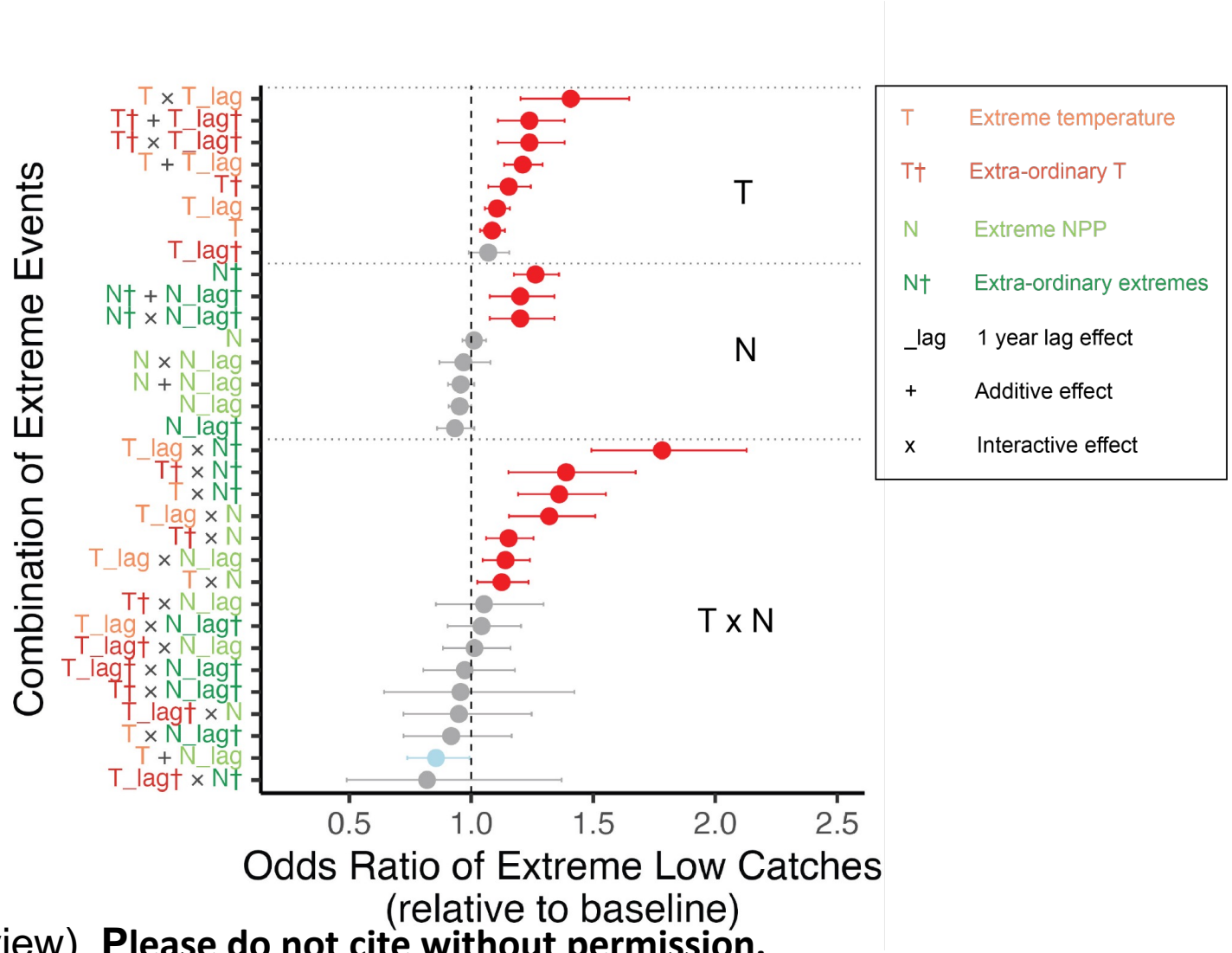
Extreme low catches are primarily associated with temperature extremes, especially when extremes persist across years



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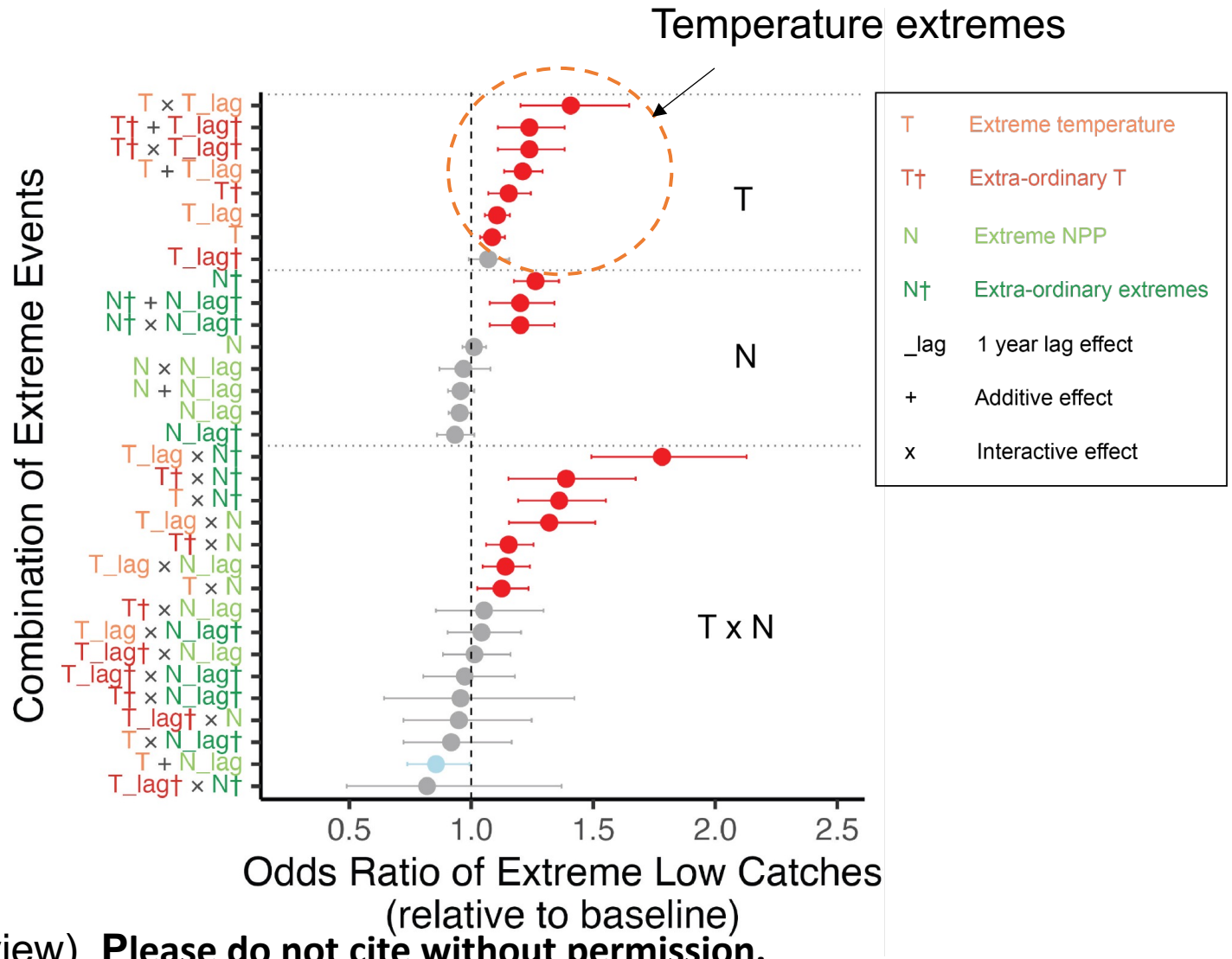

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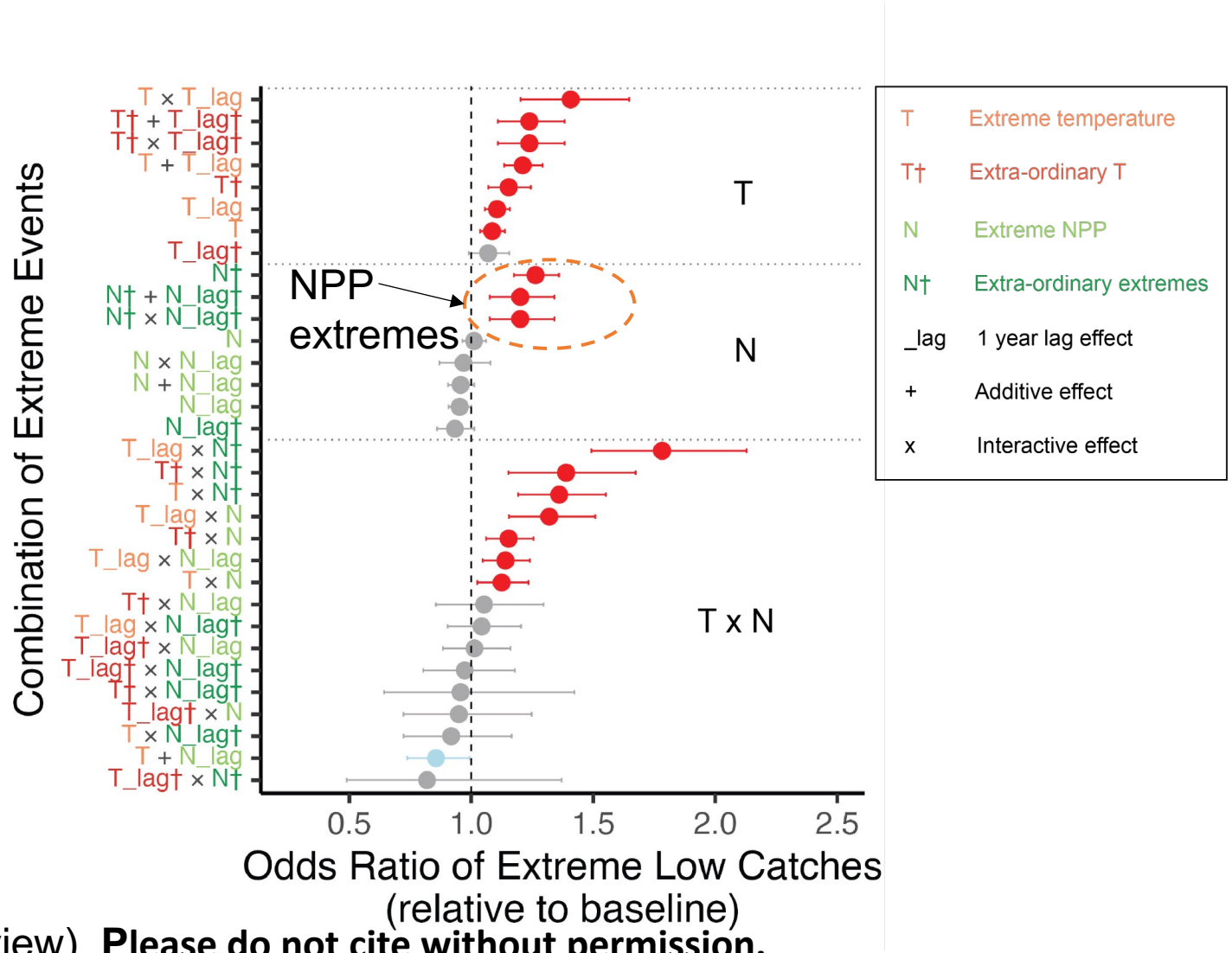
Large and persistent low net primary production extremes also increase the odds of extreme low catches



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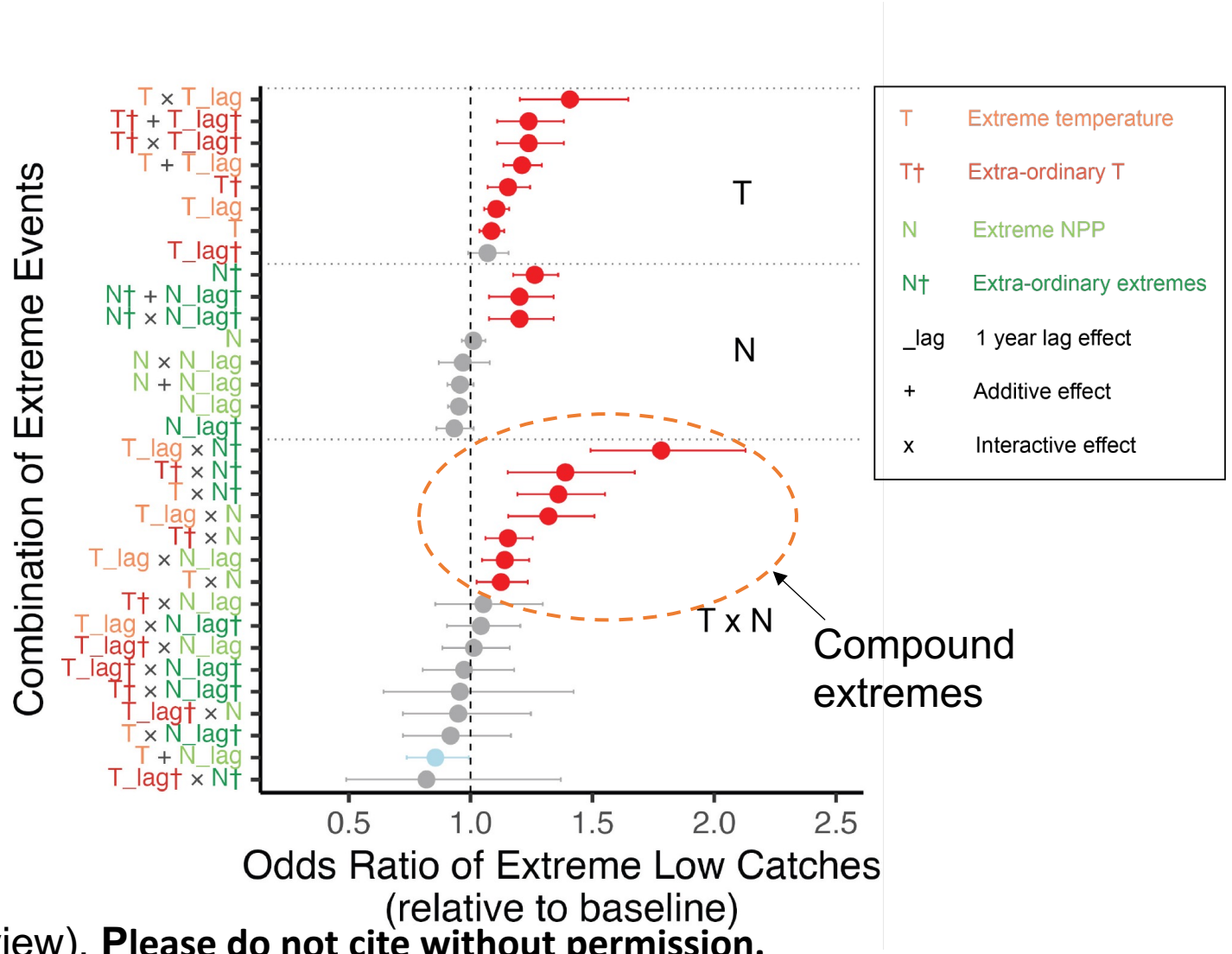
Compound high temperature and low primary production extremes exacerbate the odds of low catches



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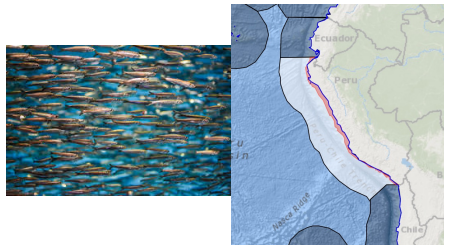
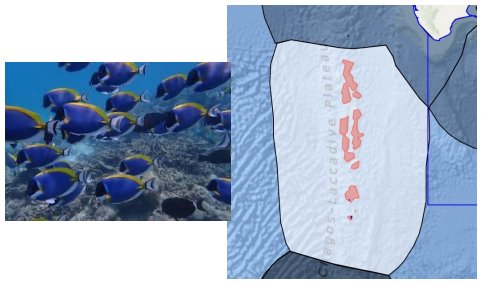
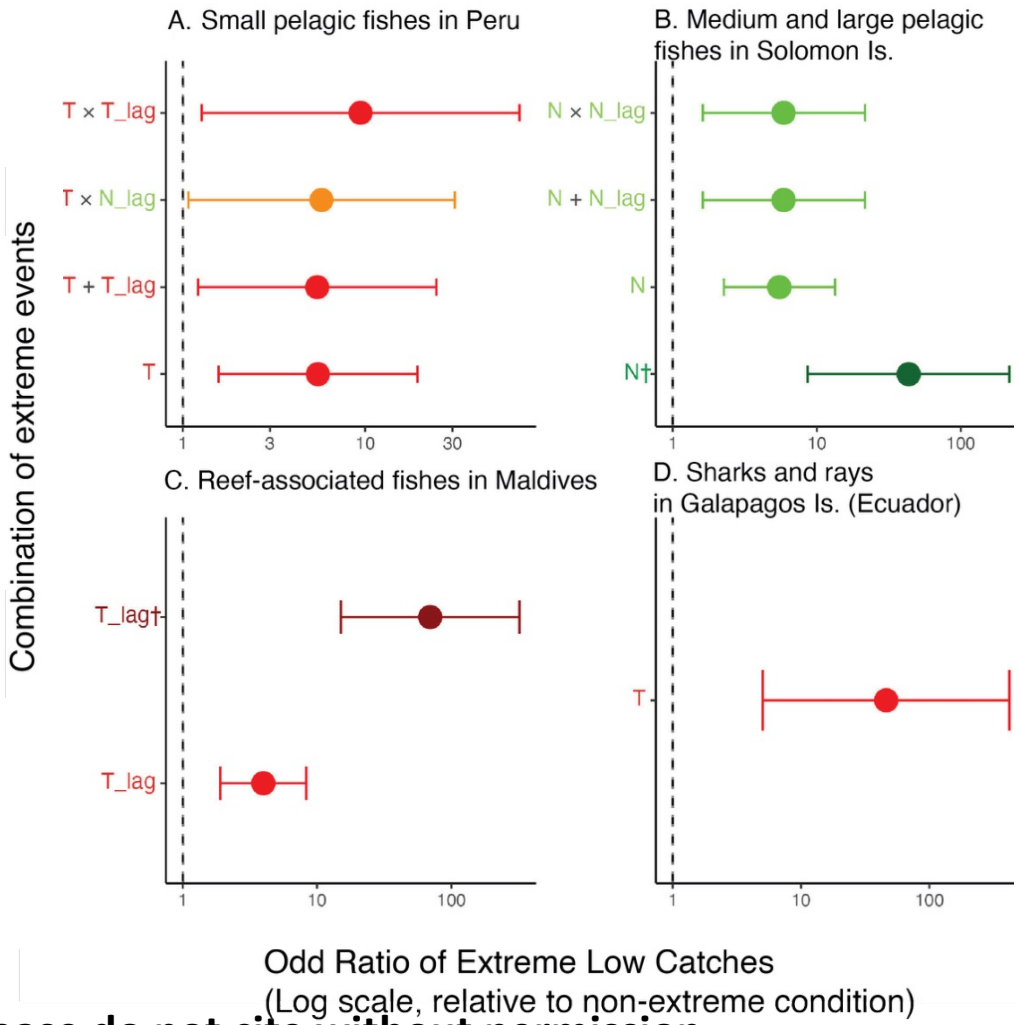
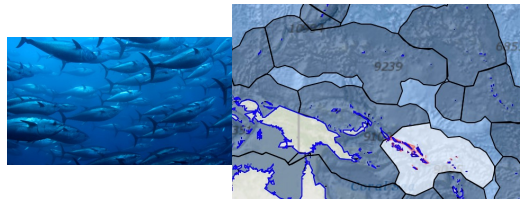
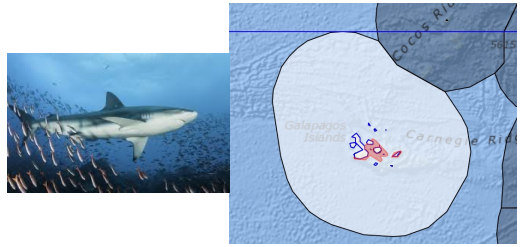
Climate extremes can dramatically increase the odds of extreme low catches in specific fisheries











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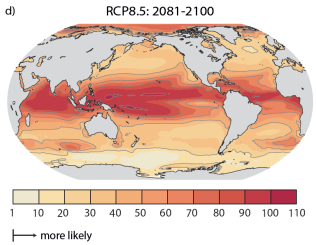
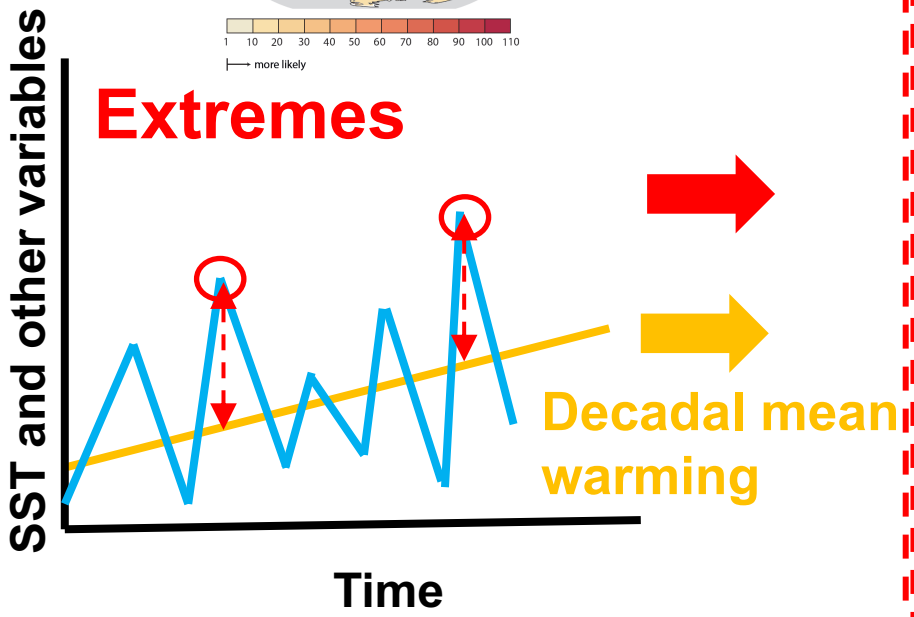
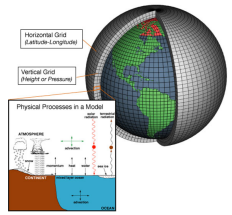
Projecting the future under climate change

Source: Seychelles Nation

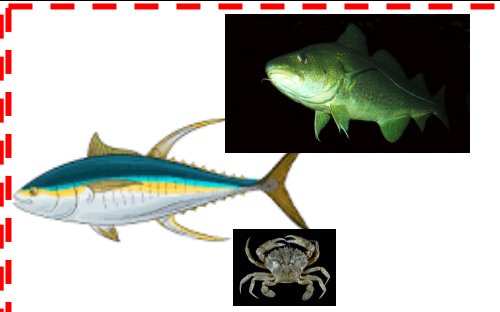
Using integrated climate-fish-fisheries-socio-economic models and scenarios to project impacts of marine temperature extremes



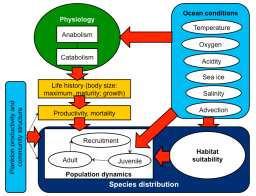




Earth system model
(Large ensemble simulations)

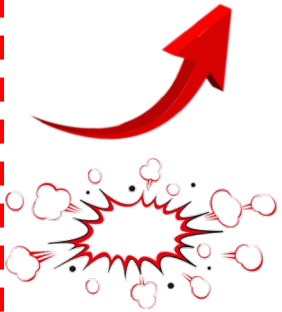


Biomass | Range shift | Catch



Dynamic bioclimate envelope model (DBEM)

Food, revenue, jobs



Shared Socio-economic pathway (SSPs) with Empiri models and Artifici Neural Network

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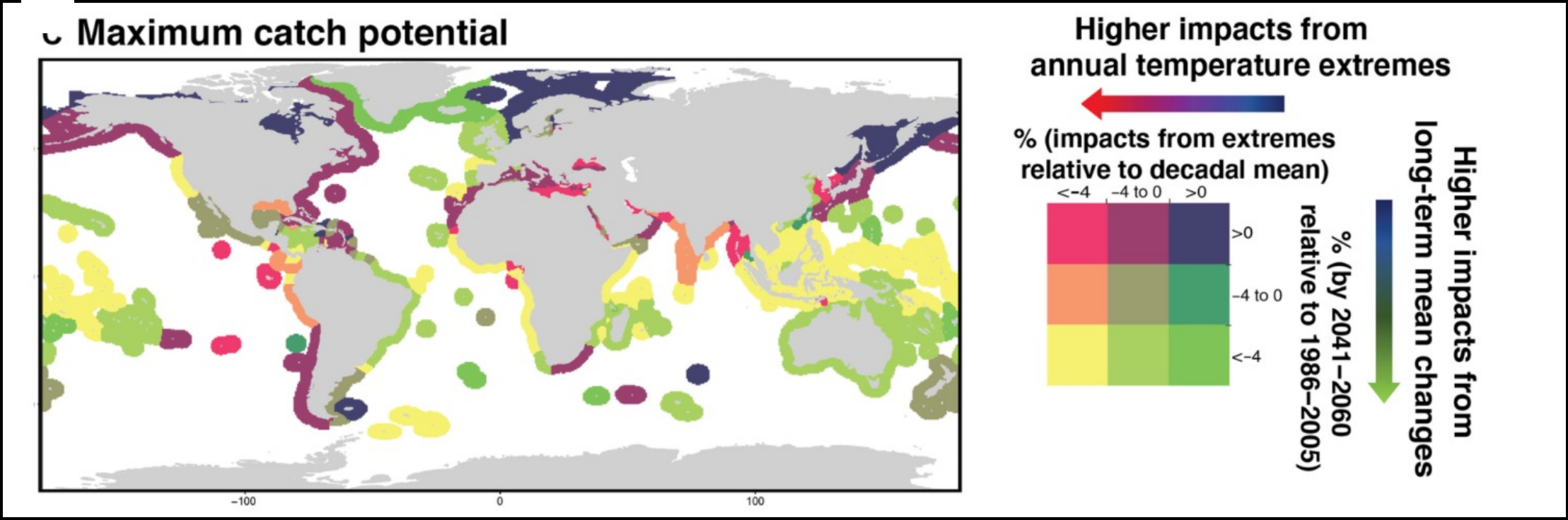
Impacts of marine temperature extremes on fisheries catch potential add to the impacts from long-term climate change



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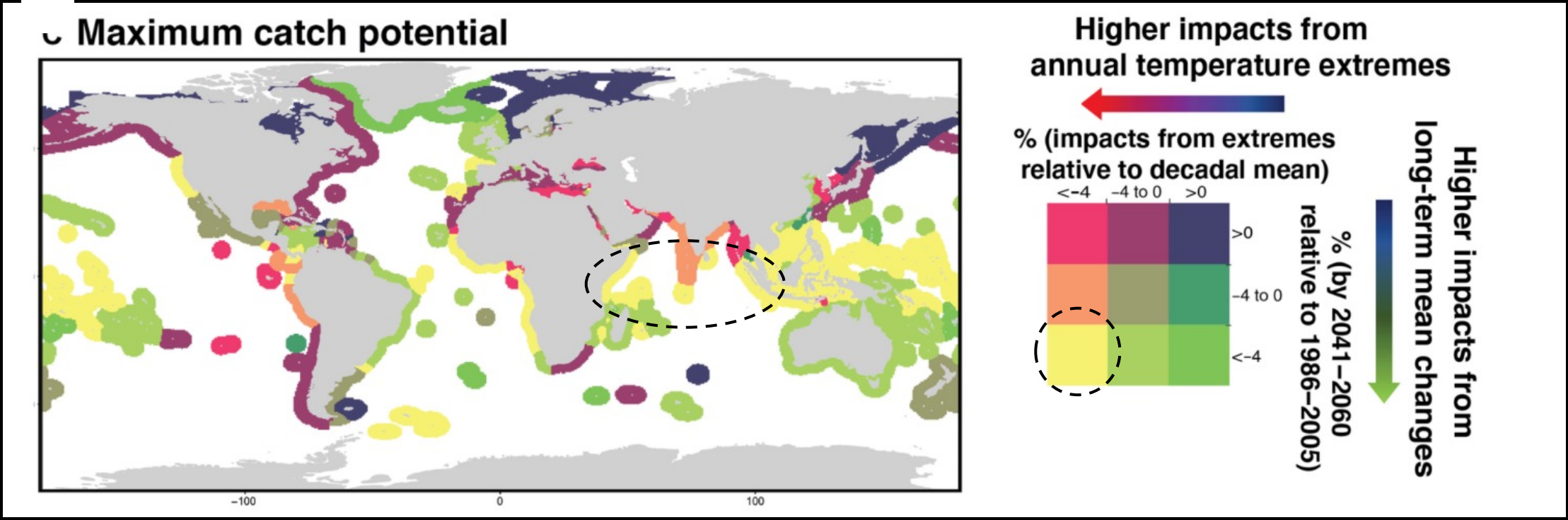

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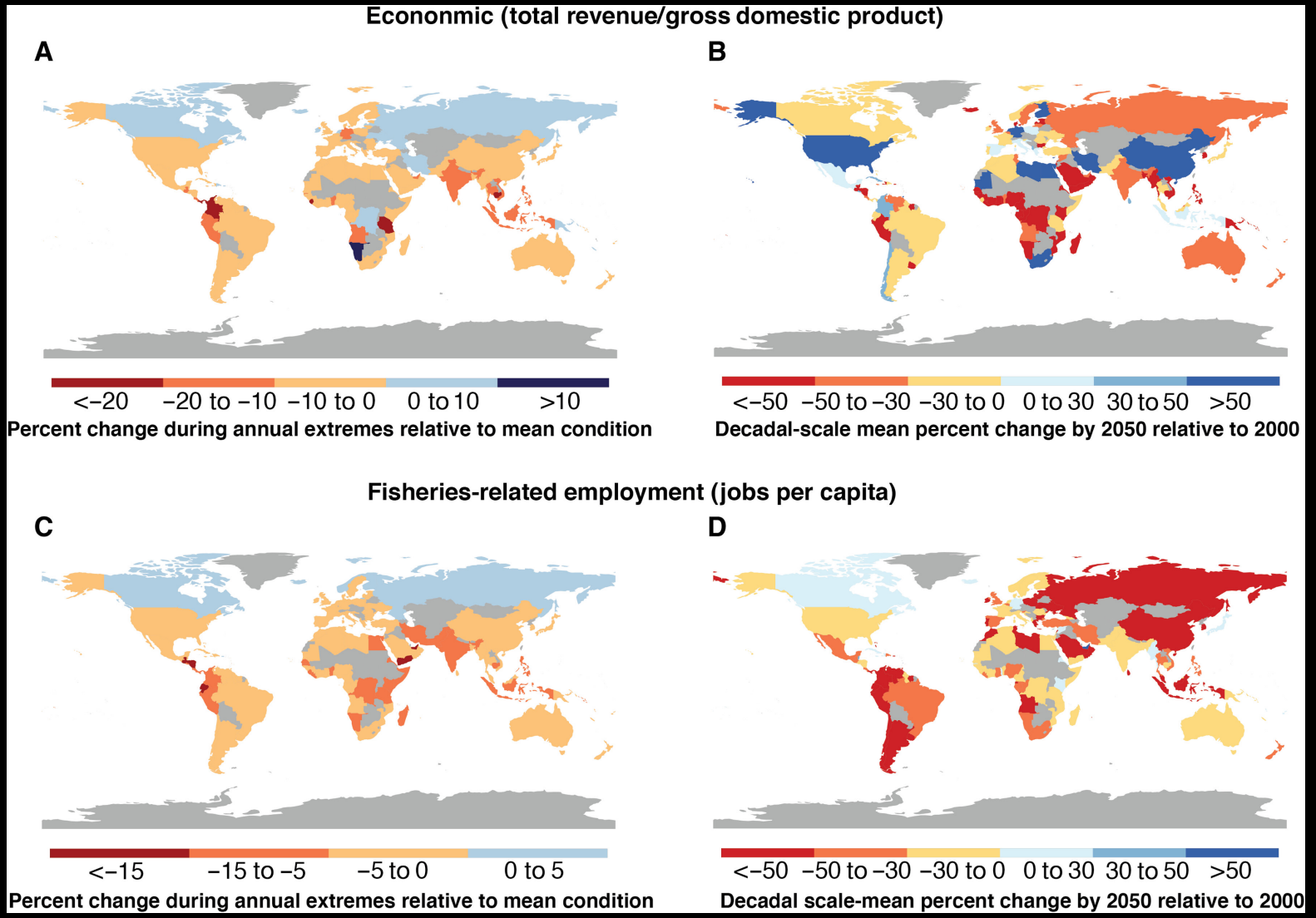
Annual climate extremes can cause economic and employment losses comparable to, or greater than, long-term climate change



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Building resilience to climate change and fisheries extremes

Diversify target species and livelihoods

- Sensitivity varies amongst species, so diversification can reduce risk;

Strengthen monitoring and rapid knowledge exchange

- Better environmental and fisheries monitoring supports faster response;

Use participatory scenarios and modelling

- Helps identify preferred response options, maximize co-benefits, and minimize maladaptation;

Explore innovative financial tools

- For example, parametric insurance can reduce economic hardship following extreme events.

Thank you

Collaborations, colleagues, students, stakeholders and knowledge holders that I worked with, and many more…